10/22/1963
08/20/1964
BAC 1-11

"Deep Stall"

British Ministry of Aviation Accident Report:

Stable Stall Ruled BAC 111 Crash Cause

(The British Ministry of Aviation has issued the following report on an accident that occurred during stall testing of a British Aircraft Corp. BAC 111 [AW&ST Apr. 5, p. 50]. Seven persons, two crew members and five test personnel, were killed when the aircraft, G-ASGH, failed to recover from a stall and crashed at Cratt Hill near Chicklade, Wiltshire, on Oct. 22, 1963.—Ed.)

Notification was by telephone from the Southern Air Traffic Control Centre, at 1208 hr. on Oct. 22, 1963. Investigation was begun at the scene the same day.

The aircraft took off from Wisley aerodrome at 1017 hr. to carry out stalling tests with the centre of gravity (CG) near the aft limit. It climbed to 17,000 ft. and carried out four stalls with undercarriage and flaps up. The flaps were then lowered to 8 deg. to investigate the stalling characteristics in this configuration. The aircraft entered a stable stalled condition, in which it descended at over 10,000 fpm.; the pilots were unable to regain control and the aircraft struck the ground in a flat attitude 90 sec. later. All on board were killed by the ground impact, and fire destroyed much of the wreckage.

The Aircraft

The aircraft was constructed by Vickers-Armstrongs (Aircraft) Ltd. at Bournemouth (Hurn) Airport. It was the first One-Eleven to be completed and had made its first flight on Aug. 20, 1963, since when it had completed 52 test flights involving 81 hr. flying.

The aircraft was registered in the name of the British Aircraft Corporation Ltd., and was engaged in a flying programme aimed at obtaining a certificate to airworthiness for airline service. It was flown under the B Conditions of the Air Navigation Order, 1960; a certificate of safety for flight had been completed at 0900 hr. on Oct. 22.

The total weight of the aircraft was 70,125 lb., maximum permissible being 73,500 lb. The fuel load was 2,200 gal. of kerosene. The CG was 0.38 standard mean chord (SMC), the furthest aft position for which the aircraft had been cleared. The design range of the CG was 0.11 to 0.41 SMC.

The elevators were aerodynamically operated by tabs controlled by a duplicated cable control system. They were in two independent sections but linked through their control systems at the top of the fin and at the flight deck. A hydraulic artificial feel simulator was coupled to the right hand elevator control circuit in the rear fuselage to give control feel in flight.

Longitudinal trim was effected by a variable incidence tailplane powered by duplicated hydraulic motors.

The range of the tailplane setting was from 3 deg. leading edge up to 12 deg. leading edge down.

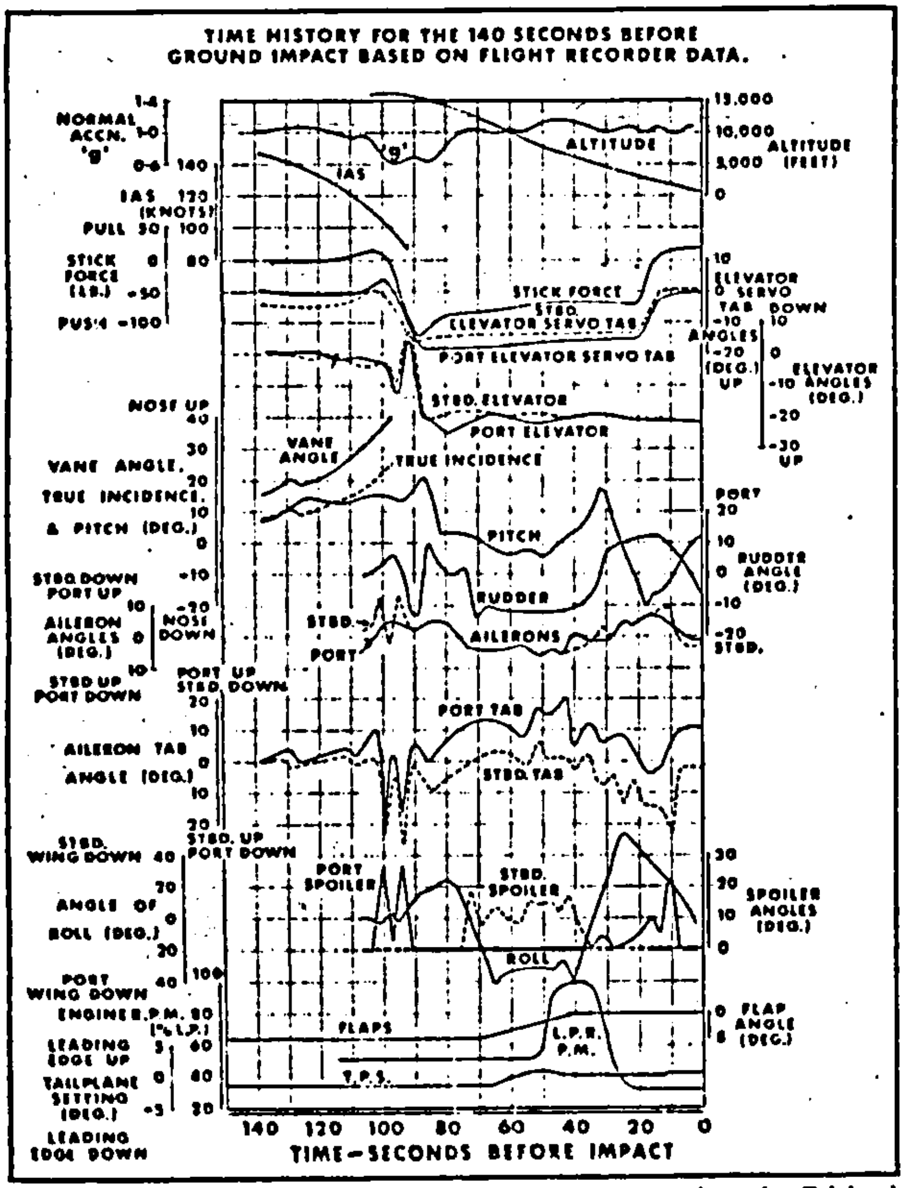
Lateral control was by means of servo-tab operated ailerons supplemented by hydraulically operated spoilers which also acted as air brakes when deflected symmetrically.

Two emergency escape exits had been provided for the crew, one at the forward freight loading aperture on the lower starboard side of the fuselage and the other using the rear ventral passenger entrance situated in the aft end of the fuselage. For the first a special door was made and was kept in position by 38 explosive bolts.

A vertical tunnel led to the door from the cabin floor. The tunnel structure was spring-loaded to exert an outward pressure on the door. The explosive bolts were connected to their own battery and could be fired by a switch on the pilots' centre pedestal or from a similar switch situated at the entrance to the tunnel.

It was intended that if the bolts were fired, the door should fall away allowing the tunnel structure to slide down until its upper end was level with the cabin floor and its lower end protruded into the airstream, thus providing the crew with an escape chute. The rear escape exit was a modification to the rear ventral entry door. After opening the rear pressure bulkhead door, the crew could jettison the ventral door by means of a foot-operated lever.

Among special test instruments displayed to the pilot were elevator angle indicators



DATA GATHERED FROM two recorders, a Royston Instruments Midas and a Colnbrook Instruments O2E, give time-history of last 140 sec. of flight of BAC 111 that crashed.

which showed the position of both the port and starboard elevators. There was also an angle of incidence indicator which gave the aircraft's body incidence. A vane on the side of the fuselage provided the sensing unit and the indicator was calibrated in accordance with the results of wind tunnel tests. The scale on its dial read from 20 deg. to —10 deg., but the instrument was capable of indicating to 25 deg. It is not known how the instrument would have behaved when body incidence exceeded 25 deg.

The Pilots

Mr. M. J. Lithgow, aged 43, was deputy chief test pilot of Vickers-Armstrongs (Aircraft) Ltd., and was the senior project pilot on the One-Eleven. He served throughout the war in the Fleet Air Arm, which he left in 1945 with the rank of Lieutenant Commander. He joined Vickers-Armstrongs (Supermarine Division) as a test pilot, becoming chief test pilot in 1948. In 1953 he set up a world airspeed record. He had been engaged more recently in test flying the Vanguard. On Aug. 20, 1963, he flew as copilot on the first flight of the One-Eleven and had subsequently taken part in almost all the test flying of this aircraft, as either pilot-in-command or copilot. He had taken part in each of the flights during which stalls had previously been carried out. He was a Ministry of Aviation approved test pilot and held a private pilot's license valid until Apr. 1, 1964. It was endorsed in Group C for DH 114, Vanguard and Viscount aircraft and included a valid instrument rating. His log book showed a total of 5,385 hr.; over 2,000 were on multi-engined aircraft including 78 on the One-Eleven.

Mr. R. Rymer, aged 46, joined the RAF in 1939 and served throughout the war, attaining the rank of flight lieutenant. In April, 1946, he was seconded from the RAF to BOAC, then joined BEA on its formation in August, 1946. He resigned from BEA in 1953 to join Vickers-Armstrongs as a test pilot. Since then he had done a great deal of test flying of Viscount and Vanguard types, and had been engaged in delivery and demonstration flights and attachment to a number of airlines to give pilot familiarisation. He made his first flight in the One-Eleven on Sept. 20, 1963, as copilot to Mr. Lithgow and had subsequently flown for 13½ hr. as copilot and two hours as pilot-in-command. His log book shows a total of 9,648 hr. flying. He held an airline transport pilot's license valid until Apr. 6, 1964, endorsed in Group 1 for Viscount and Vanguard aircraft. He was a Ministry of Aviation approved test pilot.

The Weather

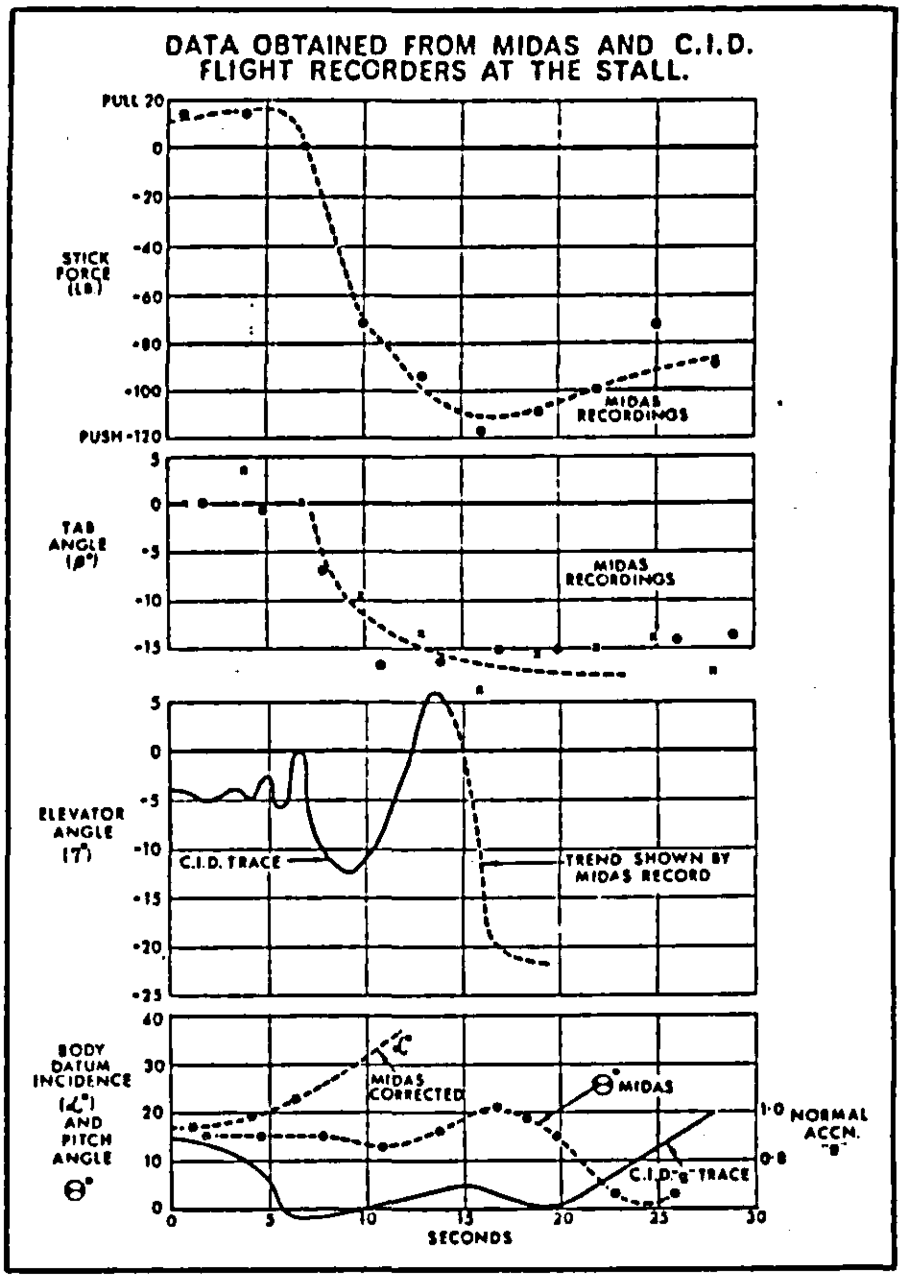
Observations of the weather in the area at the time of the accident by the meteorological office at Boscombe Down were:

Wind 060 deg./5 kt.
Visibility 22 mi.
Weather Nil.
Cloud 3/8 Sc. 2,400 ft.; 2/8 Ci. 30,000

The weather is considered to have had no bearing on the accident.

The Flight

The aircraft was making its 53rd flight; the programme for this flight consisted of stalls in all configurations, with the CG at 0.38 SMC, the furthest aft limit for which



FLIGHT RECORDER DATA charted above shows pilot's attempt to recover from stable stall. Period shown occurred between 110 and 80 sec. before aircraft crashed.

the aircraft had then been cleared.

The inspector who completed the certificate of safety also checked the fuel load, the ballast and its disposition, and the names of the occupants. He ensured that everyone had a parachute and that it was properly adjusted, and he assisted both pilots to fasten their safety harnesses. Mr. Lithgow was in left seat, Mr. Rymer in the right.

The aircraft took off from runway 10 at Wisley aerodrome at 1017 hr. The radiotelephony conversations were automatically recorded in Wisley Tower and the voice from the aircraft throughout the flight was identified as that of Mr. Rymer. The progress of the flight has been deduced from the Tower recording and from the flight recorders recovered from the wreckage.

After take-off the aircraft climbed in VMC on a westerly heading to 17,000 ft., monitored by Wisley radar. At 1026 hr. the copilot reported that they were just about to commence the tests at flight level 170. At 1035 hr. he reported that four stalls had been completed in the clean configuration. At 1036 hr. he acknowledged a fix from Wisley, after which nothing further was heard from the aircraft.

From the data provided by the flight recorders it is apparent that run No. 5, a stall with 8-deg. flap and undercarriage retracted, was commenced at about 1038 hr. at an altitude of between 15,000 and 16,000 ft. Approach to the stall appears to have been normal. When recovery was attempted the elevators responded initially to the control movement but subsequently floated to the fully up position in spite of a large push force on the control column. The aircraft then descended in a substantially horizontal fore and aft attitude at about 180 fps. During the descent it banked twice to the right and once to the left and at one stage the engines were opened up to full power. The latter action resulted in a large nose-up pitch which, when power was taken off, was followed by a pitch down. The aircraft then assumed the substantially horizontal attitude in which it made impact with the ground.

At about 1040 hr. the aircraft was seen by many people in the Chicklade area. It had approached from the southwest and was seen to be descending rapidly in a flat attitude. Many observers remarked on the low level of the engine noise and some heard a sharp report from the aircraft whilst it was in the air.

It crashed in a field, exploded and caught fire, those on board being killed by the ground impact.

Examination of Wreckage

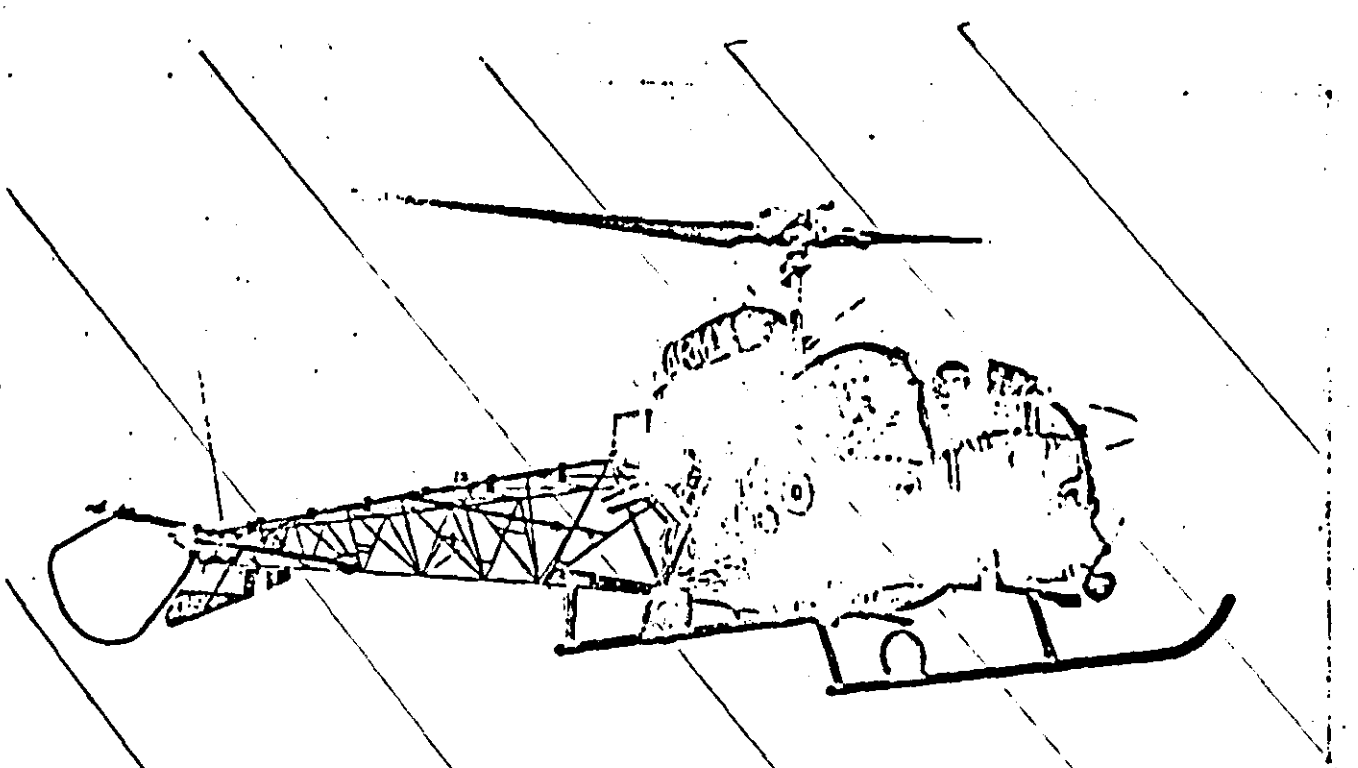
The aircraft crashed on level ground about 700 ft. amsl. At the moment of impact it was on a heading of 324 deg. magnetic, almost level fore and aft, banked approximately 3 deg. to the left, and skidding slightly to the right. The marks on the ground and the wreckage distribution showed that the rate of descent had been very high and the forward speed low. After initial impact the aircraft moved forward only 70 ft. and some 15 ft. to the right before coming to rest. Inertia loads at impact produced a failure of the rear fuselage which caused the fin and tailplane to swing down until the outer portions of the latter came into contact with the ground. Cabin windows and a door, with pieces of cabin furnishings, were thrown forward. The starboard wing broke chordwise from the trailing edge at about mid span and swung tip forward.

Fire broke out after impact and destroyed the fuselage and starboard wing. The upper portion of the fin, the tailplane and elevators, together with the outer portion of the port wing, survived the fire. There was no evidence that any part of the aircraft became detached in the air.

The forward freight hold door and the remains of the door frame were found in the wreckage, both partially melted and burned. The door was not in its frame, being inverted and trapped between the fuselage and the ground slightly to the rear of its normal position so that the frame was only partly covered by the inverted door. All the explosive bolts recovered had been detonated. It is considered they were fired by action of the crew rather than by the heat of the fire, because the latter could not have resulted in the door being jettisoned and inverted and a careful search of the ground beneath the door failed to reveal any sign of the bolt heads.

Both the landing gear and the flaps were up on impact. The tailplane was still attached to the fin and was at a setting of 1 deg. 33 min. leading edge up, i.e. trimming the aircraft nose down.

Both elevators remained attached to the tailplane and received upward bending of their tips when they struck the ground. The elevators themselves showed no evidence of jamming or fouling at their hinge points. All the mass balance weights were securely attached to the leading edges. Four of the six sections of the elevator leading edge, forward of the hinge line and carrying the mass balance, had been displaced downwards under high inertia loads. This displacement showed that the elevators were up at impact as they could not have moved up subsequently without interference between tailplane and elevators, and there was no evidence of any such interference. The servo and gear tabs were still attached to their



British-Built Bell Agusta 47G-3B-1 Makes First Flight

First Bell Agusta 47G-3B-1 manufactured under license in Britain by Westland Aircraft, Ltd., makes first flight. The British Army has ordered 150 of the helicopters, 50 off the shelf and 100 to be made by Westland. Each is powered by a Lycoming TVO-435 piston engine.

respective elevators and showed no signs of pre-crash damage or defect. The torsion bar counter-balance installation in both elevators had been in good condition prior to impact. Both hydraulic gust dampers were removed, examined and functionally checked. The loads required to operate the dampers were normal and they travelled smoothly over their full range of movement.

The run of the aileron and rudder control systems was traced and no evidence of pre-crash defect or failure found. The aileron cables were complete and unbroken but both aileron/spoiler mixing units had been largely destroyed by fire. Two breaks in the rudder circuit were consistent with impact breaks in the fuselage.

Elevator Control

Examination of the elevator control circuit showed that the control columns and the linkage to the forward quadrants had been destroyed by fire. From these quadrants under the flight deck to the hydraulic feel unit in the rear fuselage, the duplicated cable control circuits had survived the fire and were traced through the fuselage debris. There were tension breaks in each circuit consistent with the fuselage impact failures, but there was no evidence of pre-crash failure or defect. The artificial feel unit was examined and appeared to be in good condition. The rod circuit running up the fin from the rear fuselage had been partly destroyed by fire at the base of the fin but all other damage was attributable to impact loads.

The servo tab operating linkage within the elevators was complete and capable of operation, with no sign of pre-crash damage or defect. No rigging check was possible because of damage, but by cutting the starboard elevator chordwise it was possible to operate the inboard portion with the two inner hinges and to operate the final section of the tab mechanism. This check showed that the elevator and its tab and linkage operated correctly over the design range of movement, with the correct follow-up ratio.

The engines were stripped and thoroughly examined. No evidence could be found of pre-crash defect or malfunctioning. The internal condition of each engine indicated that it was alight and rotating at idling speed at the time of impact.

Flight Recorders

Two flight recorders were installed in the aircraft for accident investigation purposes, a Royston Instruments Ltd. Midas Type CMM/24/7S/F and a Colnbrook Instruments Development Ltd. Type 02F which was on loan from the Aircraft & Armament Experimental Establishment.

The Midas is a magnetic tape recorder capable of dealing with 270 inputs and on this occasion was being used to record 59 parameters. It was installed in the top starboard side of the rear fuselage. The associated amplifiers were fitted to one of the special bulkheads in the cabin. The recorder was a cassette type, designed to eject automatically when subjected to heat or immersion in water; the ejection mechanism was to be fired electrically by power supplied from special batteries. The sampling rate was once per three seconds for most of the parameters, but five were sampled every half second.

Aircraft heading was intended to be recorded but for this flight no serviceable heading source was available.

The CID recorder was fitted in the cabin inside a steel fireproof box. It recorded photographically on paper and gave continuous recording of 10 inputs, including altitude, indicated airspeed, normal acceleration (g), and elevator, aileron and rudder angles. It had no automatic ejection mechanism but relied upon its structural integrity to survive fire and crash.

The Midas recorder broke loose from its attachment upon impact with the ground, owing to the high inertia forces. It fell through a split in the rear fuselage onto the ground and was recovered about 15 ft. behind the tail of the aircraft, untouched by the fire. The CID recorder had been in the heart of the fire and much of the trace information was lost, but the elevator angle trace remained legible.

Previous Stalling Investigation in Flight

Two approaches to the stall were carried out on Flight 2. They terminated in a wing drop at 116 kt., clean, and at 100 kt. with 18 deg. flap. A further approach to the stall was made on Flight 5 but with 45 deg. flap and the undercarriage down; it was again terminated by a wing drop. These early approaches to the stall were made in order to check the validity of the take-off and approach speeds being used.

Exploration of the stalling characteristics of the aeroplane was begun in earnest on Flight 47 which was made on Oct. 16 with a forward CG position. Mr. Lithgow was copilot on this flight. The briefing sheet for the flight gave an incidence for each of the five configurations in which stalling was to be conducted. These were:

Configuration	Incidence
Clean	16 deg.
8 deg. flap, undercarriage up	15 deg.
18 deg. flap undercarriage down	14 deg.
26 deg. flap, undercarriage down	13 deg.
45 deg. flap, undercarriage down	12 deg.

The pilot's report repeated these figures, referring to them as the "limiting incidence." Twelve stalls were carried out and the test data shows that the actual maximum figures recorded were 21 deg., 20½ deg., 23½ deg., 26 deg. and 16 deg. respectively. (A reappraisal, made subsequent to the accident, of the correction to be applied revealed that for the 8 deg. flap position the observations on this and subsequent flights were in fact still some 3 deg. greater than actual.) The pilot stated that his reasons for exceeding the limiting incidence figures were that when he reached them the handling characteristics of the aeroplane were innocuous and the indicated airspeed was in excess of that expected. He considered that at the limiting figures information gained on the flight would be small and that, in order to produce the kind of data required, greater angles of incidence would have to be achieved. He believed that he was engaged in investigating the stalling characteristics of the aeroplane and that he had to get to, or close to, the stall in order to get any useful and necessary data on the recording film. In this way he reached indicated angles that were considerably in excess of the limits. On none of the stalls did he have any serious qualms about the behaviour of the aeroplane, nor any difficulty in recovering.

Because of his concern at the difference between the limiting and the achieved angles of incidence on Flight 47 the pilot immediately called a debriefing meeting to discuss them. At that meeting the point was made that the "limits" set were conservative and made no allowance for scale effect which would delay the onset of changes in the flow (e.g. incidence for C_L max *) by some 3 deg. to 4 deg. of incidence full scale as compared with the wind tunnel tests; no criticism was made of the handling of Flight 47.

Although there was perhaps never any intention that this experience should be taken as an indication that there was an implied relaxation in the manner in which the stall should be approached, it is regrettable that the need was not felt to lay down some new and somewhat higher "limiting" incidences as a guide.

The purpose of Flight 48, two days later, when Mr. Lithgow was in command, was to measure C_L max. This involved stalls in the five configurations, and a forward CG position was again used. The incidence angles reached in the five configurations, according to the pilot's report, were 21 deg., 21 deg., 20 deg., 19 deg. and 16 deg. respectively. The flight test data showed maximum angles of 22 deg., 23 deg., 25 deg., 23 deg. and 21 deg. with the minimum speeds very much as they had been on the previous flight. The differences between the two sets of figures are explained from the fact that pitch and incidence would continue to increase by one or two deg. due to dynamic overshoot after initiation of recovery action and that the figures in the pilot's report were readings of a small dial which was not graduated beyond 20 deg.; the copilot who made the readings was also engaged in observing and recording other matters. After the flight, which involved 25 stalls, Mr. Lithgow commented in his report that apart from those with 45 deg. flap, when the right wing drop appeared to be a limiting factor, he gained the impression in the other configurations "that it should be perfectly possible to fight one's way through the wing drop."

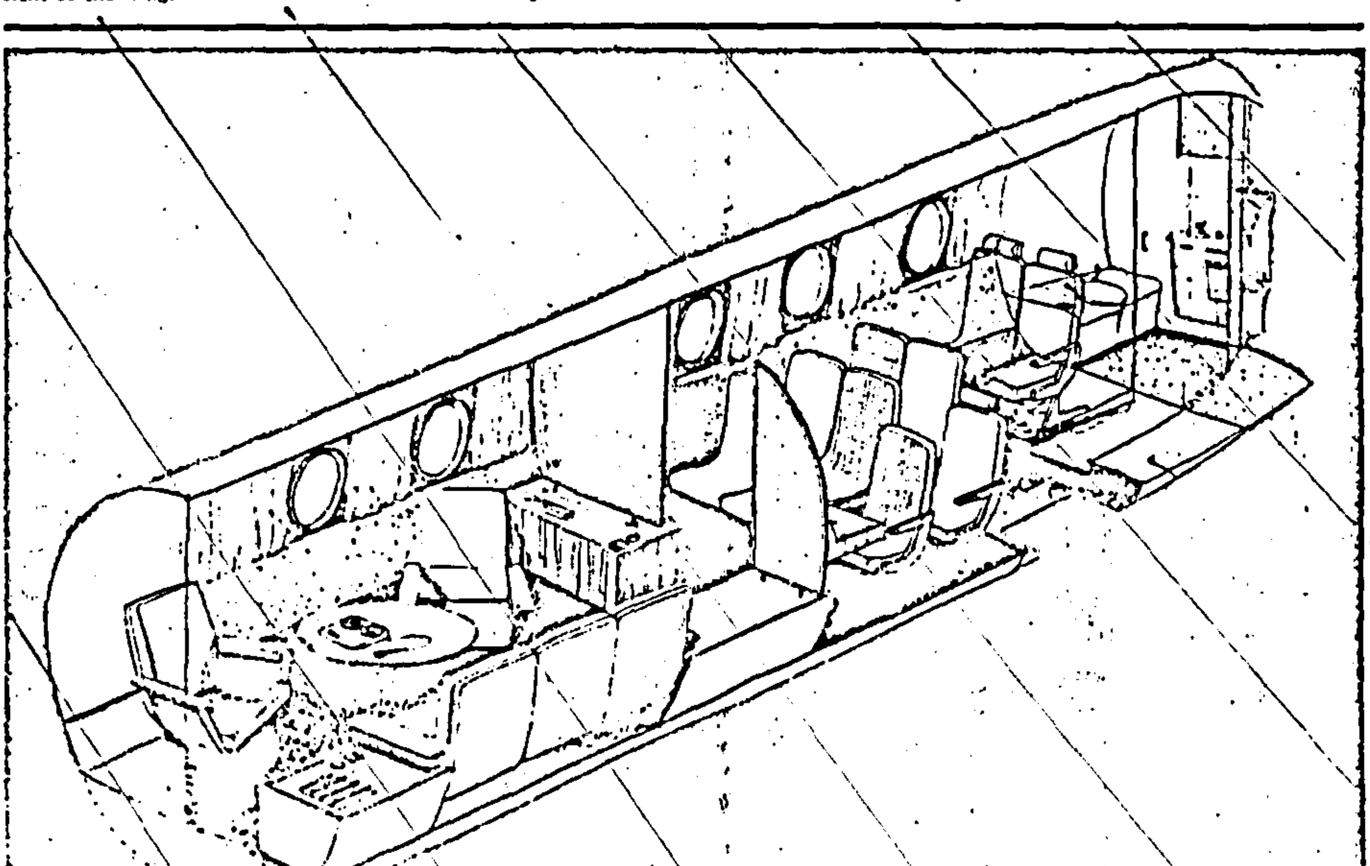
In response to pilots' reports on the lateral control characteristics in turbulence on the approach, a modification to the aileron tab/spoiler linkage was made before Flight 52 to provide for only one degree of aileron movement from neutral instead of four degrees before the commencement of spoiler movement. This resulted in improved lateral control at small deflection, but the maximum rolling moment available remained essentially the same.

Aerodynamic Characteristics of the Aircraft

In investigating the accident it has been necessary to examine what theoretical and wind tunnel investigations into the stalling characteristics of the One-Eleven had been made and the extent to which they gave warning of the possibility of difficulty at high angles of incidence. The Royal Aircraft Establishment has provided valuable help on this aspect by analysing the aerodynamic characteristics of the aircraft and the results of BAC wind tunnel tests, and by applying the results of these analyses to the flight test data obtained from flight recorder information.

Prior to the commencement of flight testing, wind tunnel tests had been conducted

* Note: C_L max is the maximum lift coefficient of the wing.



Nord to Display Executive Version of 262 at Air Show

One interior design of executive version of the Nord-Aviation 262 twin-turbojet is shown in drawing above. Interior is being installed in prototype by a French company, S.I.P.A., in time for exhibition at Paris Air Show at LeBourget in June.

into the variation of lift and pitching moment with incidence for the range 0 deg. to 28 deg. (NOTE: The angles of incidence quoted are taken directly from the wind tunnel data and are not corrected for scale effect.) From these tests it was clear that the stalling behaviour of the aircraft was characterized by a fairly sharp drop in lift coefficient at about 19 deg. incidence. The onset of the stall extended over the range 15-19 deg. and towards the end of this range the aircraft's pitching moment showed a marked nose down tendency; the latter however was not very large or long-lived in terms of persistence with increase of incidence. On the contrary, by 25 deg. incidence, it is clear that there is evidence of a pitch-up tendency in the pitching moment characteristics of the aircraft.

In this connection it is necessary to bear in mind the extent to which incidence can build up following the abrupt loss of lift. To subject the aircraft to a sudden loss of lift is equivalent to an instantaneous decrease of normal acceleration (referred to as the g-break) which in turn leads to an increase downwards in the normal component of velocity and thus an increased incidence. It is thus possible for the incidence to increase with little or no rotation of the aeroplane. Other changes will occur in the flight condition arising from changes in drag and pitching moment but these are more indirectly related to incidence than is the g-break.

After the accident, more extensive wind tunnel tests were made by BAC from which lift and pitching moment coefficients over the incidence range of 0 deg. to 45 deg. were obtainable. The behaviour of the servo tab-operated elevator control system was studied over the same range. From these tests a number of important deductions have been possible relating to the behaviour of the aircraft in its final stall.

The basic factor in the final pitch-up tendency displayed by the pitching moment curves is the loss of effectiveness of the tail as aircraft incidence is increased. This is accompanied by a loss of elevator effectiveness, which is sufficiently large to render recovery from an excursion into the post-stall region difficult.

An analysis of the hinge moment characteristics of the elevator shows that as body incidence is increased the up-floating tendency of the elevators increases and at large incidence (about 40 deg.) can reach a stage when it is no longer possible to prevent the elevators moving into an up position even though the tab is held in its fully up position.

Since it is not possible to establish with reasonable accuracy the tailplane effective incidence and its variation with body incidence, it has also proved impossible to carry the analysis of the elevator hinge moment to the stage where a complete study in relation to estimates was feasible.

However, the rate of change of elevator hinge moment with elevator angle and with tab angle which it was possible to obtain from the wind tunnel data checked reasonably well with the estimated values. These estimates of hinge moment characteristics were further checked against the records of Flights 47 and 48 (previous stalling tests) and reasonable agreement was obtained. The variation of the elevator hinge moment with body incidence was then deduced to give a curve from which it could be seen that at incidences in excess of 25 deg. incidence contributed an appreciably increased amount to the hinge moment.

Reproduction of the type of behaviour shown in the flight recorder traces would have required further aerodynamic data of a dynamic nature and a study of the dynamics of the aeroplane as well as the elevator tab system. Nevertheless, for the accident investigation sufficient conclusions could be drawn from a consideration confined to the static aspects of the problem. From these static considerations it was concluded that there was insufficient elevator power to maintain a nose-down pitching moment beyond about 36 deg. incidence and that therefore beyond this figure recovery would not be possible even with full down elevator. Furthermore at some incidence in the region of 45 deg. with fully down elevator, and 50 deg. with elevator fully up, it was evident that the aeroplane would "lock in" to this incidence.

This latter deduction was consistent with the behaviour of the aeroplane as shown by the flight recorders.

The preceding discussion on elevator effectiveness applies to the aircraft configuration as at the time of the accident and is to a large extent independent of the type of longitudinal control used within the same tailplane geometry. As has been mentioned, the elevator hinge moment is appreciably affected by incidence. This effect is such that, although the amount of down-elevator that can be held by full up tab decreases progressively with increase of incidence beyond 27 deg., it is still possible to hold some down-elevator to somewhere in the neighbourhood of 40 deg. incidence.

The type of longitudinal control, therefore, is a feature which does not in itself prevent recovery, but coupled with the pitching moment characteristics makes recovery more difficult. In particular if the stick is held centrally (near zero stick force), then, under static conditions, the elevator would as was remarked previously assume an upward deflected position. Furthermore just beyond the limit of incidences reached in Flights 47 and 48, that is, beyond say 25 deg., the angle assumed by the elevator would be quite large. However in view of the much reduced elevator effectiveness this up-elevator would have a relatively small effect on the rate of build up of incidence.

Interpretation of Flight Recorder Data

In analysing the flight recorder traces of the final stall in the light of the results of these theoretical considerations, it must be emphasized that the recordings are open to a certain amount of variation in interpretation, largely because the sampling rate of the elevator stick force and the servotab angles was once every 3 sec.; further, the incidence recording stopped at 25 deg. A continuous trace of the all-important elevator angle was, however, available.

A time-history for the 140 sec. before ground impact based on Midas recorder data supplemented by that from the CID recorder was studied (see page 94). Relevant portions of this have been plotted to a time base with a zero for an incidence of the order of 16 deg. to 17 deg. (see p. 95).

On all the runs of this flight the elevator deflections are generally more oscillatory than on previous occasions. A number of factors would contribute to this, the pitching moment variation with incidence for incidence beyond 20 deg. or so, the greater sensitivity of the aircraft at an aft centre of gravity and the fact that incidences where hinge moment changes were taking place were being reached just before or during recovery.

The attempt by the pilot to recover is shown by the change in direction of elevator movement at around 9 sec. on the time scale. A number of things may have prompted this action and it is by no means clear what, for example, was the tab position or the stick force just previous to this.

He may have been faced, as has been pointed out above, with an unexpected up-elevator position or he may have been alerted by the incidence meter. Whatever was the exact sequence of events it is certain that incidence would have continued to increase during the recovery attempt. According to the analysis of the hinge moment data an incidence of about 40 deg. or more was reached, since it will be seen that at about 13-14 sec. the elevator "up floats" to reach a fully up position shortly after.

As has been noted, beyond an incidence of about 36 deg. a fully down elevator does not provide a sufficiently large nose-down pitching moment contribution to result in an overall pitching moment in the recovery sense. Hence, even if the elevator had been maintained in a fully down position, recovery from the flight conditions prevailing would have been ruled out. In fact, with the elevator virtually locked in its up position the incidence will increase further till the aircraft reaches the stable equilibrium state at about 50 deg. incidence.

The time history indicates that as the aircraft entered the stall there was a tendency to a wing drop which was corrected by the pilot. Subsequently during the deep stall the aircraft banked successively right, left, then right again.

At the high incidence conditions prevailing during the descent the aileron rolling effectiveness would fall off to such an extent that the ailerons become of little value as a roll control. Nevertheless, since the tab, aileron and spoiler movements are consistent, it can be concluded that the pilot was moving his lateral control deliberately; but it should be remembered that some movement of the ailerons would result from the incidences induced by the aircraft's motion and, in the absence of wheel and rudder pedal force records, this tends to obscure the picture.

However, the movement of rudder and ailerons is not inconsistent with an attempt by the pilot to regain control by putting the aircraft into an appreciable asymmetric flight condition. At impact minus 50 sec., when the pitch angle was 4 deg. nose-down, full power was applied from both engines and maintained for about 15 sec. This application of power was accompanied by a rapid pitch-up reaching 17 deg. nose-up; power was then reduced by the pilot apparently to prevent continuation of the pitch-up.

Whilst there is some lack of evidence on the pilot's intentions in this stalling test, the traces, taken in conjunction with Mr. Lithgow's remark after the previous stalling tests that it should be possible to fight one's way through the wing drop, are not inconsistent with an attempt to reach a stall as defined by the British Civil Airworthiness Requirements. As a result, the aircraft penetrated further into the post-stall region than it had been taken previously and reached the stable stalled condition from which recovery was not possible.

Further Consideration of Circumstances of Accident

The probable cause of the One-Eleven accident was evident at an early stage in the investigation but it has been necessary to consider whether there were in the attendant circumstances any contributory factors. The matter was therefore examined under three broad heads:

- Were the design and wind tunnel investigations carried sufficiently far?
- Were the flight tests organised and conducted with sufficient prudence to obviate unnecessary risk?
- Were additional safeguards warranted having regard to the nature of the tests undertaken?

The design and wind tunnel investigation aspect has been largely dealt with. There was evidence in the wind tunnel tests of a fairly sharp drop in the lift coefficient associated with the onset of the stall, and a nose-down tendency in the pitching moment. It was expected that in flight there would be a pronounced nose-down pitch at the stall, providing the approach to the stall was gradual. The evidence of a pitch-up tendency which was appearing by 25 deg. incidence in the wind tunnel tests was not interpreted as a matter demanding special precaution; the VC.10 technique which it had been decided should be used in exploring the One-Eleven stalling characteristics was considered to be sufficiently cautious to avoid difficulty.

Against this background it cannot be said that the design and wind tunnel investigations should have been carried further than they w

As regards prudence, the technique followed in the VC.10 stalling programme consisting of taking the aircraft up to or just beyond the angle of incidence at which wind tunnel tests had shown C_L max to occur so that experience and information would be built up gradually.

During the initial stalling tests (Flight 47) of the One-Eleven, however, the angles of incidence based on wind tunnel tests, which were provided as a guide to the test pilots, were considerably exceeded, but as explained in section 9, no allowance for scale effect had been made when establishing these incidence values. Nevertheless, if the VC.10 stall investigation technique had been closely followed in this case the One-Eleven stalling tests would not have been taken so far, so fast. The apparent lack of concern after Flight 47 appears to have been based on the expectation that a pronounced nose-down change of pitch would occur and also on the innocuous stalling behaviour reported by the pilots after that flight. Since no steps were taken either to warn them of the special features revealed at angles above 25 deg. during the wind tunnel tests or to lay down new "limiting" angles as a guide or to fit a new incidence meter, the pilots may well have interpreted the position as one in which the stall could be explored not only at the higher angles then reached but even beyond.

It appears that the pilots themselves were under the impression that an increase of incidence would be associated with a visible pitch-up which would give them adequate warning to recover; they had probably not appreciated that not only would incidence continue to increase after the g-break with no visible pitch-up but that it would increase at a much higher rate than previously, as explained earlier. But although the pilots had not been warned that if incidence reached a sufficiently high angle a stable stall was a real possibility and recovery therefrom most unlikely, there was some knowledge among them and the aerodynamicists of difficulties that had occurred during stalling tests of military aircraft with T-tails.

It seems reasonable to conclude, therefore, that as by 25 deg. in the wind tunnel tests the nose-down tendency in the pitching moment gave way to a nose-up tendency, and as the firm had a general background knowledge of stalling problems which had arisen with T-tail aircraft, stalling tests should have been more cautiously approached, more closely controlled and more carefully correlated with wind tunnel and flight recorder data.

As regards additional safeguards, the matters examined included the fitting of a tail parachute, the incidence meter, escape arrangements, and exchange of information. These are discussed below.

• Tail Parachute—Consideration had been given in the case of the One-Eleven, as in that of the VC.10, to the fitting of a tail parachute. The matter was being kept under review and no final decision had been made, although it had been intended that a parachute should be fitted before the aircraft made a dynamic stall, thus significantly exceeding the stalling incidence. The retention of the matter under review and deferring of a decision to fit were influenced by the time that would be taken for such a modification and acceptance that the policy of 'gradualness' in relation to stalling would ensure safety.

Wind tunnel tests carried out by BAC since the accident indicate that with the elevators in effect locked up and with the aircraft in a stable stall, a tail parachute of the type it was intended to fit would not have given sufficient pitching moment to provide for recovery.

Tail Parachute

The question of whether to fit a tail parachute for stalling tests in civil aircraft is a matter for the constructor to decide. It may be noted however that for prototype or development military aircraft, the Ministry of Aviation requires all types of aeroplane, unless otherwise agreed by the Ministry, to be fitted with an anti-spin parachute before stalling or spinning trials are undertaken.

• Incidence Meter—As mentioned previously, the presentation of body incidence to the pilot was achieved by means of a small dial and pointer. Although the graduated range of the instrument was from 20 deg. to —10 deg. the pointer was free to move to a position equivalent to 25 deg., where it might either have stopped or flicked to some spurious reading quite unrelated to the vane position. It seems probable that the pilots were unaware of this characteristic of the instrument; the possibility that they were misled by its reading cannot therefore be dismissed although the evidence suggests they were not working to an incidence limitation but were attempting to reach a clearly defined stall. Incidence in excess of the maximum reading of the instrument had been recorded during Flights 47 and 48, and it should have been clear that the range of indication provided was insufficient to present the pilots with a means of monitoring the incidence reached during stalling trials. It would consequently have been an act of reasonable prudence to replace the incidence meter used by one capable of registering appreciably higher incidence, irrespective of whether there was any intention of exploring this region immediately.

• Escape—Two emergency escape exits were provided in the aircraft, as noted in section 3, and each occupant had a parachute. In considering why, nevertheless, no-one escaped by this means, it was necessary first to examine the extent to which those on board, and in particular the pilot, could have realised the seriousness of their difficulties. During the period between 100 and 80 sec. before impact the following could have been noted:

(1) Incidence, at one stage, reached the limit of the instrument.

(2) After this the elevator took up a position about half fully up (—13 deg.) with the control column probably nearly central.

(3) The control column was then pushed hard forward (stick force of the order of 100 lb.), as a result of which the elevator moved to a 6 deg. (down) position but soon after moved to a fully up position and stayed there with the forward stick force still applied.

(4) Height was lost at a rate of about 180 fps. from the time at which the elevator assumed the fully up position.

The pilots and the third occupant of the flight deck could have been aware of each of these events while one or more of the flight observers could have known of (1) and (4). During this time there was also a decrease of pitch from 21 deg. to 3 deg. after which the attitude did not vary much from the horizontal. Because of the decrease in pitch, and perhaps because of some indication of the incidence meter (see above), the pilot may have been misled at this stage into thinking that the aircraft was recovering in spite of the elevator indicator reading. However, he must quickly have realised this was not the case because there was only the slightest easing of the stick force which had reached more than 120 lb. by 85-90 sec. before impact. In addition, from this time, a considerable sideslip condition developed; this may in part have resulted from an attempt to upset the stable stall through a change of airflow.

About 55 sec. before impact the Midas trace of stick force showed a momentary reduction to zero. (This is not shown on the time history). If the control movement was intentional, it served to establish that there was no effect on the indicated elevator angle; thereafter a much reduced push force (60 lb.) was maintained. The pilot next tried the effect of thrust which was increased to its maximum value at 45 sec. before impact. This resulted in a rapid pitch-up of the nose which apparently caused the pilot soon to reduce thrust again.

Although it may be expected that there was considerable alarm at the rapid loss of height, it seems reasonable to accept that no question of abandoning the aircraft arose until all possibilities of recovery, culminating in the application of full power, had been attempted. When this had been done the aircraft was probably at just under 5,000 ft. with less than 30 sec. to go before impact. There is evidence that some attempt was made to abandon the aircraft at a very low height, probably far less than 5,000 ft. since:

(1) Witnesses heard a sharp report, which could have been the firing of the explosive bolts on the forward escape exit, when they estimated the height of the aircraft to be a few hundred feet; after the crash the door was found trapped between the fuselage and the ground in an inverted position still partly covering the door opening and two of the occupants were near this exit.

(2) Although the rear ventral door (second escape exit) was in position, two occupants were some distance towards it.

In test and experimental flying there must at times be a degree of hazard, and a pilot will continue to investigate an unusual or difficult situation while any possibility of recovery exists. Nevertheless, it remains a possibility that the chance of escape might have been improved if emergency drills had been laid down and practised since this could have led the pilot to order at least some members of the crew to abandon the aircraft at an earlier stage and perhaps have enabled any escape attempt to be carried out with greater prospect of success.

• Exchange of Information—During the investigation consideration was given to the extent of exchange of information between research establishments and the aircraft industry, and among constructors themselves. It emerged that no formal action had been taken in respect of the experience which had accumulated from stalling problems encountered in aircraft with T-tails, although there had been some informal liaison. In respect of this particular accident the British Aircraft Corporation announced almost immediately its intention to make known to manufacturers both in this country and overseas the results of its investigations so that the knowledge gained would be of lasting benefit to the safety of aviation. It appears, nevertheless, that knowledge gained from other incidents and accidents may not always be so applied owing to the lack of effective formal or standing arrangements, and that a more regular basis for the exchange of experience among aircraft constructors and research establishments on new problems affecting safety encountered during aircraft development would have considerable value.

Conclusions

• The aircraft was flying in accordance with the B Conditions of the Air Navigation Order, 1960; it had been certified as safe for the flight, and was properly loaded.

• The pilots were appropriately licensed and were experienced in experimental flight test work.

• There was no evidence of any pre-crash structural failure.

• The nose-down pitching moment (elevator neutral) just beyond the stall was insufficient to rotate the aeroplane at the rate required to counteract the increase of incidence due to the g-break.

• During the fifth stall the angle of incidence reached a value at which the elevator effectiveness was insufficient to effect recovery.

Opinion

During a stalling test the aircraft entered a stable stalled condition recovery from which was impossible.

J. B. Veal
Chief Inspector of Accidents
Accidents Investigation Branch,
Ministry of Aviation.

(A second accident in the BAC 111 stall test program occurred on Aug. 20, 1964, when the pilot, believing the aircraft to be irrecoverably stalled, streamed a tail parachute and made a wheels-up landing on Salisbury Plain near Tilshead, Wiltshire. None of the seven aboard was injured. The British Ministry of Aviation report on this accident will appear in a subsequent issue.)

Ministry of Aviation,
Accidents Investigation Branch,
Shell Mex House,
Strand,
LONDON, W.C.2.

November, 1964.

The Minister of Aviation

Sir,

I have the honour to submit my Report on the circumstances of the accident to B.A.C. One-Eleven G-ASHG which occurred at Cratt Hill, near Chicklade, Wiltshire on 22nd October, 1963.

I have the honour to be,

Sir,

Your obedient Servant,

J. B. VEAL
Chief Inspector of Accidents

MINISTRY OF AVIATION

CIVIL AIRCRAFT ACCIDENT

Report on the accident to

B.A.C. One-Eleven G-ASHG

at Cratt Hill, near Chicklade,

Wiltshire on 22nd October, 1963.

LONDON: HER MAJESTY'S STATIONERY OFFICE

1965

ACCIDENTS INVESTIGATION BRANCH

AIRCRAFT:	British Aircraft Corporation One-Eleven Series 200 G-ASHG	**ENGINES:**	Two Rolls-Royce Spey 505-14

OWNER AND OPERATOR: British Aircraft Corporation Ltd.

CREW:

Mr. M. J. Lithgow, O.B.E.	- Pilot-in-Command	- Killed
Mr. R. Rymer	- Co-pilot	- "
Mr. R. A. F. Wright	- Senior Flight Test Observer	- "
Mr. G. R. Poulter	- Flight Test Observer	- "
Mr. D. J. Clark	- Flight Test Observer	- "
Mr. B. J. Prior	- Assistant Chief Aerodynamicist	- "
Mr. C. J. Webb	- Assistant Chief Designer	- "

PLACE OF ACCIDENT: Cratt Hill, 1¼ miles NNW of Chicklade, Wiltshire.

DATE AND TIME: 22nd October, 1963, at 1040 hrs.

All times in this report are G.M.T.

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1. NOTIFICATION

By telephone from the Southern Air Traffic Control Centre, at 1208 hrs. on 22nd October, 1963. Investigation was begun at the scene of the accident the same day.

2. BRIEF CIRCUMSTANCES

The aircraft took off from Wisley aerodrome at 1017 hrs. to carry out stalling tests with the centre of gravity (CG) near the aft limit. It climbed to 17,000 feet and carried out four stalls with undercarriage and flaps up. The flaps were then lowered to 8° to investigate the stalling characteristics in this configuration. The aircraft entered a stable stalled condition, in which it descended at over 10,000 feet per minute: the pilots were unable to regain control and the aircraft struck the ground in a flat attitude 90 seconds later. All on board were killed by the ground impact, and fire destroyed much of the wreckage.

3. THE AIRCRAFT

The aircraft was constructed by Vickers-Armstrongs (Aircraft) Ltd. at Bournemouth (Hurn) Airport. It was the first One-Eleven to be completed and had made its first flight on 20th August, 1963, since when it had completed 52 test flights involving 81 hours flying.

The aircraft was registered in the name of the British Aircraft Corporation Ltd., and was engaged in a flying programme aimed at obtaining a certificate of airworthiness for airline service. It was flown under the B Conditions of the Air Navigation Order, 1960; a certificate of safety for flight had been completed at 0900 hrs. on 22nd October.

The total weight of the aircraft was 70,125 lb., maximum permissible being 73,500 lb. The fuel load was 2,200 gallons of kerosene. The CG was 0.38 standard mean chord (SMC), the furthest aft position for which the aircraft had been cleared. The design range of the CG was 0.11 to 0.41 SMC.

The elevators were aerodynamically operated by tabs controlled by a duplicated cable control system. They were in two independent sections but linked through their control systems at the top of the fin and at the flight deck. A hydraulic artificial feel simulator was coupled to the right-hand elevator control circuit in the rear fuselage to give control feel in flight.

Longitudinal trim was effected by a variable incidence tailplane powered by duplicated hydraulic motors. The range of the tailplane setting was from 3° leading edge up to 12° leading edge down.

Lateral control was by means of servo-tab operated ailerons supplemented by hydraulically operated spoilers which also acted as air brakes when deflected symmetrically.

Two emergency escape exits had been provided for the crew, one at the forward freight loading aperture on the lower starboard side of the fuselage and the other using the rear ventral passenger entrance situated in the aft end of the fuselage. For the first a special door was made and was kept in position by 38 explosive bolts. A vertical tunnel led to the door from the cabin floor. The tunnel structure was spring-loaded to exert an outward pressure on the door. The explosive bolts were connected to their own battery and could be fired by a switch on the pilots' centre pedestal or from a similar switch situated at the entrance to the tunnel. It was intended that if the bolts were fired, the door should fall away allowing the tunnel structure to slide down until its upper end was level with the cabin floor and its lower end protruded into the airstream, thus providing the crew with an escape chute. The rear escape exit was a modification to the rear ventral entry door. After opening the rear pressure bulkhead door, the crew could jettison the ventral door by means of a foot-operated lever.

Among special test instruments displayed to the pilot were elevator angle indicators which showed the position of both the port and starboard elevators. There was also an angle of incidence indicator which gave the aircraft's body incidence. A vane on the side of the fuselage provided the sensing unit and the indicator was calibrated in accordance with the results of wind tunnel tests. The scale on its dial read from 20° to -10°, but the instrument was capable of indicating to 25°. It is not known how the instrument would have behaved when body incidence exceeded 25°.

4. THE PILOTS

Mr. M. J. Lithgow, aged 43, was deputy chief test pilot of Vickers-Armstrongs (Aircraft) Ltd., and was the senior project pilot on the One-Eleven. He served throughout the war in the Fleet Air Arm, which he left in 1945 with the rank of Lieutenant Commander. He joined Vickers-Armstrongs (Supermarine Division) as a test pilot, becoming chief test pilot in 1948. In 1953 he set up a world airspeed record. He had been engaged more recently in test flying the Vanguard. On 20th August, 1963, he flew as co-pilot on the first flight of the One-Eleven and had subsequently taken part in almost all the test flying of this aircraft, as either pilot-in-command or co-pilot. He had taken part in each of the flights during which stalls had previously been carried out. He was a Ministry of Aviation approved test pilot and held a private pilot's licence valid until 1st April, 1964. It was endorsed in Group C for DH 114, Vanguard and Viscount aircraft and included a valid instrument rating. His log book showed a total of 5,385 hours; over 2,000 were on multi-engined aircraft including 78 on the One-Eleven.

Mr. R. Rymer, aged 46, joined the R.A.F. in 1939 and served throughout the war, attaining the rank of Flight Lieutenant. In April, 1946, he was seconded from the R.A.F. to B.O.A.C., then joined B.E.A. on its formation in August, 1946. He resigned from B.E.A. in 1953 to join Vickers-Armstrongs as a test pilot. Since then he had done a great deal of test flying of Viscount and Vanguard types, and had been engaged in delivery and demonstration flights and attachment to a number of airlines to give pilot familiarisation. He made his first flight in the One-Eleven on 20th September, 1963, as co-pilot to Mr. Lithgow and had subsequently flown for 13½ hours as co-pilot and two hours as pilot-in-command. His log book shows a total of 9,648 hours flying. He held an airline transport pilot's licence valid until 6th April, 1964, endorsed in Group 1 for Viscount and Vanguard aircraft. He, also, was a Ministry of Aviation approved test pilot.

5. THE WEATHER

Observations of the weather in the area at the time of the accident by the meteorological office at Boscombe Down were:-

Wind	-	060°/5 knots
Visibility	-	22 n.m.
Weather	-	Nil
Cloud	-	3/8 Sc. 2,400 feet; 2/8 Ci. 30,000 feet.

The weather is considered to have had no bearing on the accident.

6. THE FLIGHT

The aircraft was making its 53rd flight; the programme for this flight consisted of stalls in all configurations, with the CG at 0.38 SMC, the furthest aft limit for which the aircraft had then been cleared.

The inspector who completed the certificate of safety also checked the fuel load, the ballast and its disposition, and the names of the occupants. He ensured that everyone had a parachute and that it was properly adjusted, and he assisted both pilots to fasten their safety harnesses. Mr. Lithgow was in the left seat and Mr. Rymer in the right.

The aircraft took off from runway 10 at Wisley aerodrome at 1017 hrs. The radio-telephony conversations were automatically recorded in Wisley Tower and the voice from the aircraft throughout the flight was identified as that of Mr. Rymer. The progress of the flight has been deduced from the Tower recording and from the flight recorders recovered from the wreckage.

After take-off the aircraft climbed in VMC on a westerly heading to 17,000 feet, monitored by Wisley radar. At 1026 hrs. the co-pilot reported that they were just about to commence the tests at flight level 170. At 1035 hrs. he reported that four stalls had been completed in the clean configuration. At 1036 hrs. he acknowledged a fix from Wisley, after which nothing further was heard from the aircraft.

From the data provided by the flight recorders it is apparent that run No. 5, a stall with 8° flap and undercarriage retracted, was commenced at about 1038 hrs. at an altitude of between 15,000 and 16,000 feet. Approach to the stall appears to have been normal. When recovery was attempted the elevators responded initially to the control movement but subsequently floated to the fully up position in spite of a large push force on the control column. The aircraft then descended in a substantially horizontal fore and aft attitude at about 180 feet per second. During the descent it banked twice to the right and once to the left and at one stage the engines were opened up to full power. The latter action resulted in a large nose-up pitch which, when power was taken off, was followed by a pitch down. The aircraft then assumed the substantially horizontal attitude in which it made impact with the ground.

At about 1040 hrs. the aircraft was seen by many people in the Chicklade area. It had approached from the south-west and was seen to be descending rapidly in a flat attitude. Many observers remarked on the low level of the engine noise and some heard a sharp report from the aircraft whilst it was in the air. It crashed in a field, exploded and caught fire, those on board being killed by the ground impact.

7. EXAMINATION OF WRECKAGE

The aircraft crashed on level ground about 700 feet a.m.s.l. At the moment of impact it was on a heading of 324° magnetic, almost level fore and aft, banked approximately 3° to the left, and skidding slightly to the right. The marks on the ground and the wreckage distribution showed that the rate of descent had been very high and the forward speed low. After initial impact the aircraft moved forward only 70 feet and some 15 feet to the right before coming to rest. Inertia loads at impact produced a failure of the rear fuselage which caused the fin and tailplane to swing down until the outer portions of the latter came into contact with the ground. Cabin windows and a door, with pieces of cabin furnishings, were thrown forward. The starboard wing broke chordwise from the trailing edge at about mid-span and swung tip forward.

Fire broke out after impact and destroyed the fuselage and starboard wing. The upper portion of the fin, the tailplane and elevators, together with the outer portion of the port wing, survived the fire. There was no evidence that any part of the aircraft became detached in the air.

The forward freight-hold door and the remains of the door frame were found in the wreckage, both partially melted and burned. The door was not in its frame, being inverted and trapped between the fuselage and the ground slightly to the rear of its normal position so that the frame was only partly covered by the inverted door. All the explosive bolts recovered had been detonated. It is considered they were fired by action of the crew rather than by the heat of the fire, because the latter could not have resulted in the door being jettisoned and inverted and a careful search of the ground beneath the door failed to reveal any sign of the bolt heads.

Both the landing gear and the flaps were up on impact. The tailplane was still attached to the fin and was at a setting of 1° 33' leading edge up, i.e. trimming the aircraft nose down.

Both elevators remained attached to the tailplane and received upward bending of their tips when they struck the ground. The elevators themselves showed no evidence of jamming or fouling at their hinge points. All the mass balance weights were securely attached to the leading edges. Four of the six sections of the elevator leading edge, forward of the hinge line and carrying the mass balance, had been displaced downwards under high inertia loads. This displacement showed that the elevators were up at impact as they could not have moved up subsequently without interference between tailplane and elevators, and there was no evidence of any such interference. The servo and gear tabs were still attached to their respective elevators and showed no signs of pre-crash damage or defect. The torsion bar counter-balance installation in both elevators had been in good condition prior to impact. Both hydraulic gust dampers were removed, examined and functionally checked. The loads required to operate the dampers were normal and they travelled smoothly over their full range of movement.

The run of the aileron and rudder control systems was traced and no evidence of pre-crash defect or failure found. The aileron cables were complete and unbroken but both aileron/spoiler mixing units had been largely destroyed by fire. Two breaks in the rudder circuit were consistent with impact breaks in the fuselage.

Examination of the elevator control circuit showed that the control columns and the linkage to the forward quadrants had been destroyed by fire. From these quadrants under the flight deck to the hydraulic feel unit in the rear fuselage, the duplicated cable control circuits had survived the fire and were traced through the fuselage debris. There were tension breaks in each circuit consistent with the fuselage impact failures, but there was no evidence of pre-crash failure or defect. The artificial feel unit was examined and appeared to be in good condition. The rod circuit running up the fin from the rear fuselage had been partly destroyed by fire at the base of the fin but all other damage was attributable to impact loads.

The servo tab operating linkage within the elevators was complete and capable of operation, with no sign of pre-crash damage or defect. No rigging check was possible because of damage, but by cutting the starboard elevator chordwise it was possible to operate the inboard portion with the two inner hinges and to operate the final section of the tab mechanism. This check showed that the elevator and its tab and linkage operated correctly over the design range of movement, with the correct follow-up ratio.

The engines were stripped and thoroughly examined. No evidence could be found of pre-crash defect or malfunctioning. The internal condition of each engine indicated that it was alight and rotating at idling speed at the time of impact.

8. <u>FLIGHT RECORDERS</u>

Two flight recorders were installed in the aircraft for accident investigation purposes, a Royston Instruments Ltd. Midas Type CMM/24/7S/E and a Colnbrook Instruments Development Ltd. Type O2E which was on loan from the Aircraft & Armament Experimental Establishment.

The Midas is a magnetic tape recorder capable of dealing with 270 inputs and on this occasion was being used to record 59 parameters. It was installed in the top starboard side of the rear fuselage. The associated amplifiers were fitted to one of the special bulkheads in the cabin. The recorder was a cassette type, designed to eject automatically when subjected to heat or immersion in water; the ejection mechanism was to be fired electrically by power supplied from special batteries. The sampling rate was once per three seconds for most of the parameters, but five were sampled every half second. Aircraft heading was intended to be recorded but for this flight no serviceable heading source was available.

The CID recorder was fitted in the cabin inside a steel fireproof box. It recorded photographically on paper and gave continuous recording of 10 inputs, including altitude, indicated airspeed, normal acceleration (g), and elevator, aileron and rudder angles. It had no automatic ejection mechanism but relied upon its structural integrity to survive fire and crash.

The Midas recorder broke loose from its attachment upon impact with the ground, owing to the high inertia forces. It fell through a split in the rear fuselage onto the ground and was recovered about 15 feet behind the tail of the aircraft, untouched by the fire. The CID recorder had been in the heart of the fire and much of the trace information was lost, but the elevator angle trace remained legible.

9. PREVIOUS STALLING INVESTIGATION IN FLIGHT

Two approaches to the stall were carried out on Flight 2. They terminated in a wing drop at 116 knots, clean, and at 100 knots with 18° flap. A further approach to the stall was made on Flight 5 but with 45° flap and the undercarriage down; it was again terminated by a wing drop. These early approaches to the stall were made in order to check the validity of the take-off and approach speeds being used.

Exploration of the stalling characteristics of the aeroplane was begun in earnest on Flight 47 which was made on 16th October with a forward CG position. Mr. Lithgow was co-pilot on this flight. The briefing sheet for the flight gave an incidence for each of the five configurations in which stalling was to be conducted. These were:-

Configuration	Incidence
Clean	16°
8° flap, undercarriage up	15°
18° flap, undercarriage down	14°
26° flap, undercarriage down	13°
45° flap, undercarriage down	12°

The pilot's report repeated these figures, referring to them as the "limiting incidence". Twelve stalls were carried out and the pilot's report indicated the maximum incidence angles reached in the five configurations were 23°, 19°, 21°, 20° and 17°. Examination of the flight test data shows that the actual maximum figures recorded were 21°, 20½°, 23½°, 26° and 16° respectively. [A reappraisal, made subsequent to the accident, of the correction to be applied revealed that for the 8° flap position the observations on this and subsequent flights were in fact still some 3° greater than actual.] The pilot stated that his reasons for exceeding the limiting incidence figures were that when he reached them the handling characteristics of the aeroplane were innocuous and the indicated airspeed was in excess of that expected. He considered that at the limiting figures information gained on the flight would be small and that, in order to produce the kind of data required, greater angles of incidence would have to be achieved. He believed that he was engaged in investigating the stalling characteristics of the aeroplane and that he had to get to, or close to, the stall in order to get any useful and necessary data on the recording film. In this way he reached indicated angles that were considerably in excess of the limits. On none of the stalls did he have any serious qualms about the behaviour of the aeroplane, nor any difficulty in recovering.

Because of his concern at the difference between the limiting and the achieved angles of incidence on Flight 47 the pilot immediately called a debriefing meeting to discuss them. At that meeting the point was made that the "limits" set were conservative and made no allowance for scale effect which would delay the onset of changes in the flow (e.g. incidence for C_L max *) by some 3° to 4° of incidence full scale as compared with the wind tunnel tests; no criticism was made of the handling of Flight 47.

Although there was perhaps never any intention that this experience should be taken as an indication that there was an implied relaxation in the manner in which the stall should be approached, it is regrettable that the need was not felt to lay down some new and somewhat higher "limiting" incidences as a guide.

The purpose of Flight 48, two days later, when Mr. Lithgow was in command, was to measure C_L max. This involved stalls in the five configurations, and a forward CG position was again used. The incidence angles reached in the five configurations, according to the pilot's report, were 21°, 21°, 20°, 19° and 16° respectively. The flight test data showed maximum angles of 22°, 23°, 25°, 23° and 21° with the minimum speeds very much as they had been on the previous flight. The differences between the two sets of figures are explained from the fact that pitch and incidence would continue to increase by one or two degrees due to dynamic overshoot after initiation of recovery action and that the figures in the pilot's reports were readings of a small dial which was not graduated beyond 20°; the co-pilot who made the readings was also engaged in observing and recording other matters. After the flight, which involved twenty-five stalls, Mr. Lithgow commented in his report that apart from those with 45° flap, when the right wing drop appeared to be a limiting factor, he gained the impression in the other configurations "that it should be perfectly possible to fight one's way through the wing drop".

In response to pilots' reports on the lateral control characteristics in turbulence on the approach, a modification to the aileron tab/spoiler linkage was made before Flight 52 to provide for only one degree of aileron movement from neutral instead of four degrees before the commencement of spoiler movement. This resulted in improved lateral control at small deflection, but the maximum rolling moment available remained essentially the same.

10. AERODYNAMIC CHARACTERISTICS OF THE AIRCRAFT

In investigating the accident it has been necessary to examine what theoretical and wind tunnel investigations into the stalling characteristics of the One-Eleven had been made and the extent to which they gave warning of the possibility of difficulty at high angles of incidence. The Royal Aircraft Establishment has provided valuable help on this aspect by analysing the aerodynamic characteristics of the aircraft and the results of BAC wind tunnel tests, and by applying the results of these analyses to the flight test data obtained from flight recorder information.

Prior to the commencement of flight testing, wind tunnel tests had been conducted into the variation of lift and pitching moment with incidences for the range 0° to 28°. (NOTE: The angles of incidence quoted are taken directly from the wind tunnel data and are not corrected for scale effect.) From these tests it was clear that the stalling behaviour of the aircraft was characterised by a fairly sharp drop in lift coefficient at about 19° incidence.

*NOTE: C_L max is the maximum lift coefficient of the wing.

The onset of the stall extended over the range 15° - 19° and towards the end of this range the aircraft's pitching moment showed a marked nose down tendency; the latter however was not very large or long-lived in terms of persistence with increase of incidence. On the contrary, by 25° incidence, it is clear that there is evidence of a pitch-up tendency in the pitching moment characteristics of the aircraft.

In this connection it is necessary to bear in mind the extent to which incidence can build up following the abrupt loss of lift. To subject the aircraft to a sudden loss of lift is equivalent to an instantaneous decrease of normal acceleration (referred to as the g-break) which in turn leads to an increase downwards in the normal component of velocity and thus an increased incidence. It is thus possible for the incidence to increase with little or no rotation of the aeroplane. Other changes will occur in the flight condition arising from changes in drag and pitching moment but these are more indirectly related to incidence than is the g-break.

After the accident, more extensive wind tunnel tests were made by BAC from which lift and pitching moment coefficients over the incidence range of 0° to 45° were obtainable. The behaviour of the servo-tab-operated elevator control system was studied over the same range. From these tests a number of important deductions have been possible relating to the behaviour of the aircraft in its final stall.

The basic factor in the final pitch-up tendency displayed by the pitching moment curves is the loss of effectiveness of the tail as aircraft incidence is increased. This is accompanied by a loss of elevator effectiveness, which is sufficiently large to render recovery from an excursion into the post-stall region difficult.

An analysis of the hinge moment characteristics of the elevator shows that as body incidence is increased the up-floating tendency of the elevators increases and at large incidence (about 40°) can reach a stage when it is no longer possible to prevent the elevators moving into an up position even though the tab is held in its fully up position.

Since it is not possible to establish with reasonable accuracy the tailplane effective incidence and its variation with body incidence, it has also proved impossible to carry the analysis of the elevator hinge moment to the stage where a complete study in relation to estimates was feasible. However, the rate of change of elevator hinge moment with elevator angle and with tab angle which it was possible to obtain from the wind tunnel data checked reasonably well with the estimated values. These estimates of hinge moment characteristics were further checked against the records of Flights 47 and 48 (previous stalling tests) and reasonable agreement was obtained. The variation of the elevator hinge moment with body incidence was then deduced to give a curve from which it could be seen that at incidences in excess of 25° incidence contributed an appreciably increased amount to the hinge moment.

Reproduction of the type of behaviour shown in the flight recorder traces would have required further aerodynamic data of a dynamic nature and a study of the dynamics of the aeroplane as well as the elevator tab system. Nevertheless, for the accident investigation sufficient conclusions could be drawn from a consideration confined to the static aspects of the problem. From these static considerations it was concluded that there was insufficient elevator power to maintain a nose-down pitching moment beyond about 36° incidence and that therefore beyond this figure recovery would not be possible even with full down elevator. Furthermore at some incidence in the region of 45° with fully down elevator, and 50° with elevator fully up, it was evident that the aeroplane would "lock in" to this incidence. This latter deduction was consistent with the behaviour of the aeroplane as shown by the flight recorders.

The preceding discussion on elevator effectiveness applies to the aircraft configuration as at the time of the accident and is to a large extent independent of the type of longitudinal control used within the same tailplane geometry. As has been mentioned, the elevator hinge moment is appreciably affected by incidence. This effect is such that, although the amount of down-elevator that can be held by full up tab decreases progressively with increase of incidence beyond 27°, it is still possible to hold some down-elevator to somewhere in the neighbourhood of 40° incidence.

The type of longitudinal control, therefore, is a feature which does not in itself prevent recovery, but coupled with the pitching moment characteristics makes recovery more difficult. In particular if the stick is held centrally (near zero stick force), then, under static conditions, the elevator would as was remarked previously assume an upward deflected position. Furthermore just beyond the limit of incidences reached in Flights 47 and 48, that is, beyond say 25°, the angle assumed by the elevator would be quite large. However in view of the much reduced elevator effectiveness this up-elevator would have a relatively small effect on the rate of build-up of incidence.

11. INTERPRETATION OF FLIGHT RECORDER DATA

In analysing the flight recorder traces of the final stall in the light of the results of these theoretical considerations, it must be emphasised that the recordings are open to a certain amount of variation in interpretation, largely because the sampling rate of the elevator stick force and the servo-tab angles was once every three seconds: further, the incidence recording stopped at 25°. A continuous trace of the all-important elevator angle was, however, available. A time-history for the 140 seconds before ground impact based on Midas recorder data supplemented by that from the CID recorder is at Appendix A. Relevant portions of this have been plotted to a time base with a zero for an incidence of the order of 16° to 17°, as shown in Appendix B.

On all the runs of this flight the elevator deflections are generally more oscillatory than on previous occasions. A number of factors would contribute to this, the pitching moment variation with incidence for incidence beyond 20° or so, the greater sensitivity of the aircraft at an aft centre of gravity and the fact that incidences where hinge moment changes were taking place were being reached just before or during recovery.

The attempt by the pilot to recover is shown by the change in direction of elevator movement at around 9 seconds on the time scale (Appendix B). A number of things may have prompted this action and it is by no means clear what, for example, was the tab position or the stick force just previous to this. He may have been faced, as has been pointed out above, with an unexpected up-elevator position or he may have been alerted by the incidence meter. Whatever was the exact sequence of events it is certain that incidence would have continued to increase during the recovery attempt. According to the analysis of the hinge moment data an incidence of about 40° or more was reached, since it will be seen that at about 13-14 seconds the elevator "up-floats" to reach a fully up position shortly after.

As has been noted, beyond an incidence of about 36° a fully down elevator does not provide a sufficiently large nose-down pitching moment contribution to result in an overall pitching moment in the recovery sense. Hence, even if the elevator had been maintained in a fully down position, recovery from the flight conditions prevailing would have been ruled out. In fact with the elevator virtually locked in its up position the incidence will increase further till the aircraft reaches the stable equilibrium state at about 50° incidence.

The time history at Appendix A indicates that as the aircraft entered the stall there was a tendency to a wing drop which was corrected by the pilot. Subsequently during the deep stall the aircraft banked successively right, left, then right again. At the high incidence conditions prevailing during the descent the aileron rolling effectiveness would fall off to such an extent that the ailerons become of little value as a roll control. Nevertheless, since the tab, aileron and spoiler movements are consistent, it can be concluded that the pilot was moving his lateral control deliberately; but it should be remembered that some movement of the ailerons would result from the incidences induced by the aircraft's motion and, in the absence of wheel and rudder pedal force records, this tends to obscure the picture. However, the movement of rudder and ailerons is not inconsistent with an attempt by the pilot to regain control by putting the aircraft into an appreciable asymmetric flight condition. At impact minus 50 seconds, when the pitch angle was 4° nose-down, full power was applied from both engines and maintained for about 15 seconds. This application of power was accompanied by a rapid pitch-up reaching 17° nose-up; power was then reduced by the pilot apparently to prevent continuation of the pitch-up.

Whilst there is some lack of evidence on the pilot's intentions in this stalling test, the traces, taken in conjunction with Mr. Lithgow's remark after the previous stalling tests that it should be possible to fight one's way through the wing drop, are not inconsistent with an attempt to reach a stall as defined by the British Civil Airworthiness Requirements. As a result, the aircraft penetrated further into the post-stall region than it had been taken previously and reached the stable stalled condition from which recovery was not possible.

12. FURTHER CONSIDERATION OF CIRCUMSTANCES OF ACCIDENT

The probable cause of the One-Eleven accident was evident at an early stage in the investigation but it has been necessary to consider whether there were in the attendant circumstances any contributory factors. The matter was therefore examined under three broad heads:

(a) were the design and wind tunnel investigations carried sufficiently far:

(b) were the flight tests organised and conducted with sufficient prudence to obviate unnecessary risk: and

(c) were additional safeguards warranted having regard to the nature of the tests undertaken.

The design and wind tunnel investigation aspect has been largely dealt with in section 10. There was evidence in the wind tunnel tests of a fairly sharp drop in the lift coefficient associated with the onset of the stall, and a nose-down tendency in the pitching moment. It was expected that in flight there would be a pronounced nose-down pitch at the stall, providing the approach to the stall was gradual. The evidence of a pitch-up tendency which was appearing by 25° incidence in the wind tunnel tests was not interpreted as a matter demanding special precaution; the VC.10 technique which it had been decided should be used in exploring the One-Eleven stalling characteristics was considered to be sufficiently cautious to avoid difficulty. Against this background it cannot be said that the design and wind tunnel investigations should have been carried further than they were.

As regards (b), the technique followed in the VC.10 stalling programme consisted of taking the aircraft up to or just beyond the angle of incidence at which wind tunnel tests had shown C_L max to occur so that experience and information would be built up gradually. During the initial stalling tests (Flight 47) of the One-Eleven, however, the angles of incidence based on wind tunnel tests, which were provided as a guide to the test pilots, were considerably exceeded, but as explained in section 9, no allowance for scale effect had been made when establishing these incidence values. Nevertheless if the VC.10 stall investigation technique had been closely followed in this case the One-Eleven stalling tests would not have been taken so far, so fast. The apparent lack of concern after Flight 47 appears to have been based on the expectation that a pronounced nose-down change of pitch would occur and also on the innocuous stalling behaviour reported by the pilots after that flight. Since no steps were taken either to warn them of the special features revealed at angles above 25° during the wind tunnel tests or to lay down new "limiting" angles as a guide or to fit a new incidence meter, the pilots may well have interpreted the position as one in which the stall could be explored not only at the higher angles then reached but even beyond. It appears that the pilots themselves were under the impression that an increase of incidence would be associated with a visible pitch-up which would give them adequate warning to recover; they had probably not appreciated that not only would incidence continue to increase after the g-break with no visible pitch-up but that it would increase at a much higher rate than previously, as explained in section 10. But although the pilots had not been warned that if incidence reached a sufficiently high angle a stable stall was a real possibility and recovery therefrom most unlikely, there was some knowledge among them and the aerodynamicists of difficulties that had occurred during stalling tests of military aircraft with T-tails. It seems reasonable to conclude, therefore, that as by 25° in the wind tunnel tests the nose-down tendency in the pitching moment gave way to a nose-up tendency, and as the firm had a general background knowledge of stalling problems which had arisen with T-tail aircraft, stalling tests should have been more cautiously approached, more closely controlled and more carefully correlated with wind tunnel and flight recorder data.

As regards (c), the question of additional safeguards, the matters examined included the fitting of a tail parachute, the incidence meter, escape arrangements, and exchange of information. These are discussed below.

Tail Parachute Consideration had been given in the case of the One-Eleven, as in that of the VC.10, to the fitting of a tail parachute. The matter was being kept under review and no final decision had been made, although it had been intended that a parachute should be fitted before the aircraft made a dynamic stall, thus significantly exceeding the stalling incidence. The retention of the matter under review and deferring of a decision to fit were influenced by the time that would be taken for such a modification and acceptance that the policy of 'gradualness' in relation to stalling would ensure safety. Wind tunnel tests carried out by BAC since the accident indicate that with the elevators in effect locked up and with the aircraft in a stable stall, a tail parachute of the type it was intended to fit would not have given sufficient pitching moment to provide for recovery.

The question of whether to fit a tail parachute for stalling tests in civil aircraft is a matter for the constructor to decide. It may be noted however that for prototype or development military aircraft, the Ministry of Aviation requires all types of aeroplane, unless otherwise agreed by the Ministry, to be fitted with an anti-spin parachute before stalling or spinning trials are undertaken.

Incidence Meter As mentioned previously, the presentation of body incidence to the pilot was achieved by means of a small dial and pointer. Although the graduated range of the instrument was from 20° to -10° the pointer was free to move to a position equivalent to 25°, where it might either have stopped or flicked to some spurious reading quite unrelated to the vane position. It seems probable that the pilots were unaware of this characteristic of the instrument; the possibility that they were misled by its reading cannot therefore be dismissed although the evidence suggests they were not working to an incidence limitation but were attempting to reach a clearly defined stall. Incidence in excess of the maximum reading of the instrument had been recorded during Flights 47 and 48 and it should have been clear that the range of indication provided was insufficient to present the pilots with a means of monitoring the incidence reached during stalling trials. It would consequently have been an act of reasonable prudence to replace the incidence meter used by one capable of registering appreciably higher incidence, irrespective of whether there was any intention of exploring this region immediately.

Escape Two emergency escape exits were provided in the aircraft, as noted in section 3, and each occupant had a parachute. In considering why, nevertheless, no-one escaped by this means, it was necessary first to examine the extent to which those on board, and in particular the pilot, could have realised the seriousness of their difficulties. During the period between 100 and 80 seconds before impact the following could have been noted:

(i) incidence, at one stage, reached the limit of the instrument;

(ii) after this the elevator took up a position about half fully up (-13°) with the control column probably nearly central;

(iii) the control column was then pushed hard forward (stick force of the order of 100 lb.), as a result of which the elevator moved to a 6° (down) position but soon after moved to a fully up position and stayed there with the forward stick force still applied;

(iv) height was lost at a rate of about 180 feet per second from the time at which the elevator assumed the fully up position.

The pilots and the third occupant of the flight deck could have been aware of each of these events while one or more of the flight observers could have known of (i) and (iv). During this time there was also a decrease of pitch from 21° to 3° after which the attitude did not vary much from the horizontal. Because of the decrease in pitch, and perhaps because of some indication of the incidence meter (see above), the pilot may have been misled at this stage into thinking that the aircraft was recovering in spite of the elevator indicator reading. However, he must quickly have realised this was not the case because there was only the slightest easing of the stick force which had reached more than 120 lb. by 85-90 seconds before impact. In addition, from this time, a considerable sideslip condition developed; this may in part have resulted from an attempt to upset the stable stall through a change of airflow.

About 55 seconds before impact the Midas trace of stick force showed a momentary reduction to zero. (This is not shown on the time history at Appendix A). If the control movement was intentional, it served to establish that there was no effect on the indicated elevator angle; thereafter a much reduced push force (60 lb.) was maintained. The pilot next tried the effect of thrust which was increased to its maximum value at 45 seconds before impact. This resulted in a rapid pitch-up of the nose which apparently caused the pilot soon to reduce thrust again.

Although it may be expected that there was considerable alarm at the rapid loss of height, it seems reasonable to accept that no question of abandoning the aircraft arose until all possibilities of recovery, culminating in the application of full power, had been attempted. When this had been done the aircraft was probably at just under 5,000 feet with less than 30 seconds to go before impact. There is evidence that some attempt was made to abandon the aircraft at a very low height, probably far less than 5,000 feet, since

(i) witnesses heard a sharp report, which could have been the firing of the explosive bolts on the forward escape exit, when they estimated the height of the aircraft to be a few hundred feet; after the crash the door was found trapped between the fuselage and the ground in an inverted position still partly covering the door opening and two of the occupants were near this exit;

(ii) although the rear ventral door (second escape exit) was in position, two of the occupants were some distance towards it.

In test and experimental flying there must at times be a degree of hazard, and a pilot will continue to investigate an unusual or difficult situation while any possibility of recovery exists. Nevertheless, it remains a possibility that the chance of escape might have been improved if emergency drills had been laid down and practised since this could have led the pilot to order at least some members of the crew to abandon the aircraft at an earlier stage and perhaps have enabled any escape attempt to be carried out with greater prospect of success.

Exchange of Information During the investigation consideration was given to the extent of exchange of information between research establishments and the aircraft industry, and among constructors themselves. It emerged that no formal action had been taken in respect of the experience which had accumulated from stalling problems encountered in aircraft with T-tails, although there had been some informal liaison. In respect of this particular accident the British Aircraft Corporation announced almost immediately its intention to make known to manufacturers both in this country and overseas the results of its investigations so that the knowledge gained would be of lasting benefit to the safety of aviation. It appears, nevertheless, that knowledge gained from other incidents and accidents may not always be so applied owing to the lack of effective formal or standing arrangements, and that a more regular basis for the exchange of experience among aircraft constructors and research establishments on new problems affecting safety encountered during aircraft development would have considerable value.

13. CONCLUSIONS

(i) The aircraft was flying in accordance with the B Conditions of the Air Navigation Order, 1960; it had been certified as safe for the flight, and was properly loaded.

(ii) The pilots were appropriately licensed and were experienced in experimental flight test work.

(iii) There was no evidence of any pre-crash structural failure.

(iv) The nose-down pitching moment (elevator neutral) just beyond the stall was insufficient to rotate the aeroplane at the rate required to counteract the increase of incidence due to the g-break.

(v) During the fifth stall the angle of incidence reached a value at which the elevator effectiveness was insufficient to effect recovery.

14. <u>OPINION</u>

During a stalling test the aircraft entered a stable stalled condition recovery from which was impossible.

J. B. VEAL

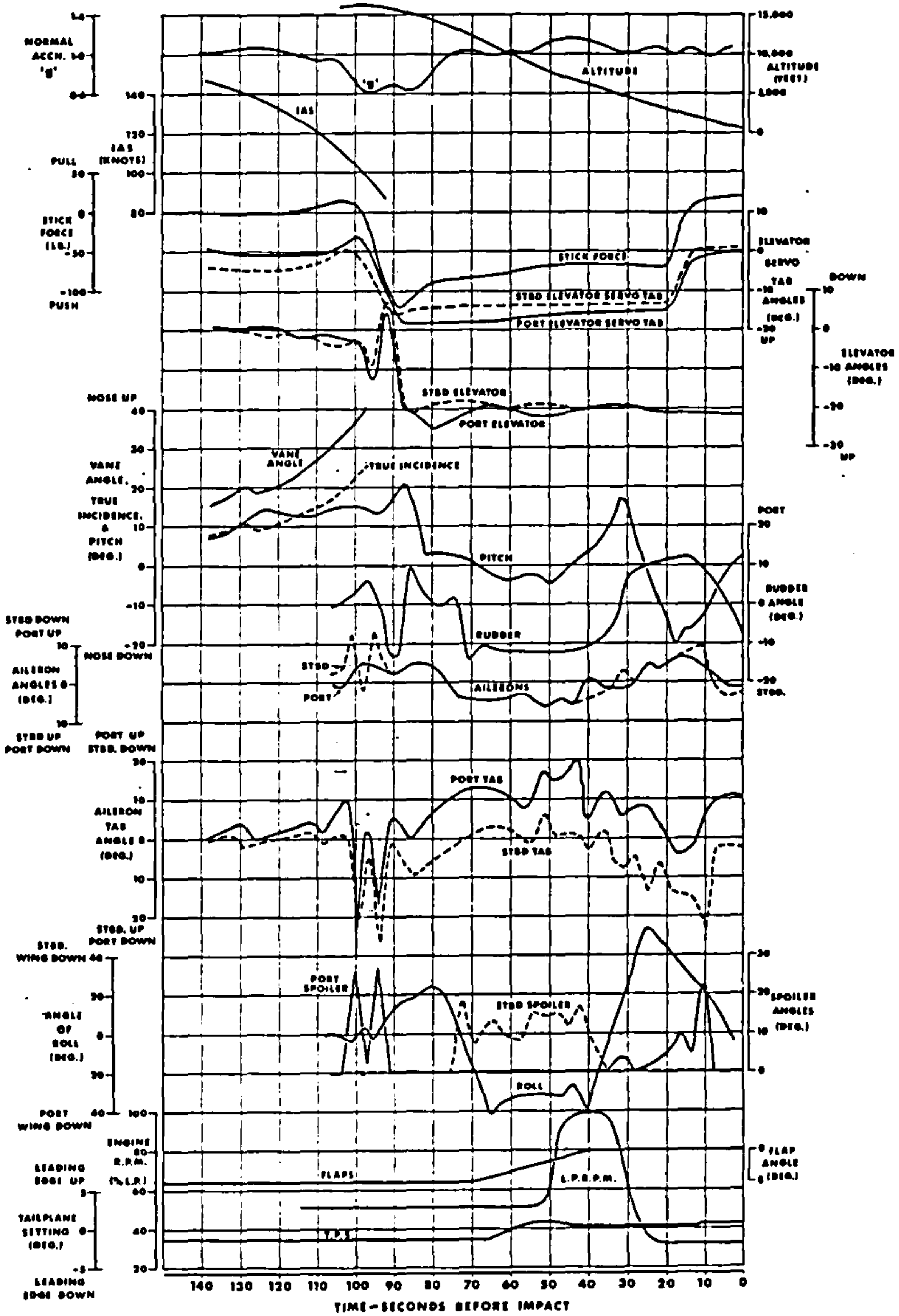
Chief Inspector of Accidents

Accidents Investigation Branch,
Ministry of Aviation.

November, 1964.

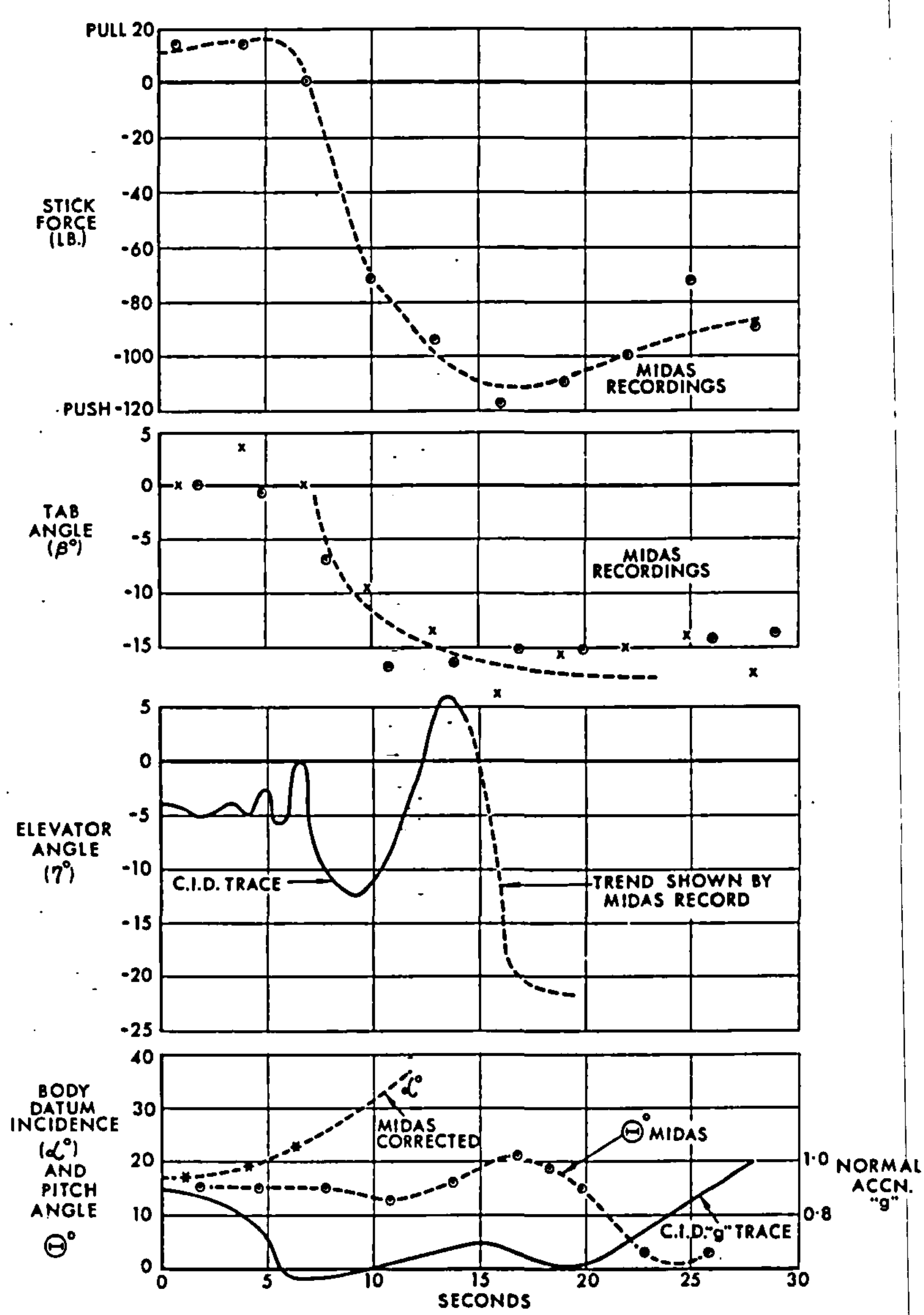
D 32440/1/Wt.77 K7 12/64 XL

APPENDIX 'A'
TIME HISTORY FOR THE 140 SECONDS BEFORE GROUND IMPACT BASED ON FLIGHT RECORDER DATA.



Appendix "B"

DATA OBTAINED FROM MIDAS AND C.I.D. FLIGHT RECORDERS AT THE STALL.



M O A COPS 10 D O Drg No 4257 30-10-64

Ministry of Aviation,
Accidents Investigation Branch,
Shell Mex House,
Strand,
LONDON, W.C.2.

December, 1964.

<u>The Minister of Aviation</u>

Sir,

I have the honour to submit my Report on the circumstances of the accident to British Aircraft Corporation One-Eleven Series 200 G-ASJD which occurred on Salisbury Plain, one mile NW of Tilshead, Wiltshire on 20th August, 1964.

I have the honour to be,

Sir,

Your obedient Servant,

J. B. VEAL
Chief Inspector of Accidents

MINISTRY OF AVIATION

CIVIL AIRCRAFT ACCIDENT

Report on the accident to B.A.C. One-Eleven G-ASJD on Salisbury Plain, one mile NW of Tilshead, Wiltshire on 20th August, 1964.

LONDON : HER MAJESTY'S STATIONERY OFFICE

1965

ACCIDENTS INVESTIGATION BRANCH

Civil Accident Report No. EW/C/073

AIRCRAFT:	British Aircraft Corporation One-Eleven Series 200 G-ASJD	ENGINES:	Two Rolls-Royce Spey

REGISTERED OWNER: British United Airways Ltd.

OPERATOR: British Aircraft Corporation Ltd.

CREW:			
	Mr. P. P. Baker	- Pilot-in-Command	- Uninjured
	Mr. T. S. Harris	- Co-pilot	- "
	Mr. T. I. Y. Jones	- Senior Flight Test Observer	- "
	Mr. J. F. Reeves	- Flight Test Observer	- "

PLACE OF ACCIDENT: On Salisbury Plain, one mile NW of Tilshead, Wilts.

DATE AND TIME: 20th August, 1964, at 1456 hrs.

All times in this report are G.M.T.

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1. NOTIFICATION

By telephone from Southern Air Traffic Control Centre at 1545 hrs. on 20th August, 1964. Investigation was begun the same day.

2. BRIEF CIRCUMSTANCES

The aircraft took off from Wisley aerodrome at 1438 hrs. to carry out stalling tests with the centre of gravity (CG) at the then forward limit. It climbed to a little over 20,000 feet where the first run was made in the clean configuration with power off. As a slight pitching oscillation developed whilst the pilot was attempting to hold the target incidence, he decided to recover and begin again. During the recovery he gained the impression that the elevator response was not normal and that the aircraft might be in a stable stall. The tail parachute was therefore streamed, although the IAS had by then increased to 225 knots and incidence was 6°. With the parachute still streamed the application of upward and also forward thrust, which were tried on a number of occasions, served only to increase the pilot's conviction that a stable stalled condition existed. Late in the descent full flap and full power were found to reduce the rate of descent considerably, and a wheels-up landing was made on undulating grassland. The aircraft was relatively little damaged in the ground slide and none of the crew was injured.

3. THE AIRCRAFT

G-ASJD was constructed by the Weybridge Division of the British Aircraft Corporation (Operating) Ltd. at Bournemouth (Hurn) Airport. It was registered in the name of British United Airways Ltd. and was being operated by B.A.C. under the B Conditions of the Air Navigation Order, 1960. It made its first flight on 6th July, 1964, and prior to the flight on which the accident occurred it had completed 38 test flights involving 47 hours 35 minutes flying. A certificate of safety for flight had been completed on the day of the accident. A 55-minute flight made in the morning was followed by a between-flight inspection.

For Flight 39 the total weight of the aircraft was 69,890 lb., maximum permissible for take-off being 73,500 lb. The CG was 0.15 standard mean chord (SMC), the furthest forward position for which the aircraft was then cleared. The design range of the CG was 0.11 to 0.41 SMC.

The aircraft had a modified wing leading edge and power-operated elevators, introduced following the accident to the prototype G-ASHG. The purpose of the wing leading edge modification was to improve the pitch-down characteristics in the stall; in conjunction with this change the wing fences were moved further inboard.

For the stalling tests the following emergency recovery provisions were made:-

(a) A 13-foot diameter ring slot parachute with an 80-foot strop was carried in a housing mounted on a special gantry at the tail cone. The attachment incorporated a weak link designed to fail at a load of 32,100 lb., equal to the estimated steady parachute drag with no jet effect at 244 knots. The purpose of the parachute was to give a powerful nose-down pitching moment if high angles of incidence were reached.

(b) A special modification to the engine reverse thrust cascades was incorporated. The upper cascades were partially blanked off and the lower cascades turned, so that by selecting reverse thrust an upward thrust component of 44 per cent of the gross thrust appropriate to the conditions could be obtained from each engine, thus giving a powerful nose-down pitching moment to the aircraft.

The upper wing surfaces were tufted and four cine-cameras were used to film the behaviour of the tufts during each stall.

Among special flight-test instruments were two incidence indicators alongside each other in the lower left-hand corner of the first pilot's instrument panel, fed from separate vane sources and showing body incidence up to 45°, a pitch angle indicator covering the range 5° nose-down to 20° nose-up, and elevator angle indicators showing port and starboard elevator positions.

4. THE PILOTS

Mr. P. P. Baker, aged 38, had been a test pilot with B.A.C. since July, 1963. He served in the Royal Air Force from 1944 to 1959 rising to the rank of Squadron Leader. He completed the Empire Test Pilots School (E.T.P.S.) course in 1953 and, after three years as a test pilot at the Aeroplane and Armament Experimental Establishment, Boscombe Down, returned to E.T.P.S. as a tutor (flying) in 1957. On leaving the R.A.F. he joined Handley Page Ltd. as a test pilot, flying mainly Victor bombers. When he took up his appointment with B.A.C. he initially flew VC.10 aircraft; in December, 1963, he became project pilot on the One-Eleven and had since flown about 250 hours in that type. He made the first flight in G-ASJD on 6th July, 1964, and had been engaged in almost all the flying of it since. He had flown the aircraft on the six previous stalling flights, which were the first stalling tests conducted on the type since the accident to G-ASHG in October, 1963.

His log books show a total flying experience of 5,400 hours and that he had flown every month in the five-year period he had been a civilian test pilot. He held a private pilot's licence valid until 15th January, 1966; it included an instrument rating and was endorsed in Group C for Dart Herald, VC.10, D.H.114 and B.A.C. One-Eleven aircraft.

Mr. T. S. Harris, aged 41, had been a test pilot with B.A.C. since 1954. He served in the R.A.F. during and after the war, had done the E.T.P.S. course and was for three years a test pilot at Boscombe Down. He had flown with Mr. Baker on many occasions before but this was his first flight in this particular aircraft and also his first experience of stalling in the type. He had been detailed for this flight only on the day of the accident and for this reason was not present at the pre-flight briefing with the other members of the crew. His total flying experience amounted to 7,458 hours, of which 19 hours were in command and 16½ hours were as co-pilot of One-Elevens. He held a private pilot's licence valid until 14th October, 1964. It included an instrument rating and was endorsed in Group C for Viscount, D.H.114, Vanguard and One-Eleven aircraft.

5. THE WEATHER

Observations of the weather in the area at the time of the accident by the meteorological office at Boscombe Down were:-

Wind	-	060°/7 knots
Visibility	-	16 n.m.
Weather	-	Nil
Cloud	-	3/8 Cu. at 3,000 feet; 4/8 Sc. at 4,000 feet; 7/8 Ci. St. at 25,000 feet.

The pilot has stated that the cirro-stratus cloud was about 23,000 - 24,000 feet; the horizon was not clearly defined at the test altitude when flying in a westerly direction due to haze and the effect of the sun shining through the cirro-stratus layer.

6. PREVIOUS STALLING FLIGHTS WITH THIS AIRCRAFT

For the stalling trials, angle of incidence limits were laid down and stated on the briefing sheet for each flight. A clear distinction was made between the target figure and its corresponding limiting figure. The pilots were instructed that prompt and positive recovery action must be taken when the first of the following occurred:

(i) a pronounced wing dropping tendency;

(ii) a significant change in the rate at which the angle of incidence was increasing, or

(iii) the angle of incidence reached the relevant limiting value.

Instructions were also given that the emergency recovery devices were to be used immediately on any significant uncontrollable increase of incidence.

Previous stalling tests with the CG at 0.15 SMC, had commenced with Flight 26 on 12th August and had been continued on Flights 30, 32, 33, 34 and 37, all with Mr. Baker as pilot-in-command. On each of these flights, except Flight 37, the aircraft was trimmed to zero stick force by tailplane incidence at 1.4 Vms with engines idling and then decelerated at a rate generally much less than 1 knot per second to the target incidence appropriate to the configuration. Time histories for these flights showed no peculiarities in aircraft or control behaviour or in recovery. In connection with the pilot's reactions on Flight 39, which is the subject of this investigation, it may be relevant that on Flight 34 when he was endeavouring to maintain the target incidence a mild pitching oscillation was set up. The incidence was observed to reach 22° (the recorder traces showed a maximum of 25°) but recovery was immediate upon application of down elevator.

On Flight 36 a further calibration of the incidence vanes was made at all flap settings and using 1.2 Vms as the trim speed. On Flight 37 the new trim speed of 1.2 Vms (143 knots IAS for the flaps-up condition at that weight) was used primarily in order to reduce the pilot's hand loads and so improve his accuracy in the approach to the stall. Stalls in the first three configurations (0, 8° and 18° flap) were carried out with incidence targets of 18°, 17° and 16° respectively. The aim in each run on this flight was to pull back the stick at the rate necessary to achieve 1 knot per second speed reduction until the target incidence was reached, and then to hold the elevator angle required to reach that incidence; the limiting incidence was 3° greater than the target incidence. The pilot reported that this rate of speed reduction, which was slightly greater than he had previously used, resulted in a more positive g-break and nose-down pitch in the clean configuration. With the flaps down the pitch-down was very small; this was because the aircraft did not quite get to the g-break as the target incidence was reduced by 1° for each increase of flap setting whereas the stalling incidence decreased at a lesser rate.

7. THE FLIGHT

For Flight 39 it was decided, in the light of the results of Flight 37, to use a slower rate of approach to the stall and to endeavour to hold an incidence that was known to be definitely but very slightly in excess of the stalling incidence in order to check the relationship between the magnitude of the g-break and the resulting curvature of the flight path. For the first run, with the flaps up and undercarriage retracted, the target incidence was 18°; if this proved insufficient, a further run using 19° was to be tried, and if this too proved insufficient the test was to be abandoned. Runs were also to be made at flap settings of 8° and 18° with undercarriage retracted. The limiting incidence had been raised to 23°, 22° and 21° respectively for the three configurations.

The aircraft took off from Wisley at 1438 hrs. with Mr. Baker at the controls and climbed on a westerly heading to just over 20,000 feet. Because of the sun fine on his port side, the pilot lowered the sun visor to reduce the glare. The aircraft was brought to the desired trim speed of 143 knots, with undercarriage and flaps up and with the engines at idling r.p.m. Speed was then reduced at approximately ¾ knot per second. At the target incidence of 18° the pilot noticed a slight pitch-down and when he tried to maintain the incidence in order to assess the amount of nose-down pitch, a small pitching oscillation was set up. He stated that he therefore abandoned the test and recovered by relaxing backward pressure on the control column, and that the aircraft returned to the trim speed and 10° of incidence.

In order to accelerate the aircraft prior to climbing to 20,000 feet again for the next run, he pushed forward on the control column with the power still off. In doing so he gained the impression that the aircraft was not responding normally to the down elevator or building up speed in the manner he anticipated and that the rate of descent was unusually high. In view of this, and in spite of the incidence and speed indications which had shown the aircraft to be unstalled, he thought that it was possibly in a stable stall. He stated, however, that he was not convinced of this but was sufficiently concerned by what he then believed to be abnormal control response from the elevator that he decided to stream the tail parachute. He asked the co-pilot to operate the stream switch and they felt the jerk as the parachute deployed. The pilot's statement of subsequent events reads:- "This gave no noticeable nose-down pitch, which I would have expected if the aircraft had had excessive incidence and the parachute had been effective in reducing it. Recovery was the prerequisite of jettisoning the parachute. As recovery to my mind had not been effected, the question of releasing it did not arise. To try and resolve the condition conclusively I tried application of full reverse (i.e. upward) thrust. This application gave no significant nose-down pitch although I was aware that it was a very powerful control and would have to be used with care as a result. I therefore took out reverse and applied full forward thrust and when this gave no immediate acceleration nor appreciable decrease in the rate of descent I then became convinced that the aircraft was stable stalled despite the incidence and speed indications; the latter at least being, I knew, liable to large errors in this condition." He added that all his actions taken towards effecting recovery were conditioned by his initial impression that the aircraft was not responding normally to fore and aft control. Once the tail parachute was streamed, its effect was to endorse this impression, which led to the complete misinterpretation of the aircraft's condition.

Shortly after the tail parachute was streamed, he asked the co-pilot to transmit a MAYDAY call. This was done twice and on the second occasion the words "stable stall condition" were added, then repeated a few seconds later. Boscombe Down answered the calls with a position and a course to steer to the aerodrome. At a height of 5,000 feet with a rate of descent of 6,000 f.p.m. or more the pilot felt it was then too late to order the crew to abandon the aircraft. In view of the need to attempt a landing he experimented with the flaps and was surprised to find that they considerably reduced the rate of descent; he consequently applied full flap and found that with full power the rate of descent reduced to about 1,000 f.p.m. A suitable area was selected and a wheels-up landing made on undulating grassland at an IAS of about 100 knots with the tail parachute still attached. There were no injuries to the crew and no outbreak of fire. A helicopter from Boscombe Down landed alongside within a few minutes.

The co-pilot stated that after recovery action was taken the aircraft nose pitched down, airspeed built up and the incidence decreased. The rate of descent increased, but, in his opinion, not to an abnormal extent. The expected levelling of the aeroplane did not occur and he believed the speed went on increasing, still with a high rate of descent and with the nose slightly down. After a height-loss of about 3,000 feet he was surprised when the pilot said they were in a stable stall. Nevertheless he fully accepted the pilot's assessment of the position and operated the parachute stream switch when instructed to do so. During the final stages of the descent, with Mr. Baker's consent, he applied full forward thrust and this together with full flap enabled the aircraft to be brought sufficiently under control to make a wheels-up landing.

The senior observer stated that the approach to the stall was normal but close to the stall there were two or three mild oscillations in the pitching sense. On the last oscillation the incidence reached 19° and he heard the pilot say he was taking recovery action. Subsequently he saw on his instruments the IAS build up to 144 knots and the incidence fall off to 10°; he accordingly turned off the recorders, as was normal practice, as the recovery appeared to him to be complete. He also switched off the cameras for the wool tufting and then began to write notes. Later he heard on the intercom a remark about being in a stable stall, and that the rate of descent was 6,000 f.p.m. Shortly afterwards he heard the order given to stream the tail parachute. He did not observe a nose-down pitch from the effect of the parachute but noticed that shortly after it had streamed the IAS was 205 knots. He has stated that he accepted the pilot's assessment of the situation even though he could not reconcile it with the incidence indication. He remembered to switch on the recorders again soon after the parachute was streamed.

The second observer, whose main task was to watch the tufting on the port wing during each stall, stated that as the speed was reduced for the initial run, he noticed more and more of the tufts inboard of the wing fence were whirling, until a point was reached when all were doing so, whilst those outboard of the fence were lying down. He understood from something the pilot said that the run was being discontinued and he then saw the tufts beginning to lie down. He stopped watching the wing as he believed recovery was imminent and he too began to write notes. About 10 seconds later he felt the aircraft oscillating in pitch just as it had done in the approach to the stall, so he looked out of the window and saw all the tufting inboard of the fence was whirling. This was followed by the pilot saying he thought they were in a stable stall. He was almost positive that at about the time the parachute was streamed some of the tufting on the outer wing was whirling, but he could not remember whether this occurred before or after the streaming.

In addition to the flight recorders fitted for accident investigation purposes, the aircraft had its normal test flight automatic recording equipment so that a comprehensive record of the flight was available. There was also a voice recorder; unfortunately the recording was garbled in many places due to the incomplete erasure of the record of a previous flight and added only a little to the information available from other sources. A time history of the more significant recorder data for the 250 seconds period before touchdown is given in the appendix and has been completed by reference to all the recorders. The record of pitch and elevator stick force for the period during which the normal test recorders were switched off was unreadable; the gap in the pitch record has been filled from calculation but this could not be done in respect of elevator stick force.

Cine-cameras were used to film the tufting on the upper surface of the wings. The cameras were running during the period 258-223 seconds before touchdown, being switched on by the first observer at 130 knots in the approach to the stall and switched off when stall recovery was complete. The three disruptions and recoveries of the tufting shown by the film record correspond well with the three peaks of incidence shown on the first 10 seconds of the time history; partial disruption occurred during the period 235-227 seconds before touchdown when the incidence was about 15°. The time history shows that a pull-force of 20 - 45 lb. on the control column was sustained during this period, but that IAS had nevertheless increased by the end of it to 143 knots. The pull-force then changed to a push-force of 70 lb. over a period of 6 seconds, applying some 6° down-elevator. As a result the nose pitched down, IAS increased steadily and normal acceleration decreased to 0.7g. The time history also shows that subsequently, up until the streaming of the parachute, there were variations of 'g', incidence and the calculated pitch angle in close correlation with elevator angle, incidence remaining in the region between 8° and zero; the aircraft was clearly in an unstalled condition.

It can be seen that the rate of descent was 1,000 feet in the first 25 seconds of the time history, then 2,000 feet in the second 25 second period, reaching 6,000 feet per minute in the remaining 7 or 8 seconds before the parachute was streamed. In keeping with these rates of descent at normal incidence and with power off, the IAS increased steadily until it reached 225 knots at 190 seconds before touchdown, when the parachute was streamed. After the parachute had opened there was an immediate and steady reduction of IAS over the next minute owing to the increased drag but the rate of descent continued high. It has been calculated that the aircraft was about 10° nose-down at the time the parachute was streamed and increased to about 24° nose-down due to the effect of the parachute and down-elevator. Subsequently pitch underwent fairly rapid alterations of some magnitude due to elevator and application of forward and upward thrust but it went only twice above zero, and then only to +2°; the incidence trace shows a normal correlation with other relevant parameters and that incidence reached a maximum of 13°.

The first application of upward thrust combined with some down-elevator, 15 seconds after the parachute had streamed, produced pronounced pitch-down. This effect was quickly reversed when 10° of up-elevator was applied at the same time as upward thrust was taken off. On the first three of the four applications of upward thrust the pitch was brought to more than 30° nose-down and only on the last application was there more than 10° of down-elevator. Use of full forward thrust made it possible for pitch to be kept near zero and, together with full flap, enabled the rate of descent to be reduced sufficiently for a wheels-up landing.

8. EXAMINATION OF THE AIRCRAFT

The aircraft had touched down with undercarriage retracted on the downward slope of a shallow valley and had slid a distance of 400 yards which had taken it partially up the other side. During the ground slide the flaps and bottom of the fuselage received substantial damage; otherwise the damage was superficial and largely restricted to the underside of the wings. One undercarriage door had been torn off during the landing and earth had been forced into the wheel wells. When the aircraft had been raised all three legs were extended by free fall and were found to be mechanically serviceable.

The pilot had operated the engine fire extinguishers after touchdown as a precaution as there was no crash inertia switch fitted. There were no ruptured fuel connections at the engines, but slight leaks were observed from the integral tanks in each wing. Little damage, apart from that caused by the ingestion of earth and grass, appeared to have been suffered by the engines.

The tail parachute was found still attached to the aircraft by its 80-foot strop. The weak link showed evidence of having been close to its breaking strain.

A full inspection of the flying controls was made after the aircraft had been returned to the factory. No defect or malfunctioning was revealed; this confirmed the assessment made from the flight recorder time histories of control movements which showed no abnormality.

9. OBSERVATIONS

Since the accident to the prototype One-Eleven G-ASHG on 22nd October, 1963, a considerable amount of work had been done by B.A.C., both to eliminate the risk of the aircraft entering a stable stall and, if nevertheless it did during test flying, to enable it to be recovered. This included the modification made to the leading edge, the fitting of power-operated elevators, a greater range of incidence indication for the pilot, the setting of precise incidence limits for the flights and careful control of their conduct: a tail parachute and an engine reverse thrust modification were introduced to provide for recovery from a high angle of incidence, if this were inadvertently achieved. The evidence shows that B.A.C. was approaching the stalling tests of this aircraft with deliberation and caution.

The comprehensive record of the flight available from the automatic data recording equipment and the photographic record of the wing tufting behaviour show that the aircraft made a complete recovery from the stall. There is nothing in the time history to suggest the risk of a stable stall developing, and careful analysis of all the evidence confirms that the aircraft behaved in a completely normal manner up to the streaming of the parachute. Subsequently the only unusual features were those due to the parachute, and to the vertical thrust when this was applied. It is clear that the fore and aft oscillation and the whirling of the inboard tufting noticed by the second observer just after he commenced to write his notes occurred during the period 225-235 seconds before touchdown when the incidence was about 15° in the final stage of the stall recovery. His recollection that some of the tufting on the wing may have been whirling either just before or just after the parachute was streamed could not be checked against a film record of the tufting behaviour because filming ceased when the senior observer switched off the camera after the stall recovery. However, after the parachute was streamed, the aircraft came close to a stall on at least two occasions when a C_L was reached which was close to the expected C_L max for the prevailing flight condition; whirling of the tufting on these occasions may well account for his recollection.

Examination of the time history and the voice recording for the period covering the approach to the stall shows that at the moment when the pilot said on the intercom that he was "leaving it at 18° incidence", the aircraft was at the third peak of incidence, an oscillation having arisen from the attempt to maintain the target incidence. Although pressure on the stick was then relaxed, the time history shows that for the next twelve seconds there was still a pull-force ranging between 20 and 40 lb. During this period the following occurred:-

(a) an up-elevator angle of some 5° was maintained;

(b) IAS increased to 143 knots;

(c) an initial nose-down pitch to 7° became 5° nose-up;

(d) normal acceleration was approximately 1.2g;

(e) incidence fell initially to 10° then returned to around 15° and remained there for some 7 seconds during which there was partial disruption of the wing tufting; and

(f) altitude decreased at some 3,000 f.p.m.

At the end of the twelve-second period the elevator stick force was reversed over a period of six seconds to become a push of 70 lb., dropping to 50 lb. two seconds later.

The pilot stated that he pushed forward when he wanted to accelerate the aircraft for the climb back to 20,000 feet. The effect of the push-force was normal in that both incidence and pitch decreased, normal acceleration (g) decreased to below unity, the IAS increased steadily, and, in the power-off dive that ensued, the rate of descent increased to about 6,000 f.p.m. before the parachute was streamed. It was immediately after applying this push-force that the pilot became concerned about the aircraft's behaviour - he was not satisfied that the pitch response was normal or correct, relating it to external reference rather than instruments. It seems possible, however, that the period previous to this, when incidence was held at 15°, may have contributed to the pilot's doubts. He stated after the accident that he recovered from the stall by relaxing the pressure on the control column. This would be consistent with recovery having been initiated at about 240 seconds before touchdown, at the third peak of incidence and similar to his practice on previous flights of recovering from the stall by relaxing pressure on the control column rather than pushing forward. The pitch-up and the continuation of the aircraft in a near-stalled condition after the apparent initiation of recovery some seconds previously might well have made the pilot receptive to the possibility of a stable stall.

The assistance of the Royal Air Force Institute of Aviation Medicine (I.A.M.) was sought on the question of why the pilot misinterpreted the behaviour of his aircraft in the way he did. After consideration of all relevant evidence and oral examination of the pilot the I.A.M. concluded that the history of the incident closely resembled cases of loss of control resulting from various forms of disorientation, which are not infrequent, particularly those which commence with an illusion of some kind. There was, in this case, sufficient evidence to state that an illusion occurred at 228-225 seconds before touchdown and that it was sufficiently compulsive to act as a trigger to the subsequent action. When Mr. Baker pushed forward on the control column he transferred from his instruments to a visual reference. At the same time there was a recorded change of normal acceleration from 1.2g to 0.7g, i.e. a negative increment of 0.5g which would have been exaggerated at the pilot's position due to its distance forward of the centre of gravity. Mr. Baker has stated that he was conscious of no visual reference to the aircraft nose, the ground or the wings and it seems probable that his actual visual reference would have been the lower cockpit coaming. Under these circumstances he would have experienced an illusion of the same general kind as that experienced in an elevator but it would have been more akin to the oculogravic illusion in which at the beginning there is an upward movement of the visual scene followed by a change in direction of the perceived vertical. This would have been much stronger than the elevator illusion, and the lower cockpit coaming frame would appear to tilt upwards giving him the sensation that the pitch response was not normal or correct. Thereafter the ensuing rise in airspeed of some 2.6 knots per second would tend to maintain the illusion by giving a sensation of nose-up attitude which would cancel other indications of nose-down attitude. The illusion which the I.A.M. concluded Mr. Baker experienced would be fostered by fatigue, of which the pilot may not have been aware, and by 'set'. The latter is a term used in experimental psychology meaning that if there are two possible responses to a given sensation or sensory stimulus, the person concerned would be more prone to choose the one which accords to that 'set'. It is known that

(a) Mr. Baker had had no real break from test flying since he took up his first civilian test pilot post some five years ago, and recently the intensity of his test flying had increased, although he himself was quite happy about this and felt no ill effects;

(b) while with Handley Page Ltd. he had needed to use an anti-spin parachute to recover from a spin which developed from a sudden uncontrollable pitch-up during a test flight in a Victor bomber; and

(c) B.A.C. had taken great care to prevent the occurrence of a further accident; the instructions given for the conduct of the stalling tests and the need for immediate use of the emergency devices, should these be required, amounted to a conditioning which could conceivably result in a reflex action if doubt arose in his mind.

The I.A.M. considered that a 'set' towards the occurrence of a stable stall was apparent from the evidence of Mr. Baker's previous Victor experience, and the conditioning of his mind over a lengthy period to the possibility of entering a stable stall and the suddenness of its onset.

Although the effects of the tail parachute and of forward and upward thrust were consistent with what would be expected having regard to the IAS and incidence record and the stabilising effect of the parachute, it seems clear that the pilot had become convinced of the existence of a stable stall, and the relatively small (to him) changes of pitch induced by the parachute and upward thrust were interpreted as the ineffectiveness of these devices in reducing the incidence. If the parachute had been jettisoned, the aircraft could have been flown away normally, but it appears that the stress condition induced by the conviction that the aircraft had entered a stable stall from which it had not recovered ruled out any logical thought process.

During the investigation consideration was given to the duties of the co-pilot, and the extent to which he might have been expected to influence correction of the assumption the pilot had made. Although he was surprised when the pilot said the aircraft was in a stable stall, he nevertheless accepted his statement of the position and streamed the parachute when instructed to do so. Although the airspeed information might have given reason for stronger doubt on his part, the incidence gauges which were located on the left-hand side of the pilot's panel could not easily be read by him; nor was he in a position to question the pilot's interpretation of the response to the pressure he exerted on the control column. Responsibility for the conduct of the test lay entirely with Mr. Baker, and the duties of the co-pilot were, in essence, to do what he was told; Mr. Harris cannot therefore be criticised for lack of action although some other pilots might not perhaps so readily have accepted Mr. Baker's assessment of the situation.

10. CONCLUSIONS

(i) The aircraft was flying in accordance with the B Conditions of the Air Navigation Order, 1960; it had been certified as safe for the flight and was properly loaded.

(ii) The pilot and co-pilot were properly licensed and were experienced in experimental flight test work.

(iii) No evidence of pre-crash malfunction or defect was found in the aircraft.

(iv) When the pilot pushed the control column forward after the stalling run the aircraft responded normally, resulting in a marked reduction of normal acceleration (g).

(v) Although the aircraft's behaviour and instrument information indicated otherwise, the pilot believed the aircraft to be developing a stable stalled condition, and streamed the tail parachute.

(vi) The nose-down pitch due to the tail parachute was small because the angle of incidence was low.

(vii) Had the tail parachute been jettisoned during the descent, the flight could have been continued normally.

11. OPINION

During a stalling test the pilot streamed the tail parachute under the erroneous impression that the aircraft was in a stable stall; an emergency landing was necessitated by the retention of the tail parachute.

12. COMPLIANCE WITH REGULATIONS

Mr. Baker was given notice in accordance with the provisions of Regulation 7(5) of the Civil Aviation (Investigation of Accidents) Regulations, 1951, and informed of his rights under the Regulation and the facilities available to him to make representations should he wish to do so. Representations which he made were taken into account in the preparation of this report, but it was not considered necessary to make any change in the opinion as to the cause of the accident.

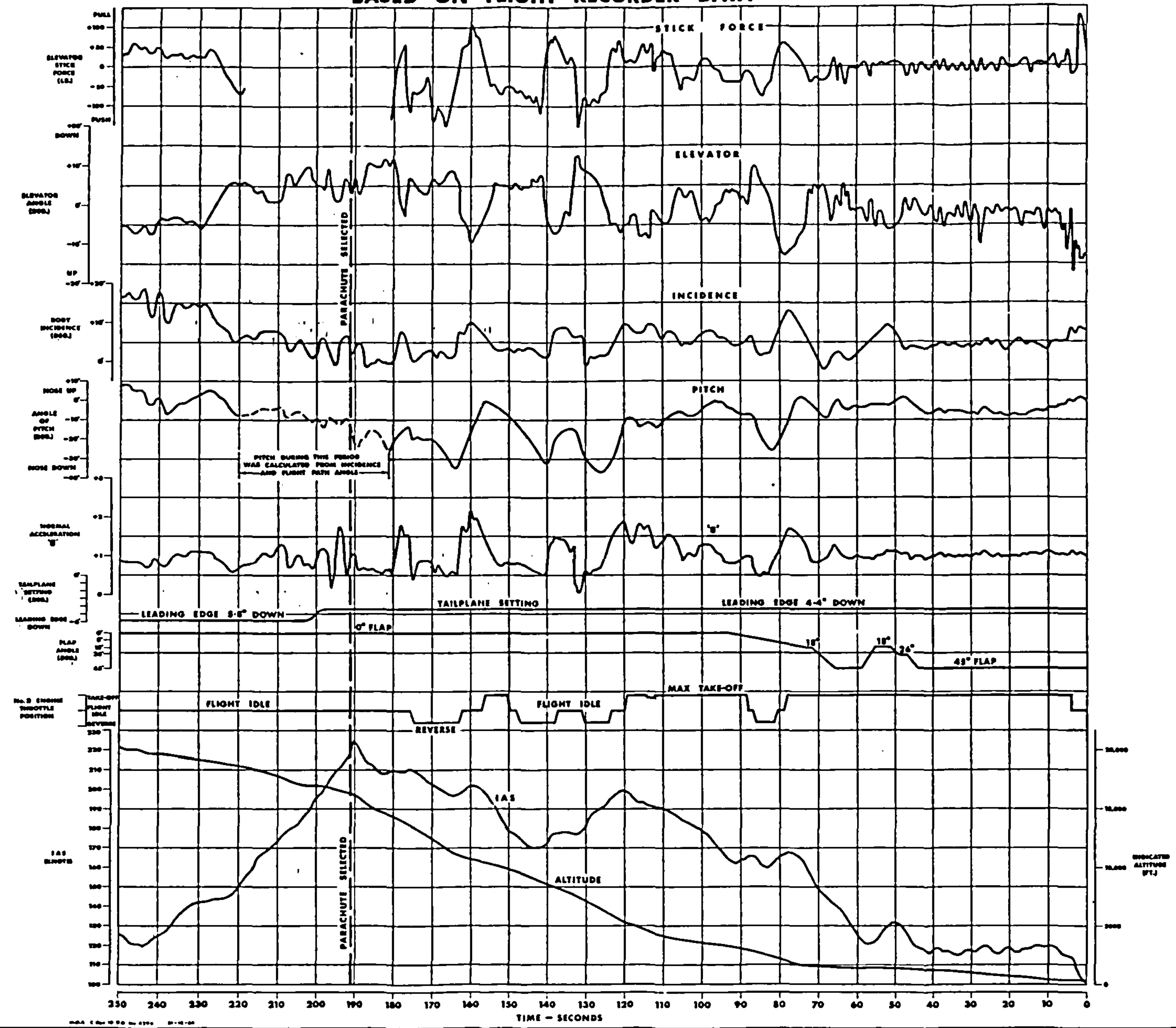
J. B. VEAL

Chief Inspector of Accidents

Accidents Investigation Branch,
Ministry of Aviation.

December, 1964.

TIME HISTORY FOR THE 250 SECONDS BEFORE TOUCHDOWN BASED ON FLIGHT RECORDER DATA



06/03/1966

TRIDENT

Board of Trade
Accidents Investigation Branch
Shell Mex House
London WC2

July 1968

President, Board of Trade

Sir,

I have the honour to submit the report by Mr. N. S. Head, an Inspector of Accidents, on the circumstances of the accident to Trident G-ARPY which occurred near Felthorpe, Norwich, on 3rd June 1966.

I have the honour to be,

Sir

Your obedient Servant,

V. A. M. Hunt
Chief Inspector of Accidents

SBN 11 510047 4

BOARD OF TRADE

CIVIL AIRCRAFT ACCIDENT

Report on the Accident
to Trident G-ARPY
near Felthorpe, Norwich
on 3 June 1966

LONDON: HER MAJESTY'S STATIONERY OFFICE

ACCIDENTS INVESTIGATION BRANCH

Civil Accident Report EW/C/0130

Aircraft:	Trident Series 1 - G-ARPY	*Engines:* Three Rolls Royce Spey Series 505-5

Registered Owner:	British European Airways Corporation
Operator:	Hawker-Siddeley Aviation Ltd
Crew:	Mr. P. Barlow DSC - Commander - Killed Mr. G. B. S. Errington OBE - Co-pilot - Killed Mr. E. Brackstone-Brown - Flight Engineer - Killed Mr. C. W. Patterson - Flight Navigator - Killed
Place of Accident:	1 mile SSW of Felthorpe, Nr. Norwich, Norfolk
Date and Time:	3rd June 1966, at 1836 hrs All times in this report are GMT

Summary

The aircraft went out of control during a stalling test on a production test flight with the centre-of-gravity in an aft position. No evidence was found of pre-crash malfunction of the aircraft and the report concludes that during the test decisive recovery action was delayed too long to prevent the aircraft entering a super-stall from which recovery was not possible.

1, Investigation

1.1 History of the flight

The aircraft took-off from Hatfield at 1652 hrs to carry out the first of a series of production test flights for the purpose of qualifying for a Series certificate of airworthiness. The schedule for the flight called for stalling tests should the aircraft and the flight conditions be suitable.

After take-off the aircraft climbed towards the north-east and at about 1830 hrs, after completing the greater part of the flight test schedule, the stalling tests were begun. Three approaches to the stall were made in order to check the aircraft's stall warning and stall recovery systems and the flight engineer's log shows that with the aircraft in the landing configuration the stick shaker operated at 102 kts and the stall recovery system at 93 kts. The fourth stalling run was made at a height of 11,600 feet with the aircraft still in the landing configuration but, in accordance with the requirements of the test schedule, the stall warning and stall recovery systems had been made inoperative.

Radio telephony communication with the aircraft consisted only of routine messages until at 1834 hrs when the pilot in command reported "we are in a superstall at the moment". This was the last radio communication received.

At about this time the aircraft was seen over Felthorpe flying very slowly heading south-west at about 10,000 feet. The nose was seen to go up 30 to 40 degrees and the aircraft began to turn to port; the starboard wing then dropped sharply and, following a short burst of engine power, the aircraft went into a flat spin to starboard. The spin continued, the aircraft turning once every 6 to 8 seconds until it reached the ground about a minute and a half later.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal	4	-	-
Non-fatal	-	-	-
None	-	-	-

1.3 Damage to aircraft

Destroyed.

1.4 Other damage

Growing crops were damaged by the wreckage, rescue personnel and equipment.

1.5 Crew information

Mr. Peter Barlow, aged 39, held a valid commercial pilot's licence endorsed in Part 1 for HS 104, HS 125, Comet and Trident aircraft. He qualified as a pilot in the Royal Navy in 1949 and in 1953 completed a course at the Empire Test Pilot's School; he served with the Naval Test Squadron until 1958, and then joined the de Havilland Aircraft Company as a development test pilot on Sea Vixens. He joined the Trident development programme in 1962 and later assisted Iraqi Airways and Kuwait Airways with Trident 1E crew training. His total flying experience amounted to about 4,500 hours including about 1,600 hours test flying of the Trident. He first flew as test pilot in command of the Trident after 80 flights as co-pilot and two flights in command under supervision with the chief test pilot. Since then he had made 416 test flights in command of Trident 1 aircraft and 52 in command of Trident 1E aircraft. He had taken part in about 2,195 stalls on the Trident in various configurations including 750 as pilot in command.

Mr. G. B. S. Errington, OBE, aged 64, had held a valid private pilot's licence since 1930. He had qualified as a ground engineer in 1932. In 1935 he joined Airspeed Limited as a test pilot and became chief test pilot in 1939. In 1949 he undertook the development and production test flight programmes for the Airspeed Ambassador. At Hawker Siddeley he was responsible for operations liaison with airlines flying Comets and Tridents and helped as required on test work at Hatfield. At the time of the accident his licence was endorsed for group A and B aircraft and he had accumulated a total of 6,800 flying hours.

Mr. E. Brackstone-Brown, aged 47, was chief flight test engineer with Hawker Siddeley Aviation at Hatfield and had been in charge of flight engineering in the flight test department from 1949. Since that time he had flown over 2,200 hours on development and production testing in Comet and Trident aircraft.

Mr. G. W. Patterson, aged 43, joined the de Havilland Flight test department as a radio navigator in 1958 after eleven years as a radio Officer in BOAC. His flying experience in Trident aircraft amounted to 57 hours.

1.6 Aircraft Information

Trident G-ARPY

The Trident I is a turbine powered rear-engined, swept wing, high tail transport aircraft fitted with adjustable high lift devices including a droop leading edge. The flying controls are hydraulically operated, and the tailplane is all moving, with a geared elevator to improve its effectiveness. G-ARPY was the twenty-third production Trident I aircraft. It was a standard aircraft with standard equipment, except that a specially calibrated air speed indicator was fitted to assist the pilot to control the air speed accurately during the stalling tests. At the time of the accident its weight was approximately 32,800 kgs. and the centre of gravity was at 0.246 mean aerodynamic chord (MAC), the normal position for these tests. The fuel was standard aviation kerosene.

Development testing

Part of the intensive pre-production test programme for the Trident was devoted to examining the stalling characteristics. Ideally there should be a clear warning of an imminent stall; at the stall an aircraft should pitch nose down so strongly that the pilot cannot keep the wing stalled by applying nose-up elevator and there should be no tendency for a wing to go down. Such characteristics are difficult to achieve with aircraft of the physical shape of the Trident. High lift devices and a powerful tailplane increase the difficulty.

In spite of a programme of over 3,000 stalls and much wind tunnel testing it was not found possible to produce the ideal stalling characteristics in the Trident aerodynamically and an electrically operated stall warning system (stick shaker) was therefore incorporated to comply with British Civil Airworthiness Requirements. As the natural nose down pitch of the aircraft could only be detected by very careful handling and as the tailplane was powerful enough to permit the pilot to overcome this nose down pitch, a stall recovery system was installed. This consisted of a pneumatic stick pusher triggered by the same incidence detecting system as the stall warning device, to push the control column forward and pitch the aircraft nose down before the wing became fully stalled. It included compensation for the rate of change of pitch attitude.

Production flight tests

It was agreed between the constructor and the Air Registration Board that before any newly constructed Trident was delivered to the operator it would undergo a series of flights covered by a Production Flight Test Schedule. During these flights, checks were made to ascertain, among other things, that the stall warning and stall recovery systems worked as intended. After one or two of the first batch of aircraft had shown that a wing-drop might be encountered at or near the stick-push, a further stall check was added to ensure that the aircraft would remain reasonably level laterally through the stall. When the stall warning and recovery systems had been found to operate satisfactorily, and at the right speeds, the pilot was required by the test schedule to switch them off and, using as datum the airspeed at which the stall recovery system had operated, to explore the speeds between the onset of the stall and the speed at which the greatest permissible deployment of the stall over the wing occurred.

Many hundreds of tests on the final Trident I configuration, including a series flown by Mr. Barlow to investigate detail problems on production aircraft, had shown that the normal break down of flow at the stall took 3 or 4 kts. (of pilots' ASI reading) to spread from the initial small local area over the whole of the inner wing. This spread was always accompanied by a sharp increase in buffet in a 1 g stall. A wing-drop could result from either a delay in the matching of the spread of the stall on both inner wings or from a premature loss of lift over one tip section; in the latter case the buffet was usually not so marked.

For performance purposes the operation of the stick-pusher at low rates of approach to the stall had been accurately tied, in terms of incidence, to the peak of the lift curve and hence the start of the development of the stall. There was agreement between the manufacturer and the ARB that there should be a small margin beyond this point which provided a safeguard against an uncontrollable wing drop developing as a result of a delayed stick push.

When the additional check on the stall was added to the test schedule there was no simple readily available means of incidence presentation for production Trident I aircraft and, as later versions of the aircraft with a leading edge slat had regularly operated to much higher incidences without problems, an incidence meter was not considered necessary. Instead a specially calibrated airspeed indicator was fitted. In view of the extensive development experience it was considered a safe test flying technique to first make an accurate correlation of airspeed and incidence during a stall with the stick-pusher operating and then to switch it off and to reduce this speed by the 3 to 4 kt margin established for the deployment of flow separation. As flow separation developed it produced a sharp increase in buffet and as an additional safeguard the pilots were told to recover immediately any buffet was felt regardless of the ASI reading. This additional check was carried out by the manufacturers only and was not to be repeated in the service life of the aircraft.

Examination of the flight engineer's log for the subject flight shows that the test had followed the standard procedure. The recorded speeds for the operation of the stick shakers and stick pusher were normal for the weight and configuration of the aircraft. Additional data for the flight is contained in Section 1.11.

The superstall

With the aim of making recovery from the stall a natural characteristic of a swept wing aircraft the wing is usually designed so that as its incidence increases to the critical stalling angle, the root (forward) portion stalls first thereby producing a nose down pitching moment. However, to appreciate what happens to the overall aircraft pitching moment it is necessary to consider contributions arising from the fuselage and tailplane. A large fuselage with appreciable forward overhang generates a nose-up contribution to the pitching moment as incidence is increased. Below stalling incidence the tailplane contribution, which increases with incidence, is sufficient to overcome the unstable nature of the pitching moment arising from the wing-fuselage combination.

However, it is inherent in a high-tail design that at angles of incidence appreciably above the stall the tailplane will be in the wake behind the wing. At these angles of incidence the velocity of the airflow in the wake is low and this seriously reduces the efficiency of the tailplane. The tailplane contribution to the overall pitching moment can also be adversely affected by changes in flow direction. Thus, while the tailplane contribution may still be in a nose-down sense, it will be much reduced. In addition, the contribution from the wing may have been made less nose-down by the spread of the stall over the entire wing. The combined effects of wing and tailplane can then be insufficient to overcome the large fuselage contribution and, when incidence is increased appreciably beyond the stall, the nose-down pitching moment can give way to a marked nose-up tendency.

Loss of lift resulting from the development of the stall causes the aircraft to sink and this further increases the incidence to the relative air-flow so that the situation becomes unstable. Also a long rear-engined layout implies large inertia in pitch and so results in a tendency to overswing, thereby aggravating the effect of the unstable aerodynamic situation. In these circumstances great care has to be exercised to avoid too deep a penetration into the post-stall regime.

For certain aft positions of the centre of gravity the overall pitching moment can be nose-up over a certain range of incidence angles even with the control column fully forward. The aircraft then will tend towards and stay in the neighbourhood of the upper limit of this incidence range and, as simple nose-down application of control will have a negligible effect, is said to be "locked in" a stalled condition, or to be "superstalled". It can only be brought back into the normal flying regime by means of an additional device such as a tail parachute. G-ARPY was not fitted with such a device and at the time of the accident its centre of gravity was within the critical range.

On the Trident I, at the rate of approach to the stall of 1kt per second specified in the test schedule the incidence for stick pusher operation was $17\frac{1}{2}^{\circ}$. During the reduction in airspeed of 3-4 kts the incidence could rise to $19\frac{1}{2}^{\circ}$ to $20^{1}/_{4}^{\circ}$ depending on the pilot's technique. Although no firm figures of maximum permissible incidence to avoid a superstall had been quoted before the accident, values of 22° to 23° were seen on occasions on the Trident 1E development aircraft.

Although it was appreciated that a more forward C of G would give greater safety in the event of late recovery action, in view of the considerable background experience the manufacturer and the ARB considered that the tests with the stick-pusher inoperative could be safely undertaken at the C of G position obtained on an empty aircraft without ballast. This C of G position was still well forward of the aft limit.

1.7 Weather

An anticyclone over southern England was declining slowly; the weather was fine with little or no cloud with the wind from the WSW at 6-12 kts. The weather had no bearing on the accident.

At the time of the accident the sun was in the west and should not have caused the pilots any inconvenience.

1.8 Aids to navigation

Not relevant to this accident.

1.9 Communications

Communications with various stations by R/T or VHF were normal and suggest that the flight was without significant incident until about 1833 hrs.

1.10 Aerodrome and ground facilities

Not relevant to this accident.

1.11 Flight recorder

The aircraft was fitted with a Plessey-Davall type PV 710 Flight Data Recorder System. This was a digital type system using pulse code modulation on an electric magnetic wire. In addition to a time scale, the parameters recorded were as follows:

Indicated air speed	-	one sample per second
Pressure altitude	-	" " " "
Heading	-	" " " "
Normal acceleration	-	5 " " "
Pitch attitude	-	" " " "

The recorder was installed in the aircraft above the centre engine at the base of the fin. It sustained only slight damage in the accident. Play-back was achieved without difficulty and this showed that information had been recorded throughout the accident flight with the exception of the take-off and a period immediately prior to the crash when it had been switched off by the air speed switch.

The time history of the flight parameters for the last three minutes of recorded flight is contained at Appendix A. The stalling tests begin at a height of 15,700 feet which agrees with the flight engineer's log. At this time the aircraft was in almost level flight at a speed of 130 knots. A gradual nose-up pitch accompanies the steady decrease in airspeed towards the stall, while normal acceleration changes very little. This first "stall" which occurs at about two minutes before the end of the record was straightforward and recovery was made with the stick pusher system fully operative. There followed a second and then a third approach to the stall; these were designed to check the functioning of the duplicated parts of the stick pusher system. Finally, towards the end of the record, the aircraft levels out at 11,600 feet and the fourth stalling run is started. After the stall the aircraft starts to pitch nose-down and speed falls off rapidly. Then for about 5 seconds the nose-down pitching motion ceases indicating that the aircraft was tending towards a superstalled condition. At the same time the heading changes, the aircraft turning to port at the rate of 8° per second.

The rate of decay of airspeed during this last stalling run averaged at about 1¼ kts. per second - but the rate was increasing towards the end of the run.

1.12 Wreckage

On site examination showed that the aircraft had struck the ground in a flat attitude with little forward speed and a high rate of descent while spinning to the right. The fuselage was grossly flattened in the impact and the tail unit, which had rolled and skidded to port, had detached at the rear pressure dome. The engine installation and rear equipment bay had been demolished. A localised ground fire which had been initiated in the region of the centre engine on impact had affected the No. 1 engine.

The main planes, particularly the port, had broken up in the violent impact with the ground. It was concluded that the aircraft was complete at impact and that its configuration was:

Landing flaps	-	UP
Undercarriage	-	UP
Airbrakes/spoliers and lift dupers	-	IN
Droop leading edge	-	DROOPED

It was considered that all three Rolls Royce engines had been running, the centre (No. 2 engine) at a higher speed than the other two engines which were probably throttled to flight idle.

The wreckage was dismantled and transported to Hawker Siddeley Aircraft Ltd. premises at Hatfield where it was further examined in conjunction with the company.

The following were examined in detail, certain items being examined at the suppliers works.

Pitch controls

The tail plane circuit in the fin was virtually undamaged. A check of the rigging and operation of this assembly proved satisfactory. Subsequent test and examination of the tail plane operating jacks proved these to be normal and satisfactory. Fore and aft trim was established as slightly aft of neutral.

Mainplane droop leading edge and kruger flaps

It was confirmed that the main plane leading edge had been in the drooped position at impact. All failures and disconnections are attributable to overstressing in the crash impact. Examination of the leading edge sealing and vortex generators has shown these to be of normal and satisfactory standard.

Pitot static system

Wind tunnel calibration of the pitot heads showed that these conformed to standards within the applicable range of incidence. Insofar as practicable the pitot and static system pipelines were tested. All fractures and leaks with two exceptions, were attributable to the crash impacts. The exceptions were small leaks in the No. 1 pitot and No. 2 static systems, which were reported by the flight crew prior to take off.

Stall warning and recovery system

The damage to the circuit breakers rendered it impossible to determine whether the system was switched ON or OFF.

Impact marks in the airstream detectors showed that these had responded to the upward air flow of the high angle of attack associated with a stalled condition.

The stick pusher jack was found jammed by impact in the non operated setting. Examination of all components and details of the system produced no evidence that, had it been switched ON, it would not have operated correctly.

Airspeed indicators

No defects found.

Flight attitude indicator system

The captain's flight attitude indicator and associated components were examined for evidence of pre-crash failure and/or malfunctioning. Inspection showed that the vertical gyro rotor had been rotating at impact.

Stand by horizon

This instrument had been operating satisfactorily at impact.

General

The detailed examination served to confirm the findings of the on site inspection. All control separations and disconnections and damage to instruments and equipment are, with the exceptions of the leaks in the pilot/static systems, attributable to the crash impact.

1.13 Fire

A small fire broke out in the vicinity of No. 2 engine at or shortly after impact. It did not spread and caused little damage. It was brought under control by fire appliances from RAF Coltishall.

1.14 Survival aspects

The impending crash was reported by RAF personnel living in the vicinity. RAF Coltishall dispatched fire and rescue appliances and called up helicopters from RAF Manston. Norwich Fire Service also attended and removed the bodies of the crew members. The injuries to the occupants of the aircraft could not have been prevented by anything in the nature of safety equipment or stronger seats or flight deck structure. The accident is therefore classified as non-survivable.

1.15 Test and research

After the accident further studies were made using the flight simulator at Hatfield. These examined in detail the relationship between rate of approach to the stall, recovery action and the probability of the occurrence of a superstall. The studies showed that with the stick pusher inoperative the safety margins were not large. In addition to these studies the Royal Aircraft Establishment undertook a more specific investigation which aimed at computing an approximate history of the tailplane deflection that occurred on the fatal test. For this investigation the aerodynamic and other characteristics of the aircraft were taken to be the same as those used in the simulator. The history of the pitch attitude was also assumed to be known and to be given by the recorded data corrected for instrument error. On this basis it was possible to deduce the other flight parameters and the tailplane angle. This was not, however, a simple matter of inverting the calculation procedures since the accuracy of the recorded data was not such as would permit successive differentiation of the attitude angle with respect to time. The situation was further complicated by the fact that no information was available on the level of engine thrust being used at various stages of the test. This again made it necessary to do additional exploratory calculations to assess the most plausible assumption on which to proceed. A detailed account of the RAE study is at Appendix B.

2, Analysis and Conclusions

2.1 Analysis

It was apparent at the start of this investigation that the accident had resulted from a deep pentration into the post-stall regime and that a superstall had occurred from which recovery was not possible. During an extensive examination of the wreckage particular attention was paid to possible defects which could have affected the handling of the aircraft and its stalling characteristics. None were found. The investigation then sought to determine the speed at which recovery action was initiated by the pilots.

Control surface movement was not measured by the flight recorder and consequently considerable work was necessary before a reasonable assessment of the pilot's actions could be made. On the basis of the data derived from the flight recorder and from a knowledge of the static aerodynamic characteristics of the aircraft obtained from wind tunnel tests, an attempt was made to reconstruct the aircraft's motion up to the penetration into the superstall (Appendix B). From this it appears that recovery action was not taken until the speed had dropped to about 8 knots below the stick pusher datum and that the control movement was insufficient to arrest the development of the stall. The reason why the pilot delayed recovery action is not known. It may be that with his very considerable experience of stalling the Trident he expected to detect the true stall or alternatively, to initiate recovery at a wing drop which did not occur on this occasion. On the other hand, his hesitation after moving the controls most probably resulted from an impression that the nose down pitch was providing effective recovery but at that time the rate of sink was increasing and its effect was to cause a rapid increase in incidence to a superstall.

The general nature of the superstall problem was widely known at this time both from accidents which had occurred on other aircraft and also from theoretical and flight simulator investigations undertaken on the Trident at Hatfield. These had been discussed in reports circulated to the pilots and the flight test and design teams. Early in 1965 Mr. Barlow had taken part in simulator studies of the Trident 1C and Trident development including stall investigation. This was in addition to his experience of stalls during the development flying. However, it is apparent that the danger does not only arise from a lack of awareness of the problem but from the circumstance that the time the aircraft takes to pass from the stalling incidence to the entry into a superstall is very short and small delays have a major influence on the outcome. The greater the rate of decay of airspeed during the approach to the stall the less time is available for recovery action and in addition the extra inertia results in a considerable overswing in incidence before the pilot's control movement can be effective. Therefore, bearing in mind the very short margin by which the pilot missed retaining control, consideration was given to whether the addition of an incidence meter might have enabled him to have carried out the test in greater safety; no definite conclusion could be reached. However, if the flight region beyond the stick pusher datum (i.e. $17\frac{1}{2}^{\circ}$ in this case) is to be explored there is a greater need for information on incidence; this becomes the only means by which the pilot can assess the flight condition as the usual relationship between air speed and incidence has become invalid. On this occasion, if an incidence meter had been provided the rapid increase in incidence that occurred below 90 kts might have impressed upon the pilot the need for quick and decisive recovery action. On the other hand it must be stated that if the approach to the stall had been carried out by reducing speed at 1 kt per second and particularly, if the test had been terminated by decisive recovery action by the time the ASI was reading 4 kts below the stick pusher datum, the specially calibrated air speed indicator that had been fitted should have provided sufficient information. The onset of buffet at this point is common to this type and should also have provided a positive recovery cue. Therefore, although the provision of an incidence meter would have been prudent it is considered that the accident indicates that a greater contribution to safety would have been made if a suitable "backing up" system had been devised as a safeguard for the occasion when a pilot might fail to take prompt action. In this respect it is understood that since the accident, tests on this type of aircraft are carried out only with the stick pusher operating and with additional safety measures to reduce the possibility of failure following a single fault, and includes the fitting of incidence meters.

2.2 Conclusions

(a) *Findings*

(i) The documentation of the aircraft was in order.

(ii) The flight was being conducted in accordance with an agreed test schedule.

(iii) No evidence of pre-crash failure of the aircraft has come to light.

(iv) During the final stalling run speed was reduced at a rate greater than 1 kt per second and recovery action was not initiated until the speed had fallen beyond the limit set by the test schedule.

(b) *Possible Cause*

During a stalling test decisive recovery action was delayed too long to prevent the aircraft from entering a superstall from which recovery was not possible.

3, Recommendations

Very shortly after the accident occurred the manner of the conduct of Trident tests was discussed with the Air Registration Board and the aircraft manufacturer and the view was put forward by the Chief Inspector of Accidents that, if the type of stalling test in which the accident was involved was to continue, incidence meters should be provided. Following these discussions it was decided by the Board that, for test flights and training flights involving deliberate approach to the stall, the stick pusher system must have a survival capability and additionally the crew must be provided with dual incidence indicators independent of the stick push incidence sensors. This requirement is applied to all aeroplanes fitted with stick pushers and therefore no specific recommendation for this is required.

N. S. HEAD
Inspector of Accidents

Accidents Investigation Branch
Board of Trade
June 1968

ROYAL AIRCRAFT ESTABLISHMENT - FARNBOROUGH

An attempt to reconstruct the history of the 'superstall' of the Trident G-ARPY

Introduction

The nature of the test being conducted, the pilot's report that the aircraft was in a superstalled condition and the recorded data all fairly clearly indicate that the most likely primary cause of the accident was a deep penetration into the post-stall regime, which resulted in a superstalled condition. Since the centre of gravity of the aircraft was at its aft position recovery from such a flight condition is extremely unlikely. Accordingly there is little to explain in relation to what was broadly the cause of the accident. Nevertheless it would be wholly unsatisfactory if the matter were allowed to rest there.

It is, in fact, necessary to examine the background of the test, the conditions governing the conduct of the test as laid down by the firm and finally to assess the actions of the pilot in this case.

A background knowledge of the sensitivity of the behaviour of this class of aircraft, particularly the way this depends on the centre of gravity location, was available to the firm from its own researches and other sources. This is discussed in other sections of the report.

This appendix, on the other hand, attempts a reconstruction of the history of the aircraft's motion, up to the time it ceased to be essentially confined to the longitudinal plane, with the object of defining, as clearly as possible, the actions of the pilot during the manoeuvre.

Having ascertained the pilot's actions which best correlate with the recorded flight data the former are then examined to see how far they are in line with the conditions laid down for the test procedure, how far they are conditioned by motion cues and finally how sensitive the aircraft's behaviour is to the pilot's input.

The required matching of the response and input could be sought along a number of different lines of approach. With high grade data it might be tempting to try to use as much of these directly and deduce the unknown variables from the equations of motion. It is doubtful whether circumstances such as prevail in the particular problem considered here will yield data of sufficiently high quality to admit of the necessary smoothing and repeated differentiation. Furthermore corrections, which are functions of the unknown angle of attack, have to be applied to the airspeed and the apparent normal acceleration to yield the true normal acceleration. This would have had to be done on an iterative basis.

Yet a third approach, and the one chosen here because it enabled an existing computer programme to be used, is to compute the response to an input which might be expected to yield something close to the assumed (or given) response. The small adjustment necessary to produce a specified closeness of fit with the known response for one of the motion variables can be estimated on some approximate basis from the discrepancy between the recorded data and the initially computed response.

Outline of the calculation procedure

An outline of the procedure just hinted at follows and the first step is to establish the initial conditions. In order to avoid unduly lengthy calculations these are chosen to correspond to an instant during which the aircraft is already decelerating towards the stalling speed. Since various corrections to quantities V_i, $\dot{V}_i$, h_i and n_i depend on the incidence some interation is necessary. The form of the θ curve in the neighbourhood of the chosen instant is used to determine the out-of-trim tailplane setting implicit on the initial conditions. The best fit to the initial conditions is obtained by assuming the error in θ to be 1.6°. It has been established separately that an instrument error of between 1° and 2° would be expected. The record showed that an error of +0.03 was present in the apparent normal acceleration.

It is of interest to note that the estimated initial value of thrust was higher than that normally used in stalling tests.

As indicated earlier the assumed elevator input (elevator is used to denote longitudinal control, which in this case was an all-moving tailplane with geared flap) for the first stage of the calculating that is in the approach to the stall, has the form $\eta_T = \eta_{T trim} + \Delta\eta_T$. The increment over the trimmed value is subject to adjustment, on a step-wise basis, so as to maintain good correlation with the observed pitch attitude. Thus the reduced steepness of the θ curve at about 4 sec. (on time scale used here) and again around 6 sec. is reflected in the two small steps in the elevator angle, see figs. 1 and 3.

In the neighbourhood of the stall, in order to maintain the same high standard of correlation with respect of the maximum value of the pitch attitude angle, the sharpness of the break in the normal acceleration curve as well as the speed loss, it proves necessary to make some further assumption. Since "no a priori" case exists for assuming the aerodynamic data to be in error and the fact that little rational basis exists on which changes could be introduced, attention is directed to the assumption concerning thrust. It has already been noted that more than usual thrust seems to have been used in the approach. It is, therefore, all the more plausible that a reduction was made.

Calculations using different levels of thrust show that a reduction to a sixth of the initial value at 6 sec. yields the best speed correlation. Correlation of the calculated and measured values of other parameters were also improved slightly. It is noteworthy that the changes in the estimated control input associated with the different levels of thrust are trivial.

Exploratory calculations assuming the stick held constant, moved forward step fashion or gradually in a linear manner at around 9 secs. show an optimum correlation of measured and calculated θ values, when the stick is moved forward at a slow rate corresponding a rate of change of tailplane angle of 0.25°/sec.

This is taken to indicate that the recovery attempt is imminent. Accordingly the assumed form of control input is changed to a polygonal form.

The slope of each segment is adjusted so that the pitch attitude is faithfully reproduced. It is of interest that the sensitivity of the pitch attitude to small changes is higher than that of the other parameters.

In this way the curves shown in figs. 1, 2 and 3 are obtained. The estimation of both the indicated airspeed showing on the recorder and the indicated airspeed of the pilot's instrument involved large corrections for instrument and position errors.

In fact with the suggested extrapolation of the pitch and static errors beyond an incidence of about 30° (i.e. beyond a time of 16.5 sec.) the corrections become meaningless. This may account for the rather poorer correlation of airspeed as compared with all other measured quantities. For these the measured and recorded values agree within acceptably small limits. On this high degree of correlation rests the assertion that notwithstanding its somewhat unrealistic character the calculated input must approximate closely the pilot's action. The only doubt concerns the aerodynamic data used in the calculations and it is scarcely conceivable that these can be materially in error in view of the results.

At 20.5 secs. the calculation has been terminated, since the recorded data show that at this time a small change of heading is taking place. It is, therefore, inferred that the motion is no longer confined to the longitudinal plane and account must be taken of the lateral motion if the correlation were to be taken further, which seems an exercise of little profit or hope of success in the absence of fuller lateral motion data.

Interpretation of the results

If it is accepted, on the basis of the above argument, that the input history shown in fig. 3 closely approximates the tailplane movements made by the pilot then it remains to interpret these as far as it is possible to do so.

It is essential to this part of the investigation to consider that airspeed reading was displayed to the pilot. His instrument is subject to entirely different corrections as compared with those of the recorder equipment c.f. figs. 2 and 3. Estimates of the readings of the pilot's airspeed indicator can be obtained in two ways. In the first of these the calculated equivalent airspeed is converted into a pilot's instrument reading. This yields the curve marked 'estimated V_{ip}' in fig. 3. In the second method the recorded airspeed (corrected for instrument error) is multiplied by a factor, which accounts for the different position errors. This gives the curve marked 'derived V_{ip}'. In the range of speeds covered by the 'estimated V_{ip}' instrument corrections are small and no account is taken of them. Although the values obtained by the two methods are quite different beyond about 10 sec., both curves indicate that a flattening off or even an increase of speed occurs at around 13 sec.

Examination of the behaviour of the various motion parameters shows that having brought the aircraft down to 'stick-pusher' speed, or strictly a somewhat slower speed, the pilot eases the stick forward. During the phase he could have been awaiting the occurance of the buffet and would have noted the change to a mild nose-down retation, which results mainly from the inherent pitching moment characteristics of the aircraft and partly from his action. This latter hardly merits being called a recovery action and might rather have been an attempt to hold a given flight condition. A plausible reason for doing so is that the pilot was not convinced that he had achieved the objective of the test, namely to explore the aircraft's behaviour to the buffet or the over-riding speed limit.

There is no means of resolving this particular problem, but whatever the reason it would seem that no forcible recovery action was taken till about 12.5 sec. on the present time scale. After applying the 'elevator' control at a fairly fast rate in the nose-down sense for about half a second there now seems to follow another interval during which the rate of application of the tailplane is much reduced. This hesitation may be related to the pilot's assessment of the situation, in particular the apparent deceleration, as has been demonstrated, exhibits a marked falling off, if not reversal. It also seems possible that a further apparent drop in speed alerted him to the true situation and resulted in the final push forward of the stick.

The calculations this give clear indications that in the absence of lateral motion the aircraft would have 'superstalled' or penetrated so deeply into the poststall regime that recovery by longitudinal control would have been impossible. Evidence is given elsewhere that the flight condition was so diagnosed by the pilot and that he sought to increase the chances of regaining control by use of thrust and possibly by putting the aircraft into a turn.

Some general remarks

The present investigation raises a number of points of more general interest. When data of the type used herein are recorded, whether in flight testing or operationally, two requirements have to be borne in mind. These are:

(a) the provision of as much data as possible from which the flight conditions can be directly and unambiguously interpreted, and the nature of an incident, if any, directly determined.

(b) that the data are such as permit correlative calculations to be most easily and relaibly undertaken.

To meet these in flight testing is perhaps somewhat easier, since the purpose of the test often provides an indication of those parameters that are more critical. For instance, in the tests being analysed here it would have been extremely valuable to have had incidence measured.

Apart from this there is generally a strong case for recording the pilot's inputs (as elevator deflections etc.), since the calculation of the corresponding response of the aircraft is then a relatively straightforward calculation as compared with the one outlined above.

In the particular test under consideration it is of interest to see whether a situation could have arisen in which recovery would have proceeded without mishap and yet there would be little evidence immediately available to someone examining the recorded data, much less to the pilot, of how narrowly disaster had been avoided. From amongst a number of calculations made to test the sensitivity of the deteriorating situation to the pilot's action, as well as the sensitivity of the calculation process to the tightness of the correlation tolerance allowed between calculated and measured pitch attitude angle, one was chosen which illustrates this point well. In this calculation the pilot is assumed to start his final push forward of the stick half a second earlier than he seems to have done in reality.

The effect of such a change in input on the history of the variables recorded is shown in figs. 4, 5 and 6. Up to 15 sec. the curves marked (1) and (2) are, of course, identical. Beyond this there is some gradual divergence of the curves, but the significance of this could easily be overlooked in a casual examination of the recorded data. It is difficult to see how the pilot could distinguish between these two situations with any certainty. On the other hand it is clear that such differences are significant in terms of the present analysis.

If, however, the angle of attack (2) is available it can be seen from fig. 4 that not only are the two cases more readily distinguished but also the maximum value of the angle (29°) indicates how dangerously near the manoeuvre would have been to one from which recovery would have been impossible. This fact would have been much less evident to a pilot using airspeed and altitude angle as his primary cues.

To put these marginal cases into perspective the effect of continuing the rapid forward movement of the stick at 12.5 sec., until 5° (trailing edge down) tailplane angle had been reached, is also shown on the same set of figures (fig. 4, 5, 6.) Even in this case the progress of the recovery is not easy to assess from any of the resulting responses except that for the angle of attack. In all three cases there is only a very narrow margin of speed of about 2 kts. (EAS) below the stalling speed for which speed continues to decrease as incidence increases. Thereafter speed is not a reliable indicator of the aircraft's incidence. It is worth noting, however, that the instrument and position errors are such that the indicated airspeed might be a somewhat better guide for a wider range of incidence. However it must be stressed that at speeds just below the limit set the indicated airspeed may vary so slowly with increase in incidence that, having in mind the inevitable fluctuations of the instrument reading, it is questionable whether the airspeed is an acceptable indication of the situation.

Conclusions

With reference to the specific circumstances of the accident it can be concluded from the calculations described above that:

(1) the recovery action taken, if indeed it can be classed as such at this stage, was tentative up to 12.5 sec. (on the time scale used here) by which time the pilot's airspeed indicater would have shown a speed of 85 kts. or less.

(2) a late, but more forceful, recovery action follows, but this was soon eased off possibly due to the manner in which the pilot's airspeed indicator would be behaving.

(3) it is possible that a reappraisal of the situation led to a final push forward of the stick, which came too late to prevent the aircraft superstalling.

(4) apart from rapid recoveries made in that narrow band of incidence above that at which the stick-pusher is activated and within which speed may be taken to give a reliable indication of incidence, the addition of an incidence meter would be a valuable aid to the pilot. However, since the rate of change of incidence is an equally important factor use of an incidence meter would not, in itself, render the test safe.

Aero P/HHBMT
Aerodynamics Department
8th November, 1967.

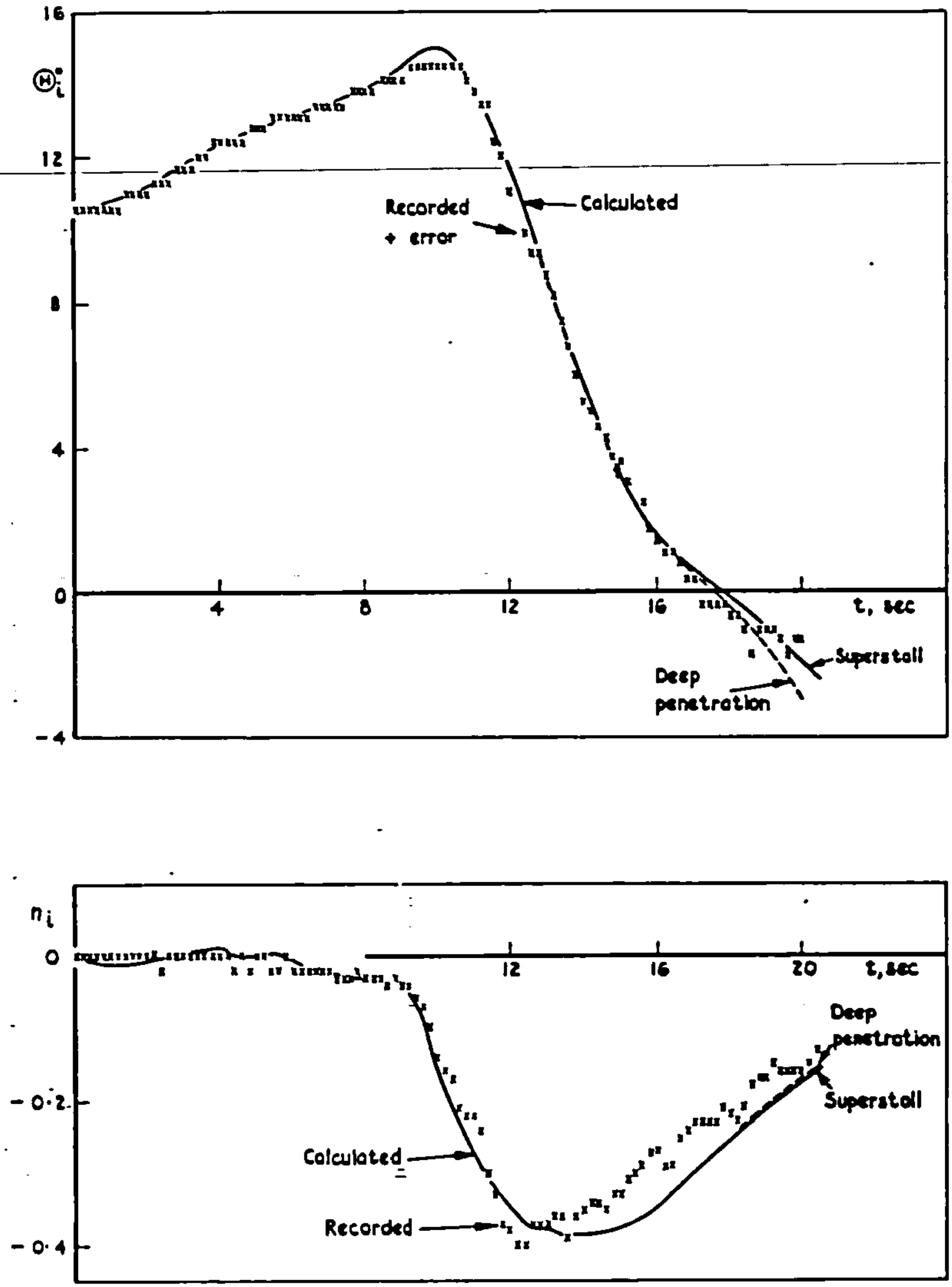


Fig. 1 Pitch attitude (angle of inclination), Θ_i, and indicated normal acceleration factor

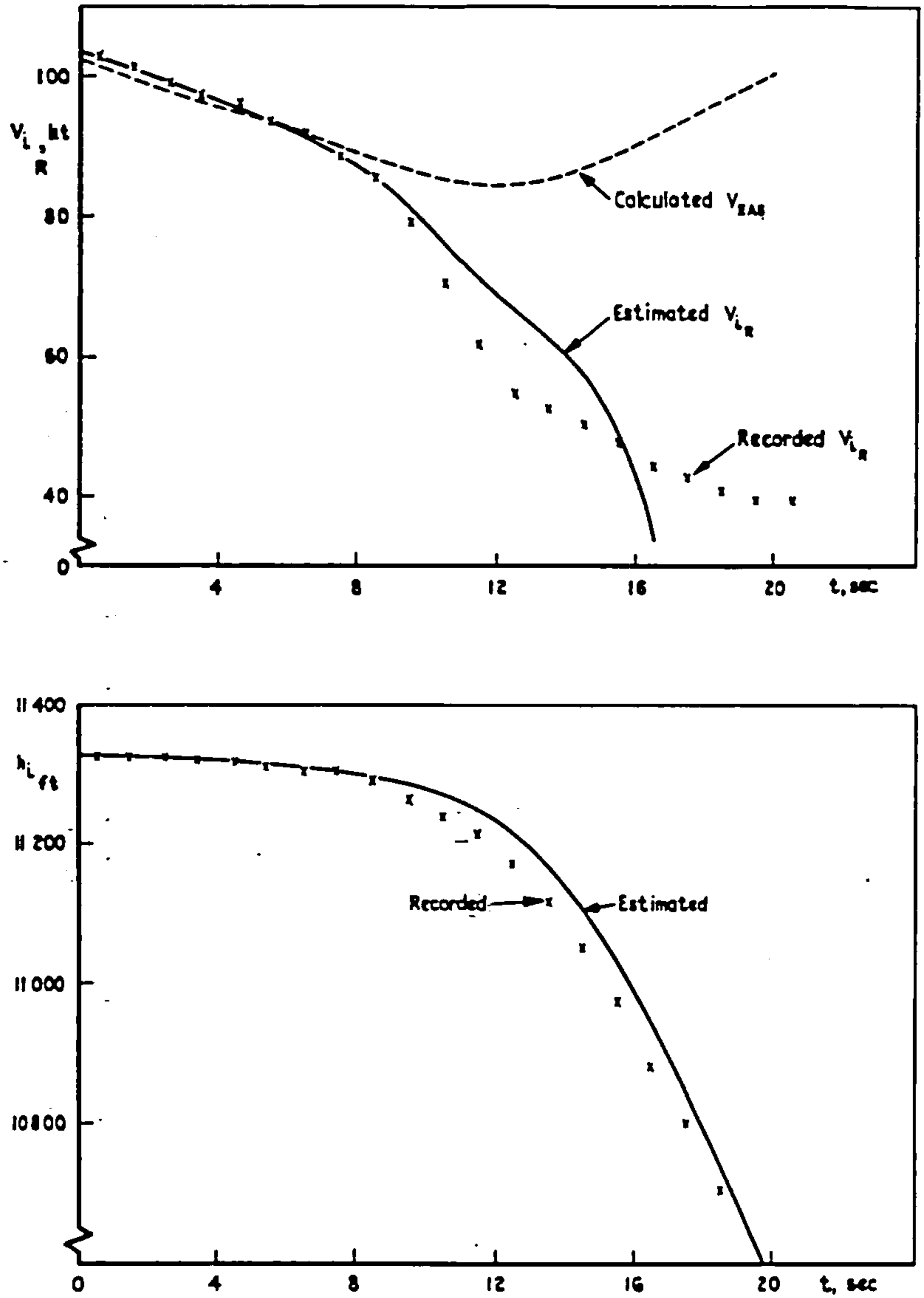


Fig. 2 Recorded indicated velocity V_{i_R} and indicated height, h_i

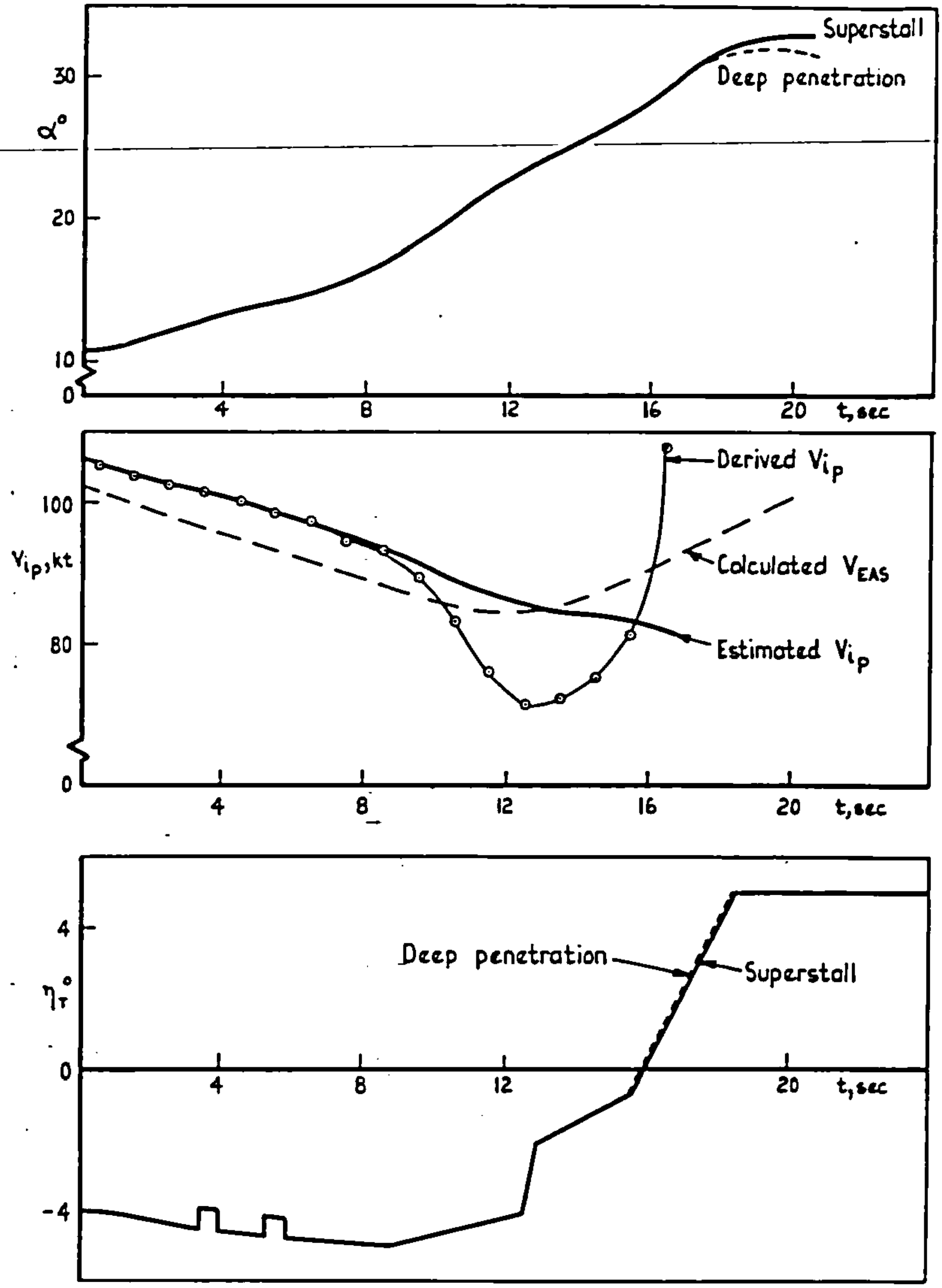


Fig. 3 Angle of incidence, α, velocity indicated to pilot, V_{ip} and tailplane angle, η_T

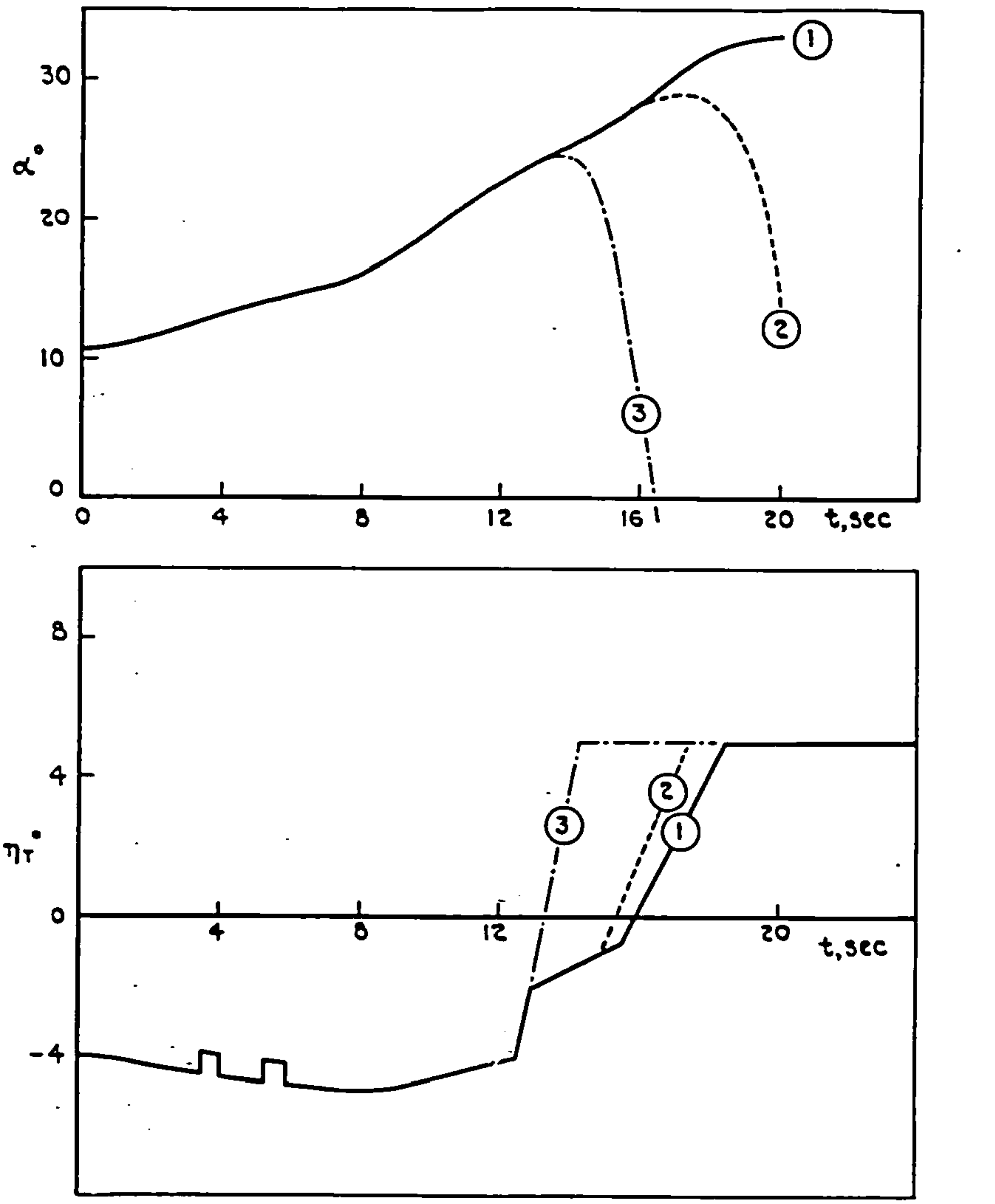


Fig. 4 Effect of different recovery action shown on the angle of attack, α

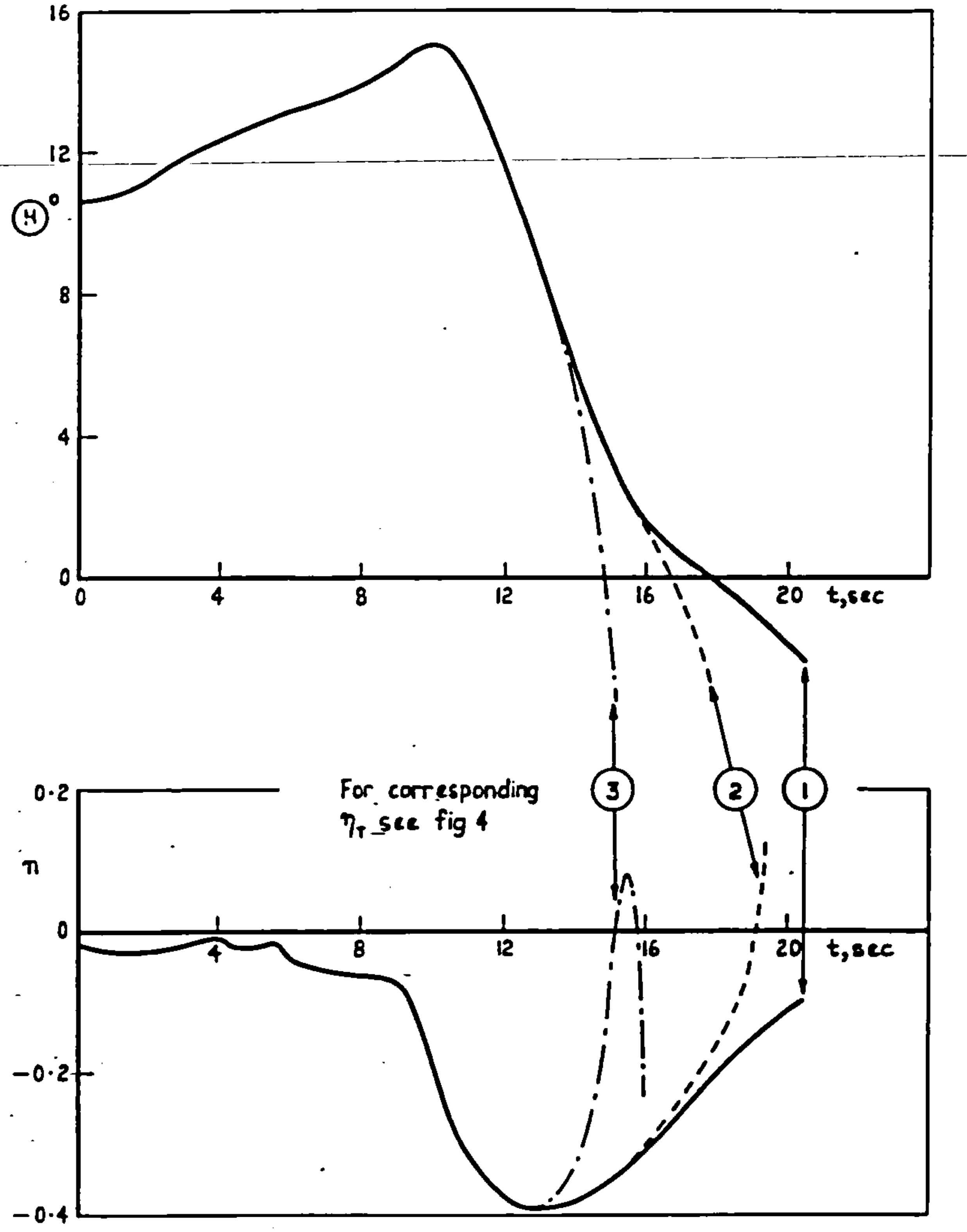


Fig.5 Effect of different recovery action on pitch attitude (angle of inclination), Ⓗ and on normal acceleration factor, n

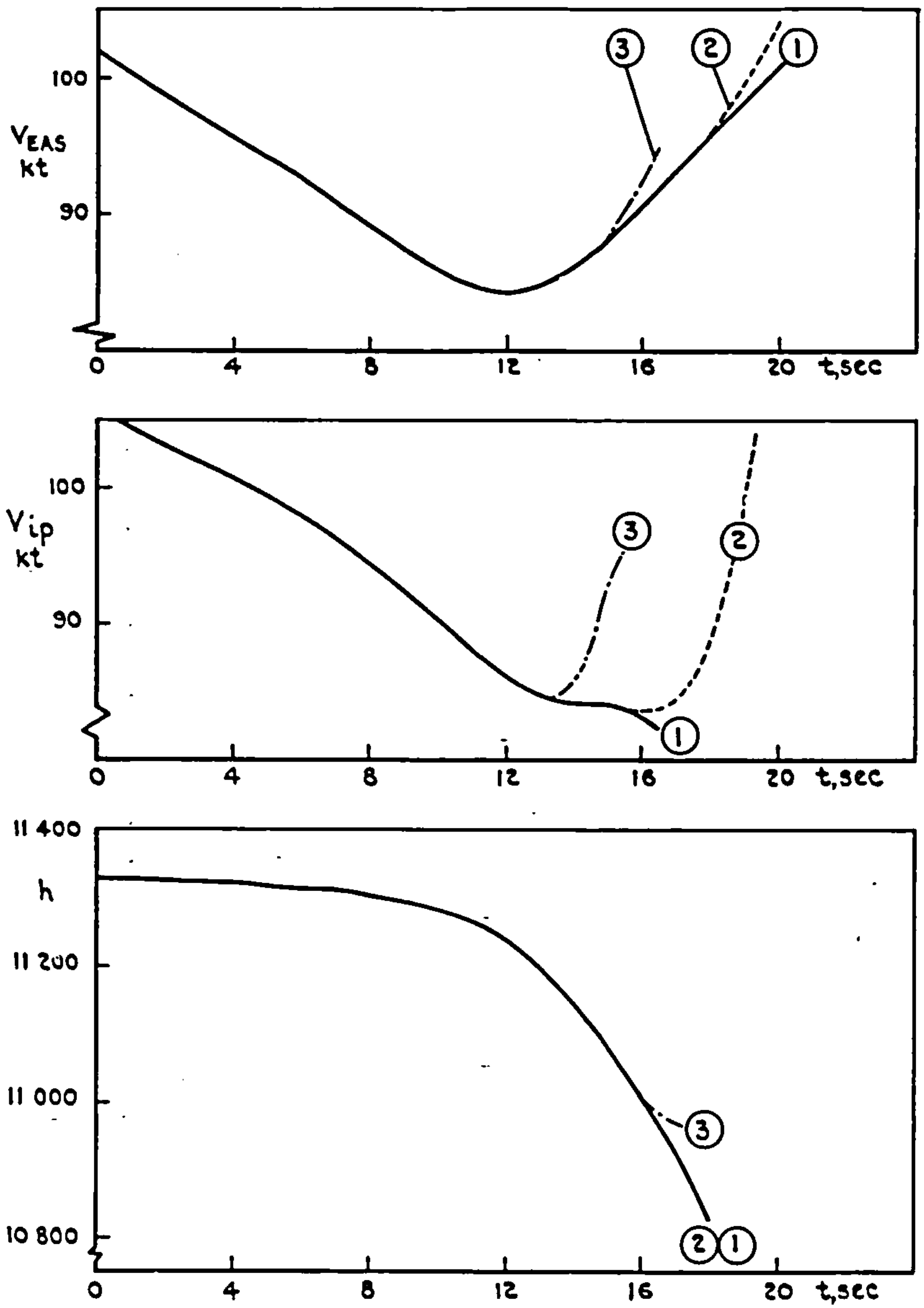
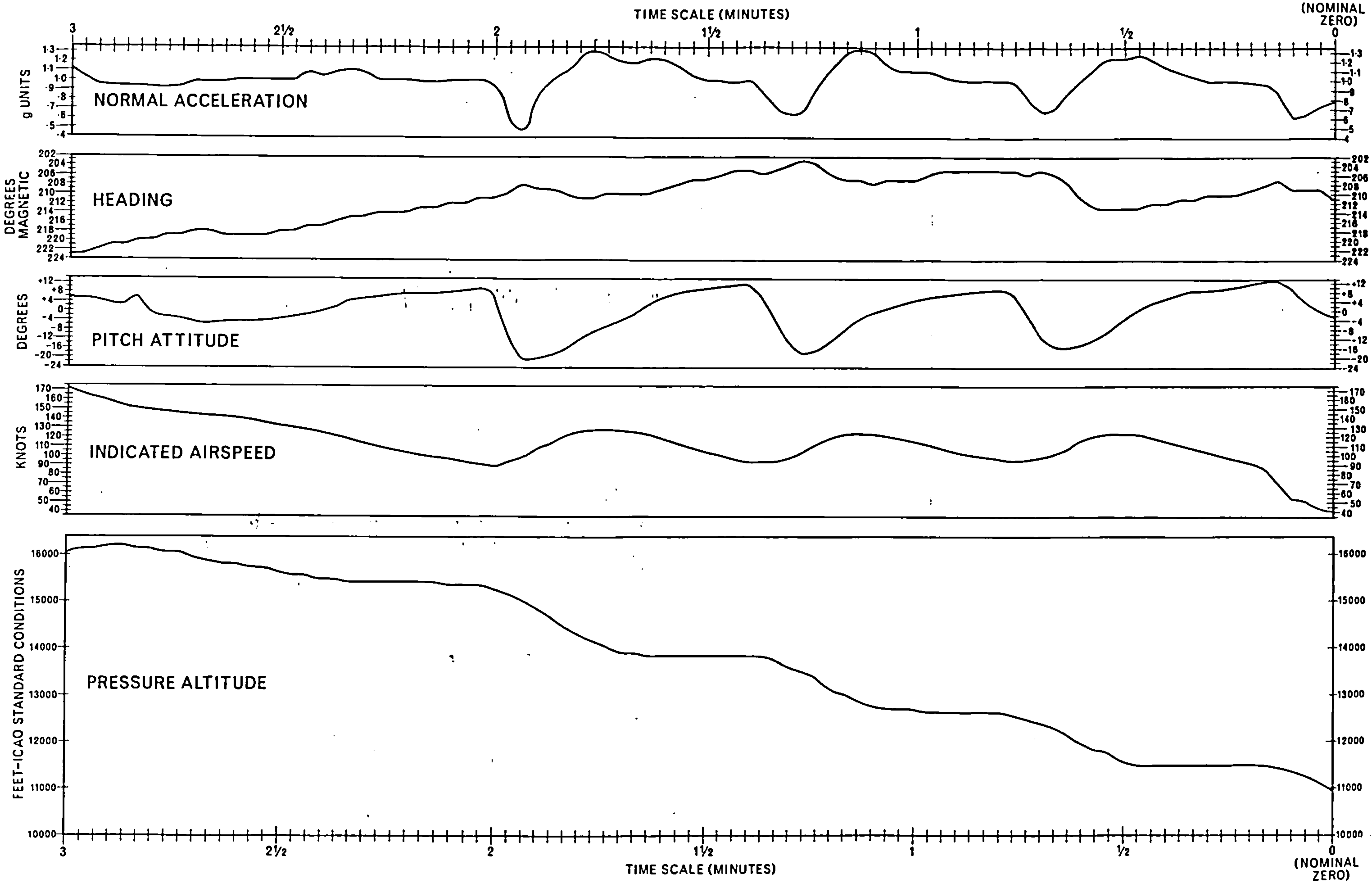


Fig. 6 Effect of different recovery action on airspeed (EAS & IAS) and height

ACCIDENT TO TRIDENT I G-ARPY. 3RD. JUNE 1966

APPENDIX "A"
EW/C/0130



TIME HISTORY OF LAST 3 MINUTES OF FLIGHT RECORDER DATA

May 24 1963
Jan 5 1967
A-17
July 30 1966
{Frozen Water Fouled P-S Boom

FT
instrum

Jan 25 1966
Unstart

Blackbird Family Losses List

Last revised: 4 October 1997

If you've ever wondered about the Lockheed A-12, YF-12, SR-71 planes that were lost, this list is for you! The information in this list is a combination of information in five books:

- *Lockheed Skunk Works: The First 50 Years* by Jay Miller
- *Lockheed SR-71: The Secret Missions Exposed* by Paul F. Crickmore
- *Lockheed SR-71 Blackbird* by Paul F. Crickmore
- *Aerofax Minigraph 1: SR-71 (A-12/YF-12/D-21)* by Jay Miller
- Lockheed Blackbirds by Anthony Thornborough and Peter Davies

All aircraft are listed by their original Air Force serial numbers.

60-6926: A-12

This was the second A-12 to fly but the first to crash. On 24 May 1963, CIA pilot Ken Collins was flying an inertial navigation system test mission. After entering clouds, frozen water fouled the pitot-static boom and prevented correct information from reaching the stand-by flight instruments and the Triple Display Indicator. The aircraft subsequently entered a stall and control was lost completely followed by the onset of an inverted flat spin. The pilot ejected safely. The wreckage was recovered in two days and persons at the scene were identified and requested to sign secrecy agreements. A cover story for the press described the accident as occurring to an F-105, and is still listed in this way on official records.

60-6928: A-12

This aircraft was lost on 5 January 1967 during a training sortie flown from Groom Lake. Following the onset of a fuel emergency caused by a failing fuel gauge, the aircraft ran out of fuel only minutes before landing. CIA pilot Walter Ray was forced to eject. Unfortunately, the ejection seat man-seat separation sequence malfunctioned, and Ray was killed on impact with the ground, still strapped to his seat.

60-6929: A-12

This aircraft was lost on 28 December 1967 seven seconds into an FCF (Functional Check Flight) from Groom Lake performed by CIA pilot Mel Vojvodich. The SAS (Stability Augmentation System) had been incorrectly wired up, and the pilot was unable to control the aircraft 100 feet above the runway. The pilot ejected safely. A similar accident occurred when the first production Lockheed F-117 was flown on 20 April 1982 by Bill Park. It's control system had been hooked up incorrectly. Bill Park survived the accident but had injuries serious enough to remove him from flight status.

60-6932: A-12

This aircraft was lost in the South China Sea on 5 June 1968. CIA pilot Jack Weeks was flying what was to be the last operational A-12 mission from the overseas A-12 base at Kadena AB, Okinawa. The loss was due to an inflight emergency, and the pilot did not survive. Once again, the official news release identified the lost aircraft as an SR-71 and security was maintained. A few days later the two remaining planes on Okinawa flew to the US and were stored with the remainder of the OXCART family.

60-6934: YF-12A

This aircraft, the 1st YF-12A, was seriously damaged on 14 August 1966 during a landing accident at Edwards AFB. The rear half was later used to build the SR-71C (64-17981) which flew for the first time on March 14, 1969.

60-6936: YF-12A

This aircraft, the third YF-12A, was lost on 24 June 1971 in an accident at Edwards AFB. Lt. Col. Ronald J. Layton and systems operator William A. Curtis were approaching the traffic pattern when a fire broke out due to a fuel line fracture caused by metal fatigue. The flames quickly enveloped the entire aircraft and on the base leg both crew members ejected. '936 was totally destroyed.

60-6939: A-12

This aircraft was lost on approach to Groom Lake on 9 July 1964 following a Mach 3 check flight. On approach, the flight controls locked up, and Lockheed test pilot Bill Park was forced to eject at an altitude of 200 feet in a 45 degree bank angle!

60-6941: M-21

This was the second A-12 to be converted to an M-21 for launching the D-21 reconnaissance drone. During a flight test on 30 July 1966 for launching the drone, the drone pitched down and struck the M-21, breaking it in half. Pilot Bill Park and LCO (Launch Control Officer) Ray Torick stayed with the plane a short time before ejecting over the Pacific Ocean. Both made safe ejections, but Ray Torick opened his helmet visor by mistake and his suit filled up with water which caused him to drown. This terrible personal and professional loss drove "Kelly" Johnson to cancel the M-21/D-21 program.

64-17950: SR-71A

The prototype SR-71 was lost on 10 January 1967 at Edwards during an anti-skid braking system evaluation. The main undercarriage tires blew out and the resulting fire in the magnesium wheels spread to the rest of the aircraft as it ran off the end of the runway. Lockheed test pilot Art Peterson survived.

64-17952: SR-71A

This aircraft disintegrated on 25 January 1966 during a high-speed, high-altitude test flight when it developed a severe case of engine unstart. Lockheed test pilot Bill Weaver survived although his ejection seat never left the plane! RSO (Reconnaissance System Officer) Jim Zwayer died in a high-G bailout. The incident occurred near Tucumcari, New Mexico.

64-17953: SR-71A

This aircraft was lost on 18 December 1969 after an inflight explosion and subsequent high-speed stall. Lt. Col. Joe Rogers and RSO Lt. Col. Garry Heidelbaugh ejected safely. The precise cause of the explosion has never be determined. The incident occurred near Shoshone, California.

64-17954: SR-71A

This aircraft was demolished on 11 April 1969 under circumstances similar to 64-17950. New aluminum wheels and stronger tires with beefed up compound were retrofitted to all SR-71s. Lt. Col. Bill Skliar and his RSO Major Noel Warner managed to escape uninjured.

64-17957: SR-71B

This aircraft was the second SR-71B built for the Air Force. It crashed on approach to Beale on 11 January 1968 when instructor pilot Lt. Col. Robert G. Sowers and his "student" Captain David E. Fruehauf were forced to eject about 7 miles from Beale after all control was lost. The plane had suffered a double generator failure followed by a double flameout (caused by fuel cavitation) and pancaked upside down in a farmer's field.

64-17965: SR-71A

This aircraft was lost on 25 October 1967 after an INS platform failed, leading to erroneous attitude information being displayed in the cockpit. During a night flight, the INS gyro had tumbled. There were no warning lights to alert pilot Captain Roy L. St.Martin and RSO Captain John F. Carnochan. In total darkness, in a steep dive and no external visual references available, the crew had little alternative. They were able to eject safely. The incident occurred near Lovelock, Nevada.

64-17966: SR-71A

Lost on the evening of 13 April 1967 after the aircraft entered a subsonic, high-speed stall. Pilot Captain Earle M. Boone and RSO Captain Richard E. Sheffield ejected safely. The incident occurred near Las Vegas, Nevada.

64-17969: SR-71A

Lost on 10 May 1970 during an operational mission, from Kadena, against North Vietnam. Shortly after air-refueling, the pilot, Major William E. Lawson initiated a normal full power climb. Stretching before him was a solid bank of cloud containing heavy thunderstorm activity which reached above 45,000'. Heavy with fuel, the aircraft was unable to maintain a high rate of climb, and as it entered turbulence both engines flamed out. The rpm dropped to a level too low for restarting the engines. Pilot and RSO, Major Gilbert Martinez ejected safely after the aircraft stalled. The plane crashed near Korat RTAFB, Thailand.

64-17970: SR-71A

Lost on 17 June 1970 following a post-tanking collision with the KC-135 tanker. Lt. Col. "Buddy" L. Brown and his RSO Maj. Mortimer Jarvis ejected safely although both legs of the pilot were broken. The SR-71 crashed 20 miles east of El Paso, Texas, but the KC-135 limped back to Beale AFB with a damaged fin.

64-17974: SR-71A

This aircraft was lost on 21 April 1989 over the South China Sea and is the last loss of any Blackbird as of December 1991. Pilot Lt. Col. Dan House said the left engine blew up and shrapnel from it hit the right-side hydraulic lines, causing a loss of flight controls. House and RSO Blair Bozek ejected and came down safely in the ocean. They had been able to broadcast their position before abandoning the Blackbird, and rescue forces were immediately on the way. However, the crew were rescued by native fisherman. The local chieftain's new throne is Colonel House's ejection seat!

64-17977: SR-71A

This aircraft ended its career in flames by skidding 1000 feet off the end of runway 14 at Beale on 10 October 1968. The takeoff was aborted when a wheel assembly failed. Major James A. Kogler was ordered to eject, but pilot Major Gabriel Kardong elected to stay with the aircraft. Both officers survived.

64-17978: SR-71A

Nicknamed the *Rapid Rabbit*, this aircraft was written off on 20 July 1972 during the roll out phase of its landing. The pilot, Captain Dennis K. Bush, had practised a rapid deploy-jettison of the braking parachute. A go-around was initiated after the chute was jettisoned. On the next landing attempt, the aircraft touched down slightly "hot" but had no chute to reduce the aircraft's speed. The pilot was unable to keep the plane on the runway. A wheel truck hit a concrete barrier. The aircraft suffered significant damage. The pilot and the RSO, Captian James W. Fagg, escaped without injury.

A total of 20 Lockheed Blackbirds have been lost due to a variety of accidents; however, not one was shot down by unfriendly forces!

Broken down by type:

Aircraft designation:	A-12	M-21	YF-12	SR-71A	SR-71B	SR-71C
No. of aircraft built:	13	2	3	29	2	1
No. of aircraft lost:	5	1	2*	11	1	0

** SR-71C (64-17981) was built using the rear half of YF-12A (60-6934) and functional engineering mockup of the SR-71A forward fuselage.*

Written by Al Dobyns
Maintained by Carl Pettypiece

The first YF-12A (60-6934) took off on its initial flight on August 7, 1963, piloted by James D. Eastham. It was equipped with a streamlined camera pod mounted underneath each engine nacelle for photographing AIM-47 missile launches. Three YF-12As were built. Serials were 60-6934/6936.

While on a routine INS test flight with A-12 number 123 on May 24, 1963, CIA detachment pilot Kenneth Collins entered some clouds. Water vapor froze in the pitot tube, giving an erroneous airspeed reading. With the airspeed indicator giving the wrong reading, the aircraft stalled. Collins ejected safely from the aircraft after it entered an inverted flat spin. The aircraft crashed 14 miles south of Wendover, Utah. The wreckage was recovered in two days, and people at the scene were identified and requested to sign secrecy agreements. A cover story for the press described the accident as occurring to a F-105, and is still listed in this way on official records.

Although this particular loss was ultimately traced to a problem that was easily corrected, it nevertheless precipitated a policy problem within the Agency. With the growing number of A-12s flying out in the western desert, the CIA felt that there was a danger that the *OXCART* project's cover could be blown at any moment. Although the program had gone through development, construction, and a year of flight testing without attracting any public attention, the Department of Defense was experiencing increasing difficulty in concealing its participation in the *OXCART* program because of the delays and cost overruns that had increased the rate of expenditures to such an extent that they might eventually get large enough to attract unwanted attention from congressional budget oversight committees. There was also a realization that the technological data would be extremely valuable in connection with feasibility studies for the SST. Finally, there was a growing awareness in the higher reaches of the aircraft industry that something new and remarkable was going on. Several commercial airline crews had reported sighting unidentified aircraft in flight. The magazine *Aviation Week* indicated to its readers that it was vaguely aware that there was some rather unusual project going on at the Skunk Works at Burbank.

Soon after President Lyndon Johnson took office following the assassination of President John Kennedy on November 22, 1963, he was briefed on the *OXCART* project and directed that some sort of cover announcement be prepared for the spring of 1964. On February 29, 1964, President Johnson announced that "The United States has successfully developed an advanced experimental jet aircraft, the A-11, which has been tested in sustained flight at more than 2,000 miles per hour and at altitudes in excess of 70,000 feet. The performance of the A-11 far exceeds that of any other aircraft in the world today. The development of this aircraft has been made possible by major advances in aircraft technology of great significance for both military and commercial applications. Several A-11 aircraft are now being flight tested at Edwards Air Force Base in California.

current information on its whereabouts?

The A-12s continued on to become operational spy planes and carried out numerous reconnaissance missions, the details of which are still highly classified even today. The OXCART document (assuming it to be genuine) gives a few of the details. The OXCART fleet was taken out of service and placed in storage in the late 1960s.

In February 1963, Lockheed undertook redesign of the basic A-12 with additional fuel tankage, broader forward nose chines, and the provision for inflight refueling and a seat for a second crewman. This eventually emerged as the SR-71.

Specification of Lockheed YF-12A:

Engines: Two Pratt and Whitney J-58 (JT11D-20B) turbojets, each rated at 32,500 lb.s.t. with afterburning. Performance (estimated): Maximum cruise speed: 2110 mph at altitude (Mach 3.2) Maximum operational ceiling: 85,000 feet Maximum unrefuelled range: 2500 miles Dimensions: Length: 101 feet 7 inches, Wingspan: 55 feet 7 inches. Height: 18 feet 6 inches. Wing Area: 1795 square feet Weights: 60,730 pounds empty, 127,000 pounds maximum takeoff. Armament: Four Hughes AIM-47A air to air missiles which are explosively ejected downwards from paired tandem missile bays.

Sources:

1. Lockheed Aircraft Since 1913, Rene J. Francillon, Naval Institute Press, 1987.
2. The American Fighter, Enzo Angelucci and Peter Bowers, Orion Books, 1987.
3. The Illustrated Encyclopedia of Aircraft Armament, Bill Gunston, Orion Books, 1988.
4. Lockheed Blackbirds, Anthony M. Thorborough and Peter E. Davies, Motorbooks International, 1988.
5. The OXCART Story, Thomas P. McIninch, available from Skunk Works Digest.
6. Lockheed A-12/YF-12/SR-71, Paul F. Crickmore, Wings of Fame Vol 8, 1997.

12/10/63
6/?/71

Lockheed NF-104A Starfighter

Last revised December 9, 1999

In 1963, three ex-USAF F-104As (56-756, -760, and -762) were taken out of storage at Davis Monthan AFB and modified as NF-104A aerospace training aircraft. All of the military equipment was removed and the original F-104A vertical fin was replaced by the larger fin that was used on the F-104G. The wingspan was increased by four feet (to 25.94 feet) and a set of hydrogen peroxide control thrusters were mounted at the nose, tail, and wingtips. A 6000 pound thrust Rocketdyne LR121/AR-2-NA-1 auxiliary rocket engine was mounted on the tail above the jet exhaust pipe. This rocket engine could be throttled from 3000 to 6000 pounds of thrust, and the burn time was about 105 seconds.

The first NF-104A was delivered on October 1, 1963, with the other two following a month later. They were operated by the Aerospace Research Pilot School at Edwards AFB, which was commanded at that time by Colonel Charles E. "Chuck" Yeager.

On December 6, 1963, the first NF-104A set an unofficial world altitude record of 118,860 feet for aircraft taking off under their own power. The official record at that time was 113,829 feet, set by the Mikoyan/Gurevich Ye-66A, an experimental version of the MiG-21 Fishbed. Later, the same NF-104A flown by Major R. W. Smith reached an altitude of 120,800 feet.

On December 10, 1963, the second NF-104A (56-762), with Chuck Yeager at the controls, went out of control at an altitude of 104,000 feet and fell in a flat spin to 11,000 feet. Yeager managed to eject successfully at that altitude, although he was badly burned on his face by the rocket motor of his ejector seat. The aircraft was destroyed in the ensuing crash. An investigation later showed that the cause of the crash was a spin that resulted from excessive angle of attack and lack of aircraft response. The excessive angle of attack was not caused by pilot input but by a gyroscopic condition set up by the J79 engine spooling after shut down for the rocket-powered zoom climb phase. So it wasn't Chuck's fault.

In June of 1971, the third NF-104A, with Capt. Howard C. Thompson at the controls, suffered an inflight explosion of its rocket motor. Although Thompson was able to land safely, the aircraft's rocket motor and half its rudder were blown away. Since the program was about to end in any case, this aircraft was retired.

The number one NF-104A is currently on display on top of aa pylon in front of the USAF Test Pilot School.

Sources:

1. The Lockheed F-104G/CF-104, Gerhard Joos, Aircraft in Profile No. 131, Doubleday, 1969.

2. The World's Great Interceptor Aircraft, Gallery Books, 1989.

3. Lockheed F-104 Starfighter, Steve Pace, Motorbooks International, 1992.

4. Lockheed Aircraft Since 1913, Rene J. Francillon, Naval Institute Press, 1987.

5. The American Fighter, Enzo Angelucci and Peter Bowers, Orion, 1987.

12/31/1963

VC-10

department I liked best during my apprenticeship was the Wind Tunnel.

The first three aircraft had escape hatches for the flight test crew and one of my jobs was to help the photographer with his high speed cine-film photographs of simulated escapes from a model in the 13' x 9' tunnel. I pulled the string which released a model man who was then photographed, something that we did for various speeds and attitudes. All was well except for one particular combination and one hatch (the one forward on the side), when the man flew into the engine. We did that test again and he hit the tailplane. At the third attempt he just caught the wing downwash and went safely below the engines.

Some time later I asked the photographer what the flight test crew said when they saw the film. He told me that he had cut that bit out and only showed the safe exit as he didn't want to worry them! I never did find out whether he was pulling my leg or whether he really did edit the film."

Well, things could have been worse! On the subject of escape hatches I couldn't resist adding the following lines from Brian Trubshaw's 1998 autobiography 'Test Pilot'. In these lines Brian Trubshaw recalls one of the stall tests that he carried out with the prototype G-ARTA when things didn't go as planned.

"The last day of 1963 nearly brought the stalling programme to an abrupt end. I was just recovering from a clean stall when at about 250 Kts all hell broke loose as G-ARTA started shaking violently. There was a shout from the Senior Observer, Chris Mullen, who was looking at the tail through his periscope, 'Right inner elevator'. I was quite certain that G-ARTA was going to come apart and it nearly did, so I fired the escape hatch door and ordered the crew to bale out. The flight engineer, Roy Mole, could not get out of his seat and the same applied to the co-pilot Captain Peter Cane of BOAC, while the crew in the back could not hear me above the general racket. I managed to reduce speed to about 160 Kts which put me very close to a pre-stall buffet, whereupon the violent vibrations and oscillations calmed down to a smaller amount. The escape hatch chute which went through the front forward hold had collapsed and gone out when the door was jettisoned, so it was as well nobody tried to use it and only a jangled bunch of metal remained. I made a very gentle return towards Wisley under Mayday conditions and soon realized that I had lost half the aircraft services. However, the split system principle worked very well but I had to free-fall the right landing gear. After flight inspection revealed that the two right-hand engines had rotated 2 inch and in doing so pulled off hydraulic pipes and air-conditioning pipes. The right inner elevator had broken its attachment bracket which had set up flutter of that surface. Two fin attachment bolts were severed. In fact poor G-ARTA with whom I had developed a great bond of affection was in a sorry state. I think that we had done about 2,300 stalls together."

The type of escape hatch discussed above was fitted to both the VC10 and also to the BAC 1-11 (and perhaps other types of aircraft but I'm not sure about that). They consisted of a metal tunnel (the escape chute) that slid down through the forward freight hold to extend down below the aircraft through the freight hold door aperture after the door was removed using explosive bolts. Whether this would have provided a safe exit for the flight crew is a debatable issue, especially when the stories above are taken into account. The BAC 1-11 prototype G-ASHG was lost in October 1963 - just months before the incident with G-ARTA - when it got itself into a stable stalled condition and the flight crew did not have enough elevator authority left to regain control. The escape system was fired but the aircraft hit the ground shortly after the freight hold door was explosively removed. The flight test crew of seven did not survive the accident.

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Memories

Jan /10 /1964

B-52 G

Lost Vertical Stab

Cool Wings Forum

Jan 10, 1964

Verticle Stab

Verticle Stab (modified 0 times) skippy

Profile | Email

Looking for info on the B-52 that lost its vertical stab over the Grand Canyon. I would love pictures. I looked at the gallery with no success.

Mar 10, 2000 08:34:24 A.M.

RE:Vertical Stab (modified 0 times) Steve

Profile | Email

Mr. Kelly M. Haggar wrote with the following: "The vertical fin (not "verticle") was JB-52H 61-0023, 10 Jan 64. See nice picture of it on page IGC790516-74 of Evolution of the B-52 Weapon System - Past, Present, and Future, Nov 88, put out by BMAC in Wichita."

Editor's Note: Pictures of this aircraft are also found in other books, one I know of is page 100 of Boeing B-52 Stratofortress by William G. Holder. It's out of print but copies aren't that hard to find.

Mar 13, 2000 11:20:09 A.M.

RE:Verticle Stab (modified 0 times) Scott

Profile

This aircraft lost its vertical stabilizer while engaged in a test flight researching mountain wave turbulence over the Rocky Mountains (Colorado?), not over the Grand Canyon. In addition to the BMAC document and the Holder book, I've found the following references: Airpower magazine Vol 12, #2, March 1982, article 'B-52, The Once And Future Emperor of Airpower' by Boyne, p. 34 (2 photos w/captions); Aircraft Profile #245, Boeing B-52A/H Stratofortress by Bowers, p. 21 (1 photo w/caption); Aerofax Datagraph 7, Boeing B-52G/H Stratofortress by Jenkins and Rogers, pp. 9-10 (text only); Boeing B-52, A Documentary History by Boyne, pp. 112-113 (text, 1 photo w/caption). Hope this helps.

Mar 20, 2000 09:34:00 A.M.

[B]RE:Verticle Stab (modified 0 times) **Medstar**

Profile | Email

You can find more about this at the US Air Force museum's web site. They have an article about the incident with a photo. Of note, it was carrying two AGM-28 Hound Dog missiles with inert warheads at the time. You may have to search a bit, but it's not too hard to find.

Medstar

Mar 24, 2000 05:41:13 P.M.

[B]RE:Verticle Stab (modified 0 times) **MB II**

Profile

This acft landed at Blytheville AFB, was painted orange and flown by a Boeing crew. It was immediately towed to a hanger and secured. No one was allowed even close to it. A Boeing repair crew was brought in and after minor repairs they flew it back without replacing the stab.
Ed

May 21, 2000 08:27:12 P.M.

[B]RE:Verticle Stab (modified 0 times) **Scott**

Profile

It seems highly unlikely that Boeing would have performed only "minor repairs" and then flown 61-0023 out of Blytheville AFB "without replacing the stab", considering the unique and very serious nature of the emergency. Without the vertical stabilizer and rudder, the aircraft would have had little, if any, yaw stability, no ability to counter loss of engine(s) with rudder and an unknown set of flight control interactions. Do you have any proof of your assertions? Is there any authoritative documentation that Boeing flew this aircraft out of Blytheville without a vertical stabilizer? If there is, I think a lot of us former B-52 drivers would like to see it.

May 23, 2000 01:00:10 P.M.

[B]RE:Verticle Stab (modified 0 times) **MB II**

Profile

I don't know of any documentation, I only know what I saw. The acft was only at Blytheville for about 7-10 days, not enough time to install a new stab. If I remember correctly, only about the top 1/3 of the fin was gone. Not being a driver, only a crew chief I wouldn't know how it affected the handling, but they flew it to Ark from the Rockies and I watched it land at Blytheville perfectly. After flying it that far I can see of no reason not to fly it back to Wichita.
Ed

May 25, 2000 12:59:28 P.M.

[B]RE:Verticle Stab (modified 0 times) **Scott**

Profile

We must be talking about 2 different aircraft. The B-52H I've been referring to, 61-0023, had much more than the top 1/3 of the fin gone. Photographs of the aircraft show only about 15% of the fin remaining on the aircraft, with the entire rudder gone. As far as it having flown from the Rockies to Blytheville and managing to avoid crashing being a good enough reason to fly it back out unrepaired, I doubt it. Aircraft are often flown long distances after having suffered major emergencies in order to obtain the most favorable conditions for landing - that doesn't mean the aircraft can or should take back off again without repairs. I often briefed my crew that in the event of certain hydraulic failures resulting in loss of brakes, we would divert from our home base of Griffiss in NY to Edwards in CA because of the long lakebed runway available there. That sure doesn't mean I would turn around and fly it back to Griffiss just because I was able to fly it all the way to Edwards and land successfully. The crew involved sure didn't fly all the way to Blytheville just to show it could be done. Several sources (Boyne, p. 113; Jenkins & Rogers, p. 10)state that Blytheville was selected because the approach there was over unpopulated areas and the winds were right down the runway. This tells me that the crew were concerned about possibly losing control and didn't want to kill people on the ground, and that they needed the most favorable wind conditions to try to land. That doesn't sound like an aircraft anybody would want to take back off in again without repairing the damage. As to the aircraft landing perfectly at Blytheville, the pilot involved, Chuck Fisher, is quoted as saying, "the landing was not my best one but the airplane was drifting left off the runway and the only way to stop it was to get it on the ground." I guess your perspective varies when you're actually in the airplane and not watching it from the ground. The aircraft made a flaps-up landing since, as every B-52 pilot knows, you want to make minimal configuration changes after experiencing structural damage as 61-0023 did. Therefore, if the aircraft was flown back out of Blytheville unrepaired after having made a flaps-up landing with major structural damage, it would have either had to take back off flaps up (ie, in the same configuration it landed in)or it would have had to have its flaps lowered on the ground after it landed and then take back off in a new, untested and probably unflyable configuration. A flaps-up takeoff in a B-52 is a non-starter, unless you're the NB-52B at Edwards with 20 miles of dry lakebed to use. I can't imagine any sane pilot/crew agreeing to take off in an unrepaired aircraft that had lost all of its rudder and 85% of its vertical stabilizer, with unknown takeoff and flight characteristics, no capability to effectively counter loss of engine(s) on takeoff, and no idea if the mountain wave turbulence had caused additional hidden structural damage that might decide to propagate further at any time. With respect to this incident,the Boeing document "Evolution of the B-52 Weapon System-Past, Present and Future" says, "Although the directional stability of the airplane was very marginal, the airplane was safely recovered by use of special techniques of increasing drag aft of the CG, i.e. use of aft landing gear during cruise, and outboard airbrakes only." That doesn't sound to me like an aircraft I'd want to fly anywhere in unrepaired. My copies of Boeing document D3-5393, Time for Action, and D3-5393-1, Time For Action AGAIN, make it very clear that "the rudder should be used as the primary yaw control on the aircraft" (Time for Action AGAIN, p. 98)and that pilots should "Use the rudder to assist the spoilers to control roll, and use the spoilers to assist the rudder to control yaw." (Time for Action, p. 69). Without the rudder, the pilot will be unable to do these things and will be sacrificing a significant aspect of overall aircraft control. As far as 7-10 days not being enough time to change a vertical stabilizer/rudder, I can't say. My guess would be that changing a vertical stab/rudder wouldn't be much harder than changing a pair of engines, and I've seen that done in less than 7 days, but I could be wrong. On this particular aircraft, the entire Boeing flight crew was ready to eject after the damage was sustained - the only reason they didn't was a desire to try to save a highly-instrumented aircraft and the valuable flight test data they had just acquired. That they were able to save the aircraft by flying it to a landing location far removed from where it was damaged (and where landing conditions were the best obtainable)is a testament to their skill and professionalism and not an indication that the unrepaired aircraft could or should have been flown one more foot without significant repairs. With all due respect, I have to believe that 61-0023 had its vertical stabilizer and rudder replaced at Blytheville by Boeing before it was flown back out and on to B-52 fame. I was never a test pilot, but with over 3000 hours of B-52 pilot, instructor pilot and evaluator pilot time, I can't conceive of any B-52 pilot being willing to fly that airplane back out unrepaired with that kind of damage, even a test pilot. I await documentation proving otherwise.

May 29, 2000 02:12:20 P.M.

RE:Verticle Stab (modified 0 times) dennis

Profile | Email

I can't imagine any aircraft taking off with only a portion of it's vertical stab, let alone a BUFF! I was never a pilot, but was on seveal ground crews (FMS and OMS)and studied as a hobby aero dynamics (I'm no expert). In some cases I suppose it could be done, but obviously certain parameters and conditions would have to be met in order to achieve the end result. In addition, I would think that the assigned C.O. at that time would never ever approve such a flight unless once again it was under strict controlled conditions, permission for this type of flight would obviously have to come from the highest authorities like the SAC commander himself, or maybe even higher? But who knows, the AF did some weird things that had all of us wondering sometimes??? Ha!

Dennis Wheeler
Gold Hill, Oregon

Jun 01, 2000 07:23:15 A.M.

RE:Verticle Stab (modified 0 times) pete

Profile

Sounds to me like MBII saw the Buf leave with a new fin, perhaps didn't recognize that an H has a short fin compared with the older talltails. It might be noted to you younger guys that for a long time after that accident we flew training low level routes at 260 KIAS, as the fleet was restricted to 270KIAS until extensive structural mods had been completed. At the time, low level was becoming the primary EWO mode of delivery and the 52 had not been originally designed with that in mind. The incident proved the vulnerability to turbulence.

Jun 01, 2000 04:04:47 P.M.

RE:Verticle Stab (modified 0 times) MB II

Profile

It's been 35 years since I've even thought about this incident, but at the time we thought they were out of their minds to fly the acft back without a complete new stab. Concerns about the structural integrity of the tail section, the amout of security required and the fact that repairs had to be made outside contributed to the decision to fly it back to depot. We were not allowed close enough to see what type of repairs were made, but I was used to seeing G models and when this acft left the tail didn't look like any of the planes we had at Blytheville. I'm sure they installed some type of rudder and repaired the jagged edges where it had been ripped off. I've got no axe to grind on this incident, I was only relating the information as best as I could remember it. Things were done differently in the mid 60's, I launched an acft with only 7 engines running (starter problems) just to preserve a string of on time take-offs. (Memphis Belle II, 57-6513, 300 consectutive on time take-offs 1967) Acft Co's decision, I was told later that they got the engine fired prior to take-off? The Buf aircrews were some of the best and safest people I've ever had the pleasure of serving with, but believe it or not, there were a few Cowboys around back then.

Jun 01, 2000 10:34:14 P.M.

RE:Verticle Stab (modified 0 times) **Twinspin**

Profile

Concerning the B-52 without a V Stablizer... This is from an old man who only remembers certain things..... A B-52 did land at Blytheville AFB with its entire V Stablizer GONE.. (all except about 2-3 feet). Boeing Boys came, refused any help from OMS or FMS, (however a few airman did some of the grunt work) jacked the aircraft, retracted and extended the landing gear several times, changed the V Stablizer and took it back to the factory... Did not remember any orange paint... Could have been that the V Stab had some orange primer paint on it due to it being from the production line at Boeing. Again... as best as I can remember they would not let anyone close to the Aircraft because they really wanted to see were they were going to place the blame...

Ernie
Crewchief 1959-1967
Blytheville AFB, Eglin AFB, Ellsworth AFB

Jun 16, 2000 04:24:25 P.M.

RE:Verticle Stab (modified 0 times) **LoadToadB52H**

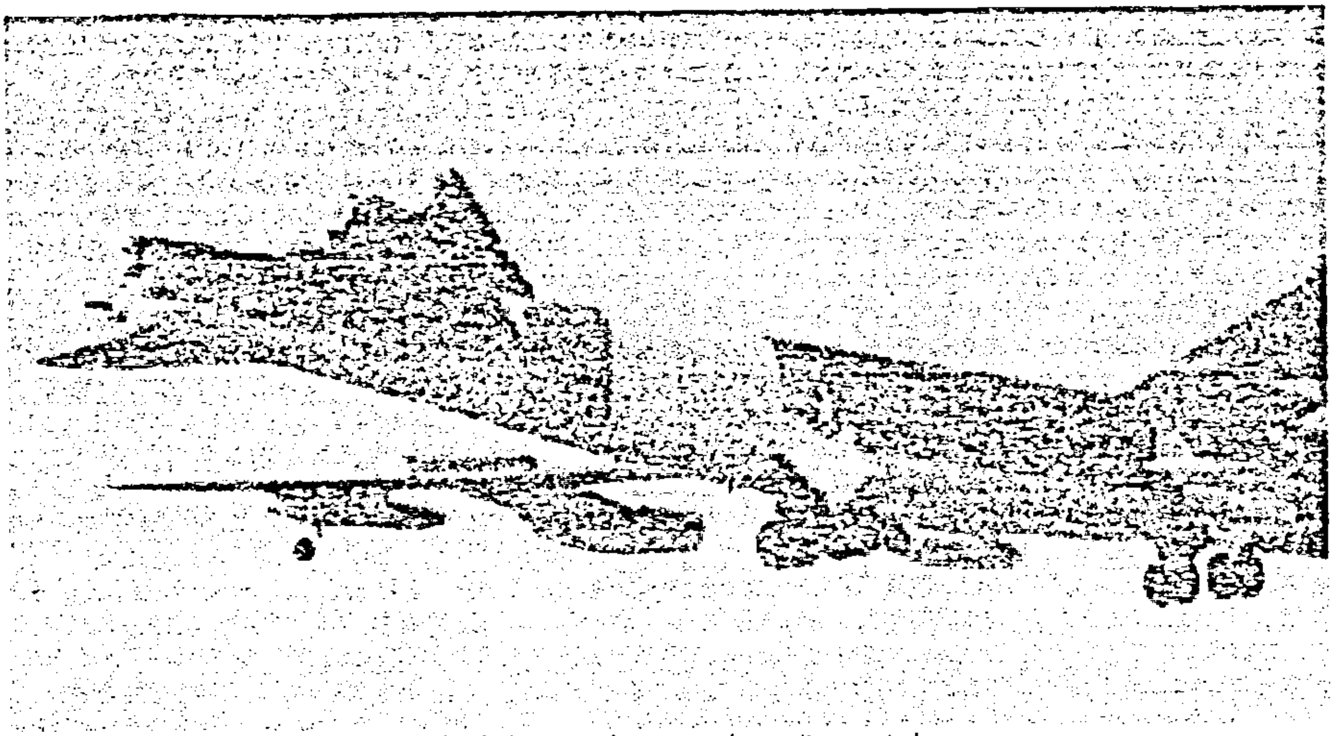
Profile | Email

Well, I have a pic of a G model in glight with almost no vertical stab remaining. I'm not sure if this is the jet in question, but it sure sounds like it. I'll mail out the pic if you want. Can't tell the Acft #, so like I said, this may not be it.

Jun 16, 2000 06:50:58 P.M.

RE:Verticle Stab (modified 0 times)

Profile | Email



I came across this image but I don't know when or where it was taken.

Jun 17, 2000 10:35:26 A.M.

RE:Verticle Stab (modified 0 times) **Twinspin**

Profile

Loadtoad....

Picture could have been taken before it landed at Blytheville AFB.. Instead of after takeoff from Blytheville.. Again, Hell I'm just an ol man that barely remembers the incident... Triming the old J-57's with water injection engaged, will rattle anybody's ol brain....

Ernie
Crewchief 1959-1967
Blytheville AFB, Eglin AFB, Ellsworth AFB

Jun 17, 2000 10:44:26 A.M.

RE:Verticle Stab (modified 0 times) **Twinspin**

Profile

Yep..... that's her.... Hounds and everything except no V Stab... Could be landing... has gear down, outboard airbrakes up...

Ernie
Crewchief 1959-1967
Blytheville AFB, Eglin AFB, Ellsworth AFB

Jun 17, 2000 10:55:49 A.M.

RE:Verticle Stab (modified 0 times) **Twinspin**

Profile

Also..... If the picture was post Blytheville it would not have the hounds still on it.

Jun 18, 2000 10:19:17 A.M.

RE:Verticle Stab (modified 0 times) **Scott**

Profile

This is probably the most well-known of the photos of the aircraft involved in the loss of the rudder and most of the vertical stabilizer due to mountain wave turbulence and was most likely taken by the chase aircraft that accompanied her to Blytheville AFB. There are other, less well-known photos also. Also, this is an H-model, not a G-model as Loadtoad states. The 20mm Vulcan cannon in the tail and the bypass exhaust ducts of the TF33 turbofan engines are all clearly visible in the photo.

Jun 20, 2000 09:56:37 A.M.

RE:Verticle Stab (modified 0 times) **Joseph**

Profile | Email

Scott do you know where I can get any other photos of this B-52?

Jun 24, 2000 10:34:43 A.M.

RE:Verticle Stab (modified 0 times) **Scott**

Profile

Joseph,
The copy that I have of this particular picture of 61-0023 is on page 21 of Aircraft Profile 245, Boeing B-52A/H Stratofortress, by Peter M. Bowers. There are at least 3 other, very similar, pictures that I have copies of. These 4 photos were all probably taken only minutes apart, all obviously by the same person. One is on page 112 of the book Boeing B-52: A Documentary History by Walt Boyne. Another is on page 34 of the March 1982 issue (Vol 12, #2) of Airpower magazine in an article called B-52: The Once And Future Emperor of Airpower, also by Walt Boyne. The third photo is on an unnumbered page in a Boeing Wichita document called Evolution of the B-52 Weapon System-Past, Present and Future. This document was referenced in one of the first posts in this thread. Finally, also on page 34 of the Airpower magazine, there is a completely different view of the damaged vertical stabilizer (or what's left of it) taken on the ground, probably at Blytheville. These 5 photos of 61-0023 with its damaged vertical stabilizer are the only ones published that I'm aware of. I would bet that the photo that Steve references as being on page 100 of Holder's book is one of these 5, probably one of the sequence of 4 taken at about the same time in flight.

Jun 26, 2000 12:58:25 P.M.

RE:Verticle Stab (modified 0 times) **Scott**

Profile

Joseph, I just checked the USAF Museum site that Medstar referenced in his earlier post on this thread and the photo there is the same as the one on page 34 of the Airpower magazine article that I referenced.

Jun 26, 2000 01:09:38 P.M.

RE:Verticle Stab (modified 0 times) **alfie**

Profile

what i remember about this incident was being on a bomb run against little rock bomb plot and being diverted off range at 120 sec tg (i think)and to report any visual sightings of the aircraft. got all the details after landing. but never heard of flying the aircraft w/o a vert stab after the landing at blythville

Oct 09, 2000 11:20:44 A.M.

RE:Verticle Stab (modified 0 times) **Mike**

Profile | Email

Not sure if this is the same incident but I attended the retirement of Col Charlie Brown at Edwards AFB in 1996 at the B-2 test facility, and the presiding officer told a story about Col Brown being the only pilot to ever land a B-52 without a Vert Stab. I'm sure he never worked for boeing so this may have happened a couple of times

---

Mike L

Oct 31, 2000 07:26:36 P.M.

RE:Verticle Stab (modified 0 times) **Boneman**

Profile

Actually, Charlie landed the aircraft without an operable horizontal stab. He experienced a dual SASS failure (the vertical stab was intact). The aircraft broke into three pieces after "landing." The EW and Gunner were actually "hanging out the back" still strapped into thier seats. All survived. Charlie did a great job. Two other "stab out" dual SASS failure landings occured after this one, one at Wurtsmith and the other (I think) at KI. Because of lessons learned from Charlie's experience, both aircraft were able to land safely. BTW, Charlie's accident was at Wright-Patterson before the BW closed there.

Nov 12, 2000 03:54:21 P.M.

Post a New Message | Reply this Thread | Printer | Forward

All times are PCT

Contact Us | Home

- B-52 Talk GO

06/04/1964

NTSB Identification: **Unknown**
14 CFR Part 91 General Aviation
Event occurred Thursday, June 04, 1964 in WICHITA, KS
Aircraft: LEAR M23, registration: N801L

FILE	DATE	LOCATION	AIRCRAFT DATA	INJURIES F S M/N	FLIGHT PURPOSE	PILOT DATA
2-0240	64/6/4 TIME - 0800	WICHITA KAN	LEAR M23 N801L DAMAGE-DESTROYED	CR- 0 0 2 PX- 0 0 0 OT- 0 0 0	MISCELLANEOUS TEST	AIRLINE TRANSPORT, AC 41, 5700 TOTAL HOURS, IN TYPE, INSTRUMENT RATED.

NAME OF AIRPORT - WICHITA
TYPE OF ACCIDENT
STALL: SPIN
WHEELS-UP

PHASE OF OPERATION
TAKEOFF: INITIAL CLIMB
TAKEOFF: ABORTED

PROBABLE CAUSE(S)
PILOT IN COMMAND - INADEQUATE PREFLIGHT PREPARATION AND/OR PLANNING
PILOT IN COMMAND - FAILED TO USE OR INCORRECTLY USED MISC.EQUIPMENT
FACTOR(S)
MISCELLANEOUS ACTS,CONDITIONS - SIMULATED CONDITIONS
FIRE AFTER IMPACT
REMARKS- ATTEMPTED TAKEOFF WITH SPOILERS EXTENDED

Printable brief - Please change to print landscape.

Index for Jun1964 | Index of months

1965 / 1966

50th Anniversary of the Air Force Flight Test Center

THIS WEEK IN HISTORY

60s

80s

90s

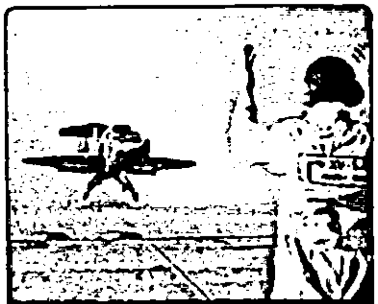
Edwards Air Force Base

AUG. 13, 1965

To commemorate the 50th Anniversary of the Air Force Flight Test Center, which was established June 25, 1951, the AFFTC History Office will recall some of the milestones in flight that took place here during the last half century. These articles will appear on a weekly basis throughout the year 2001.

Why Not Put Lift Fans in the Wings?

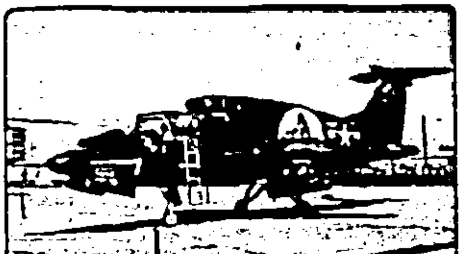
By Dr. Raymond L. Puffer
Air Force Flight Center historian


An XV-5A approaches the ramp at South Base

Aviation designers have been working on the concept of vertical and short takeoff and landing (V/STOL) aircraft for many years.

There are a number of different ways to combine a helicopter's lift with the performance of a conventional airplane, but developing a practical and successful hybrid aircraft has proven to be a surprisingly difficult task. Numerous approaches have been explored over the years, of which the two Joint Strike Fighter concept demonstrators are only the latest. There have been tilt-rotors like the CV-22 Osprey, tilt-props and tilt-wings, as well as deflected-slipstreams, deflected-thrust, thrust augmentors, and tailsitters. Many of these exotic designs have been tested at Edwards, and Air Force Flight Test Center pilots have often been called to fly some extremely unusual aircraft.

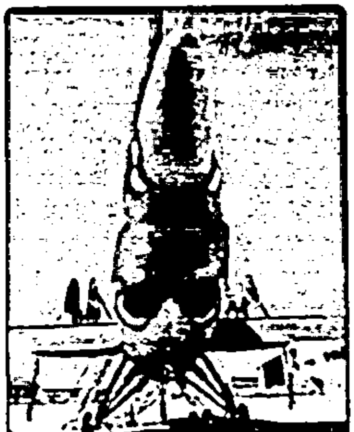
On Aug. 13,1965, Maj. Robert L. Baldwin lifted an oddly humpbacked brown jet into the air and began the Air Force Flight Evaluation of the GE-Ryan XV-5A. General Electric had been researching a fan-in-wing concept for V/STOL aircraft, and late in 1961 it won an Army contract for a concept demonstrator. GE subcontracted the design and construction work to Ryan. The XV-5A that resulted was a small, fighter-like design: 44 feet long with a 30-foot wingspan.



An XV-5A is pictured on the ramp, with air duct doors opened on the nose and wings.

A pair of J85-GE-5 turbojets mounted in the fuselage spine provided approximately 5,000 pounds of thrust in normal flight. When vertical thrust was needed, the pilot could actuate a diverter valve that directed some of the exhaust gases to a pair of fans, 5 feet in diameter, located in the inboard portion of each wing. The wing fans rotated in opposite directions and were covered by large hinged doors in conventional flight. Exhaust gas also powered a smaller fan in the nose that provided pitch control and a measure of additional lift. All three fans together provided 16,000 pounds of vertical thrust. A set of louvered vanes underneath each of the large wing fans could vector the thrust in any direction and provided yaw control.

The XV-5A was essentially an Army project, and the AFFTC's role was mission support. This always involves a lot more than just letting the Responsible Test Organization (RTO) use the runways and fire trucks. In this instance, the Flight Test Center provided weight and balance facilities, chase and pace aircraft, photography coverage, fuel and lubricants, instrumentation and calibration lab facilities, power plant services, the thrust stand, theodolite and telemetry coverage, and parachute facilities.



This rear view of the XV-5A shows the wing fan doors and louvres.

AFFTC pilots flew the two XV-5A's on many occasions and built up a lot of expertise. During the Air Force evaluation phase, Baldwin found over the course of 15 sorties that the little jet had a large airspeed envelope, from total hover to speeds in excess of 400 knots. It was "... stable, easy to control, and a pleasure to fly," at least in most of its flight envelope. However the changeover from horizontal to vertical flight (or vice-versa) was abrupt and occurred in one stage — this made for tricky handling in the air.

All in all, though, the XV-5A had turned out to be a promising concept. Why, then, didn't some equivalent of the AV-8 Harrier or the X-35 appear decades earlier? The lift fan system was heavy and required too much internal volume, and service pilots would have difficulty with the narrow transition zone.

After a series of accidents, the Army and the Air Force lost interest [redacted] and soon it became literally a case of "back to the drawing board." [redacted]

Previous week Following week

[redacted]

Care

	Routine Physical Exams (Adult)	Well-Baby Care	Screening Exams, Incl. Office Visit *Pap Smears, Mammograms and Prostate Exams*
Kaiser (HMO)			
Network	$10 copay per visit; covered according to plan-approved schedule	100%; covered according to plan-approved schedule	$10 copay per visit; women may self-refer to a network provider for Pap smears and mammograms; covered according to plan-approved schedule
Non-Network	Not covered	Not covered	Not covered
Maxicare (HMO)			
Network	$10 copay per visit; covered according to plan-approved schedule	$10 copay per visit; covered according to plan-approved schedule	$10 copay per visit; women may self-refer to a network provider for Pap smears and mammograms; covered according to plan-approved schedule
Non-Network	Not covered	Not covered	Not covered
PacifiCare (HMO)			
[redacted]work	100%; covered according to plan-approved schedule	100%; covered according to plan-approved schedule	100%; women may self-refer to a network provider for Pap smears and mammograms; covered according to plan-approved schedule
Non-Network	Not covered	Not covered	Not covered
SmartCare (HMO)			
Network	[redacted]	[redacted]	[redacted] a [redacted] rs and [redacted] ing to
Non-Net[redacted]	[redacted]	[redacted]	[redacted]

Late 1965
& into 1966

XC-142A

50th Anniversary of the Air Force Flight Test Center

THIS WEEK IN HISTORY...

50s
60s
70s
80s
90s

Edwards Air Force Base

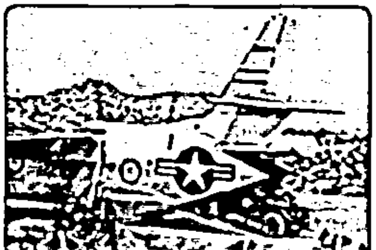
MAY 18, 1966

To commemorate the 50th Anniversary of the Air Force Flight Test Center, which was established June 25, 1951, the AFFTC History Office will recall some of the milestones in flight that took place here during the last half century. These articles will appear on a weekly basis throughout the year 2001.

A Strange Bird Goes To Sea

By Dr. Raymond L. Puffer
Air Force Flight Center historian

Support for the warfighter sometimes takes many interesting forms. On May 18, 1966, a team of Flight Test Center pilots performed one of the more unusual feats in Air Force Flight Test Center's experience. On that date, just 35 years ago, they performed the first successful landing of a vertical/slow takeoff and landing (V/STOL) aircraft — on a Navy aircraft carrier.



The XC-142 is pictured disgorging a jeep and trailer cargo during desert trials.

The XC-142A itself was an unusual bird. The 1960s saw a fair number of experimental vertical/short takeoff and landing (V/STOL) aircraft, but one of the most feasible-looking was LTV Aerospace's XC-142A. For one thing, the goal from the outset was to develop a practical intra-theater transport capable of delivering cargo to forward combat positions. Although the five aircraft constructed were concept demonstrators, LTV was thinking prototype as much as possible. In order to operate from short, unimproved strips or from aircraft carriers at sea, it was designed with a pivoting wing and four T64-GE-5 3080-horsepower turboprop engines. A complex interconnected drive system linked the 15-foot fiberglass propellers and allowed a single engine to turn all four lightweight props if necessary. A small, horizontally mounted tail rotor assisted controllability in hover.

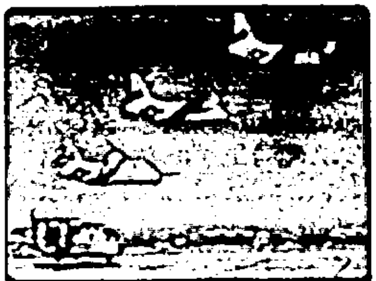
Aside from the pivotal wing, however, the XC-142A looked like a somewhat stubby, efficient small cargo hauler. Its designers had provided it with a compartment capable of carrying 32 fully equipped combat troops or 8,000 pounds of cargo in a vertical-lift mode. Top speed in horizontal flight was 430 mph and, fitted with special fuel tanks, it would have an ocean-hopping ferry range of some 3,800 miles. Some enthusiasts even predicted a submarine-hunting role, with the radical aircraft operating from

Navy anti-submarine task forces. The end product of this thinking was the world's largest V/STOL aircraft and the first such American vehicle with enough payload capability to permit operational evaluation by the military services.

A Tri-Service Test Force of 150 military and civilian personnel was established at the Flight Test Center, and eventually demonstrated AFFTC's ability to handle a difficult and innovative evaluation program. AFFTC's Lt. Col. Jesse B. Jacobs directed the test force, which included Army, Navy and Marine Corps pilots as well as Air Force. The first of five XC-142As built by LTV arrived at Edwards on July 9, 1965 following a 1,200-mile flight from Dallas — the first long distance hop of a V/STOL aircraft. The new transport proved easy to convert from vertical to horizontal flight, and the test force gave it high marks for its speed and stability in hover. Over the following months the team conducted a wide variety of tests. At El Centro, they developed a "dump truck" method of offloading cargo at extremely low altitudes and speeds. The aircraft carrier handling trials went just as well.

In this photo, the XC-142 begins the transition to vertical flight following its takeoff from an aircraft carrier.

Preliminary carrier evaluation trials took place during one intensive day of flight operations aboard the USS Bennington (CVS 20). Ideal flight conditions of daylight, mild winds and calm seas were established for this event, which was conducted in the Pacific just offshore from San Diego. That day marked the first time in American naval aviation history that a transport-type airplane capable of flying more than 400 mph had taken off and landed from a vessel underway at sea. Before nightfall, relays of test force pilots had performed six vertical and 44 short takeoff-and-landings, including touch-and-go, full stop, and go-around flight configurations. They completed successful landings and takeoffs from all sections of the antisubmarine carrier's flight deck.



This series of shots shown in this composite photo shows the transition from the XC-142's vertical takeoff to forward flight

For all of its great promise, however, the four-engine V/STOL transport was still somewhat ahead of its time and never reached its full potential. The airplane was somewhat underpowered and was subject to a number of handling difficulties. An accident took place during the course of a simulated rescue mission in Texas and killed three crew members. Another XC-142A was heavily damaged during a hard landing and a third was written off following a taxi accident. Soon attrition left only a single aircraft to continue the trials and the XC-142 program eventually was canceled.

Previous week Following week

May 12, 1965

HFB 320
"Hansa Jet"

Super Stall

Accident Description

Status: [legenda]

Date:	**12 MAY 1965**
Type:	MBB HFB-320 Hansa Jet
Operator:	Hamburger Flugzeugbau
Registration:	D-CHFB
Msn / C/n:	1001
Year built:	1964
Crew:	1 fatality / 3 on board
Passengers:	0 fatalities / 0 on board
Total:	1 fatality / 3 on board
Airplane damage:	Written off
Location:	Torrejon (Spain)
Phase:	Cruise
Nature:	Test

Narrative:

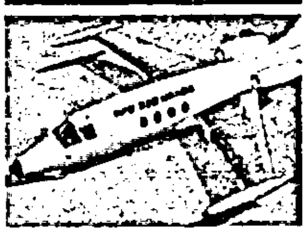
The HansaJet prototype was in the midst of stall configuration tests at 22,000 feet. when it attained an extreme angle of attack resulting in a superstall. The airplane then entered an uncontrollable flat spin. Two crew members were able to parachute to safety.

Source: (also check out sources used for every accident)

FS-DESIGN BERLIN

fsberlin@gmx.net

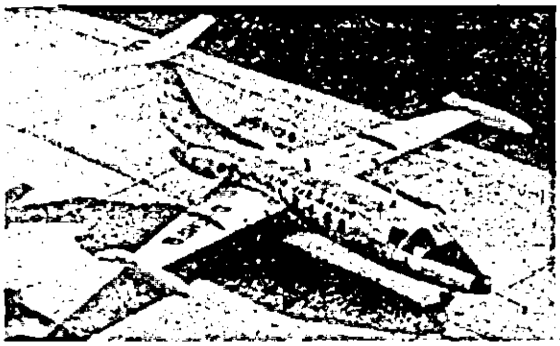
HFB HANSA HISTORY

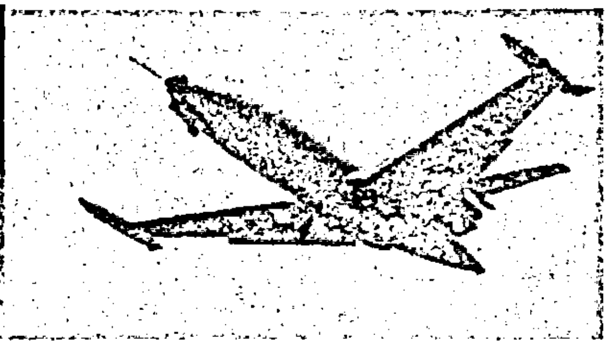


Updated 19.05.2004

Hamburger Flugzeugbau G. m. b. H.
Hamburg-Finkenwerder Germany

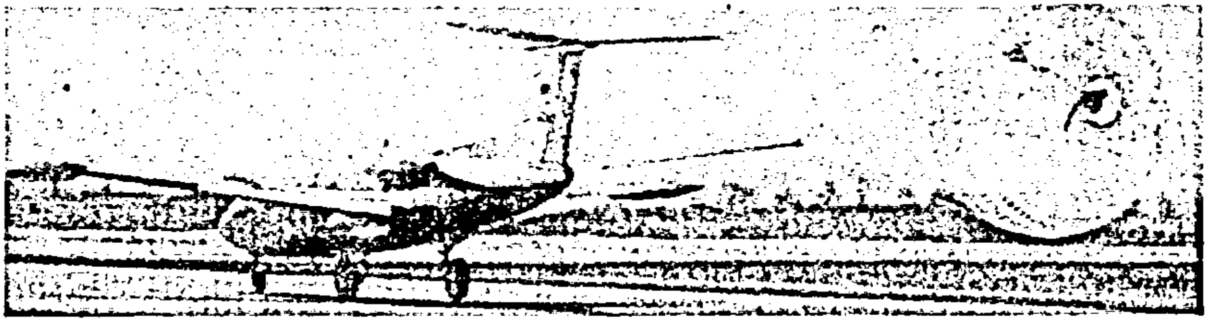
HFB 320 Hansa Jet



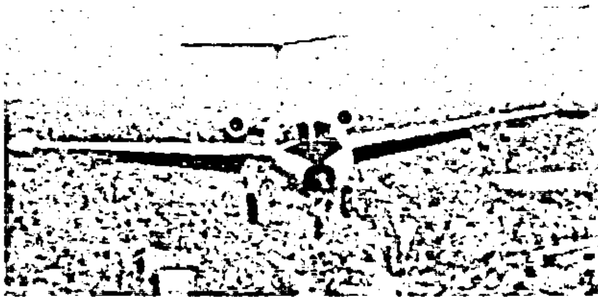
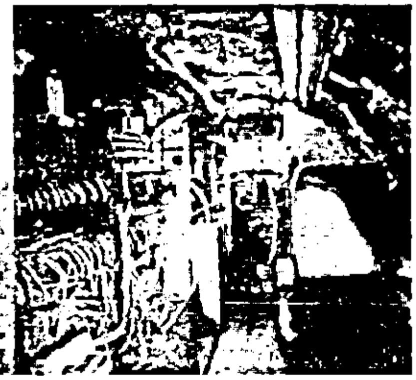


D-CHFB before the first flight... ... and at the first flight on April 21, 1964.

Loren William Davis H. Bardill



An intensive prooftesting was started. The chief of this test programm was Dr. Studer. The V1 prototype was equipped with a numerous measuring equipment (310 measuring values could be determined).

Test flight of prototype V1. with measuring equipment

Cabin inside

D-CHFB crashed during the 121th test flight on May 12, 1965; but a second prototype has been flying since October 19, 1964, and manufacture of the first 10 production Hansas was scheduled for completion early in 1966.

The Hansa History will be continued

In essential parts this text dates from the following sources:
Herbert Neppert (1984): Die Hansa-Jet-Story. Erinnerungen eines Aerodynamikers.

< Home Downloads ELECTRA HISTORY >

08/04/1965

Convair 240D Conversion
"Flutter FT" program

NTSB Identification: **LAX66A0015**
14 CFR Part 91 General Aviation
Event occurred Wednesday, August 04, 1965 in SAN DIEGO, CA
Aircraft: CONVAIR CV240D, registration: N94294

```
FILE     DATE          LOCATION            AIRCRAFT DATA        INJURIES    FLIGHT                          PILOT DATA
                                                                 F  S M/N    PURPOSE

2-0712   65/8/4  NR.SAN DIEGO,CALIF   CONVAIR CV240D       CR-  0  0  3  MISCELLANEOUS               COMMERCIAL, AGE 44, '
         TIME - 0920                  N94294               PX-  0  0  0  TEST                        TOTAL HOURS, 92 IN T'
                                      DAMAGE-SUBSTANTIAL   OT-  0  0  0                              INSTRUMENT RATED.
         TYPE OF ACCIDENT                                            PHASE OF OPERATION
            AIRFRAME FAILURE: IN FLIGHT                                 IN FLIGHT: OTHER
         PROBABLE CAUSE(S)
            AIRFRAME - FLIGHT CONTROL SURFACES: ELEVATOR ASSEMBLY,ATTACHMENTS
            AIRFRAME - FLIGHT CONTROL SURFACES: HORIZONTAL STABILIZER, ATTACHMENTS
            MISCELLANEOUS ACTS,CONDITIONS - FLUTTER
            MISCELLANEOUS ACTS,CONDITIONS - OVERLOAD FAILURE
         EMERGENCY CIRCUMSTANCES - PRECAUTIONARY LANDING ON AIRPORT
                                   SUSPECTED OR KNOWN AIRCRAFT DAMAGE
                                   PITCH CONTROL PROBLEM
         REMARKS- AIRCRAFT IS CONVERSION MODEL IN EXPERIMENTAL CATAGORY.ACCIDENT DURING FLUTTER TEST PROGRAM
```

NTSB Identification: MKC65F0006
14 CFR Part 91 General Aviation
Event occurred Thursday, January 14, 1965 in WICHITA, KS
Aircraft: CESSNA 337, registration: N2102X

FILE	DATE	LOCATION	AIRCRAFT DATA	INJURIES F S M/N	FLIGHT PURPOSE	PILOT DATA
3-0108	65/1/14	WICHITA KAN	CESSNA 337	CR- 0 0 1	MISCELLANEOUS	COMMERCIAL, AGE 43,
	TIME - 1530		N2102X	PX- 0 0 1	TEST	TOTAL HOURS, 19 IN T
			DAMAGE-SUBSTANTIAL	OT- 0 0 0		NOT INSTRUMENT RATED

NAME OF AIRPORT - CESSNA FIELD
TYPE OF ACCIDENT
WHEELS-UP

PHASE OF OPERATION
LANDING: LEVEL OFF/TOUCHDOWN

PROBABLE CAUSE(S)
LDG GR-IMPROPERLY RIGGED.
PERSONNEL - MAINTENANCE,SERVICING,INSPECTION: IMPROPER MAINTENANCE (MAINTENANCE PERSONNEL)
PERSONNEL - MAINTENANCE,SERVICING,INSPECTION: INADEQUATE INSPECTION OF AIRCRAFT (MAINTENANCE PERSONNEL)

01/04/1966

Cessna T-210F

AP Testing

V

NTSB Identification: MKC66A0036
14 CFR Part 91 General Aviation
Tuesday, January 04, 1966 in MAYFIELD, KS
Aircraft: CESSNA T-210F, registration: N6708R

FILE	INJURIES				FLIGHT PURPOSE	PILOT DATA
		F	S	M/N		
2-0868	CR-	2	0	0	MISCELLANEOUS	COMMERCIAL, FL.INSTR.,
TIME - 1341	PX-	0	0	0	TEST	AGE 46, 5800 TOTAL HOURS,
DAMAGE-DESTROYED	OT-	0	0	0		51 IN TYPE, NOT INSTRUMENT RATED.

TYPE OF ACCIDENT / PHASE OF OPERATION
COLLISION WITH GROUND/WATER: UNCONTROLLED / IN FLIGHT: UNCONTROLLED DESCENT
PROBABLE CAUSE(S) MISCELLANEOUS - UNDETERMINED
FIRE AFTER IMPACT
REMARKS- CREW WAS TO CALIBRATE AUTO-PLT SENSITIVITY.
ACFT ENTERED CLMB AT LO ALT,THEN ENTERED DIVE,CRASHED.

Airliners.net: Cessna 210 Centurion
Photos

210L - One 225kW (300hp) Continental IO-520-L fuel injected flat six piston engine driving a three blade constant speed McCauley prop.
TSIO-520-R, driving a constant speed three blade prop.
P210R - One 240kW (325hp) turbocharged and fuel injected TSIO-520-CE.

Performance

210L - Max speed 324km/h (175kt), max cruising speed 317km/h (171kt), long range cruising speed 249km/h (134kt). Initial rate of climb 950ft/min. Service ceiling 17,300ft. Max range with reserves 1972km (1065nm).
T210M - Max speed 380km/h (205kt), max cruising speed 367km/h (198kt), long range cruising speed 260km/h (140kt). Initial rate of climb 1030ft/min. Service ceiling 28,500ft. Range at long range cruising speed 1455km (785nm).
P210R - Max speed 417km/h (225kt) at 20,000ft, max cruising speed 394km/h (213kt) at 23,000ft. Initial rate of climb 1150ft/min. Service ceiling 25,000ft. Range with reserves and optional fuel 2205km (1190nm).

Weights

210L - Empty 1015kg (2238lb), max takeoff 1725kg (3800lb).
T210M - Empty 1022kg (2250lb), max takeoff 1725kg (3800lb).
P210R - Empty 1120kg (2470lb), max takeoff 1860kg (4100lb).

Dimensions

210 - Wing span 11.15m (36ft 9in), length 8.59m (28ft 2in). Wing area 16.3m2 (175.5sq ft).
T210M - Wing span 11.21m (36ft 9in), length 8.59m (28ft 2in), height 2.87m (9ft 5in). Wing area same.
P210R - Wing span 11.84m (38ft 10in), length 8.59m (28ft 2in),

06/08/1966

XB-70A

Mid-Air while in
Formation Flight

USAF ACCIDENT/INCIDENT REPORT

(Fill in all spaces applicable. If additional space is needed, use additional sheet(s).)

1. DATE OF OCCURRENCE (Year, month and day)	2. VEHICLE(S)/MATERIEL INVOLVED (UAS & Serial Nr., if applicable)	3. FOR GROUND ACCIDENTS ONLY (Base Code and Report Serial Nr.)
1966 June 8	XB-70A 62-207 F-104N NASA 813	66-6-8-2

4. PLACE OF OCCURRENCE: STATE, COUNTY, DISTANCE AND DIRECTION FROM NEAREST TOWN. IF ON BASE, IDENTIFY. IF OFF BASE GIVE DISTANCE FROM NEAREST BASE.	5. HOUR AND TIME ZONE LOCAL	6.
California, San Bernardino, 11 miles N. Barstow 50½ miles 065 deg Mag from Edwards AFB	0926 PDT	[X] DAY [ ] NIGHT [ ] DAWN [ ] DUSK

7. ORGANIZATION POSSESSING OWNING VEHICLE OR MATERIEL AT TIME OF MISHAP

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Name and Base Code
XB-70A AFSC	AFCMD	—	—	—	—	Edwards FSPM

8. (List organizations of second vehicle, if they differ from item 7 above)

F-104N NASA	Flight Research Center					Edwards FSPM

9. BASE AND COMMAND SUBMITTING REPORT (Do not Abbreviate)

Norton Air Force Base — Directorate of Aerospace Safety, United States Air Force

10. LIST OF PERSONNEL DIRECTLY INVOLVED

(For aircraft include operator and all other persons whether in plane or out. If more space is required to list all personnel, use additional sheet(s).)

Last Name	First Name	M.I.	Grade	Service No.	Assigned Duty	Aero Rating	Injury to Individual
XB-70A							
WHITE	ALVIN	S	CIV		Pilot	Plt	Major
CROSS	CARL	S	MAJ	FR41721	Co-pilot	Cmd Plt	Fatal
F-104N							
WALKER	JOSEPH	A	CIV		Pilot	Plt	Fatal

11. NARRATIVE DESCRIPTION OF ACCIDENT: Give a detailed history of flight, or chronological order of facts and circumstances leading to the mishap as applicable, the results of investigation and analysis to include discussion of all cause factors listed, findings, and recommendations, and any corrective action taken. (Continue on reverse, if more space needed.)

SEE ATTACHED SHEETS.

12. AUTHENTICATION

CERTIFICATION BY (Title)	TYPED NAME AND GRADE	SIGNATURE	DATE
Accident Board President	WILLIAM R. GRADY Colonel, USAF	William R Grady	27 Jul 66

AF FORM DEC 62 711 PREVIOUS EDITION OF THIS FORM IS OBSOLETE.

—26/05/66

AIRCRAFT ACCIDENT/INCIDENT REPORT

To be filled out for principal aircraft involved. (Appropriate blocks only should be filled out on secondary aircraft.)

1. ACCIDENT/INCIDENT CLASSIFICATION (Check one)

	Major	Minor		
Flight Accident Resulting in Aircraft Damage	[X]	[ ]	Accident Not Resulting in Aircraft Damage	[ ]
Aircraft Non-flight Accident	[ ]	[ ]	Air Force Aircraft Incident	[ ]

2. Aircraft/Serial Number	3. Type, Model, Series, Block No.	4. Assignment/Status Code (AFM 65-110)
62-0207	XB-70A	EB

5. If aircraft was being ferried or delivered indicate gaining and losing organizations, date of transfer, ultimate destination.

N/A

6. CLEARANCE. From Local | To | To

7. Flight: VFR X VFR—ON TOP ___ IFR ___ Local X Other ___ Direct ___ Airways ___ (Controlled)

8. Flight conditions at time of accident	9. Duration of Flight Hrs.	Min.	10. Mission of flight
Contact X Instrument: Actual ___ Sim. ___ Other ___ Unk. ___	2	10	0-4

11. ALTITUDE DATA	Cleared Alt. MSL	Altitude above terrain path on accident began	Altitude MSL impact point	Highest altitude MSL flown	Time flown highest alt.
	FL 250 ft.	22,000 ft.	3,000 ft.	32,500 ft.	Hrs. 0 Min. 21

12. Fire and explosion data
a. Fire: None ___ Inflight ___ Ground X
Result of gnd. impact? Yes X No ___
b. Explosion: None ___ Inflight ___ Ground X
Result of gnd. impact? Yes X No ___

13. Airfield data: Applicable to takeoff and landing accidents occurring within 2 miles of airfield — N/A
Field elevation in use ___ ft. Length of runway in use ___ ft. Length of overrun ___ ft. Distance of touchdown from runway ___ ft. Heading of runway ___ °
Composition of rwy. Asphalt ___ Concrete ___ Other (Specify) ___ Composition of overrun (Specify) ___ Surface condition. Dry ___ Wet ___ Icy ___ Other (Specify) ___
Conditions affecting occurrence, e.g., type of instrument or lighting approach aid used, obstruction, barrier, airspeed, gross weight, forced landing

14. (If answer is "Yes," to either question, discuss under item 11, AF Form 711) Violations [redacted]

15. PHASE OF OPERATION	16. TYPE OF ACCIDENT
Normal Flight - Formation	Mid-Air Collision

17. WEATHER AT TIME AND PLACE OF ACCIDENT (If a factor in the accident, attach statement of weather officer)

Sky condition	Visibility	Wind direction and velocity	Temperature	Dew point	Alt. setting	Other weather conditions
High - thin broken	15 miles	Calm	66	47	29.87	-

PILOT(S) INVOLVED (FLIGHT CREW)

18. OPERATOR (Person at controls at time of accident)

a. LAST NAME (Jr., II, etc.)	FIRST NAME	MIDDLE NAME	GRADE	COMPONENT	SERVICE NUMBER	NATIONALITY	YR. OF BIRTH
WHITE	ALVIN	S.	CIV	-	-	U.S.	1918

b. POSITION IN AIRCRAFT AT TIME OF ACCIDENT: Front or Left Seat X Rear or Right Seat ___
c. ASSIGNED DUTY ON FLIGHT ORDER: AC ___ IP ___ P X CP ___ Other (Specify) ___

d. ASSIGNED ORGANIZATION

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
	NORTH AMERICAN AVIATION		COMPANY			

e. ATTACHED ORGANIZATION FOR FLYING

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base

f. ORIGINAL AERONAUTICAL RATING AND DATE RECEIVED	g. PRESENT AERONAUTICAL RATING AND DATE RECEIVED	h. INSTRUMENT CARD	i. AFSC
Pilot, July 1940	Commercial May 54	Type Comm. Inst; Date of expiration Indef	N/A

19. OTHER PILOT

a. LAST NAME (Jr., II, etc.)	FIRST NAME	MIDDLE NAME	GRADE	COMPONENT	SERVICE NUMBER	NATIONALITY	YR. OF BIRTH
CROSS	CARL	SPENCER	Maj	Reg AF	FR41721	U.S.	1925

b. POSITION IN AIRCRAFT AT TIME OF ACCIDENT: Front or Left Seat ___ Rear or Right Seat X Other ___
c. ASSIGNED DUTY ON FLIGHT ORDER: AC ___ IP ___ P ___ CP X Other (Specify) ___

d. ASSIGNED ORGANIZATION

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
AFSC	AFFTC	-	-	-	-	Edwards AFB, Calif

e. ATTACHED ORGANIZATION FOR FLYING

Major Command	Subcommand or AF	Air Division	Wing	Group	Squadron or Unit	Base
AFSC	AFFTC	-	-	-	-	Edwards AFB, Calif

f. ORIGINAL AERONAUTICAL RATING	g. PRESENT AERONAUTICAL RATING	h. INSTRUMENT CARD	i. AFSC
Pilot 11 Mar 45	Cmd Plt 27 Apr 61	Type AF No 1; Date of expiration 16 Aug 66	Primary 2865; Duty 2865

NOTE: IF MORE THAN TWO PILOTS ARE INVOLVED (FLIGHT CREW) REPORT SAME INFORMATION REQUIRED ON ADDITIONAL SHEET FOR EACH.

AF FORM DEC 62 711b PREVIOUS EDITION OF THIS FORM IS OBSOLETE.

AIRCRAFT ACCIDENT/INCIDENT REPORT

To be filled out for principal aircraft involved. (Appropriate blocks only should be filled out on secondary aircraft.)

1. ACCIDENT/INCIDENT CLASSIFICATION (Check one)

Flight Accident Resulting in Aircraft Damage: [X]

Aircraft Nonflight Accident: [ ]

Accident Not Resulting in Aircraft Damage: [ ]

Air Force Aircraft Incident: [ ]

2. Aircraft/Serial Number	3. Type, Model, Series, Block No.	4. Assignment/Status Code
NASA 813	F-104N	None (NASA Owned)

5. If aircraft was being ferried or delivered indicate gaining and losing organizations, date of transfer, ultimate destination.

N/A

6. CLEARANCE: From: Local; To: ; To:

7. Flight: VFR X; VFR—On Top; IFR; Local X; Other; Direct; Airways; (Controlled)

8. Flight reference at time of accident: Contact X; Instrument Actual; Sim.; Other; Unk.

9. Duration of Flight: Hrs. 1, Mins. 19

10. Mission of flight: X-2

11. ALTITUDE DATA: Cleared Alt. MSL: FL 250 ft.; Altitude above terrain at occurrence began: 22,000 ft.; Altitude MSL impact point: 3,000 ft.; Highest altitude MSL flown: 27500 approx; Time flown highest alt.: Hrs. 1, Min. 00

12. Fire and explosion data

a. Fire: None; Inflight X; Ground; Result of gnd. impact? Yes; No X

b. Explosion: None; Inflight X; Ground; Result of gnd. impact? Yes; No X

13. Airfield data: Field elevation in use: N/A ft.

14. Violation: [redacted] Breaches of air discipline: [redacted]

15. PHASE OF OPERATION: Normal - Flight - Formation

16. TYPE OF ACCIDENT: Mid-Air Collision

17. WEATHER AT TIME AND PLACE OF ACCIDENT

Sky condition	Visibility	Wind direction and velocity	Temperature	Dew point	Alt. setting	Other weather conditions
High- thin broken	15 miles	Calm	66	47	29.87	-

PILOT(S) INVOLVED (FLIGHT CREW)

18. OPERATOR

Last Name	First Name	Middle Name	Grade	Component	Service Number	Nationality	Yr. of Birth
WALKER	JOSEPH	A.	CIV	NASA	-	U.S.	1921

b. Position in aircraft at time of accident: Front or Left Seat X

c. Assigned duty on flight order: P X

d. Assigned organization: Subcommand or AF: NASA, Air Division: FRC; Base: Edwards AFB, Calif

e. Attached organization for flying:

f. Original aeronautical rating and date received: Private Pilot Feb 42

g. Present aeronautical rating and date received: Inst. - Sep 45, Comm-Multi Eng - Mar 45

h. Instrument card: Type Comm-Inst Indef

i. AFSC: N/A

19. OTHER PILOT

Last Name	First Name	Middle Name	Grade	Component	Service Number	Nationality	Yr. of Birth

NOTE: IF MORE THAN TWO PILOTS ARE INVOLVED (FLIGHT CREW) REPORT SAME INFORMATION REQUIRED ON ADDITIONAL SHEET FOR EACH.

AF FORM 711b DEC 62 PREVIOUS EDITION OF THIS FORM IS OBSOLETE.

SUMMARY

At 0926 on 8 June 1966, an Air Force XB-70A, serial number 62-0207, and a NASA F-104N were involved in a midair collision eleven miles north of Barstow, California. The XB-70 departed Edwards AFB, CA at 0715 on a scheduled test mission to accomplish flight requirements as specified by the contractor, North American Aviation Company and the Air Force. The aircraft commander was a pilot employed by the contractor. The aircraft was scheduled to accomplish the following: (1) airspeed calibration, (2) sonic boom run, (3) flight familiarization for an Air Force crewmember, and (4) a formation flight with five other aircraft. During the accomplishment of the formation portion of the mission, the XB-70A and the F-104N collided. Both aircraft were destroyed. The XB-70 copilot and the F-104N pilot received fatal injuries.

20 FLYING EXPERIENCE (Attach copy of AF Form 5 for Pilot(s) involved as outlined in AFR 127-4.)					
ASSIGNED DUTY ON FLIGHT ORDERS (Give last names only. List all flight times to nearest hour.)	Pilot	Co-Pilot	Inst. Pilot	Acft. Cmdr.	Student Pilot
	WHITE	CROSS			
a. Total flying hours (including AF time, student and other accredited time):	6346	8530			
b. Total Jet Time	2326	2790			
c. Total 1st Pilot/IP hours, all Aircraft	5981	5266			
d. Total Weather Instrument Hours	123	704			
e. Total 1st Pilot/IP hours this Model	127	2			
f. Total 1st Pilot/IP hours last 90 Days	49	33			
g. Total 1st Pilot/IP hours last 90 Days this Model	45	2			
h. Total 1st Pilot/IP hours weather and hood last 90 Days	1	4			
i. Total Pilot hours night last 90 Days	0	3			
j. Total Pilot hours last 30 Days	12	8			
k. Total 1st Pilot/IP hours last 30 Days	12	6			
l. Total 1st Pilot/IP hours last 30 Days this Model	9	2			
m. Date and Duration last previous flight this Model	19May66 2hrs	N/A			
n. Date of last proficiency flight check	N/A (NAA)	13 Mar 66			

21 CAUSATIVE AGENCY

Cause Factors (Check one primary and all applicable contributing and probable factors.)

	Primary	Contributing	Probable
Operators	[redacted]	[redacted]	[redacted]
Pilot			
Co-Pilot			
Controller (Drones)			
Commanders (Other than Operator) (Specify)			
Supervisory Personnel (Specify)			
Maintenance Personnel — Type of pers. and orgn. level			

	Primary	Contributing	Probable
Other Personnel (Specify)	[redacted]	[redacted]	[redacted]
Materiel Failure or Malfunction			
Engines			
Airframe			
Landing Gear			
Other (Specify)			
Airbase or Airways			
Weather			
~~[illegible]~~ [redacted]			
Undetermined ☐			

22. DAMAGE

Damage to Aircraft	Damage Beyond Economical Repair	Manhours to Repair	Cost (Est.)
☒ Destroyed ☐ Substantial ☐ Minor ☐ None	☐ Yes ☐ No	N/A	$ 219,500,000

Description of Damage (Describe briefly extent of damage to aircraft and any property damage incurred)

Aircraft Totally destroyed.

PD

~~Materiel~~ Materiel Factors Group
[signature] Lt Col USAF

23. AUTHENTICATION (Signature and grade)

President: [signature] Col USAF	~~[illegible]~~ Operations & Witness Group: [signature] Lt Col
~~[illegible]~~ NASA Representative: Donald [signature]	Student Officer: Richard M. [signature] Major USAF
~~[illegible]~~ Coordinating Group: Henry W. [signature] COLONEL USAF	~~[illegible]~~ Human Factors Group: [signature] MAJOR USAF
Member: XB-70 Pilot Member: [signature] LTCOL USAF	~~Member~~ F-104 Pilot Member: [signature] MAJOR, USAF

U.S. GOVERNMENT PRINTING OFFICE

PILOT INDIVIDUAL FLIGHT RECORD

1. AF OR COMMAND	2. WING, GROUP, AND SQUADRON OR UNIT	3. PERIOD COVERED	4. SHEET NO.	5. NAME (Last - first - middle)	6. SERVICE NUMBER
AFSC	HQ AFFTC	JAN, FEB, MAR 66	120	CROSS, CARL SPENCER	FR11721

7. BASE AND LOCATION	8. BIRTH (Day, month, year)	9. DUTY AFSC	10. INSTRUMENT CERTIFICATE	11. GRADE AND COMPONENT
EDWARDS AFB, CALIFORNIA	16 AUG 25	2865	WHITE / GREEN / NONE	MAJOR, REG AF

12. ORIGINAL RATING AND DATE	13. PRESENT RATING AND DATE	14. DATE PHYSIOLOGICAL TRAINING CERTIFICATE EXPIRES	DATE OF EXPIRATION
PLT 11 MAR 45	CMD PLT 27 APR 61	3 NOV 68	AF NO. 1 16 AUG 66

SECTION 1

	DATE (A)	TYPE MODEL SERIES (B)	MISSION SYMBOL (C)	LANDINGS (D)	INSTRUCTOR PILOT TIME (E)	FIRST PILOT TIME (F)	Instr. & First Pilot – Day VFR (G)	Day Weather (H)	Night VFR (I)	Night Weather (J)	HOOD (K)	COMMAND PILOT TIME (L)	CO-PILOT TIME (M)	Cmd/Co-Pilot – Day VFR (N)	Day Weather (O)	Night VFR (P)	Night Weather (Q)
	JAN – NO TIME THIS MONTH THIS STATION																
	FEB – NO TIME THIS MONTH THIS STATION																
	MAR																
300 EI	2	KC135A	04	2		300	215				45						
330 EI	13	KC135A	04	4		330	200				130						
225 EH	17	TB58A	05	2		225	225										
240 EH	24	TB58A	05			120	100	20					120	100	20		
200 EH	25	TB58A	05			130	30				100		30		30		
340 EH	26	TB58A	05	3		340	255	15	30								
270 EH	28	TB58A	05	3		270	270										
215 EH	29	TB58A	05	1		215	215										
21 00	15. TOTALS THIS SHEET			15		2000	1500	030	030		500		100	100	030		
7,127.5	16. TOTALS BROUGHT FORWARD FROM SHEET NO.			1,484	2,409[illegible]	2,824 15	3,367[illegible]	362 15	1,10[illegible]	159[illegible]	[illegible]	150[illegible]	1,744[illegible]	1,171 10	104[illegible]	842[illegible]	7[illegible]15
[illegible]	17. TOTALS TO DATE			1,499	2,409[illegible]	2,844 15	3,383 30	362 00	1,105[illegible]	159[illegible]	345[illegible]	150[illegible]	1,745[illegible]	1,172[illegible]	105[illegible]	842[illegible]	75[illegible]

18. TYPED NAME AND GRADE OF OPERATIONS OFFICER OR AUTHORIZED DEPUTY	19. SIGNATURE (Sign initial and duplicate)
VERL C. WHITTEN, CIV	Verl C Whitten

AF FORM 5 - PART I PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

PILOT INDIVIDUAL FLIGHT RECORD

Sheet number: 120-121 | Name (Last, first, middle): CROS , CARL S[illegible] | Service number: [illegible] 11721

SECTION II - MISCELLANEOUS ENTRIES

Date	Type model series	Auth mission symbol	Radio control pilot time	Aircraft commander time	Day VFR	Day weather	Night VFR	Night weather	Approaches: Date	Type	A	B	Instrument trainers	Flight simulator	W	N
									AR 8		1	1				1
									13		4	1				2
									24		1	1			2	
Totals this sheet											6	3			2	3
Totals brought forward from sheet no. 118-119				46:55	27:15	4:00	12:40	3:00			251	286	137:25	19:30	14	60
Totals to date				46:55	27:15	4:00	12:40	3:00			257	249	137:25	19:3[illegible]	1[illegible]	63

SECTION III - SUMMARY OF PILOT EXPERIENCE

Duty	Single engine	Two engines	More than two engines	Single jet propulsion	Multi jet propulsion	Jet rocket	Rocket	Rotary wing type	Glider	Turbo prop: Two engines	Turbo prop: More than two engines	Total
Instructor pilot		709:00	911:55	2:45	597:00					03:55	113:45	[illegible]
First pilot	93:05	631:20	730:05	162:20	762:45			:10		72:05	[illegible]	2057:15
Command pilot		120:25	5:15		13:30						11:10	[illegible]
Co pilot	14:00	546:10	645:20	42:35	215:20					57:30	2[illegible]:20	17[illegible]7:15
Aircraft commander			36:55								[illegible]	[illegible]
Radio control pilot												
Total USAF rated time	107:05	1997:55	2329:30	207:40	15[illegible]:35			:50		213:30	[illegible]	[illegible]

Pilot combat time	Instructor	First	Command	Co pilot	Radio control	F E comdr	Total combat time
	29:00	1:00	96:15	22:35			148:50

AF student pilot time	[illegible]
Civil air over [illegible]	[illegible]
Foreign military	
Other U.S. military	
Total flying time	[illegible]

Remarks (Use reverse if more space needed): 13 MAR 64 - [illegible] 11

13 ar 66 Completed Re-Qualification and Proficiency Check in [illegible]135 as IP, b JOE S. SC[illegible], Major, [illegible]AF, [illegible]

16 A[illegible] 66 Completed Requal Check as FE in C141, by JOE S. SC[illegible], Major, [illegible]AF, [illegible]

21 A[illegible] 66 Completed Requal Check in C141, by [illegible] D. CL[illegible]Y, Sqdn Ldr, [illegible]AF, FE

AF Form 5 - PART II

PILOT INDIVIDUAL FLIGHT RECORD

1. Air Command	2. Wing, Group, and Squadron or Unit	3. Period Covered	4. Sheet No.	5. Name	6. Service Number
AF SYSTEMS COMMAND	HQ, AIRFORCE FLIGHT TEST CENTER	APRIL-MAY-JUNE 1965	121	[illegible], CARL [illegible]	[illegible] 11721

7. Base and Location	8. Birth Date	9. Date Assigned	10. Instrument Certificate	11. Grade and Component
EDWARDS AIR FORCE BASE, CALIFORNIA	16 AUGUST 1925	2665	[illegible]	MAJOR (Reg AF)

12. Original Rating and Date	13. Present Rating and Date	14. Date Physiological Training Certif. Expires	Date of Examination
[illegible] 11 [illegible] 1945	COMMAND PILOT: 27 APRIL 1961	[illegible] 1968	AF # 1 - 16 AUGUST 1966

SECTION I

Date A	Type Model Series B	Mission Symbol C	Landings D	Instructor Pilot Time E	First Pilot Time F	Instr. & First Pilot Day VFR G	Day Weather H	Night VFR I	Night Weather J	Hood K	Command Pilot Time L	Co-Pilot Time M	Command/Co-Pilot Day VFR N	Day Weather O	Night VFR P	Night Weather Q
APRIL																
1[illegible]	JL141A	04	2		[illegible]	[illegible]										
21	JL141A	04	1 NL		2:00			2:00								
MAY																
22	TH58A	05			1:[illegible]	1:[illegible]						1:[illegible]	1:[illegible]			
24	TH58A	05	[illegible]		2:00	2:00										
JUNE																
4	XB70A	04			2:00	2:00										
13	FORM CLOSED IAW PAR 12 B (5), AFR 60-25															
15. Totals This Sheet			7		13:00	11:00		2:00				1:25	1:25			
16. Totals Brought Forward From Sheet No.			2499	2109:20	2944:15	3283:00	362:50	1105:50	170:55	343:10	150:20	1775:50	1172:10	275:35	[illegible]	75:15
17. Totals to Date			2506	2109:20	2957:15	3294:00	362:50	[illegible]	[illegible]	343:[illegible]	[illegible]	177[illegible]	1273:35	275:35	[illegible]	7[illegible]:15

18. Typed Name and Grade of Operations Officer or Authorized Deputy	19. Signature
[illegible], [illegible]	Carl C Whitten (signature)

AF Form 5, PART I — Previous editions of this form are obsolete

April 1, 1966

CURRENT AIRCRAFT TYPES

TYPE, MODEL AND SERIES	TOTALS			INSTRUCTOR PILOT & FIRST PILOT			CO-PILOT			FIRST PILOT NIGHT			FIRST PILOT WEATHER			HOOD		
	FORWARD	THIS SHEET	TO DATE	FORWARD	THIS SHEET	TO DATE	FORWARD	THIS SHEET	TO DATE	FORWARD	THIS SHEET	TO DATE	FORWARD	THIS SHEET	TO DATE	FORWARD	THIS SHEET	TO DATE
XB-70A	99:45	17:30	117:15	99:45	17:30	117:15							1:15	-	1:15			
B-58	122:45	-	122:45	118:25	-	118:25	4:20	-	4:20	22:55	-	22:55	2:45	-	2:45	8:30	-	8:30
T-38	3:05	-	3:05															
Sabreliner	8:10	-	8:10	8:10	-	8:10												
VTOL FS-1	:25	-	:25															
Travelair	137:15	-	137:15							13:30	-	13:30	2:00	-	2:00	12:25	-	12:25

SUMMARY OF FLIGHT EXPERIENCE

DUTY	JET PROPULSION				RECIPROCATING				ROTARY WING	ROCKET JET	ROCKET	OTHER
	SINGLE	2 ENGINE	MORE THAN 2 ENGINE	TOTAL	SINGLE	2 ENGINE	MORE THAN 2 ENGINE	TOTAL				
FIRST PILOT	1353:20	356:45	514:30	2224:35	1307:20	2407:45	6:40	3721:45	2:00			C130 1:00 FS-1 :25
CO-PILOT	-	7:40	83:30	91:10	1:00	286:25	4:25	291:50				
TOTAL	1353:20	364:25	598:00	2315:45	1308:20	2694:10	11:05	4013:35	2:00			1:25

SIMULATOR, LINK, ETC.

DATE	TYPE	PURPOSE	LOCATION	FORWARD	THIS SHEET	TOTAL
	XB-70		L.A. Division	187:15	-	187:15
	XB-70 AICS		L.A. Division	5:00	-	5:00
	SST		L.A. Division	21:15	-	21:15
	707		L.A. Division	3:40	-	3:40
	VTOL		L.A. Division	26:55	-	26:55

INDIVIDUAL FLIGHT RECORD

MONTH: January, 1965

NAME: White, A. S.

DATE	TYPE	SERIAL NUMBER	PURPOSE OF FLIGHT	LOCATION	LDG	TOTAL	NIGHT	INSTRUMENT ACTUAL	INSTRUMENT HOOD	IP	Co-Pilot
8	XB-70A	62-207	Mach 3 performance @ 70K (103)	EDW	1	1:55				1:55	
11	"	62-001	Performance and propulsion tests	EDW	[illegible]	1:00				1:00	
12	"	62-207	Mach 3 perf. @ 70K; AICS Tests (-C)	EDW	1	1:50				1:50	
15	"	62-001	Propulsion; Stability & Control	EDW	[illegible]	1:30				1:30	
25	SLX	N-47067	Company Acceptance	LAX	1	1:00					
28	VTOL XC-1	—	Pilot Familiarization (8 flts)	LAX	8	:25					
			TOTAL THIS MONTH			7:40	—	—	—	6:15	[illegible]
			TOTAL BROUGHT FORWARD			6279:20	391:30	121:50	208:10	711:55	[illegible]
			TOTAL TO DATE			6287:00	391:30	121:50	208:10	718:10	[illegible]

SUMMARY OF FLIGHTS: XB-70A [illegible]

INDIVIDUAL FLIGHT RECORD

[illegible]

NAME White, A. S.

DATE	TYPE	SERIAL NUMBER	PURPOSE OF FLIGHT	LOCATION	Ldg	TOTAL	NIGHT	INSTRUMENT ACTUAL	INSTRUMENT HOOD	IP	Co-Pilot
9	XB-70A	62-207	Mach 3 @70K; duct unst. & restart @ M 3	EDW	1	1:55				1:55	
16	"	"	Stab.&Cont;Perf;Grnd.Effects;A/S Calib. Tests	EDW	1	3:10				3:10	
17	"	"	Mach 3 perf. @ 70K (:15)	EDW	1	1:50				1:50	
23	B-58	55-662	Pilot Proficiency	EDW	4	2:40		:15			
NUMBER OF FLIGHTS: XB-70A 6:55 3 Flts.			TOTAL THIS SHEET		7	9:35	-	:15	-	6:55	-
B-58 2:40 1 Flt.			TOTALS BROUGHT-FORWARD			6287:00	391:30	121:50	208:10	718:10	391:[illegible]
			TOTALS TO DATE			6296:35	391:30	122:05	208:10	725:05	391:[illegible]

INDIVIDUAL FLIGHT RECORD

MONTH [illegible]

NAME [illegible]

DATE	TYPE	SERIAL NUMBER	PURPOSE OF FLIGHT	LOCATION	Ldg	TOTAL	NIGHT	INSTRUMENT ACTUAL	INSTRUMENT HOOD	IP	Co-Pilot
10	XB-70A	62-207	AICS;Perf; Hi-perf.duct eval. S2.7Mn	EDW	1	2:00				2:00	
15	"	"	AICS;Perf;Stab.&Cont.;Ram Purge	EDW	1	2:05		:15		1:50	
17	"	"	" " " " " "	EDW	-	1:55				1:55	
19	"	"	AICS;Perf;Stab.&Cont. S2.9 Mn	EDW	1	2:00		:10		1:50	
22	T-38A	598	Chase for XB-70 Flight	EDW	-	1:10					
24	XB-70A	62-207	Perf; Ferry to Carswell AFB, Texas	EDW-FWH	-	1:35				1:35	
26	"	"	Ferry from Carswell AFB	FWH-EDW	1	3:15		:15		3:00	
29	"	"	Perf; Prop; Stab. & Cont.	EDW	-	1:55				1:55	
30	"	"	AICS; Perf; Stab. & Cont.;Ram Purge(32 min.2.9)	EDW	-	2:15				2:15	
21	T-air	66T	Transportation	LAX-EDW	1	:30					

NUMBER OF FLIGHTS: XB-70A	17:00	8 Flts.	TOTAL THIS SHEET	5	18:40	-	:40	-	16:20	-
T-38	1:10	1 Flt.	TOTALS BROUGHT FORWARD		296:3[illegible]	[illegible]	124:0[illegible]	203:1[illegible]	725:05	381:1[illegible]
Travelair	:30	1 Flt.	TOTALS TO DATE		[illegible]15:1[illegible]	[illegible]	12[illegible]	2[illegible]	741:25	381:[illegible]

CERTIFIED A CORRECT RECORD

[signature]

INDIVIDUAL FLIGHT RECORD

MONTH May, 1966

NAME White, A. S.

DATE.	TYPE	SERIAL NUMBER	PURPOSE OF FLIGHT	LOCATION	Ldg.	TOTAL	NIGHT	INSTRUMENT ACTUAL	INSTRUMENT HOOD	IP	Co-Pilot
3	XB-70A	62-001	Propulsion and AGPS	EDW	1	1:30				1:30	
9	"	"	AICS;Hdlg.Qual;LG Ext. on Elec.Emerg.Sys.	EDW	1	2:20				2:20	
16	"	62-207	AICS; flutter; stab. & cont.	EDW	1	2:10				2:10	
19	"	"	Mach 3 for 30 mins. (:32)	EDW	1	2:00				2:00	
NUMBER OF FLIGHTS: XB-70A 8:00 4 Flts.			TOTAL THIS SHEET		4	8:00	-	-	-	8:00	-
			TOTALS BROUGHT FORWARD			6332:45	391:30	122:45	208:10	758:55	381:10
134-F-8			TOTALS TO DATE			6340:45	391:30	122:45	208:10	766:55	381:10

CERTIFIED A CORRECT RECORD

Joan Ure

INDIVIDUAL FLIGHT RECORD

MONTH June, 1966

NAME White, A. S.

DATE	TYPE	SERIAL NUMBER	PURPOSE OF FLIGHT	LOCATION	Ldg	TOTAL	NIGHT	INSTRUMENT ACTUAL	INSTRUMENT HOOD	IP	Co-Pilot
8	XB-70A	62-207		EDW	0	2:10					
4	T-air		Transportation	EDW-MER	1	1:25					
5	"			MER-EDW	1	1:25					
			This sheet closed out as of 8 June.								

CERTIFIED A CORRECT RECORD

[signature]

NUMBER OF FLIGHTS: XB-70A	2:10	1 Flt.	TOTAL THIS SHEET	2	5:00	-	-	-	-	-
Travelair	2:50	2 Flts.	TOTALS BROUGHT FORWARD		6340:45	391:30	122:45	208:10	758:55	381:10
			TOTALS TO DATE		6345:45	391:30	122:45	203:10	758:55	381:10

ANNUAL
SUMMARY OF AIRCRAFT EXPERIENCE

NAME White, A. S.

CALENDAR YEAR 1965

TYPE	TIME	DATE LAST FLOWN	TYPE	TIME	DATE LAST FLOWN	TYPE	TIME	DATE LAST FLOWN	TYPE	TIME	DATE LAST FLOWN
F86 A&F	151:55	27 Apr.61	B-52	CP 63:40 155:30	15 Mar.65	JD-1	83:25	Dec. 51	RP-322	245:15	Mar. 44
F86 DKL	140:45	6 Apr.56	B-58	CP 4:20 115:45	18 Nov.65	R4D	20:15 35:50	Dec. 51	P-38	19:30	Jan. 44
F86 H	50:15	5 Nov.57	Vulcan Mark II	1:40	6 Sept. 62	PV-2	CP 10:55 5:20	Jan. 52	P-47	63:35	June 44
F100 ACDF	765:10	6 Dec. 6[illegible]	VC-10	1:00	5 Nov. 63	SNB	CP 7:10 10:50	Jan. 52	P-51	502:10	Sept. 45
F106	2:25	2 June 60	Boeing 707B	3:15	26 Feb.63	SNJ	6:10	Dec. 51	L-4	5:20	Oct. 45
TF-102	6:00	10 Oct.62	B29	CP 3:25 3:25	Nov. 52	TO-2	25:45	Dec. 51	F-82	8:15	Jan. 52
F104	7:50	14 Dec.65	B17	:40	July 50	JRB	CP 3:55 3:55	Aug. 51	DC-3	CP 10:50 1:45	13 Dec.65
F107	16:30	15 Apr.57	B50	1:45	Oct. 52	F6F	:35	Nov. 51	Navion	98:05	Nov. 61
F80	28:35	Nov. 53	B26	12:35 141:15	27 June63	T-28 AB	28:35	Aug. 54	Beech D-18	5:00	Jan. 56
F84	90:10	16 Feb. 54	B25	CP 81:45 149:20	Apr. 54	L-20	CP 1:00 4:10	Feb. 54	Apache	174:10	June 60
F94	3:45	19 Apr.54	DB-7	1:10	June 45	YH-13	1:40	Sept. 52	Cessna 310	:45	Nov. 59
FJ4	:20	2 Mar. 57	KC-135	CP 3:00 3:00	20 Aug.59	H-23D	:20	23 Mar.62	Aero-Cdr.	9:10	2 Aug.63
T33	63:55	23 Mar.61	KC-97	CP :50 :50	Nov. 52	L-23A	1:55	June 53	Travelair	136:45	1 Oct. 65
T37	:50	23 Feb. 60	UC-78	CP 1:15 49:50	Sept. 45	F7F3	:30	Nov. 52	XB-70A	69:35	21 Dec.65
T38	1:55	14 Dec. 65	UC-64	5:45	May 45	PT-13B	60:00	Jan. 42			
T39 APD	CP 5:40 186:05	20 May 64	UC-61	:30	July 55	BT-13-15	124:05	10 Jan. 43			
Sabre-liner	7:10	23 Aug.65	C-130	1:00	28 Oct.59	AT-6	401:25	May 54			
F39	156:25	8 May 54	C-82	CP 3:25 3:00	Oct. 50	AT-9	650:25	Mar. 44			
F101	4:10	16 Nov.60	C-119	CP 21:30 66:20	Apr. 53	AT-10	75:45	26 Aug.42			
R45	CP 6:50 19:55	3 Dec. 52	C-47	CP 49:05 94:50	Jan. 54	AT-17	331:50	May 43			
B47	CP 6:30 93:40	16 Jul. 65	C-45	CP 69:35 85:05	Apr.54	AT-11	:45 [illegible]	Mar. 43			

Total [illegible]2[illegible]9:20

CURRENT AIRCRAFT TYPES

TYPE, MODEL AND SERIES	TOTALS FORWARD	TOTALS THIS SHEET	TOTALS TO DATE	INSTRUCTOR PILOT & FIRST PILOT FORWARD	INSTRUCTOR PILOT & FIRST PILOT THIS SHEET	INSTRUCTOR PILOT & FIRST PILOT TO DATE	CO-PILOT FORWARD	CO-PILOT THIS SHEET	CO-PILOT TO DATE	FIRST PILOT NIGHT FORWARD	FIRST PILOT NIGHT THIS SHEET	FIRST PILOT NIGHT TO DATE	FIRST PILOT WEATHER FORWARD	FIRST PILOT WEATHER THIS SHEET	FIRST PILOT WEATHER TO DATE	HOOD FORWARD	HOOD THIS SHEET	HOOD TO DATE
XB-70A	125:15	2:10	127:25	125:15	2:10	127:25							1:15	-	1:15			
B-58	122:45	-	122:45	118:25	-	118:25	4:20	-	4:20	22:55	-	22:55	2:45	-	2:45	8:30	-	8:30
T-38	3:05	-	3:05															
Sabreliner	8:10	-	8:10	8:10	-	8:10												
VTOL FS-1	:25	-	:25															
Travelair	137:15	2:50	140:05							13:30	-	13:30	2:00	-	2:00	12:25	-	12:25

SUMMARY OF FLIGHT EXPERIENCE

DUTY	JET PROPULSION SINGLE	JET PROPULSION 2 ENGINE	JET PROPULSION MORE THAN 2 ENGINE	JET PROPULSION TOTAL	RECIPROCATING SINGLE	RECIPROCATING 2 ENGINE	RECIPROCATING MORE THAN 2 ENGINE	RECIPROCATING TOTAL	ROTARY WING	ROCKET JET	ROCKET	OTHER
FIRST PILOT	1353:20	356:45	524:40	2234:45	1307:20	2410:35	6:40	3724:35	2:00			C-130 1:00 FS-1 :25
CO-PILOT	-	7:40	83:30	91:10	1:00	286:25	4:25	291:50				
TOTAL	1353:20	364:25	608:10	2325:55	1308:20	2697:00	11:05	4016:25	2:00			1:25

SIMULATOR, LINK, ETC.

DATE	TYPE	PURPOSE	LOCATION	FORWARD	THIS SHEET	TOTAL
	XB-70		L.A. Division	187:15	-	187:15
	XB-70 AICS		L.A. Division	5:00	-	5:00
	SST		L.A. Division	21:15	-	21:15
	707		L.A. Division	3:40	-	3:40
	VTOL		L.A. Division	26:55	-	26:55

WALKER	F-82	B-24	F-84	F-86	B-26	B-25	B-29	B-47		Boeing 727				
JUNE 1963	–	–	–	–	–	–	–	–		–				
TOTAL	185:10	245:25	11:20	19:05	19:05	197:35	202:35	126:40		1:00				
DEC 1963	–	–	–	–	–	–	–	–		–				
TOTAL	185:10	245:25	11:20	19:05	18:05	197:35	202:35	126:40		1:00				
JUNE 1964														
	SAME AS ABOVE													

WALKER	X-3	X-1A	F-102	F-101A	PHASE II	PIPER CUB J-3	STEARMAN PT-17	VULTEE BT-13	CURTISS AT-9	N.AMERICAN T-6	CESSNA UC-78	BEECH T-11
JUNE 1963	–	–	–	–	–	–	–	–	–	–	–	–
TOTAL	8:32	:20	34:40	37:19	2:00	40:00	119:45	175:50	127:40	117:35	20:15	128:05
DEC 1963	–	–	–	–	–	–	–	–	–	–	–	–
TOTAL	8:32	:20	34:40	37:19	2:00	40:00	119:45	175:50	[illegible]	117:35	20:15	128:05
JUNE 1964												
		SAME AS ABOVE										

WALKER R.	GRUMMAN JRF	FAIRCHILD C-82A	LOCKHEED RA-29	LOCKHEED RP 322	P-38	P-59	P-63	F-61	F-47	GRUMMAN	F-80	F-51		
JUNE 1963	–	–	–	–	–	–	–	–	–	–	–	–		
TOTAL	4:00	2:25	2:20	22:45	413:15	2:25	7:05	167:55	2:30	2:30	:30	99:00		
DEC 1963	–	–	–	–	–	–	–	–	–	–	–	–		
TOTAL	4:00	2:25	2:20	22:45	413:15	2:25	7:05	167:55	2:30	2:30	:30	99:00		
JUNE 1964														
			SAME AS ABOVE											

	TV2933	F9F2	TRIDENT (FRANCE)	NORD ALPHA (FRANCE)	KC-135	F107	F-8U	PHASE I	X-1E	X-1-2	X-4	X-5		
JUNE 1963	–	–	–	–	–	–	–	–	–	–	–	–		
TOTAL	:40	1:00	2:55	:30	3:25	:45	3:00	10:10	4:32	:30	1:00	68:35		
DEC 1963	–	–	–	–	–	–	–	–	–	–	–	–		
TOTAL	:40	1:00	2:55	:30	3:25	:45	3:00	10:10	4:32	:30	1:00	68:35		
JUNE 1964														
	SAME AS ABOVE													
				TOTAL OF THIS & FOLLOWING 3 PAGES							2642:38			

	F-104	X-15	X-15 CAPTIVE	C-47	[illegible]	T-33	F5D	T-37	JET STAR	F-100	X-14	HELICOPTER	TOTAL
[illegible] 1962	44:55	:48	4:34	7:55	32:40	11:25	—	—	—	—			93:17
TOTAL	359:05	3:35	30:30	954:08	33:40	94:05	2:30	:35	:30	33:30			4159
Dec 1963	90:00	:31	6:38	5:10	25:25	12:15	—	—	2:30	[illegible]			[illegible]
TOTAL	449:05	4:06	37:08	959:18	59:05	106:20	2:30	:35	3:[illegible]	[illegible]			4297
JUNE 1964	47:20	—		:55	2:30	1:35					4:12	34:45	131:37
TOTAL	[illegible]:25	4:06	37:08	960:13	61:35	107:55	2:30	[illegible]	[illegible]	[illegible]	4:12	34:45	4449
DEC. 1964	60:30	—	—		2:50							100:[illegible]	163:22
TOTAL	556:[illegible]	4:06	37:08	[illegible]0:13	64:25	[illegible]:54	[illegible]	[illegible]	[illegible]	33:30	4:12	134:57	4612
JUNE 1965	71:05				3:50							67:54	162
TOTAL	62[illegible]	4:06	37:08	960:13	68:15	107:55	2:30	[illegible]	[illegible]	33:30	4:12	[illegible]	4774
DEC. 1965	65:[illegible]				5:05							[illegible]	139
TOTAL	[illegible]	4:06	37:08	960:13	73:20	107:55	2:30	:35	3:00	33:30	4:12	[illegible]	4913
May 66	35:[illegible]	—	—	4:20		1:50						29:[illegible]	[illegible]
TOTAL	72[illegible]:05	4:06	37:08	964:33	73:20	107:45	2:30	:35	3:00	33:30	4:12	[illegible]:15	[illegible]
June	3:19												4998
66	741:24												

[illegible]	[illegible] A 310	[illegible]	[illegible] P	[illegible] RV	[illegible] 278	B-58
JUN 1965	4:05	4:25		:42		
TOTAL	4:05	4:25		:42		
DEC 1965			2:30	1:14		
TOTAL	4:05	4:25	2:30	2:45		
MAY 31 1966					2:45	2:50
TOTAL	4:05	4:25	2:30	2:45	2:45	2:50

LOCAL FLIGHT CLEARANCE

PIFF

STATION			DATE
AFFTC, Edwards AFB, California			8 June 66
TYPE A/C: XB-70	A/C NO.: 62-207		MISSION: 04

OCCUPANTS (State whether crew or passenger. List additional passengers on reverse.)

DUTY SYMBOL	NAME AND INITIALS	GRADE	SERVICE NO.	HOME STATION
P	White, A.S.	civ	—	EAFB
CP	CROSS, C.S	Maj.	FR41721	"
			Ch T-38	~~TYPE A/C OO/A-C. NO~~
			~~BE EF'D IAW~~	~~60-16 PAR 55~~
	Bicycle Lake R-2501		AFSCM 60-1	PAR 42
	EDW 057°/110		CIF	Ck SUP FILE
	EDW 065°/110			

(R) MS ✓

ETD	ETE (Home base)	HOURS OF FUEL	AUXILIARY BASE OF 1ST INTENDED LANDING
~~0700~~ 1400Z	2+30	3+00	N/A

FORM "F" FILED AT: EAFB

DATE FILED (Day, month, year):

WEATHER IS FORECAST TO REMAIN VFR FOR THE DURATION OF THIS FLIGHT. I AM FAMILIAR WITH ALL CURRENT REGULATIONS AFFECTING THIS FLIGHT AND THIS FLIGHT WILL BE CONDUCTED IN ACCORDANCE WITH SUCH REGULATIONS.

CLEARANCE AUTHORITY: A.S. White

PILOT'S SIGNATURE: A.S. White

ACTUAL DEPARTURE:

ACTUAL ARRIVAL:

REMARKS: REQUEST R-2502 FL 250 and ABOVE

TYPE FLIGHT

RESTRICTED AREA ✓ VFR ✓

MARSA ✓ *SPECIAL

FREQUENCY(S) 351.4, 316.0

EDWARDS SOA(S) ✓ FLT LEVEL(S)

ALFA

BRAVO

CHARLIE

SUPERSONIC CORRIDOR

ENTRANCE BETWEEN 1+2 ALT FL 310

EXIT 5 ALT 310

CORRIDOR ALT FL 310

ACCELERATION TIME EST 1450 Z

*SPECIAL ROUTE

FIX	ALT	TIME
Southward Edge 5C.		

SPIN AREA — DIVE CORRIDOR —

PRESS ALT 2300 ft. TEMP 55°F

TAKEOFF DISTANCE 8800

DD FORM 1 JAN 56 1080 REPLACES AF FORM 113, 1 NOV 51, WHICH MAY BE USED.

AFFTC OP 77, Aug 63

LOCAL FLIGHT CLEARANCE

PIF

STATION	DATE
AFFTC, Edwards AFB, California	6-8-66

TYPE A/C	A/C NO.	MISSION
F-104N	NASA 813	X-2

OCCUPANTS (State whether crew or passenger. List additional passengers on reverse.)

DUTY SYMBOL	NAME AND INITIALS	GRADE	SERVICE NO.	HOME STATION
P	WALKER, J.A.	CIV		EAFB

ETD	ETE (Home base)	HOURS OF FUEL	AUXILIARY BASE OF 1ST INTENDED LANDING
1415 Z	1+30	1+45	

FORM "F" FILED AT	DATE FILED (Day, month, year)

WEATHER IS FORECAST TO REMAIN VFR FOR THE DURATION OF THIS FLIGHT. I AM FAMILIAR WITH ALL CURRENT REGULATIONS AFFECTING THIS FLIGHT AND THIS FLIGHT WILL BE CONDUCTED IN ACCORDANCE WITH SUCH REGULATIONS.

CLEARANCE AUTHORITY	PILOT'S SIGNATURE
	J A Walker
ACTUAL DEPARTURE	ACTUAL ARRIVAL

REMARKS

TYPE FLIGHT
RESTRICTED AREA ✓ VFR ✓
MARSA *SPECIAL
FREQUENCY(S) 316.6
EDWARDS SOA(S) FLT LEVEL(S)
ALFA
BRAVO
CHARLIE
SUPERSONIC CORRIDOR
ENTRANCE ALT
EXIT ALT
CORRIDOR ALT
ACCELERATION TIME

*SPECIAL ROUTE

FIX	ALT	TIME

SPIN AREA DIVE CORRIDOR
PRESS ALT TEMP
TAKEOFF DISTANCE

DD FORM 1 JAN 56 1080 REPLACES AF FORM 112, 1 NOV 51, WHICH MAY BE USED.

AFFTC OP 77, Aug 63

FEDERAL AVIATION AGENCY
EDWARDS RAPCON

EDWARDS RAPCON
Subject: Recorded conversations relating to mid-air collision of Air Force 20207 and NASA 813. Period covered from 1621 GMT through 1635 GMT on June 8, 1966.

Edwards RAPCON Radar Advisory Position 2	-	RA-2
Edwards Data Control	-	DATA
Air Force Aircraft 20207	-	207
Aircraft NASA 813	-	813
Aircraft 989	-	989
Air Force Aircraft 601	-	601
Aircraft Bartender 97	-	97
Air Force Aircraft 194	-	194
Aircraft Spell 61	-	61
Unknown (Station making transmission is not known)	-	UNK

I HEREBY CERTIFY that the following is a true transcription of the recorded conversations pertaining to the subject accident.

William C. Cable

Facility Operations Officer

1622	UNK	WE MUST BE HELPING THE CUMULUS ACTIVITY ALONG WITH ALL THIS HOT AIR
1622	UNK	ROG
1623	61	EDWARDS THIS IS SPELL SIX ONE ARE WE CLEARED IN SOA ALPHA OVER
1623	RA-2	SPELL SIX ONE CLEARED TO OPERATE IN SOA ALPHA FLIGHT LEVEL TWO FOUR ZERO TO FOUR ZERO ZERO THERE IS A AH FORMATION AH B SEVENTY AND ENTOURAGE AT TEN O'CLOCK FIFTEEN MILES IN A LEFT TURN SOUTHEAST BOUND WHAT POSITION AH WHAT AREA WILL YOU BE OPERATING

1623	61	I'LL BE OPERATING IN THIS POSITION TO ABOUT THREE OR FOUR MILES NORTH OF HERE
1623	RA-2	AH ROGER WE'LL KEEP YOU ADVISED OF HIS POSITION AND SPELL SIX ONE WHAT ALTITUDE
1623	61	ROGER WE'LL BE FROM AH TWO FOUR ZERO TO ABOUT TWO EIGHT ZERO
1623	RA-2	ROGER THEY'RE AT FLIGHT LEVEL TWO FIVE ZERO
1624	UNK	POSITIVE IDENT (UNINTELLIGIBLE) ONE TWO FIVE POINT ONE OVER
1624	RA-2	TWO ZERO SEVEN TRAFFIC TWO ZERO MILES EAST OF YOUR POSITION ORBITING THREE SISTERS FLIGHT LEVEL TWO FOUR ZERO TWO SEVEN ZERO
1624	207	ROGER THANK YOU
1625	RA-2	SPELL SIX ONE THE B SEVENTY AH
1625	UNK	(UNINTELLIGIBLE) I GOTTA CONTRAIL OUT THERE BUT I DON'T (UNINTELLIGIBLE)
1625	RA-2	(UNINTELLIGIBLE) MILES SOUTHWEST OF YOUR POSITION EASTBOUND
1625	UNK	LEAR JETS CLEARED ANOTHER FOUR MINUTES. THE LEAR JET SAID.
1625	UNK	THANKS JOE
1625	UNK	LOOKS LIKE THAT GUY IS COMING DOWN THE CORRIDOR PROBABLY A FIFTY EIGHT DON'T YOU THINK
1625	UNK	YEAH
1625	RA-2	SPELL SIX ONE AH B SEVENTY IS NOW
1625	UNK	OK DICK

1625	RA-2	ONE TWO MILES SOUTHWEST OF YOUR POSITION EASTBOUND DO YOU HAVE HIM IN SIGHT?
1625	61	AH NEGATIVE
1625	RA-2	ROGER NOW TEN O'CLOCK ONE TWO MILES EASTBOUND
1625	61	ROGER WHATS HIS ALTITUDE
1625	RA-2	AT FLIGHT LEVEL TWO FIVE ZERO
1625	61	ROGER WE'RE DOWN BELOW AH SIXTEEN HERE NOW
1626	RA-2	AH ROGER
1626	RA-2	TWO ZERO SEVEN HE'S OFF YOUR LEFT WING NOW AH BELOW THE CLOUDS
1626	207	AH ROGER THANK YOU
1626	RA-2	THE B FIFTY EIGHT SPEED RUN IS NOW ONE FIVE MILES EAST OF YOUR POSITION WESTBOUND AT THREE ZERO ZERO OR ABOVE
1626	207	ROGER I HAVE HIM THANK YOU
1626	UNK	(UNINTELLIGIBLE) MID-AIR. MID-AIR. STANDBY FOR
1626	UNK	YOU GOT THE VERTICALS
1626	UNK	THIS IS COTTON YOU GOT THE VERTICALS CAME OFF LEFT AND RIGHT WE'RE STAYING WITH YA NO SWEAT NOW YOU'RE HOLDING GOOD AL
1626	UNK	JOE WALKER RAN INTO HIM AND I THINK HE'S HAD IT
1626	UNK	OK THE B SEVENTY WENT UPSIDE DOWN IT'S ROLLING NOW THE LEFT WING (UNINTELLIGIBLE)

1626	UNK	BAIL OUT. BAIL OUT. BAIL OUT.
1626	UNK	BAIL OUT. BAIL OUT. BAIL OUT.
1627	RA-2	SPELL SIX ONE THE B SEVENTY'S CREW HAS BAILED OUT ONE ZERO MILES SOUTH OF YOUR POSITION REMAIN WELL CLEAR OF THAT AREA
1627	UNK	THE B SEVENTY IS SPINNING TO THE RIGHT
1627	61	ROGER WE HAVE HIM IN SIGHT
1627	UNK	LOOKS LIKE A CAPSULE CAME OUT IT'S SPINNING TO THE RIGHT NOSE IS SLIGHTLY DOWN
1627	UNK	NO CHUTES
1627	UNK	SEE NO CHUTES YET. THE MAIN GEAR IS (UNINTELLIGIBLE)
1627	61	EDWARDS THIS IS SPELL SIX ONE WE HAVE THE AIRCRAFT IN SIGHT GOING DOWN IN FLAMES
1627	UNK	THERE IS A CHUTE. THERE IS A CHUTE. THERE IS A CAPSULE, JUST ONE CHUTE
1627	UNK	B SEVENTY WING UP HERE HIGH TO THE RIGHT
1627	UNK	B SEVENTY WINGS TO OUR RIGHT WE'RE AT FIFTEEN THOUSAND FEET. B SEVENTY IS GOING DOWN I SEE ONE CHUTE, ONE CAPSULE
1627	RA-2	SPELL SIX ONE REMAIN WELL CLEAR OF THAT AREA THERE ARE SIX AIRCRAFT IN THAT FORMATION
1627	61	AH ROGER WE'RE GOING BACK TO THE NORTH
1627	UNK	THE AIRPLANE IS IN A FLAT SPIN. THE AIRPLANE IS IN A FLAT

SPIN SLIGHTLY NOSE DOWN MOST OF THE LEFT WING IS GONE HALF, I'D SAY A THIRD OF THE LEFT WING IS GONE.

1627	UNK	WE GOT SEVERAL PIECES AROUND US
1627	UNK	(UNINTELLIGIBLE) BURNING PIECES TO THE NORTHWEST THE AIRPLANE IS FLAT. WE'RE STAYING CLEAR OF THE CAPSULE.
1627	UNKN	(UNINTELLIGIBLE)
1628	UNK	WE GOTTA WATCH THAT WING PETE
1628	UNK	(UNINTELLIGIBLE)
1628	UNK	AND THE AIRPLANE IMPACTED WATCH THE WING, WATCH THE WING OF THE AIRPLANE. BE CAREFUL OF THE CAPSULE. ZEKE DO YOU HEAR US?
1629	UNK	ROGER WE HEAR YOU GO AHEAD

7-1 (Rev. 3-7-60)

REPORT
of the
FBI
LABORATORY

FEDERAL BUREAU OF INVESTIGATION
WASHINGTON, D. C.

To: Lieutenant Colonel C. P. Patton
Inspector General's Office
Flight Safety Division
Department of Air Force
The Pentagon
Washington, D. C.

June 20, 1966

BY LIAISON

J. Edgar Hoover
John Edgar Hoover, Director

Re: UNKNOWN SUBJECT;
CRASH OF U. S. AIR FORCE
XB-70 AND F-104 AIRCRAFTS
BARSTOW, CALIFORNIA, 6/8/66
REQUEST FOR LABORATORY EXAMINATION

YOUR NO.
FBI FILE NO.
LAB. NO. E-383 JZ

Examination requested by: Addressee

Reference: Telephone call 6/11/66

Examination requested: Audio Analysis

Specimens:

Q1 Short length of 1/4-inch magnetic recording tape on 5-inch reel

Q2 Short length of 1/4-inch magnetic recording tape on 5-inch reel

Q3 Four short pieces of heat-damaged 1/4-inch magnetic recording tape

Result of examination:

No evidence of recorded information appeared on Q2.

Evidence of recorded information appeared on two pieces of Q3. However, no intelligence could be extracted because of the warped and heat-damaged condition of the tape. There was no evidence of recorded information on the remaining two pieces of Q3.

There is set out below a transcript of the intelligible portions of Q1. Those portions of Q1 which were unintelligible (garbled) apparently resulted from simultaneous transmissions or overmodulation. Other portions of Q1, which are underlined, are susceptible to interpretation.

(Continued on next page)

MCH 3

two zero seven traffic two zero miles east of your position orbiting three sisters spot 'em at two four zero two seven zero

Roger thank you

I've got a contrail out there but I don't think (pause) he looks like he's higher than this plane (Might be carrier off between "think" and "looks").

garbled transmission

garbled transmission

(tone burst)

Two zero seven the lead ship says about three more minutes

OK thank you

Two zero seven he's off your left wing now uh below the clouds

All Roger thank you

B fifty-eight the speed run is now one five miles east of your position westbound from three (word dropped or covered) above (word or words covered) thank you

(noise other than audio) (45.8 seconds after "tone burst.")

(2.2 seconds later following transmission commenced)

---air midair stand by for (garbled)

(garbled) You've got some vertical gone - this is Captain - you've got some vertical came off left and right - we're staying with you - no question your home base is out

Clear Roger Roger gentlemen I think we can make it (this transmission garbled but sounds like above)

The XB seventy went upside down

(sounds like) Bail out bail out bail out (first voice of two)

Bail out bail out bail out (second of two voices)

OK (garbled) there something fell out it looks like

It looks like a capsule came out

(garbled) spinning to the right with nose - nose slightly down (garbled) landing gear is down, nose gear is up

'Chute see a good 'chute

There's a 'chute there's a capsule

There's one 'chute (garble)

(garble) up here high and to the right (garbled) right rear

(garbled) fifteen thousand feet (garbled) I see one 'chute one capsule - correction (this could be a different voice for word "correction") - the airplane's in a flat spin the airplane is single-wing in a flat spin slightly nose down most of left wing is gone (garble) half (garbled) left wing is gone (garble)

End of tape

Q1, Q2 and Q3 are being returned under separate cover.

This report confirms information which has been submitted telephonically.

Transcript From
Flight Test Project Tape
Recording

XB-70A 207
Flight 2-46
8 June 1966
White/Cross

Time Min & Sec.	Speaker	Statement
-1:28	White:	Roger, thank you.
-1:22		I have got a contrail out there, but I don't - It looks like he is higher than that.
-1:04	Cotton:	Lear Jet cleared, another 4 minutes Lear Jet says.
-57	White:	Thanks Joe.
-54	Cotton:	It looks like that guys' coming down the corridor, probably a 58, don't you think?
-52	White:	Yeh.
-45	Hopkins:	207, the Lear Jet says about 3 more minutes.
-41	White:	OK Zeke.
-17	White:	Oh, roger, thank you.
-08	White:	Rog, I have him, thank you.
0	?.	Mid Air, Mid Air, Mid Air———
02	?	Standby for -
05	Cotton:	You got the verticals. This is Cotton. You got the verticals came off, left and right. We're staying with you. No sweat, now your holding good [illegible]
14	?	Joe Walker ran into him and I think [illegible]
16	Cotton:	OK, the air, the B-70 went upside down. It's rolling now, the left wing-
21	?.	Bail out, Bail out.
	Cotton:	Fuselage — Bail out, Bail out, Bail out Bail out, Bail out, Bail out
42	Cotton:	OK, the B-70 is spinning to the right
45	?	Something came out of it, it looks like——
47	Cotton:	looks like a capsule came out. It's spinning to the right but the nose is slightly down
53	?	No chutes
55	Cotton:	We see no chutes yet. The main gear is down, the nose gear is up.

Time Min & Sec.	Speaker	Statement
1:01	?	Chute, there is a good chute.
1:02	Cotton:	There is a chute, there is a capsule. There is one chute.
1:08	?	B-70 wing up here high to the right.
1:10	Cotton:	B-70 wing is to our right. We are 15,000 feet. B-70 is going down. I see one chute, one capsule.
1:18	?	The left one.
1:20	Cotton:	The airplanes in a flat spin. The airplane is stable in a flat spin, slightly nose down, most of the left wing is gone.
1:26	"	Half, I'd say a third of the left wing is gone. Got several pieces around us.
1:33	"	There's a burning piece to the Northwest. The airplane is flat. We're staying clear of the capsule.
1:46	"	We gotta watch that wing Pete.
1:49	?	Which way
1:51	Cotton:	The airplane impacted. Watch the wing, watch the wing of the airplane and be careful of the capsule.
1:59	Cotton:	Zeke, do you hear us?
2:02	Munds:	Roger, we hear you, go ahead.
2:04	Cotton:	Data Control, do you hear us?
2:05	Munds:	Affirmative, go ahead.
2:07	Cotton:	Roger, OK. Now there are pieces coming down. There is a large piece of wing. We are now down to 10,000. There is a capsule. We are not sure which capsule. But Pete hopes its---; almost sure capsule.
2:31	Cotton:	Check the holes on the left side and it was out. OK, We are, I-squawked emergency on our IFF to make sure they got us Pete.
2:47	989	Eddy RAPCON 989
2:52	Munds:	Joe, you are coming in a little weak. Intermittent now.
2:57	989	989 roger. I was trying to follow the F-104 position. He's a little bit, he would be about 10 miles to the Northwest of the B-70.
3:07	Cotton:	Tell the Lear Jet to get out of here. Tell the Lear Jet to please get out of here.

TRANSCRIPT OF AIR/GROUND COMMUNICATION AND INTERPHONE

CONVERSATION DURING LAST FLIGHT OF XB-70A NR 20207

NOTE: Call signs of the aircraft participating in the formation flight are given. The transcript includes only UHF communication and available interphone conversation that took place in the XB-70A.

(In formation order, left to right)	T-38	601	P: Capt Hoag. CP: Col Cotton
	F-4B	BARTENDER 97	P: Cmdr Skyrud. OBS: AT1 Black
	XB-70A	207	P: Mr White. CP: Maj Cross
	F-104N	813	P: Mr Walker
	F-5A	989	P: Mr Fritz

Times given are PDST:

0908:54	INTPH (WHITE):	Do you want to fly?
	(CROSS):	Say again.
	(WHITE):	Do you want to fly?
	(CROSS):	Affirm, I have it.
0909:31	DATA CONTROL:	Two zero seven what is your total fuel?
	207 (CROSS):	Eighty point five.
	DATA CONTROL:	Roger.
0909:54	INTERPHONE:	(Garbled and intermittent conversation up to and immediately before next sequence)
0912:13	DATA CONTROL:	Two zero seven may I have your tank one and tank eight quantity please?
0912:28	207 (CROSS):	Tank - tank one is seventeen point two. Eight left is seven point one. Eight right is nine point zero.
	DATA CONTROL:	Roger, thank you.
0912:38	207 (WHITE):	Hey, Frank, how about going to long interval here? I'm down to fifteen percent on the digital.
	DATA CONTROL:	Rog, go ahead.
	207 (WHITE):	Yes.
0912:58	989:	Data control, nine eight nine.
	DATA CONTROL:	Go ahead, nine eight nine.
	989:	You might ask the Learjet if they've ah, had enough yet, ah, I think we've given them as much as they expected. Would you mind checking that?
	DATA CONTROL:	Nine eight nine, the Learjet said they're still taking pictures and they'll let us know when they get through.
	989:	Data, nine eight nine was unable on that one.
	601 (COTTON):	John, he ah, this is Joe. He said - I heard him say ah, is back there still doing some good and wants about fifteen more minutes if possible.
0913:34	989:	This is nine eight nine. Roger, why don't we have a fuel check and confirmation from the formation members? Start with BARTENDER nine seven.

0913:45	BARTENDER 97:	This is BARTENDER nine seven. I've still got forty minutes.
	989:	Ah, Roger, you're OK for fifteen more and return to Mugu?
	BARTENDER 97:	Nine seven affirm.
	989:	Rog.
	989:	Nine eight nine's OK.
	813:	Eight one three likewise.
	601 (HOAG):	Six oh one is fat.
0914:08	DATA CONTROL:	Two zero seven's OK.
0914:12	601 (COTTON):	How's tank five, Carl? Did it stop at nine point zero?
	INTPH (CROSS):	I'll take a check on it in just a minute.
	(WHITE):	Maybe you better go up a bit.
	(CROSS):	I'll check this fuel if you want to take it a minute, Al.
0914: 25	207 (WHITE):	We're going to have to climb a little bit, I guess - either that or everybody prop your card up on - the cowl there.
0915:10	207 (CROSS):	Eight's feeding in normal sequence.
0915:24	??:	Edwards Approach Control, ah...
0917:25	??:	(Carrier keyed)
0918:20	207 (??):	-, do you want to fly?
0918:24	207 (WHITE):	Turning left.
0920:02	DATA CONTROL:	Two zero seven, is tank eight feeding now? (Not on INTPH)
	207 (CROSS):	Al. (Also recorded on INTPH)
	207 (WHITE):	Come again, two zero seven.
	DATA CONTROL:	Ah, yes, this is Data Control. Is tank eight feeding now?
	207 (CROSS):	Affirmative, tank eight is feeding properly.
	DATA CONTROL:	Rog.
0921:24	INTPH (CROSS):	They must have had that Learjet full of film or they'd be out of business by now.
	(WHITE):	Yes - - - He was sitting there but he's up here now. - - This hole is getting smaller and smaller too.
0922:47	813:	We must be helping that cumulus activity along with all this hot air.
	207 (WHITE):	Yes.
	??:	Yes.
	??:	Thank you.
0924:48	RAPCON:	Two zero seven. Traffic. Two zero miles east of your position, orbiting Three Sisters two four zero, two seven zero.
	207 (WHITE):	Roger, thank you.
0925:05	207 (WHITE):	We got a contrail out there - but, I don't ah, it looks like he's higher than that.
	INTPH (CROSS):	Probably ---- ----.
0925:23	601 (COTTON):	Learjets Lear - Another four minutes the Learjet said.
	207 (WHITE):	Thanks Joe.
0925:31	601 (COTTON):	Looks like that guy's coming down the corridor, probably a fifty-eight, don't you think?
	207 (WHITE):	Yes.

0925:40	??:	(Two carriers keyed simultaneously)
0925:42	DATA CONTROL	Two zero seven, the Learjet says about three more minutes.
	207 (WHITE):	OK, Zeke.
0926:06	RAPCON:	Two zero seven, he's off your left wing now ah, below the clouds.
	207 (WHITE):	Roger, thank you.
	RAPCON:	The B fifty-eight's speed run is now one five miles east of your position westbound three zero zero or above.
	207 (WHITE):	I have him, thank you.
0926:26	??:	(One carrier burst followed by a longer carrier, one second maximum duration, sounding like a live microphone in an open cockpit)
0926:28	??:	(Two or more carriers on frequency with resultant heterodynes)
	601 (HOAG):	Mid-air, mid-air, stand by for - - - -
	(COTTON):	You got the verticals, this is Cotton, you got the verticals - - came off left and right. We're stayin' with ya, no sweat, now you're holding good, Al.
0926:40	601 (HOAG):	Joe Walker ran into him and I think he's had it.
	(COTTON):	The B seventy went upside down, it's rolling now, the left wing - -
	(HOAG):	Bailout, bailout, bailout -
	(COTTON):	Bailout, bailout, bailout.
0927:09	601 (COTTON):	OK, the B seventy is spinning to the right -
	(HOAG):	Something came out. It looks like - -
	(COTTON):	Looks like a capsule came out. It's spinning to the right, the nose is slightly down.
0927:23	601 (HOAG):	No chute -
	(COTTON):	- - - see no chute yet. The main gear is down, the nose gear is up.
0927:28	601 (HOAG):	Chute, chute, good chute.
0927:28	601 (COTTON):	There's a chute, there's a capsule (pause) There's one chute.
	(HOAG):	B seventy wing up here to our right.
0928:02	601 (COTTON):	The B seventy wing is to our right. We're at fifteen thousand feet. The B seventy i. going down. I see one chute, one capsule.
	(HOAG):	The left one.
	(COTTON):	The airplane's in a flat spin. The airplane is stable in a flat spin slightly nose down. Most of the left wing is gone. Got several pieces around us. There's a burning piece to the northwest. The airplane is flat. We're staying clear of the capsule.

<u>NOTE</u>: Monitoring of the original voice tape from the B-70 shows the last intelligence is the sentence ending with - "I'd say a third of the left wing is gone." There is approximately 15 inches of burned tape. This amount of tape is equivalent to 14 seconds of recording. The telemetry data readout fixes the time of impact at 0928:15.8. One piece of burned tape revealed garbled verbage when pulled through a recorder tape head by hand feeding.

0928:13	601 (COTTON):	We got to watch that wing, Pete.
0928:18	601 (COTTON):	The airplane impacted. Watch the wing, watch the wing of the airplane and be careful of the capsule. And, Zeke, Zeke, do you hear us?
	DATA CONTROL:	Affirmative, go ahead.
	601 (COTTON):	Roger, OK, now there's pieces coming down, there's a large piece of wing. We are now down at at, ten thousand. There is a capsule - we are not sure which capsule but Pete Hoag says he is almost sure it's the left capsule. Pete said he checked, the hole is on the left side and it was out. OK. (0929:05)
0929:09	601 (COTTON):	Now we are - I uh - squawk emergency on our IFF to make sure they got us, Pete.
0929:16	989:	Eddie RAPCON, nine eight nine.
	DATA CONTROL:	Joe, you're coming in a little weak and intermittent now.
	RAPCON:	Six zero - correction, nine eight nine. We have the position marked on our radar.
0928:28	989:	Nine eight nine, Roger. I was trying to follow the uh F one oh four position. He's a little bit, ah he would be about ten miles northwest of the ah, B seventy.
0929:40	601 (COTTON):	Tell that Learjet to get out of here. Zeke, tell the Learjet to please get out of here.
0929:56	989:	RAPCON, nine eight nine.
	RAPCON:	Nine eight nine, say again.
	989:	Requesting vector for the base and ah, get the Learjet out also.
0930:13	RAPCON:	Nine eight nine, make the heading two six zero. Position three five miles east of the base.
0930:18	DATA CONTROL:	Nine eight nine, position of the crash?
0930:21	601 (COTTON):	We are circling it, Frank. We are at ten thousand ah, and if you can plot on radar, we are circling. The capsule is still coming down and ah, -
	(HOAG):	There's still lots of pieces floating down here and I'm trying to stay clear of 'em.
	(COTTON):	The crash, the smoke is ah, at an altitude of approximately seven thousand feet and it is burning, looks like the nose is pointed to the west, looked like it went down flat - - - (0939:57)
0930:58	DATA CONTROL:	Joe, can you - - -
0930:59	601 (COTTON):	- - - capsule is very near it, coming down, the capsule is ah, no sweat on the capsule. The wind is blowing from the - from the east generally and the capsule is going to come close to a - our big piece of wing.
0931:23	DATA CONTROL:	Rog, Joe, can you give me position on the ground of the crash?
0931:31	601 (COTTON):	Now we ah, we don't have a uh - We don't have a whale - How much fuel we got, Pete? Pete says we have plenty of fuel for fifteen or twenty minutes. We have to be careful about pieces that were still falling. The capsule is uh, coming down now.

0931:54 DATA CONTROL: Joe, can you - - -

0931:55 601 (COTTON): - - - about to touch.

0931:56 DATA CONTROL: Joe, can you give me a position of the capsule?

0931:57 601 (COTTON): - - - is - yet, let's see. Relative to Three Sisters, we're south of now - - Three Sisters to the north of us and it touched down on a peak.

0932:13 DATA CONTROL: Understand. On a peak south of Three Sisters.

0932:15 601 (COTTON): - - -the capsule's down at this time. That's at uh, about uh, thirty, thirty-two minutes after the hour the capsule touched down.

NOTE: The remaining communication during the emergency is relatively routine air/ground and air/air conversation during launching of another T-38 and helicopters to Mr. White's position, the B-70 crash site and the F-104 cockpit section.

FAA CHRONOLOGICAL SUMMARY OF FLIGHT

1416 GMT	Air Force 20207, a North American B-70 departed Edwards AFB on a local VFR flight plan to performa a flight test mission and return to Edwards AFB.
1418 GMT	Air Force 20207 was radar-identified 8 miles north of Edwards VOR; flight following and traffic information were provided throughout the remainder of the flight. The initial portion of the flight the aircraft remained in the area near the airport and performed airspeed calibration runs over the airport.
1502 GMT	NASA 813, on F-104, departed Edwards AFB on a local VFR flight plan to perform a mission with the B-70 and return to Edwards AFB.
1504 GMT	Air Force 20207 departed the airport area to make a supersonic flight from a point approximately 30 miles northeast of Daggett VORTAC to 25 miles southwest of Edwards AFB at Flight Level 310.
1510 GMT	NASA 813 was radar-identified 6 miles east of Mojave, California and requested a radar vector to the B-70.
1520 GMT	Air Force 20207 completed the supersonic portion of the test flight and proceeded toward Mojave, California to rendezvous with several other aircraft for a photography mission.
1526 GMT	NASA 813 was radar-vectored to the B-70 formation and was instructed to resume normal navigation.
1627 GMT	An unidentified voice on the B-70 flight test frequency reported a mid-air. Further conversation on the frequency verified that the B-70 had been involved in a mid-air collision with NASA 813.

ENCAPSULATED #004
Per LA Spec. 0308-041-L

PART NAME	PART NR	INSTALLED MAX TIME	INSTALLED AT
Pressure Initiator	2037-09	4 yrs	1964
Delay PSI Initiator	2037-06	4 Yrs	1964
Stab. Boom	59252-001	4 yrs	1965
Cartridge	59252-418	5 yrs	1963
Parachute Cartridge	0A-A15	5 yrs	1963
Stabilization Parachute	GID-21-212	4 yrs	1965
Impact Bladder Extractor Door Latch	257-735026-41	4 yrs	1964
Attenuator Blader	4A-1263	5 yrs	1962
Attenuator Inflation Device	4A-1442-1	3 yrs	1964
Gas System			
Door Seal	S-13649	4 yrs	1965
Shell Seal	S-13650	4 yrs	1965
Inline Reducer	258-160A	3 yrs	1964
Pressure Reducing Valve	FR77-A1	5 yrs	1964
Convenience Disconnect	GU-114-A1	4 yrs	1964
Encapsulation System			
Mech. Initiator	2037-01A	4 yrs	1964
Inertial Reel	0103136-0	4 yrs	1964
Restraint Harness	1101152-0	3 yrs	19[illegible]6
Seat Retract. Thruster	20291	3 yrs	1964
Cap. Disconnect Upper Half	257-735730	3 yrs	1964
Mech. Initiator	2037-01A	4 yrs	1964
Gas Generator	257-735600	4 yrs	1964
Foot Position Valve	2381121	4 yrs	1966
Foot Position Valve	2381118	4 yrs	1966
Press. Initiator	2037-04A	4 yrs	1964
Door Uplock Extractor	274-[illegible]350[illegible]	4 yrs	1964
Door Closure Thruster	20[illegible]1	3 yrs	1965
Door Damper Cylinder	257-735552	3 yrs	1964

[redacted]

FLIGHT CONTROLS, PNEUDRAULICS AND MECHANICAL LINKAGE REPORT

1. Telemetered data indicates that the XB-70 aircraft was flying in a straight and level condition at time of initial impact.

2. The pilot of the XB-70 noted no loss of primary hydraulic power prior to impact; it is assumed that both primary hydraulic systems were performing in a normal manner.

3. From the telemetered data, elevon motion on the L. H. wing continued for approximately 22 seconds after the loss of the L. H. vertical stabilizer.

4. From the telemetered data, elevon motion continued on the R. H. wing for approximately three seconds after the L. H. wing tip was lost.

5. Data indicates that the control functions of the XB-70 were operating in a normal manner on initial impact with the F-104 until loss of the L. H. wing section and hydraulic power.

6. The left-hand vertical actuator was broken at the point where the rod end enters the piston rod. The actuator appeared to be in its proper position and intact.

7. The right-hand vertical actuator appeared to be completely intact and in its proper A/V position. The rod end on this actuator had not failed but was free of its structural attach point ot the vertical.

8. The XB-70 Ship #2 had no history of Flight Control problems prior to the accident.

9. Both XB-70 control columns were broken free and were on the ground near the crew compartment wreckage. The columns can be individaully stowed in the forward position for crew ejection from the aircraft. They can be manually stowed by pressing a foot lever near each column or by a ballistic charge actuated by the encapsulation and capsule ejection procedures. The column stowage mechanism is located on a torque tube under the crew compartment floor. Both control columns were broken free from the torque tube and the torque tube was in several pieces. The pilot's control column was found in the full forward position which would be the stowed position and the co-pilot's control column was found in the full aft position.

10. The XB-70 wingfold hinges were in the 25° position at time of collision with the F-104 and were in this position after ground impact.

11. No data is available to establish when the XB-70 main gears dropped out of the aircraft. The nose gear remained in the up position indicating that the crew members did not initiate a gear down command.

Vernet V. Poupitch
VERNET V. POUPITCH
Group Leader Directorate Aerospace Safety
CS-14

BALLISTICS USEABLE LIFE SUMMARY
Per P. SPEC LA0308-041L dated 1 Apr 66

ITEM	P/N	MAX INSTALL LIFE	ACTUAL INSTALL
Co-pilot's Rocket Capsule	1720-12	4 yrs.	1965
Cartridge	1720-48	5 yrs	1962
Rocket Motor	1720-88	5 yrs	1962
Dis. Lower Half	257-735732	3 yrs	1965
Mech. Initiator Hatch Jettison	2037-01A	4 yrs	1965
Mech. Initiator Hatch Jettison	2037-01A	4 yrs	1965
Press Initiator Hatch Jettison	2037-04A	4 yrs	1965
Press Initiator Hatch Jettison	2037-04A	4 yrs	1965
Delay Pressure Initiator Ejection System	2037-10	4 yrs	1965
Pressure Initiator Ejection System	2037-04A	4 yrs	1965
Hatch Remover Co-pilots	960100	4 yrs	1965
Hatch cartridge	Lot 243045-1	5 yrs	1963

I. Accumulators:

A. Accumulator with lines on it: Assy no. 1011915-3-1, ser. no. 281623

1. Seals were soft and pliable in this accumulator and no apparent defects were noted.

2. The piston in this accumulator was bottomed out on the hydraulic end of accumulator, indicating that hydraulic pressure was lost before air pressure.

B. Accumulator: Assy no. 1011915-3-1, ser. no. 6431832

1. Seals were cooked in this accumulator and the teflon rings were melted. No apparent defects otherwise were noted.

2. This piston in this accumulator was also bottomed out on the hydraulic end of accumulator.

Francis J. Maher

FRANCIS J. MAHER, L-10
Hydraulic Shop
Jun 17, 1966

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The following U.R.'s were submitted on the XB-70 escape system:

AFFTC UR #66-299	(Confidential)
AFFTC UR #66-300	Method of Initiation of Ejection
AFFTC UR #66-301	Ballistic Hose Leakage
AFFTC UR #66-302	Tripping Device for Actuating Altitude Warning Light
AFFTC UR #66-303	Method of Initiation of Inflation of Attenuation Bag

S/N 170-578
Engine No. 6

50:25 Flight time; 64:30 ground time:

1. 15 Jan 65 1st Grd Run
2. 17 Jul 65 First Flight

Inspections:

A. 12.5 hr insp completed at 4:38 24 Sep 65

B. 25 hr insp completed at 20:36 23 Dec 65

C. 35 hr insp completed at 35:12 18 May 66

TCTOs OPEN

2J-J93-585C (Installation of new bearing retainer bolts in the inlet and transfer gearbox assy) 26 Feb 65 Routine

2J-J93-620 (Replacement of the main fuel control) 15 Feb 66 Routine

2J-J93-621 (Replacement of feedback arm at the 10th stage of the compressor) 14 Jan 66 Routine

2J-J93-624 (Replace nozzle area control P-7 with P-8) Routine

2J-J93-625 (Modification of compressor rotor assy) 15 Apr 66 Routine

2J-J93-626 (Replacement of thermocouple harness) 15 Apr 66 Routine

Exhaust Nozzle No. 6 S/N 553 - Outstanding TCTOs:

2J-J93-578 (Inspection of afterburner bellcrank and actuating link) 15 Sep 63 Routine

2J-J93-600D (Modification of the primary nozzle assy) 1 Mar 65 Routine

S/N 170-567
Engine No. 5

34:29 Flight time; 106:05 Ground time - 1. 19 Sep 63 1st Grd Run

2. 21 Sep 64 First Flight

Inspections:

A. 12.5 hr insp completed 15:16 hrs' 22 Feb 66

B. 25 & 35 hr insps completed 29:59 hrs

TCTOs OPEN

2J-J93-527 (Modification of stator actuator assemblies) 15 Jan 63 Routine

2J-J93-549 (Modification and replacement of transfer gearbox assy) 30 Aug 63 Routine

2J-J93-560 (Replace idle reset solenoid valve) 15 Sep 63 Routine

2J-J93-585 (Installation of new bearing retainer bolts in the inlet and transfer gearbox assy) 15 Feb 64 Routine

2J-J93-601 (Replacement of hydraulic tank) 1 Apr 65 Routine

2J-J93-608 (Replacement of self aligning washers in the compressor stator assy) 15 Dec 64 Routine

2J-J93-615 (Modification of hydraulic tank) 1 Apr 65 Routine

2J-J93-619 (Rework of the 3rd stage blades of the compressor rotor) 15 Sep 65 Routine

2J-J93-620 (Replacement of the main fuel control) 15 Feb 66 Routine

2J-J93-62. (Replacement of feedback arm at the 10th stage of the compressor) 14 Jan 66 Routine

2J-J93-622 (Damping of the ignition unit) 18 Feb 66 Routine

2J-J93-624 (Replace nozzle area control P-7 with P-8) Routine

2J-J93-625 (Modification of compressor rotor assy) 15 Apr 66 Routine

2J-J93-626 (Replacement of thermocouple harness) 15 Apr 66 Routine

Exhaust Nozzle No. 5 S/N 562 - Outstanding TCTOs:

2J-J93-578 (Inspection of afterburner bell crank) 15 Sep 63 Routine

2J-J93-609D (Modification of the primary nozzle assy) 1 Mar 65 Routine

2J-J93-610 (Modification of exhaust duct assy) 15 Jan 65 Routine

S/N 170-564
Engine No. 4

48:56 Flight time; 62:56 ground time - 1. 30 Jan 63 1st Grd Run

2. 20 Aug 65 First Flight

Inspections:

A. 12.5 hr insp completed at 6:31 15 Dec 65

B. 25 hr insp completed at 26:10 30 Mar 66

C. 35 hr insp completed at 40:36 24 May 66

TCTOs OPEN

2J-J93-560 (Replace idle reset solenoid valve) 15 Sep 63 Routine

2J-J93-570 (Inspection of #2 stage turbine disc.) 1 May 63 Routine

2J-J93-581 (Modified CIT sensor & compressor front frame) 31 Dec 63 Routine

2J-J93-588 (Inspection of afterburner flameholders & spacer rings) 24 Apr 64 Routine

2J-J93-601 (Replacement of hydraulic tank) 1 Apr 65 Routine

2J-J93-608 (Replacement of self aligning washers in the compressor stator assy) 15 Dec 64 Routine

2J-J93-619 (Rework of 3rd stage blades of the compressor rotor) 15 Sep 65 Routine

2J-J93-620 (Replacement of the main fuel control) 15 Feb 66 Routine

2J-J93-621 (Replacement of feedback arm at the 10th stage of the compressor) 14 Jan 66 Routine

2J-J93-622 (Damping of the ignition unit) 18 Feb 66 Routine

2J-J93-624 (Replace nozzle area control P-7 with P-8) Routine

2J-J93-625 (Modification of compressor rotor assy) 15 Apr 66 Routine

2J-J93-626 (Replacement of thermocouple harness) 15 Apr 66 Routine

Exhaust Nozzle No. 4 S/N 559 - Outstanding TCTOs:

2J-J93-554 (Modification of exhaust duct) 31 Jan 64 Routine

2J-J93-578 (Inspection of afterburner bell crank) 15 Sep 63 Routine

2J-J93-609D (Modification of the primary nozzle assy) 1 Mar 65 Routine

2J-J93-610 (Modification of exhaust duct assy) 15 Jan 65 Routine

S/N 170-574
No. 3 Engine

43:56 Flight time; 53:49 ground time - 1. 27 Oct 64 1st Grd Run

2. 16 Feb 65 First Flight

<u>Inspections:</u>

A. 12.5 hr insp completed at 11:04 5 Jun 65

B. 25 hr insp completed at 24:05 29 Dec 65

C. 35 hr insp completed at 35:36 25 Apr 66

TCTOs OPEN

2J-J93-620 (Replacement of the main fuel control) 15 Feb 66 Routine

2J-J93-621 (Replacement of feedback arm at the 10th stage of the compressor) 14 Jan 66 Routine

2J-J93-622 (Damping of the ignition unit) 18 Feb 66 Routine

2J-J93-624 (Replace nozzle area control P-7 with P-8) Routine

2J-J93-625 (Modification of compressor rotor assy) 15 Apr 66 Routine

2J-J93-626 (Replacement of thermocouple harness) 15 Apr 66 Routine

<u>Exhaust Nozzle No. 3 S/N 568 - Outstanding TCTOs:</u>

2J-J93-609D (Modification of the primary nozzle assy) 1 Mar 65 Routine

S/N 170-566
Engine No. 2

28:10 flight time; 66:47 ground time: 1. 12 Jul 63 1st Grd Run

2. 7 May 65 First Flight

Inspections:

A. 12.5 hr insp completed at 13:45 8 Feb 66

B. 25 hr insp complete at 21:36 27 Apr 66

TCTOs OPEN

2J-J93-527 (Modification of compressor rear frame assy) 15 Jul 63 Routine

2J-J93-549 (Modification and replacement of transfer gearbox assy) 30 Aug 63 Routine

2J-J93-560 (Replace idle reset solenoid valve) 15 Sep 63 Routine

2J-J93-581 (Modified CIT sensor and compressor front frame) 31 Dec 63 Routine

2J-J93-585 (Installation of new bearing retainer bolts in the inlet and transfer gearbox assy) 15 Feb 64 Routine

2J-J93-608 (Replacement of self aligning washers in the compressor stator assy) 15 Dec 64 Routine

2J-J93-620 (Replacement of the main fuel control) 15 Feb 66 Routine

2J-J93-621 (Replacement of feedback arm at the 10th stage of the compressor) 14 Jan 66 Routine

2J-J93-624 (Replace nozzle area control P-7 with P-8) Routine

2J-J93-625 (Modification of compressor rotor assy) 15 Apr 66 Routine

2J-J93-626 (Replacement of thermocouple harness) 15 Apr 66 Routine

Exhaust Nozzle No. 2 S/N 570 - Outstanding TCTOs

2J-J93-609D (Modification of the primary nozzle assy) 1 Mar 65 Routine

2J-J93-610 (Modification of the exhaust duct assy) 15 Jan 65 Routine

XB-70A 62-207

This is a brief summary of the engine inspections and outstanding TCTOs on air vehicle No. 2 as of 3 June 1966.

S/N 170-553 No. 1 Engine — 19:26 Flight time; 60:07 ground time - 1. 13 Sep 63 First Gnd Run

2. 12 Nov 65 First Flight

Inspections:

A. 12.5 hr insp completed at 10:43 3 Jan 66

B. 25 hr insp completed at 15:13 10 May 66

TCTOs OPEN

2J-J93-525 (Modification of compressor rear frame assy) 15 Jul 63 Routine

2J-J93-527 (Modification of stator actuator assemblies) 15 Jan 63 Routine

2J-J93-560 (Replace idle reset solenoid valve) 15 Sep 63 Routine

2J-J93-581 (Modified CIT sensor and compressor front frame) 31 Dec 63 Routine

2J-J93-585 (Installation of new bearing retainer bolts in the inlet and transfer gearbox assy) 15 Feb 64 Routine

2J-J93-588 (Inspection of afterburner flameholders and spacer rings) 24 Apr 64 Routine

2J-J93-608 (Replacement of self aligning washers in the compressor stator assy) 15 Dec 64 Routine

2J-J93-620 (Replacement of the main fuel control) 15 Feb 66 Routine

2J-J93-621 (Replacement of feedback arm at the 10th stage of the compressor) 14 Jan 66 Routine

2J-J93-624 (Replace nozzle area control P-7 with P-8) Routine

2J-J93-625 (Modification of compressor rotor assy) 15 Apr 66 Routine

2J-J93-626 (Replacement of thermocouple harness) 15 Apr 66 Routine

Exhaust Nozzle No. 1 S/N 527 - Outstanding TCTOs

2J-J93-554 (Modification of exhaust duct) 31 Jan 64 Routine

2J-J93-578 (Inspection of afterburner bellcrank and actuating link) 15 Sep 63 Routine

2J-J93-610 (Modification of the exhaust duct assy) 15 Jan 65 Routine

6. LOCATION OF INITIAL FIRE

	Known	Probable		Known	Probable		Known	Probable
Baggage Compartment			Aft of Firewall			Wheel Well		
Bomb Bay			Forward of Firewall			Cargo-Passenger Compartment		
Cockpit/Crew Quarters			Rocket Pod			Other (Specify) Rupture of fuel cells	x	
Engine Section			Tire/Wheel/Brake			Unknown		

7. MISCELLANEOUS CHEMICAL EXPLOSION DATA

	Known	Probable		Known	Probable
Initial Ignition Occurred in an Explosive Manner Prior to Ground Impact.	N/A	N/A	Intensity of Explosion Was Sufficient To Cause or Appreciably Contribute to In-Flight Airframe Break-Up.	N/A	N/A
Explosion Occurred After Fire and Before Ground Impact.	N/A	N/A	Other Significant Data (Specify)	N/A	N/A
Explosion Occurred Subsequent to Ground Impact.	N/A	N/A	Unknown or Not Available.		

8. AIRCRAFT MAINTENANCE OFFICER'S ANALYSIS AND SPECIFIC ACTION TAKEN

Describe difficulties involved and relationship of the various components to the accident. Describe specific action taken. For Fire Data describe the fire and/or chemical explosion. Cover in detail any noted deficiencies, malfunctions of fire detecting and extinguishing equipment, or questionable procedures. When discussing specific equipment, give the name of manufacturer, part number, etc., and state whether or not a UR has been submitted. Include any additional information or opinion of possible value to future technical analysis of this report.

AIRCRAFT MAINTENANCE/MATERIEL REPORT

Use this form when AF aircraft accident/incident involves inadequacy, malfunction or failure of AF materiel.

1. AIRCRAFT TMS & SERIAL NUMBER	2. SPECIAL REPORTS DATA	
	a. Were Previous UR's Submitted on Factor(s) Involved? ☐ Yes ☐ No	b. No. and Date of UR's Submitted as Result of This Accident (Attach copy)
	c. Is TDR Requested? ☐ Yes ☐ No	d. No. of T.O.'s Not Complied With at Time of Accident (List T.O. Nos. and titles on separate sheet(s)—Tab K)

3. AIRCRAFT HISTORICAL DATA

Item	Aircraft	Part, Component or Accessory
Identification of Aircraft/Part, etc.		
Air Force Acceptance Date		
Total Flight Hours		
Last Overhaul Date		
Overhauling Activity (Name and location)		
Hours Since Overhaul		
Hours Since Last Periodic Inspection		
Date of Last Periodic Inspection		
Type of Last Periodic Inspection		

4. ENGINE HISTORICAL DATA

(Complete a separate column for each engine involved. Also, complete a separate column for each power plant component involved.)

Installed Position	#5	#6		
Engine Model and Series	YJ-93-3	YJ-93-3		
Engine Serial Number	170567	170578		
Total Engine Hours	34:35	50:25		
Number of Major Overhauls	N/A	N/A		
Hours Since Last Major Overhaul	N/A	N/A		
Date of Last Overhaul	N/A	N/A		
Overhaul Activity	N/A	N/A		
Date Last Installed	6 Jun 66	20 May 66		
Hours Since Last Installed	32:22	35:12		
Date of Last Periodic Inspection	19 May 66	18 May 66		
Type of Last Periodic Inspection	25 Hr	35 Hr		
Fuel (Type and octane rating)	JP-6	JP-6		

5. FIRE DATA

(To be completed when fire or chemical explosion occurs, not resulting from ground impact. Indicate: P—Probable or K—Known, in squares below.)

a. MATERIEL FAILURE CAUSING THE FIRE				b. IGNITION SOURCE				c. COMBUSTIBLE MATERIAL			
Electrical System		Propulsion System		Electrical System		Static Electricity/ Lightning		Cargo		Hydraulic Fluid	
Fuel System		Other (Specify)		Pneumatic System		Other (Specify)		Electrical Insulation		Lubricating Oil	
Hydraulic System				Propulsion System				Explosives		Other (Specify)	
Pneumatic System		Unknown				Unknown		Fuel		Unknown	

d. AIRCRAFT FIRE EXTINGUISHING SYSTEM	Fixed	Portable		Fixed	Portable	e. FIRE/OVERHEAT WARNING	Fire Detector	Overheat Indicator
Extinguished Fire			Not Activated and Not Near Fire			Operated Properly		
Reduced Fire			If Discharged, Chemical Used			Not Operated, but Near Fire		
No Effect When Discharged			If Discharged, Amount of Chemical Used			Not Operated and Not Near Fire		
Activated but Did Not Discharge			Other Pertinent Info.			Not Installed		
Not Activated but Near Fire						Other (Specify)		

f.	SHUT OFF PROCEDURE	RESULTS OF ALLOWING FIRE TO BURN OUT	g. EFFECT OF FIRE	MARK ONE
Extinguished Fire			Catastrophic	
Reduced Fire			Increased Severity of Mishap	
No Effect			No Change in Severity of Mishap	
Not Accomplished			Unknown	
Unknown				

AIRCRAFT MAINTENANCE/MATERIEL REPORT

Use this form when AF aircraft accident/incident involves inadequacy, malfunction or failure of AF materiel.

1. AIRCRAFT MD & SERIAL NUMBER

XB-70A
62-207

2. SPECIAL REPORTS DATA

a. Were Previous UR's Submitted on Factor(s) Involved? ☐ Yes ☒ No

b. No. and Date of UR's Submitted as Result of This Accident (Attach copy): N/A

c. Is TDR Requested? ☐ Yes ☒ No

d. No. of T.O.'s Not Complied With at Time of Accident (List T.O. Nos. and bries on separate sheet(s)—Tab K): Engine 77, Aircraft N/A

3. AIRCRAFT HISTORICAL DATA

Item	Aircraft	Part, Component or Accessory
Identification of Aircraft/Part, etc.	62-207	
Air Force Acceptance Date	17 Jul 65	
Total Flight Hours	92:22	
Last Overhaul Date	N/A	
Overhauling Activity (Name and location)	N/A	
Hours Since Overhaul	N/A	
Hours Since Last Periodic Inspection	N/A	
Date of Last Periodic Inspection	N/A	
Type of Last Periodic Inspection	N/A	

4. ENGINE HISTORICAL DATA

(Complete a separate column for each engine involved. Also, complete a separate column for each power plant component involved.)

Installed Position	#1	#2	#3	#4
Engine Model and Series	YJ-93-3	YJ-93-3	YJ-93-3	YJ-93-3
Engine Serial Number	170553	170566	170574	170564
Total Engine Hours (Flight)	19:26	28:10	43:56	48:56
Number of Major Overhauls	N/A	N/A	N/A	N/A
Hours Since Last Major Overhaul	N/A	N/A	N/A	N/A
Date of Last Overhaul	N/A	N/A	N/A	N/A
Overhaul Activity	N/A	N/A	N/A	N/A
Date Last Installed	5 Jun 66	7 Jun 66	1 Jun 66	1 Jun 66
Hours Since Last Installed	15:13	25:57	37:38	42:38
Date of Last Periodic Inspection	10 May 66	27 Apr 66	25 Apr 66	24 May 66
Type of Last Periodic Inspection	25 Hr	25 Hr	35 Hr	35 Hr
Fuel (Type and octane rating)	JP-6	JP-6	JP-6	JP-6

5. FIRE DATA

(To be completed when fire or chemical explosion occurs, not resulting from ground impact. Indicate: P—Probable or K—Known, in squares below.)

a. MATERIEL FAILURE CAUSING THE FIRE				b. IGNITION SOURCE				c. COMBUSTIBLE MATERIAL			
Electrical System	N/A	Propulsion System	N/A	Electrical System	N/A	Static Electricity/ Lightning	N/A	Cargo	N/A	Hydraulic Fluid	N/A
Fuel System	N/A	Other (Specify)	N/A	Pneumatic System	N/A	Other (Specify)	N/A	Electrical Insulation	N/A	Lubricating Oil	N/A
Hydraulic System	N/A		N/A	Propulsion System	N/A		N/A	Explosives	N/A	Other (Specify)	N/A
Pneumatic System	N/A	Unknown	N/A		N/A	Unknown	N/A	Fuel	N/A	Unknown	N/A

d. AIRCRAFT FIRE EXTINGUISHING SYSTEM	Fixed	Portable		Fixed	Portable	e. FIRE/OVERHEAT WARNING	Fire Detector	Overheat Indicator
Extinguished Fire	N/A	N/A	Not Activated and Not Near Fire	N/A	N/A	Operated Properly	N/A	N/A
Reduced Fire	N/A	N/A	If Discharged, Chemical Used	N/A	N/A	Not Operated, but Near Fire	N/A	N/A
No Effect When Discharged	N/A	N/A	If Discharged, Amount of Chemical Used	N/A	N/A	Not Operated and Not Near Fire	N/A	N/A
Activated but Did Not Discharge	N/A	N/A	Other Pertinent Info.	N/A	N/A	Not Installed	N/A	N/A
Not Activated but Near Fire	N/A	N/A		N/A	N/A	Other (Specify)	N/A	N/A

f.	SHUT OFF PROCEDURE	RESULTS OF ALLOWING FIRE TO BURN OUT	g. EFFECT OF FIRE	MARK ONE
Extinguished Fire	N/A	N/A	Catastrophic	N/A
Reduced Fire	N/A	N/A	Increased Severity of Mishap	N/A
No Effect	N/A	N/A	No Change in Severity of Mishap	N/A
Not Accomplished	N/A	N/A	Unknown	N/A
Unknown				

AF FORM DEC 62 711c PREVIOUS EDITION OF THIS FORM IS OBSOLETE.

PROPULSION REPORT

Review of the telemetered engine vibration data concerning the XB70 Flight #2-46 indicates the YJ93 engines were operating in the 90 to 95% engine speed range during the 15 to 20 minutes preceding the mid-air collision. Within the 30 second time period preceding the collision, engines 1 through 6 were running 92%, 91%, 93%, 93%, 92% and 96% respectively. Engine vibration levels were 2 mils or less.

Engine operation following the mid-air collision was within the above ranges up to a point approximately 20 seconds later at which time Col. Cotton in the chase aircraft reported the XB70 rolling. Coincident with this report, was an increase in vibration level on engines 5 and 6 and a rapid decrease in R/H inlet duct pressure level. The L/H inlet duct pressure also decreased, but at a slower rate and to a lesser magnitude. The engine vibration data is telemetered on a commutated basis, i.e., calibrate step, #1 engine, #2 engine, #3 engine, etc., therefore precise engine response to this inlet duct pressure decrease cannot be defined. Engines 1, 2, 3 and 4 continued operating down to the point of impact. Engines 5 and 6 appeared to be windmilling at a speed below flight idle speed during this period. All signals ceased at impact.

Examination of the engines in the XB70 crash wreckage showed positive indication of engine rotation at the time of impact on engines 1, 2, 3 and 4. Engine #5 and #6 indicated low rotating speed at impact.

Arthur G. Smith

ARTHUR G. SMITH
Directorate of Aerospace Safety
Office of the Inspector General
Norton AFB

XB-70 #62-207 COST DATA

USAF:

Value of XB-70 #2

A/V	209.3
(6) J-93 Engines	7.2
GFAE	1.0
	$217.5 M

NASA:

There was also $2.0M (acquisition cost)
NASA Instrumentation

George W Bollinger
GEORGE W. BOLLINGER
Deputy Director
Directorate of Research Vehicles
Deputy for Systems Management
Aeronautical Systems Division

7 June 1966

66LA-12336-186

Subject: Crew Assignment, XB-70A

TO: Air Force Plant Representative

In turn to: Joint Test Force (FTTB)
Edwards AFB, California

In conformance with the XB-70 Flight Test Contract, #12395, the Contractor is required to furnish the Joint Test Force Director the names of assigned crew 48 hours prior to flight.

The Contractor has assigned the qualified listed crew for Flight 2-46:

A. S. White, NAA, pilot and aircraft commander

Major Carl Cross, AFFTC, copilot

NORTH AMERICAN AVIATION, INC.
LOS ANGELES DIVISION

S/T Roy Ferrun, Manager
Flight Test

RF:JM

A true Copy:
ELDON D. MORTENSEN
Lt. Colonel, USAF
Recorder

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NASA FRC TECHNICAL FILES

*AFR 55-20
1-3

AIR FORCE REGULATION
NO. 55-20

DEPARTMENT OF THE AIR FORCE
Washington, 12 June 1959

Operations

USE OF AIR FORCE AIRCRAFT BY NASA TEST PILOTS

This regulation establishes policy and responsibility for the use of Air Force aircraft by test pilots of the National Aeronautics & Space Administration (NASA).

1. Mission of NASA. NASA is an independent Government agency engaged in conducting fundamental aeronautical research. It is organized and operates for the practical advancement of the science of aeronautics. Its efforts are applied to both military and civil fields of aviation, which means it functions in coordination with military and civil organizations and authorities.

2. Policy on Use of Aircraft.

a. Air Force aircraft are furnished to NASA for conducting research for the direct benefit of, and often at the request of, the Air Force. These aircraft will be operated under the jurisdiction and at the discretion of NASA authorities.

b. NASA pilots operate these aircraft within limitations imposed on them individually by NASA and in such manner as may be determined by competent NASA authority. Frequently, they must engage in flights involving advanced and unconventional flying techniques. Provisions of AFR 60-16 and other Air Force flying regulations, therefore, do not apply to NASA pilots. Air Force personnel concerned with flying operations must be familiar with NASA operations in order to avoid imposing Air Force rules and regulations on NASA pilots and thus hampering NASA operations.

3. NASA Responsibility. NASA has agreed to insure that:

a. Flying personnel are qualified as pilots and operate Air Force aircraft within the limitations imposed on them individually.

b. Pilots use sound judgment and do not engage in unsafe operating practices that unnecessarily endanger lives and property.

c. Individuals qualified as test pilots are given an identification card signed by an appropriate NASA official. The card will contain a direct reference to this regulation, a brief description of the pilot, and the pilot's signature.

BY ORDER OF THE SECRETARY OF THE AIR FORCE:

OFFICIAL:

THOMAS D. WHITE
Chief of Staff

J. L. TARR
Colonel, USAF
Director of Administrative Services

*This regulation supersedes AFR 55-20, 2 August 1957.

OPR: AFDDP

DISTRIBUTION: S; X:

NASA .... 100 copies

U. S. GOVERNMENT PRINTING OFFICE: 1959

DIRECTORATE OFFICE INSTRUCTION
NR 55-3

DIRECTORATE OF FLIGHT TEST OPERATIONS
DEPUTY FOR SYSTEMS TEST
Edwards Air Force Base, California
1 March 1966

Operations

FLIGHT BRIEFING AND DEBRIEFING

PURPOSE: To establish a flight briefing and debriefing policy within the Directorate of Flight Test Operations.

1. Responsibilities. All pilots flying under the supervision of the Director, Flight Test Operations are individually responsible for compliance with applicable parts of this instruction.

2. Procedures:

a. All pilots flying under the supervision of the Director, Flight Test Operations will be individually briefed and debriefed for all flights by a designated briefing officer.

b. When deemed to be physically impossible or impractical to conduct a briefing before each flight, a pilot may be briefed for several flights at one briefing. Normally a separate briefing will be conducted for each flight.

3. Briefing - Debriefing Officers:

a. Test Missions:

(1) Director or Deputy Director, Flight Test Operations.

(2) Chief, Fighter, Bomber-Transport or V/STOL Operations Division concerned.

(3) Branch Chiefs within each Division concerned.

(4) Directorate of Flight Test Operations officer alternate appointed by either 3.a.(1), (2) or (3) above.

b. Support Missions:

(1) Director or Deputy Director, Flight Test Operations.

This DOI supersedes DOI 55-3, 1 Mar 1966
OPR: FTTO
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(2) Chief, Fighter, Bomber-Transport or V/STOL Operations Division concerned.

(3) Branch Chiefs within each Division concerned.

(4) Directorate of Flight Test Operations officer alternate appointed by either 3.b.(1), (2) or (3) above.

(5) Pilot of test aircraft being supported.

4. Briefings:

a. Flight test programs conducted within the Directorate of Flight Test Operations: The pilot will conduct or insure that a satisfactory flight briefing to all personnel is accomplished for the primary mission, and, if required, the alternate mission. The pilot will brief the supervisor in accordance with Paragraph 3 above on the conduct of the mission and when deemed necessary any or all personnel associated with the flight will attend this briefing. The briefing will include but will not be limited to:

(1) A resume' of previous flights or of test plan, as appropriate.

(2) A summary of the mission to include speed, Mach number, altitude and maneuvers anticipated by the test and/or support pilot, the use of special or restricted areas, test sites, or ranges relative to the mission, project classification and communication security.

(3) Flight conditions relative to tests that may be other than normal, i.e., aileron rolls with a chain, approved limit boundary tests.

(4) Normal flight safety considerations (hazardous flights must conform to Deputy for Systems Test DOI 55-1).

(5) Responsibilities of chase pilot when required, engineer, radio monitor, etc.

b. Flight test programs conducted by Directorate of Flight Test Operations pilots at designated Test Forces, contractor and other DOD/NASA Operations:

(1) Conduct of these flights will be in accordance with procedures established by appropriate Operations Sections, and, if deemed necessary by the pilot, accomplishment of 4.a. above.

c. Support of test programs conducted by Test Forces, contractor and other DOD/NASA Operations:

(1) Attend the briefing or attain flight briefing by telephone, as appropriate.

(2) Rebrief in accordance with Paragraphs 2 and 3 above to include a complete summary of the mission and requested responsibilities of the support pilot.

(3) Brief for possibility of an alternate mission in the event of an airborne cancellation and/or short mission.

5. Debriefings:

a. The flight debriefing for test flights will include but will not be limited to a history of the flight with particular emphasis on possible improvements of techniques or procedures.

b. A flight debriefing for support flights will not normally be required unless:

(1) The contractor desires a flight debriefing.

(2) An unusual incident has occurred during the flight.

c. The Flight Test Engineer and other flight support persons deemed necessary by the debriefing officer will be present at the flight debriefing.

JAMES I. BUTLER, JR.
Lt Colonel, USAF
Director, Flight Test Operations

DIRECTORATE OFFICE INSTRUCTIONS
NR 55-2

DIRECTORATE OF FLIGHT TEST OPERATIONS
DEPUTY FOR SYSTEMS TEST
Edwards Air Force Base, California
25 March 1966

Operations

SUPPORT, PHOTO, AND ESCORT MISSIONS

PURPOSE: To establish a policy within the Directorate of Flight Test Operations regarding support, photo and escort missions.

1. Scope. The procedures established by this instruction are applicable to all support, photo and escort flights performed by pilots under the supervision of the Director, Flight Test Operations.

2. Responsibilities. Division Chiefs and/or appropriate Aircraft Commanders are responsible for individual pilot compliance with applicable parts of this instruction.

3. General. It is the policy of the AFFTC that all flights in the categories listed below will be accompanied by an escort aircraft. The assignment of escort aircraft and pilots to these flights will be made on a priority basis and every effort will be made to avoid delaying the flight requiring escort.

a. All flights on research aircraft.

b. All flights on aircraft of unusual or radical design.

c. The first flight on all new model aircraft.

d. All flights on "one of its kind" aircraft.

e. All flights on any test aircraft which are deemed hazardous in nature or those which require observation from another aircraft to obtain data.

f. As desired by the applicable contractor.

4. Procedures:

a. To insure maximum safety while performing escort missions, the following procedures will be adhered to:

(1) Applicable provisions of DOI 55-3, Flight Briefing and Debriefing will be rigidly followed. Any in-flight deviations from the pre-briefed

This DOI supersedes DOI 55-2, 9 Nov 1965
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mission profile will be verbally coordinated with the escort pilot prior to initiation.

(2) Escort aircraft pilots will not fly below 500 feet above the runway on takeoff, pick-up or landing escort unless the mission requirements dictate a lower altitude.

(3) Radio contact with the escorted aircraft will be checked periodically and after every frequency change during the flight.

b. The escort pilot will assist the escorted pilot in any way which will enhance the conduct of the mission. Details should be clearly discussed and arranged prior to flight. Escort pilots will normally relay information requested by the escorted pilot, make radio checks and answer radar advisories if agreed upon during the preflight briefing. He will advise when the escorted aircraft is observed to deviate appreciably from briefed maneuvers, loses a portion of its airframe or stores, approaches conflicting traffic, strays near unauthorized airspace, or any unusual occurrence, in the best interest of Flight Safety.

c. Particular attention will be given to assure that escort aircraft limitations and restrictions are not exceeded and that in-flight responsibilities are clearly established and understood by all pilots in the flight.

JAMES J. BUTLER, JR.
Lt Colonel, USAF
Director, Flight Test Operations

HEADQUARTERS
AIR FORCE FLIGHT TEST CENTER (AFSC)
UNITED STATES AIR FORCE
EDWARDS AIR FORCE BASE, CALIFORNIA

NPO NR. ____________

DATE ____________

SPECIAL ORDERS 27 December 1963
P-192

1. STAFF ASSIGNMENT: COLONEL JOSEPH F COTTON, 10232A, this Hq, is relieved from present dy and assigned primary dy as Director, B-70 Test Force, position nr 00511 and DAFSC 2711, effective 18 Dec 63. No change in function code, sequence code or program element code. (ETCB)

2. The following named officers, Hq AFFTC, AFSC, this stn, are relieved from present dy assignment as Students (Pipeline) Aerospace Research Pilot Course and assigned primary dy (Permanent Party) as indicated effective 21 Dec 63. Directed dy assignment Pilot Utilization Field until 20 December 1966 in accordance with Chapter 6, Part One, AFM 35-11. Active Dy Svc Commitment until 20 December 1967 in accordance with AFR 36-51. (FTC)

CAPTAIN [illegible] I BELL, 30690A, assigned primary dy as Instructor, Stability Branch, Exper Test Pilot Division, USAF Aerospace Research Pilot School. Function code 57000, sequence code 0500, position nr 0163, program element code 660, and DAFSC 1345. (FTTE)

CAPTAIN FRANK D FRAZIER, 22487A, assigned primary dy as Instructor, Performance Branch, Exper Test Pilot Division, USAF Aerospace Research Pilot School. Function code 57000, sequence code 0495, position nr 0160, program element code 670 and DAFSC 1345. (FTTE)

CAPTAIN FRANK E LIETHEN, JR, 25155A, assigned primary dy as Instructor, Aerospace Research Pilot Division, USAF Aerospace Research Pilot School. Function code 57000, sequence code 0485, position nr 023[illegible], program element code 660 and DAFSC 1345. (FTTA)

3. The following named officers, Hq AFFTC, AFSC, this [illegible] are relieved from present dy assignment as Students (Pipeline) Aerospace Research Pilot Course and assigned primary dy (Permanent Party) as indicated, effective 21 Dec 63. Directed dy assignment Pilot Utilization Field until 20 December 1966, in accordance with Chapter 6, Part One, AFM 35-11. Active [illegible] Svc Commitment until 20 December 1967 in accordance with AFR 36-51. (FTT)(FTFO)(FTFK)

CAPTAIN MICHAEL J ADAMS, 24934A, assigned primary dy as Exper Flt Test Officer Manned Spacecraft Operations Br, Flight Test Operations Div, Directorate of Flight Test. Function code 57000, sequence code 1022, position nr 0176, program element code 660, and DAFSC 1341. (FTFOF)

CAPTAIN JAMES S IRWIN, 2222[illegible]A, assigned primary dy as Experimental Flt Test Officer, Fighter Project Office, Directorate of Flight Test. Function code 57000, sequence code 101[illegible], position nr [illegible], program element code [illegible] and DAFSC 1345. (FTF[illegible])

SO P-192 HQ AF FLT TEST CENTER, EDWARDS AFB, CALIF 27 December 1963

4. The following named officers, Hq AFFTC, AFSC, this stn, are relieved from present dy assignment as Students (Pipeline) Aerospace Research Pilot Course and assigned primary dy (Permanent Party) as indicated, effective 21 Dec 63. Directed dy assignment Pilot Utilization Field until 20 December 1966, in accordance with Chapter 6, Part One, AFM 35-11. Active dy Svc Commitment until 20 December 1967 in accordance with AFR 36-51. (FTT) (FTPO)(FTFK)

CAPTAIN LACHLAN MACLEAY, 2615CA, assigned primary dy as Exper Flt Test Officer, Manned Spacecraft Operations Branch, Flight Test Operations Division, Directorate of Flight Test. Function code 57000, sequence code 1022, position nr 0177, program element code 660 and DAFSC 1345. (FTFOF)

CAPTAIN ROBERT K PARSONS, 45251A, assigned primary dy as Experimental Flight Test Officer, Manned Spacecraft Operations Branch, Flight Test Operations Division, Directorate of Flight Test. Function code 57000, sequence code 1022, position nr 0332, program element code 660 and DAFSC 1341. (FTFOF)

FOR THE COMMANDER

William A. Hamilton

WILLIAM A. HAMILTON, Major, USAF
Chief, Career Control Branch
DCS/Personnel

DISTRIBUTION: X
2-FTA 2-FTB 1-FTBA 1-FTBM 1-FTBMT 1-FTBT
1-FTBV 1-FTC 4-FTCCA 3-FTE 5-FTEF 1-FTEL
1-FTEM 2-FTF 1-FTFE 1-FTFER 1-FTG 1-FTH
1-FTIPL 1-FTL 1-FTM 4-FTMSD-4 1-FTO
3-FTMR 1-FTP 2-FTT 6-FTPMC 6-FTPMQ 25-FTPMD
2-RTEP 2-RPEH 1-RTD(RTPMD) 1-Each Individual

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS 1002D INSPECTOR GENERAL GROUP (HQ COMD USAF)
NORTON AIR FORCE BASE, CALIFORNIA 92409

SPECIAL ORDER
M-13

22 June 1966

1. So much of para 1, Special Order M-6, this Hqs, 28 Feb 66, as amended by para 1, Special Order M-8, 1 May 66 and para 1, Special Order M-10, 26 May 66, relating to appointment of Security Officers and Alternates in the various organizational elements, is further amended as follows:

	PRIMARY	ALTERNATE	
AFIIN-E		MAJOR JAMES E McCORMICK	- add
		COLONEL HARRY W LANE	- delete
AFIIN-P		LT COL CHARLEY J ADAMS	- add
		LT COL CHARLES E REAMES	- delete
AFIIN-S		LT COL PAUL D ROBERTSON	- add
		LT COL WILLIAM A F HILL	- delete

2. So much of Special Order M-12, this Hqs, 21 Jun 66, relating to appointment of members to the Aircraft Accident Investigation Board (XB-70A SN 62-207, and F-104, NASA 813), is amended to include:

GRADE	NAME & AFSN	DUTY/GROUP	ORGN & STATION
*CIV	GEORGE W BOLLINGER	B-70 Program Office	ASZV, Wright-Patterson AFB, Ohio

FOR THE COMMANDER

R. L. Horst

R. L. HORST, CWO, W4, USAF
Chief, Administrative Services

DISTRIBUTION
D

Strength through Vigilance

SO M-12, Hq 1002 IG Gp, 21 Jun 66

GRADE	NAME AND AFSN	DUTY/GROUP	ORGN & STATION
*MSGT	LESTER E SCHROYER, AF36475394	Materiel	AFFTC, Edwards AFB, Calif
*MSGT	EDGAR E HALLEY, AF15412433	Materiel	AFFTC, Edwards AFB, Calif

FOR THE COMMANDER

HEADQUARTERS 1002D INSPECTOR GENERAL GROUP OFFICIAL

CWO, W4, USAF
Chief, Administrative Services

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D

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS 1002D INSPECTOR GENERAL GROUP (HQ COMD USAF)
NORTON AIR FORCE BASE, CALIFORNIA 92409

SPECIAL ORDER
M-12

21 June 1966

In accordance with the provisions of AFR 127-4, the following named personnel, organizations and stations indicated, are appointed members of the Aircraft Accident Investigation Board to investigate the major aircraft accident involving XB-70A SN 62-207, and F-104, NASA 813. Asterisk indicates orders published with the approval of the individuals' organization commander:

VOTING MEMBERS

GRADE	NAME AND AFSN	DUTY/GROUP	ORGN & STATION
COL	WILLIAM R GRADY, FR8581	President	1002 IG Gp, Norton AFB, Calif
COL	HENRY W RITTER, FR13847	Coordinating	1002 IG Gp, Norton AFB, Calif
*LT COL	FITZHUGH L FULTON Jr, FR36417	Coordinating	AFFTC, Edwards AFB, Calif
LT COL	HAROLD E BRANDON, FR11353	Operations	1002 IG Gp, Norton AFB, Calif
MAJ	ROBERT F BROCKMANN, FR30393	Operations	1002 IG Gp, Norton AFB, Calif
MAJ	RICHARD M CHUBB, FR49677	Life Sciences	1002 IG Gp, Norton AFB, Calif
LT COL	RAY C GORDON Jr, FR16097	Materiel	1002 IG Gp, Norton AFB, Calif
*MAJ	VERNON H SANDROCK, FR26525	Materiel	AFFTC, Edwards AFB, Calif

NON-VOTING MEMBERS

GRADE	NAME AND AFSN	DUTY/GROUP	ORGN & STATION
CIV	SYDNEY D BERMAN	Technical Advisor & Inflight Impact	1002 IG Gp, Norton AFB, Calif
*LT COL	ELDON D MORTENSEN, FR52289	Recorder	AFFTC, Edwards AFB, Calif
*CIV	DONALD R BELLMAN	Coordinating	NASA, Edwards AFB, Calif
LT COL	JEREMIAH CREEDON, FR34363	Operations	1002 IG Gp, Norton AFB, Calif
*LT COL	RALPH N RICHARDSON, FV782011	Life Sciences	AFFTC, Edwards AFB, Calif
*MAJ	ROBERT E MATEJKA, FR59702	Life Sciences	AFFTC, Edwards AFB, Calif
CIV	VERNET V POUPITCH	Materiel	1002 IG Gp, Norton AFB, Calif
CIV	ARTHUR G SMITH	Materiel	1002 IG Gp, Norton AFB, Calif
CIV	ROBERT D NAGLE	Materiel	1002 IG Gp, Norton AFB, Calif

WEIGHT AND BALANCE CLEARANCE FORM F
TACTICAL
(USE REVERSE FOR TRANSPORT MISSIONS)

DATE	AIRPLANE TYPE	FROM	HOME STATION
[illegible]	F-104 [illegible]	LCL	[illegible]
MISSION/TRIP/FLIGHT NO.	SERIAL NO.	TO	PILOT
Local	[illegible]	LCL	[illegible]

REMARKS

[illegible]
[illegible] NASA-[illegible]

[illegible]
[illegible] 950 [illegible]
(2) at time of collision

LEMAC 143.9
MAC 114.6

COMPUTER PLATE NO. (If used)

REF	ITEM				WEIGHT	INDEX OR MOMENT
1	BASIC AIRPLANE (From Chart C) [illegible]				[illegible]	[illegible]
2	OIL (Gal.)				[illegible]	[illegible]
3	DISTRIBUTION OF LOAD					
	COMPT.	CREW NO.	CREW WEIGHT	BAGGAGE / CARGO AND MISC.		
	[illegible]	1	200		[illegible]	[illegible]
		2	440	TIP TANKS	[illegible]	[illegible]
4	OPERATING WEIGHT				[illegible]	[illegible]
5	AMMUNITION: COMPT. / ROUNDS / CALIBER					
6	BOMBS, ROCKETS, ETC.: FORWARD / AFT / EXTERNAL / ROCKETS					
7	FUEL: BUILT IN (754 Gal.)				[illegible]	[illegible]
	BOMB BAY (Gal.)					
	EXTERNAL (340 Gal.)				[illegible]	[illegible]
	[illegible] (364)				[illegible]	[illegible]
8	WATER INJ. FLUID (Gal.)					
9	JATO OR RATO					
10	TAKEOFF CONDITION (Uncorrected)				[illegible]	[illegible]
11	CORRECTIONS (If required) —				[illegible]	[illegible]
12	TAKEOFF CONDITION (Corrected) (1)				[illegible]	[illegible]
13	TAKEOFF C. G. IN % M. A. C. OR IN.				[illegible]	
14	EXPENDABLES: JATO OR RATO / BOMBS / AMMUNITION / FUEL [illegible]				[illegible]	[illegible]
15	ESTIMATED LANDING CONDITION (2)				18317	[illegible]
16	ESTIMATED LANDING C. G. IN % M. A. C. OR IN.				[illegible]	

Pertinent instructions to the pilot for shifting load and crew during takeoff and landing should be noted above.

CORRECTIONS (Ref. 11)

COMPT.	ITEM	CHANGES (+ or −) WEIGHT	INDEX OR MOMENT/1000
	Gear up	—	−20
	TOTAL WEIGHT REMOVED	−	−
	TOTAL WEIGHT ADDED	+	+
	NET DIFFERENCE (Ref. 11)		

LIMITATIONS

GROSS WT. TAKEOFF (lb.)	GROSS WT. LANDING (lb.)		
PERMISSIBLE C. G. TAKEOFF	FROM −5	TO (% M. A. C. OR IN.) [illegible]	
PERMISSIBLE C. G. LANDING	FROM −5	TO (% M. A. C. OR IN.) [illegible]	

Enter amount used.
Enter values from current applicable T. O.
Applicable to gross weight (Ref. 12).
Applicable to gross weight (Ref. 15).

COMPUTED BY (Signature)
WEIGHT AND BALANCE AUTHORITY (Signature)
PILOT (Signature)

DD FORM 1 SEPT 54 365F

FLIGHT [illegible]

SERIAL NO. [illegible]

MODEL [illegible] [illegible]

[illegible] NO. [illegible] DATE [illegible]

FLT ENGINEER [illegible]

APPROVED *[signature]*

Item		WEIGHT	ARM	MOMENT/1000
BASIC WEIGHT	[illegible]	[illegible]	[illegible]	[illegible]
CREW, PARACHUTES, ETC				
PILOT & CO-PILOT	[illegible]	465	[illegible]	[illegible]
FUEL		([illegible])		([illegible])
TANK #1	[illegible]	[illegible]	1010	[illegible]
TANK #2	[illegible]	[illegible]	1285	[illegible]
TANK #3	[illegible]	[illegible]	1527	34,514
TANK #4	[illegible]	[illegible]	[illegible]	[illegible]
TANK #5	[illegible]	[illegible]	[illegible]	[illegible]
TANK #6	[illegible]	[illegible]	1627	[illegible]
TANK #7	[illegible]	[illegible]	1894	[illegible]
TANK #8	[illegible]	[illegible]	2087	[illegible]
OIL - ENGINE	[illegible]			
BALLAST	[illegible]			
LIQUIDS & GASES				
WATER	[illegible]	[illegible]	723	[illegible]
NITROGEN - FUEL PURGE	[illegible]			
AMMONIA - [illegible]	[illegible]			
NITROGEN - AICS PACKAGE	[illegible]			
INSTRUMENTATION				
PACKAGE	[illegible]			
CABIN & EQUIPMENT BAY	[illegible]			
NITROGEN - INSTRUM. PACKAGE	[illegible]			
GROSS WEIGHT - ENGINE START	C.G. [illegible] MAC	[illegible]	[illegible]	[illegible]
LESS: EXPENDABLES - TAXI & TAKE OFF				
GROSS WEIGHT - LIFT OFF (GEAR DOWN)	C.G. [illegible] MAC	[illegible],224		
MOMENT CHANGE (GEAR DOWN TO GEAR UP)				
GROSS WEIGHT - LIFT OFF (GEAR UP)	C.G. % MAC			

LOAD ADJUSTER BASIC DATA

WEIGHT = [illegible] lbs. INDEX = 58.10

REF. DATUM TO LE, MAC [illegible] " MAC [illegible]

SPECIAL REMARKS:
[illegible]
W [illegible] = 285,[illegible] LBS
C.G. = [illegible]

OPERATIONAL STATUS FOR MONTH OF JUNE 1966

AIRPLANE F104 No. 813

Date	Flt. Number	Flight Time	Type	Pilot	Comments
2	406	Takeoff: [illegible] Land: [illegible] Total: [illegible]	X-2	[illegible]	[illegible]
3	407	Takeoff: [illegible] Land: [illegible] Total: [illegible]	X-2	[illegible]	
7	402	Takeoff: [illegible] Land: [illegible] Total: [illegible]	X-2	[illegible]	WX
8	409	Takeoff: [illegible] Land: Total:	X-2	[illegible]	[illegible]
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			

FRC-196

OPERATIONAL STATUS FOR MONTH OF May 1966

AIRPLANE F104 No. 913

Date	Flt. Number	Flight Time	Type	Pilot	Comments
3	394	Takeoff: 1010 Land: 200 Total: 1:10	X-3	[illegible]	[illegible]
4	395	Takeoff: 905 Land: 1045 Total: 1:40	X-4	[illegible]	
[illegible]	397	Takeoff: 815 Land: 1000 Total: 1:45	X-2	[illegible]	[illegible]
[illegible]	396	Takeoff: 600 Land: 730 Total: 1:30	X-2	[illegible]	[illegible]
6	398	Takeoff: 625 Land: 805 Total: 1:40	X2	[illegible]	WX
9	399	Takeoff: 850 Land: 1025 Total: 1:35	X-4	[illegible]	
17	400	Takeoff: 905 Land: 1040 Total: 1:35	X-4	[illegible]	
18	401	Takeoff: 635 Land: 815 Total: 1:40	X-2	[illegible]	WX
18	402	Takeoff: 945 Land: 1105 Total: 1:20	X-4	[illegible]	
23	403	Takeoff: 910 Land: 1100 Total: 1:50	X-2	[illegible]	
25	404	Takeoff: 935 Land: 1115 Total: 1150	X-4	[illegible]	
31	405	Takeoff: 915 Land: 1100 Total: 1:45	X4	[illegible]	
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			

PAGE ____

OPERATIONAL STATUS FOR MONTH OF ~~MARCH~~ MARCH 1966

AIRPLANE F104 No. ~~[illegible]~~ 813

Date	Flt. Number	Flight Time	Type	Pilot	Comments
24	394	Takeoff: Land: Total:	X-3	[illegible]	[illegible]
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			
		Takeoff: Land: Total:			

OPERATIONAL STATUS FOR MONTH OF MARCH 1956

AIRPLANE F104 No. 813

Date	Flt. Number	Flight Time	Type	Pilot	Comments
1	380	Takeoff: 935 Land: 1100 Total: 1:25	X-2	[illegible]	
3	381	Takeoff: 845 Land: 1030 Total: 1:45	X-4	[illegible]	
4	382	Takeoff: 910 Land: 940 Total: 1:30	X-4	[illegible]	
4	383	Takeoff: 1110 Land: 1245 Total: 1:35	X-4	[illegible]	
7	384	Takeoff: 830 Land: 1005 Total: 1:35	X-2	[illegible]	
[illegible]	385	Takeoff: 1345 Land: 1540 Total: 1:55	X-[illegible]	[illegible]	[illegible] B 70[illegible]
10	386	Takeoff: 1230 Land: 1345 Total: 1:15	X-2	[illegible]	[illegible] B-70 [illegible]
10	387	Takeoff: 945 Land: 1100 Total: 2:15	X-2	[illegible]	[illegible]
11	388	Takeoff: 835 Land: 1035 Total: 2:00	X-2	Walker	
15	389	Takeoff: 910 Land: 1115 Total: 2:05	X-2	[illegible]	
22	390	Takeoff: 700 Land: 815 Total: 1:15	X-2	[illegible]	
22	391	Takeoff: 850 Land: 1105 Total: 2:15	X-2	[illegible]	B-70 Chase
23	392	Takeoff: 700 Land: 840 Total: 1:40	X-2	[illegible]	B-70 Chase
24	393	Takeoff: Land: Total: 1:[illegible]	X-2	[illegible]	

FLIGHT CONTROLS, PNEUDRAULICS AND MECHANICAL LINKAGE REPORT
F-104 LOCKHEED SN 683C - 4058 NASA 813

CONTENTS

g. Safety wires O.K. except those on filter caps, which were cut at Edwards AFB to obtain fluid samples.

2. L. H. Aileron Servo (no manifold)

a. "Soot" on unit but not in fire unless to a very minor degree. Plastic tubing on wires not melted.

b. Can move valve, input lever and bias spring moves to return spool.

c. "Soot" on torque paint.

d. Safety wire all in place.

e. "Neck" on syncro house is broken off, i.e., no feel spring.

f. Syncro shaft bent; therefore pulled spring from modulating piston at side of "wilkie" button.

3. R.H. Aileron servo (no manifold).

a. Crank chamber broken from valve and not with unit. Linkage from crank chamber also missing. Spool broken. Pin to mod piston non-existent and clevis is bent.

b. Broken spool can be moved manually.

c. No burn damage.

d. Safety wire and insp paint O.K.

e. Holder for feel spring is in place but no spring.

f. Syncro springs in place.

g. "3" "O" rings in place.

4. Rudder servo.

a. Consisted of manifold, valve and rib. No visible damage.

b. Safety wires O.K. 2 valve mounting bolts were loose or partially removed. This occurred at Edwards.

Hydraulic Tests:

1. Rudder servo.

a. Operation of yaw SAS within normal limits.

b. Servo valve O.K.

c. No noticeable leakage at 3000 psi.

2. Stabilizer servo.

a. Disconnnect cyl rod guide

b. With hydraulic power the valve controlled cyl's O.K. Also in phase visually.

c. Servo transfer valve null at 0.5 m.a. which is O.K. Controlled smoothly. Bias adjustment for modulating piston travel without hyd pressure was O.K.

d. No external leakage at 3000 psi.

3. L. H. Aileron Servo.

a. Attempted hyd operation but internal seals were damaged by heat.

b. Input levers not parallel as witnessed by fact that "test lever and pin could not be installed."

Disassembly Inspection

1. Rudder servo.

a. Opened crank chamber. Found all pins in place. Witnessed dual pin retention.

b. No further disassembly requested.

2. L. H. Aileron servo.

a. Disassembled to remove spool and modulating piston. Spool was smooth in rotation and axial stroking.

b. Witnessed double pin retention.

3. Stab servo.

a. Opened valve crank chamber. Witnessed double pin retention. All pins O.K.

b. No further disassembly.

F-104N SN 4058 Functional Tests:

1. Aileron Mech-Hyd Assy. PN 793218-7 (L.H.); Servo Valve PN 683754-5E SN 1251, 668421-1 Valve SN 54367. This servo valve assembly was X-rayed.

2. Assembly badly burned, no pressure operation possible.

3. Stability augmentation not operable because the transfer valve was burned.

4. Operation of servo valve spool was normal.

5. Excessive leakage due to burned packings. No pressure operation possible.

Valve Disassembly

1. Valve incorporates dual pin retention. (Ref. T.O. 1F-104-2026).

2. Pins were properly flared.

3. Valve spool operation normal and free.

The servo valve PN 783754-5E SN 1250 from the right hand wing, was broken off the manifold and the crank housing was broken off the valve body. It was not possible to test this valve; however, the valve spool operated smoothly by finger pressure.

e. Aileron Actuator and Surfact Position:

The aileron actuators were damaged; however, both ailerons could be operated freely by hand at the trailing edge. The ailerons, stabilizer, and rudder surfaces are free to move to any position within the limits of the actuating cylinder stroke when there is no hydraulic pressure.

f. Aileron Trim System:

Both aileron trim jackscrews were broken and failed in tension at the thread root. The trim motor drive unit actuator position was determined from the limit switch position. The trim position was determined from the limit switch position. The trim position was less than .50 degree from neutral trim. Total trim travel is $\pm$ 5.0°.

g. Aileron Auto-Pilot Actuator:

This unit is located just inboard of the fuselage side web at the root of the right hand wing at approximately fuselage station 495.0 in the fuel cell area.

The actuator was badly burned by fire and was broken from its mounting bracket. The actuator piston rod was broken. This actuator is electrically controlled by an electro-hydraulic servo valve. The actuator was burned and could not be operated or functionally checked.

2. STABILIZER CONTROLS

a. Cockpit:

The cockpit section of the fuselage was separated and was lying on the left side and had been exposed to intense fire. Remains of the control stick and rudder pedals were found in the ash debris. Remains of damaged instruments and switches were found.

The pitch controls in the cockpit area were damaged and consumed by fire but all remaining observable connections were intact.

b. Cable System and Pushrods:

The dual cable system through the fuselage was damaged and was subjected to fire. The cables were broken, but all remaining observable connections were intact.

The bell cranks at fuselage station 603 were broken and the pushrods aft were flattened. Cable and pushrod connections to the bellcranks were found intact.

c. Servo Components:

The servo components in the vertical fin were not damaged and the connections to the horizontal stabilizer were intact, except for the input linkage at the lower end of the fin.

Hydraulic oil samples were taken from the filter cavities for analysis. The filter elements were visually inspected for contamination. None was apparent.

d. Functional Test and Tear Down Inspection of Servo Valve:

F-104N SN 4058 Functional Tests:

1. Stabilizer Mech-Hyd Assy PN 782073-7; Servo Valve PN 668424-5J SN 0222; Transfer Valve PN 668421-1, SN 54378. This servo valve assembly was X-rayed.

[redacted]

2. Assembly was undamaged except for bent external valve arms.

3. Operation of pitch stability augmentation system was within limits.

4. Operation of servo valve normal.

5. No noticeable leakage at 3000 psi.

6. Operation of stabilizer actuating cylinders normal and smooth.

Valve Disassembly:

1. Valve incorporates dual pin retention.

2. Pins were properly flared.

3. Valve spool operation normal.

e. Stabilizer Actuator:

The stabilizer actuating cylinder and manifold assembly was virtually undamaged and the actuators operated normally by means of the servo valve.

f. Stabilizer Trim System:

The trim jackscrew was broken from the drive motor and gearing at the first thread. The position of the jackscrew nut indicated a trim position of 3° leading edge down.

Lockheed Aerodynamics calculated that for the existing aircraft configuration, weight, speed, altitude, etc., the normal trim position is 2.7° leading edge down.

3. RUDDER CONTROLS

a. Cockpit:

The rudder pedals and support structure were severely damaged and had been subjected to fire, but all remaining observable connections were intact.

b. Cable System and Pushrods:

The rudder cable system from the cockpit to the aft cable quadrant (which is single) were destroyed except for a few cable strands. The remaining connections were intact. The rudder travel limiter was in the de-energized (unlimited) position. The input pushrod and linkage system was virtually undamaged and all linkage connections were intact, as were the connections of the actuating cylinders to the rudder.

c. Servo Components:

The rudder servo components were removed and samples of hydraulic oil were taken from the filter cavities for analysis. The filter elements were visually inspected for contamination. None was noted.

d. Functional Test and Tear Down Inspection of Servo Valve:

F-104N SN 4058 Functional Tests:

1. Rudder Mech-Hyd Assy PN 784149-3; Servo Valve PN 783753-3F, SN 610; Transfer Valve PN 668421-1, SN 54341. This servo valve assembly was X-rayed.

2. This assembly was virtually undamaged.

[redacted]

3. Operation of yaw stability augmentation system was within normal limits.

4. Operation of servo valve was normal.

5. No noticeable leakage at 3000 psi.

Valve Disassembly:

1. Valve incorporates dual pin retention.

2. Pins were properly flared.

3. Valve spool operation was normal.

The rudder actuating cylinders were not damaged. All cylinders operate smoothly by hand with no evidence of binding or other malfunction.

e. Rudder Trim System:

The rudder trim actuator was recovered intact and apparently undamaged. The position of the nut on the jackscrew indicated a rudder trim position of .18° right rudder. Total trim travel is ± 4.0° .

4. FLAP SYSTEM

All flaps were found to be in the up (faired) position. Both leading edge flaps were latched in the up (faired) position, but the actuators were broken.

Both trailing edge flaps were found in the up position. The left hand flap actuator was partially broken loose from its mounting structure.

All the flap actuators are irreversible electrically driven screw-jacks.

The boundary layer control system, which is supplied by engine bleed air, is operational only when the trailing edge flaps are in the landing (full down) position.

F-104 Control Surfaces:

The aileron and flap surfaces were found securely attached to the wings. The empennage consisting of the damaged vertical fin, inboard section of the left horizontal stabilizer, the right horizontal stabilizer and the rudder were separated from the fuselage. The rudder was slightly deflected to the right. The rudder hinge connections were secured. The upper half of the rudder was deflected to the right and compressed downward and forward starting from the top aft corner of the rudder. The skin on the rudder on the right side near the leading edge was compressed. The left inboard stabilizer section 18 to 24 inches in length was attached to the vertical fin. The damaged right horizontal stabilizer was attached to the vertical.

5. HYDRAULIC SYSTEM

The Number 2 system reservoir and a fragment of Number 1 were damaged and had been subjected to fire.

The hydraulic equipment located on the engine access door was destroyed and was consumed by fire.

Both hydraulic pumps were recovered and examination revealed the following:

Engine Driven Hydraulic Pump

P/N 55032 S/N 71502

American Brake Shoe Company

#1 Hydraulic System

Case fairly intact. Deep slice on bottom of pump from a narrow sharp edged object. Another smaller slash mark was noted on the forward end of the pump body and one on the remains of the rear gear case. All marks were on the side of the pump next to the engine.

All bearings were found free and in working condition.

The pump was not rotating at time of impact.

The cylinder bores and pistons showed no evidence of scoring and some fluid remained in the pump.

Engine Driven Hydraulic Pump

P/N 55032 S/N 71483

#2 Hydraulic System

Case completely broken open exposing piston skirts and one side of entire pump up to the head end.

The hydraulic pump was not rotating.

Schedule arm was jammed in full flow position.

Pistons and cylinders were not scored.

Head bearing was siezed.

I. Both accumulators were examined and revealed the following:

a. Accumulator system #2; Assy No. 1011915-3-1, S/N 281623.

1. Seals were soft and pliable and no defects were noted.

2. The piston was bottomed out on the hydraulic end of accumulator.

b. Accumulator, System #1, Assy No. 1011915-3-1, S/N 6431832:

1. Seals were cooked and the teflon rings were melted. No other defects were noted.

2. The piston was also bottomed out on the hydraulic end of accumulator.

The plumbing in the fuselage was largely consumed by fire or destroyed.

The F-104 hydro system has a 10 micron nominal filtration capability, defined as capable of removing 95% of particles from 10-20 microns in size, and 100% of particles 25 microns or over in size. The filters installed in this system were designed and manufactured to conform to Mil F-5504 specification.

6. SYSTEMS - GENERAL

All uplocks, latches, etc. were in the normal position.

The main landing gear was in the retracted position.

7. FLIGHT RECORDS:

Series and periodic inspection records 829, 781 and NASA inter-stages worksheets on aircraft F-104 S/N 4058, NASA 813, maintenance records from 1 Dec 1965 to 8 Jun 1966 were examined and no significant flight control discrepancies were found.

Vernet V. Poupitch

VERNET V. POUPITCH, GS-14
Flight Controls, Pneudraulics and Mechanical Linkage
Group Leader, Directorate Aerospace Safety

D. Pertinent Discrepancy History:

1. Uncleared Discrepancies (AFTO Form 781)

   a. Date discovered - 31 May 1966
      When in NAV mode of autopilot, aircraft oscillates in roll about plus and minus 5 degrees. Symbol - red diagonal.

   b. Date discovered - 3 June 1966
      Drag chute deployment is overdue. Symbol red dash.

   c. Date discovered - 6 June 1966
      Request flight check of OMNI - NAV equipment. Unable to fully check out system on ground with present test equipment. Symbol - red dash.

   d. Date discovered - 7 June 1966
      25-hour post flight due. Symbol - red dash.

   e. Mr. J. A. Walker had signed the exceptional release on the AFFTO form 781, Part II, prior to the flight on 8 June 1966.

2. Cleared Discrepancies.

   a. Date discovered - 22 April 1965
      Pilot complained of extreme sensitivity in pitch axis during high "Q" condition. Error indicated in scheduling from air data computer. To compensate for this condition, the pitch rate pot on the AFSC computer has been set to a lower value. Symbol - red diagonal.

      Corrective Action - 25 May 1965. Reset pitch auto gain in ADC computer Mach Channel, made full ground operation O.K.

   b. Date discovered - 22 April 1965
      Both R/H elevator protective cable covering worn from rubbing. Symbol - red diagonal.

      Corrective Action - 7 May 1965
      New cables installed.

   c. Date discovered - 19 April 1965
      Pitch attitude signal from LN-3 jerky, particularly in turns. Symbol - red diagonal.

      Corrective Action - 26 May 1965
      Repaired pitch motor and shaft in LN-3 adapter in LAB. Made drift run operation O.K.

      NOTE: A functional check flight, IAW T.O. 1-1-300 was accomplished to complete the 2rd periodic inspection on 27 May 1965, and was signed off O.K. by J.A. Walker.

   d. Date discovered - 26 August 1965
      Pitch oscillations occurred at 550K, 2800 feet, inducing +6 and -5G on aircraft. Dampers engaged and autopilot off at time of incident. Was flying in wake of another aircraft at the time. It is believed that wake turbulence activated kicker causing pitch oscillation. 1000 lbs. internal - empty tips. Symbol - red X.

      Corrective action - 22 September 1965
      C/W WO #30, change stabilizer actuator servo and re-rigged, and 500-hour post-flight inspection.

   e. Date discovered - 26 August 1965
      Structure post-flight inspection required for above condition (see Item d) per T.O. 1F-104G-3. Symbol - red X.

      Corrective action - 20 September 1965
      C/W WO #30 (See Item d).

II. F-104N (NASA 813)

A. Investigation was made of the following records, forms, and documents, to determine whether maintenance or inspection inadequacies caused or contributed to the accident.

1. AFTO Form 781, Part 1 and II.
   Aircraft Flight Report and Maintenance Record

2. AFTO Form 781A
   Maintenance Discrepancy/Work Record

3. AFTO Form 781B
   Aircraft Inspection and Maintenance Status Record

4. AFTO Form 781D
   Calendar and Hourly Item Inspection Record

5. AFTO Form 781E
   Accessory Replacement Record

6. DD Form 829 Series
   Historical Record - Technical Instruction Compliance Record

7. Production Inspection Record Book (NASA-LAC)
   Periodic Inspection #3 (600 hour)

8. NASA - FRC Flight Log

9. NASA - FRC Interflight Worksheets

10. NASA - FRC Interflight Worksheet Carry - Forward Forms

11. NASA - FRC Part Removal and Installation Record

12. NASA - FRC Work Order/Technical Order Log

13. NASA - FRC Accessory and Time Compliance Log

14. NASA - FRC Calendar and Hourly Inspection Record

15. Supplemental and Special Records - NASA

B. Pertinent Airframe Data:

F-104 N-LO, Serial Number NASA 813, (Lockheed #4058) was delivered to the NASA Flight Research Center (FRC) on 22 October 1966 with 4:45 hours on the airframe. This aircraft was never assigned a USAF serial number. This aircraft was basically the F-104G with the weapons system removed, additional fuel tanks installed in the gun and ammunition bays, and the MH-97 autopilot and LN-3 navigational system installed. The last periodic inspection (#3) was completed on 2 May 1966 with airframe time of 601.4 hours. Periodic inspections were accomplished under contract by Lockheed Aircraft Corporation. The last flight of this aircraft was the 409th since delivery and the airframe had accumulated a total of 627.7 hours. There were 22 aircraft technical orders not complied with, which are listed under TAB K. A 25 hourly postflight was due prior to last take-off, and aircraft was flown on a red dash status symbol.

C. Pertinent Engine Data:

The J-79-GE-11A engine, Serial Number 411-722, had accumulated a total of 227.8 hours. Last installation was accomplished on 2 May 1966 with 26.3 hours accrued since installation. Prior to this installation a 200 hour periodic inspection was accomplished. Periodic inspection was accomplished under contract by the General Electric Company. There were ten engine technical orders not complied with, which are listed under TAB K.

[redacted]

D. Pertinent Discrepancy History:

1. Uncleared Discrepancies (AFTO Form 781)

a. Date discovered - 31 May 1966
When in NAV mode of autopilot, aircraft oscillates in roll about plus and minus 5 degrees. Symbol - red diagonal.

b. Date discovered - 3 June 1966
Drag chute deployment is overdue. Symbol - red dash.

c. Date discovered - 6 June 1966
Request flight check of OMNI - NAV equipment. Unable to fully check out system on ground with present test equipment. Symbol - red dash.

d. Date discovered - 7 June 1966
25-hour post flight due. Symbol - red dash.

e. Mr. J. A. Walker had signed the exceptional release on the AFFTO form 781, Part II, prior to the flight on 6 June 1966.

2. Cleared Discrepancies.

a. Date discovered - 22 April 1965
Pilot complained of extreme sensitivity in pitch axis during high "Q" condition. Error indicated in scheduling from air data computer. To compensate for this condition, the pitch rate pot on the AFSC Computer has been set to a lower value. Symbol - red diagonal.

Corrective Action - 25 May 1965. Reset pitch auto gain in ADC computer Mach Channel, made full ground operation O.K.

b. Date discovered - 22 April 1965
Both R/H elevator protective cable covering worn from rubbing. Symbol - red diagonal.

Corrective Action - 7 May 1965
New cables installed.

c. Date discovered - 19 April 1965
Pitch attitude signal from LN-3 jerky, particularly in turns. Symbol - red diagonal.

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Repaired pitch motor and shaft in LN-3 adapter in LAB. Made drift run operation O.K.

NOTE: A functional check flight, IAW T.O. 1-1-300 was accomplished to complete the 2rd periodic inspection on 27 May 1965, and was signed off O.K. by J.A. Walker.

d. Date discovered - 26 August 1965
Pitch oscillations occurred at 550K, 2800 feet, inducing +6 and -5G on aircraft. Dampers engaged and autopilot off at time of incident. Was flying in wake of another aircraft at the time. It is believed that wake turbulence activated kicker causing pitch oscillation. 1000 lbs. internal - empty tips. Symbol - red X.

Corrective action - 22 September 1965
C/W WO #30, change stabilizer actuator servo and re-rigged, and 500-hour post-flight inspection.

e. Date discovered - 26 August 1965
Structure post-flight inspection required for above condition (see Item d) per T.O. 1F-104G-3. Symbol - red X.

Corrective action - 20 September 1965
C/W WO #30 (See Item d).

f. Date discovered - 30 September 1965
1-1-300 check flight due flap rig, aileron, rudder and stabilizer servo replaced and rigged. Symbol - red dash.

Corrective action - 30 September 1965
O.K. - J. A. Walker.

g. Date discovered - 30 September 1965
Autopilot roll bias to right approximately 1/2 magnitude as to left previously. Symbol - red diagonal.

Corrective action - 31 January 1966
Fabricated and installed a bias compensation box per W.O. F-104N-813-0-37 and sketch 1691.

h. Date discovered - 30 September 1965
Excess yaw damper cycling after fuel load comes down to 4000#. Symbol - red diagonal.

Corrective action - 30 September 1965
Bled yaw damper thoroughly.

i. Date discovered - 3 November 1965
Aborted take-off at 170-180 KIAS due to what was felt as lack of proper longitudinal control power. At this point had in full aft stick and the nose was barely starting to rotate. Symbol - Red X.

Corrective action - 3 November 1965
(1) Made airspeed check
(2) Wheels rotated
(3) Checked flaps
(4) Operated flight system hydraulically for full throws
(5) Nose wheel height O.K.
(6) Hydraulic system bled

j. Date discovered - 3 November 1965
Request flight check for nose wheel lift off problem (See Item i.) Symbol - red dash.

Corrective action - no date.
Took weight off nose gear at 150 KIAS, rotated at 180 KIAS and was airborne at 195 KIAS. All seemed quite normal.

NOTE: Same pilot flew aircraft for corrective action in item j, that wrote discrepancy in item i.

k. Date discovered - 2 December 1965
APC light illuminated after electrical outage after start. APC ground check O.K., but light still on. Suspect indicating system. Symbol - red diagonal.

Corrective action - 7 December 1965
Replaced No. 2 and 3 APC relays, ground check O.K. OK J.A. Walker.

l. Date discovered - 11 January 1966
Oxygen regulator feeds oxygen with selector on normal on ground. Symbol - Red X

Corrective action - 12 January 1966
Replaced regulator and tested with MB2 Testor.

m. Date discovered - 7 Dec 1965
Inertial platform drifts continuously 1 mile in 2 seconds with heading on north. NAV MODE. Symbol - red diagonal.

Corrective action - 27 January 1966
Changed the LN-3 computer and ran biasing checks and stationary inertial run and shuler run.

n. Date discovered - 10 December 1965
INFO: Due to the above squawk (see item M) it is requested, auto-pilot be kept in standby until LN-3 system is changed (LN-3 computer). Symbol - red diagonal.

Corrective action - 27 January 1966
Above squawk has been corrected and the autopilot may now be used in the normal manner.

E. Pertinent Accessory Replacement Record

NOMENCLATURE & TYPE	SERIAL NR	REPLACE EVERY	INSTALLED AT	REPLACEMENT DUE AT
CATAPULT:				
XM10E1 (M10)	067	3 yrs after Instl.	6 Sep 63	6 Sep 66
INITIATORS:				
M27 (T25)	027	3 yrs after instl.	5 Sep 63	5 Sep 66
M27 (T25)	324	3 yrs after instl.	5 Sep 63	5 Sep 66
M27 (T25)	251	3 yrs after instl.	5 Sep 63	5 Sep 66
M27 (T25)	380	3 yrs after instl.	5 Sep 63	5 Sep 66
M27 (T25)	354	3 yrs after instl.	5 Sep 63	5 Sep 66
M28 (T26)	073	3 yrs after instl.	5 Sep 63	5 Sep 66
M30 (T33)	0100	3 yrs after instl.	6 Sep 63	6 Sep 66
M32 (T35)	0114	4 yrs after instl.	6 Sep 63	6 Sep 67
M32 (T35)	0208	4 yrs after instl.	6 Sep 63	6 Sep 67
THRUSTERS:				
M11 (XM11)	008	3 yrs after instl.	5 Sep 63	5 Sep 66
M11 (XM11)	024	3 yrs after instl.	5 Sep 63	5 Sep 66
M13 (XM13)	M-140	3 yrs after instl.	5 Sep 63	5 Sep 66
M15 (T17E4)	297	3 yrs after instl.	6 Sep 63	6 Sep 66
ROTARY ACTUATORS:				
PN I000-3	955	3 yrs after instl.	6 Sep 63	6 Sep 66
CARTRIDGES:				
MK I, MOD 3	None	1 yr after opening	29 Sep 65	29 Sep 66
MK I, MOD 3	None	1 yr after opening	29 Sep 65	29 Sep 66
FLIGHT CONTROLS:				
Servo Assy, Mech Hyd, Stab.	222	500 hours	495:25	995:25
Servo Assy Rudder	610	500 hours	495:25	995:25
Servo Assy, Aileron LH	1251	500 hours	495:25	995:25
Servo Assy, Aileron RH	1250	500 hours	495:25	995:25
Actuator, APC	511	1000 hours	495:25	1495:25

NOMENCLATURE & TYPE	SERIAL NR	REPLACE EVERY	INSTALLED AT	REPLACEMENT DUE AT
OXYGEN SYSTEM:				
Regulator, Oxygen Demand	408502	Every 9 months	11 Jan 66	11 Oct 66
Hose, MS 22055 (AN 6003) (All Rubber, Oxygen)	None	Every 2 years	6 Oct 65	6 Oct 67

F. Additional Data:

When performing functional check flights IAW the requirements of Section VII, Part I, of 1F-104G-6, NASA pilots utilize the Functional Check Flight List (1F-104G-6CL-1CF) as a guide during flight and record discrepancies in the aircraft AFTO Form 781A. A check flight list is not completed for each FCF and filed with the aircraft historical records.

VERNON H. SANDROCK, Major, USAF
Group Leader, Maintenance Records Group

3 Atch:
1. Memo, Carry-over item 16, to those concerned fm E.J.Bronner
2. Memo, co-pilots circuit breakers from D.H. Unnerstall
3. Memo, Carry over item 16, prior to Flight 46, 10Jun66, fm E.E.Allton

AIRCRAFT T.O.'s N,C,W on F-104 #NASA 813

DATE	T.O. #		TITLE
5 Aug. 63	1F-104-2002	(R)	Reduction of Exterior Light Brightness
17 Mar. 64	1F 104-2011	(R)	Modification of Nose Wheel Steering Control Circuit
23 Dec. 64	1F-104G-524	(R)	Revision of Aircraft to Weapon Electrical Stub Cable Access Door
15 Feb. 65	1F-104-2038	(R)	Modification of Tacan/IFF Antennae System
10 Jan. 64	1F-104-2008	(R)	Installation of Two Inch Standby Attitude Indicator
25 Jun 65	1F-104-2059	(R)	Modification of LOX Filler Valve Flange Fastenings
27 Oct. 65	1F-104-2069	(R)	Installation of External Positive Stop on Temperature Control Panel
30 Sept. 65	1F-104-2043	(R)	Modification of PHI-4 Indicator
15 Jan. 65	1F-104-2037	(R)	Installation of LN-3 Inertial Navigation System Power Provisions
22 Jul. 65	1F-104-882	(R)	Installation of Lock Assembly Arrestor Hook Ground Safety
27 Jul. 65	1F-104-2067	(R)	Re-routing of UHF Antennae Cable Harness
3 Sept. 65	1F-104-950	(R)	Inspection and Rework of Stator Plate and Lining Assemblies
15 Sept. 65	1F-104-2068	(R)	Installation of Reworked Outer Cylinder of Nose Landing Gear Strut Assembly
7 Feb. 66	1F-104G-540	(R)	Installation of APC System Emergency Disconnect
30 Mar. 66	1F-104-937	(R)	Relocation of Arrestor Hook Pressure Gage
11 Apr. 66	1F-104-2089	(R)	Rework of Horizontal Stabilizer Trim Actuator
22 Apr. 66	1F-104-970	(R)	Modification of Ejection Seat D-Ring Installation in C-2 Ejection Seat.
21 Mar. 66	1F-104-2091	(R)	Installation of Three Lamp Fixture
2 May 66	1F-104-2097	(R)	Inspection of Engine Emergency Nozzle Closure System
4 May 66	1F-104-967	(R)	Replacement of Main L/G Door and Ground-Air Safety Microswitches
10 May 66	1F-104-953	(R)	Replacement of Pressurization System Sonic Choke Flow Limiter
4 Apr 66	1F-104-957	(Safety)	Replacement of Plungers in External Stores/Special Weapons Jettison Switches

ENGINE T.O.'s N/C/W J-79-GE-11A SN 411 722

DATE	#		TITLE
22 Mar. 66	2J-J-79-945	(R)	Replacement of A/B Fuel Control, P/N 105R698P1 by P/N 105R698P9 on J79-GE-11A Engines
15 Feb. 65	2J-J79-966	(R)	Modification of Front and Transfer Gearbox on J-79-GE-11A Engines
1 Dec. 65	2J-J79-1058	(R)	Replacement of Stage 1 through 4 Compressor Vane Brushes and Spaces on J-79-GEL-11A Engines.
30 Sept. 64	2J-J79-938	(R)	Modification of the No. 2 Bearing Area on J79-GE-11A Consortium J-79-11A Engine
15 Feb. 65	2J-J79-961	(R)	Rework of Turbine Casing P/N 108R258G3 to, P/N 109R174G5 on P/N 109R174G6 on J79-GE-11A Engines

ENGINE T.O.'s N/C/W J-79-GE-11A SN 411-722 - Cont'd.

DATE	#		TITLE
31 Aug. 65	2J-J79-973	(R)	Modification of Main Fuel Control Throttle Gearbox
15 Ja. 66 (JAN)	2J-J79-1012	(R)	Installation of Improved IGV Bearings
1 Feb. 66	2J-J79-1021	(R)	Replacement of Transfer Gearbox Alternator Pad Seal
10 Feb. 66	2J-J79-1056	(R)	Corrosion Protection of Compressor Rotor and Stator Components on J-79-GE-11A Engine
4 Feb. 66	2J-J79-986	(R)	Installation of Modified Main Fuel Control 405611

FOR OFFICIAL USE ONLY

SPECIAL HANDLING REQUIRED IN ACCORDANCE WITH AFR 127.4

PROPULSION ANALYSIS REPORT
F-104N AIRCRAFT SN 4058-813

1. Engine Analysis :

a. J79-11A Engine SN 411722, which was installed in the aircraft at the time of the accident, was examined in detail. This examination revealed the engine was not rotating at the time of ground impact. No evidence of any mechanical failure or malfunction was noted which would prevent engine rotation. The bearings showed no evidence of operational damage, and appeared to have been adequately lubricated throughout their life. There was no evidence of compressor or turbine blade or stator failure. The FOD which was present in the compressor was not sufficient to cause blade failure or blade to stator interference. It is therefore evident that the lack of rotation result [illegible] the following conditions which preceded the ground impact.

1. Aircraft inflight breakup which interrupted the fuel supply.

2. Tumbling of the fuselage section containing the engine which resulted in a lack of air flow through the engine.

b. Impact and fire damage prevented bench checking of any engine fuel, lubrication, or nozzle system components. Examination of these components did not reveal any evidence of operational failure or malfunction.

1. The main fuel control and nozzle area control throttle inputs were found at a setting of 45 degrees. The 45 degree setting corresponds to an engine speed of 89 percent RPM which is reasonable for the flight conditions known to exist at the time of collision. The afterburner fuel control throttle input was found at a setting of 35 degrees. This difference in settings was probably caused by a resulting tension in the teleflex cable due to separation of components upon ground impact.

2. The exhaust nozzle actuator rods were found at a position corresponding to an approximate nozzle area of 350 square inches. This nozzle area is further confirmed by visual observation of nozzle, nozzle feedback cable position at the nozzle area control, nozzle position indicator, and the nozzle emergency closure valve. This position is not consistent with a normal engine shutdown which leaves the nozzle in an open position. The probable reason for the nozzle being in this position is actuation of the emergency nozzle closure system due to separation of the cockpit from the remainder of the aircraft. This is further substantiated by the actuation of the tail arrestor hook and drag chute. The nozzle actuator locks were engaged, which is a normal function when the nozzle emergency closure system is activated. Further, the engine can safely operate in the idle to military RPM range with the nozzle in the emergency locked position.

3. Foreign object damage was evident on all stages of compressor rotor blades. The turbine stator vanes had typical metal splatter as the result of foreign object damage. The vanes would have to be hot to make the deposits adhere. Based on their bright appearance, it is evident the deposits occurred during aircraft breakup. This is evidence that the engine was operating at aircraft breakup.

4. All outstanding engine TCTO's on this engine were reviewed to determine if any engine failure could be attributed to non-compliance. It was found that there were no failures in the areas to which these applied.

c. In the 35mm movies taken from the Lear Jet a streak was observed coming from the exhaust of the F-104 approximately 2 mins and 30 secs of film time prior to the explosion (based on 24 frames per second film speed). This time does not include stops made by the cameraman. The streak lasted for three frames which is 1/8 of a second elapsed time.

The streak was first noticed on the 16mm copy of the 35mm master and appeared to be a streak of flame. A 35mm copy of the master was then observed and the orange flame color appeared to lighten.

The following possible causes of the streak were considered:

1. Discharge of carbon build-up

2. Water in fuel

3. Foreign object damage

4. Inlet ice ingestion

5. Hydraulic, lubricating oil, or fuel leak

6. Afterburner light

7. Compressor stall or surge

8. Mechanical failure within engine gas path

The first four causes could not be eliminated as possibilities by examination of the engine or by known engine operating characteristics and reamin as possible causes. Item 5 is not possible since the streak only appeared once which would require a leak that subsequently stopped. Also, a leak would not fill the complete nozzle area. Item 6, afterburner light, is not probable since the power required for the known flight conditions is approximately 90% and an afterburner light in this range would require large rigging error. Item 7, compressor stall, is not probable since no transient flight conditions were occurring at the time. Item 8, mechanical failure within the engine gas path, was eliminated by engine examination. It is unknown if the streaking reoccurred prior to collision.

2. Aircraft Fuel System Analysis:

a. Due to the extensive fire and impact damage, it was impossible to bench check the fuel system components. However, the following factors must be considered in an analysis of the fuel system:

1. At a power setting of approximately 90 percent and an altitude of 27,000 feet, the fuel system can supply the fuel required by the engine if all four boost pumps are inoperative.

2. In the pictures following the collision, there appears to be unburned fuel coming from the tail pipe area of the F-104 fireball. This would indicate that the system was supplying fuel to the engine.

3. In the teardown of the engine, molten metal splatter was found in the turbine section. This would also indicate that fuel was being supplied to the engine.

3. Conclusions:

a. No evidence of engine or aircraft fuel system malfunction was found.

b. Available evidence indicates that the engine and aircraft fuel system were functioning normally up to the time of aircraft breakup.

c. There is no evidence to indicate that the engine or aircraft fuel system contributed to the accident.

4. Recommendations:

a. None.

Arthur G. Smith

ARTHUR G. SMITH
Directorate of Aerospace Safety
Office of the Inspector General
Norton AFB

ELECTRICAL, ELECTRONIC AND DATA ANALYSIS REPORT

ELECTRICAL SYSTEMS

1. The XB-70A was equipped with two 60 KVA, 440 volt, 3 phase AC generators driven by constant speed drives (CSD) attached to engines 3 and 4. They are normally operated in parallel. Automatic switching, by means of a bus-tie relay, permits one generator to furnish the entire electrical load in the event one of them fails. Further backup is provided by an emergency AC generator driven by a hydraulic motor at constant speed. This generator is capable of furnishing the electrical load necessary to sustain flight. Transformer-Rectifier (T-R) units are provided for furnishing DC power.

2. The F-104N was an F-104G (MAP) model configured to NASA requirements. The standard electrical power supply consisted of two variable frequency, 20 KVA generators, 208/115 volts, 3 phase, directly driven by the engine. Regulated 400 cycle AC power was derived from a hydraulically driven generator. Each 20 KVA generator feeds the Nr 1 and Nr 2 busses individually. Automatic bus-tie provisions enable both busses to be energized by one generator if the other fails. Further provision is made to enable the 400 cycle regulated AC load to be energized by an unregulated AC generator in the event the regulated AC generator or the hydraulic motor fails. Emergency AC electrical power and hydraulic power is provided by a ram air turbine (RAT) which can be extended into the slip stream by pulling a "T" handle located on the lower RH portion of the instrument panel. The RAT is not retractable after being extended. T-R units connected to each AC bus furnish DC power with bus-tie capability to provide necessary DC power from one T-R unit. Emergency DC power is provided by a battery.

3. The components of the B-70 electrical power source were still concealed in wreckage at the time of writing this report. However, there is no question regarding its integrity up to the time of impact with the ground since there was no interruption of telemetry transmission up to that time. Telemetry data reduction showed that engines 1, 2, 3 and 4 were rotating above idle speed up to the time of impact. The last air/ground communication with the B-70 began at 0926:06 and ended at about 0926:20. The mid-air collision occurred at 0926:24. The history of this B-70 flight, based on all communication and telemetry data indicates total normal integrity of the B-70 electrical system.

4. All generators of the F-104 except the RAT generator were recovered. The Nr 1 generator was severly burned, but showed no evidence of bearing failure, mechanical displacement of the armature, exciter field or output winding. The brush lengths were satisfactory. The name plate was destroyed to the extent that no useful information was available. The Nr 2 generator escaped severe heat damage. The nameplate data was: Bendix Mfr's P/N EX-28B23-3, Style B, S/N R-2776, Freq. 320 - 480 cycles, Amps. 55.5, 3-phase, PF .75 - 1.0, RPM 4800 - 7200, Contract Order Nr AF04/606/12598. These generators are rated at 20 KVA. The Nr 2 generator was identified by legible numbers on wires still attached to the generator terminals. The bearings were free to rotate and contained adequate lubricant. There was slight evidence of rotational scrolling of the exciter armature and the rotating filed of the AC generator. The brush lengths were satisfactory. The light scrolling could have occurred by damage sustained at collision time or during the break-up of the airplane before ground impact. Since the engine was not rotating at impact, the same would have to be true for generators driven therefrom. Induction of foreign objects into the generator cooling system subsequent to collision cannot be ruled out. The amount of scrolling, however, is not sufficient to have caused the generator to go off the line.

5. The constant speed AC generator and hydraulic motor assembly sustained considerable mechanical damage and moderate heat damage. The hydraulic drive assembly showed evidence of adequate drive oil before the accident. Mechanical and heat damage prevented rotation of the generator bearings. There was no evidence to indicate failure of this assembly before the collision.

[redacted]

6. The associated AC power center components have not been recovered to date.

7. There was no evidence to indicate failure of the AC or DC power producing systems of the F-104 airplane.

ELECTRONIC SYSTEMS

8. All recovered portions of the B-70 electronic system were inspected. There were two airborne digital recorders and one analog recorder, the tapes of which were destroyed by impact and fire. The cockpit camera film survived in its entirety but the end of the reel occurred at 0839 hours or 47 minutes before the collision. The developed film substantiated crew manipulations, instrument readings and reports by the crew during air/ground communication. See Atch 1, XB70A NO. 207 FLIGHT NO. 46 - 8 JUNE 1966. The left column contains flight notes as recorded on the ground. The right column contains substantiation remarks as indicated by review of the film.

9. Although there were times when air/ground communications required repeats on the part of either the ground station or formation crews, there was nothing abnormal or unusual. Repeated monitoring of all available voice tapes indicated that there were no communication failures or misunderstandings as a result of communication deficiencies. Air/ground VHF communication involving the Learjet were not recorded (123.15 mcs.) The UHF frequencies used during the photographic portion of the mission were 316.6 mcs. primary, and 351.4 mcs. alternate. The B-70 crew only was briefed to use 351.4 mcs. The other crews were briefed to use 316 6 only during the formation. Edwards Data Control acted as relay between the Learjet and the formation. The T-38 crew listened to the Learjet transmissions by tuning 123.1 mcs. on the VHF omni receiver. No airplane in the formation had the capability to transmit on VHF except the Learjet.

10. The last known transmission from Mr. Walker occurred at 0922:47 or 3 minutes, 39 seconds before collision: "We must be helping that cumulus activity with all this hot air." Mr. White replied: "Yes." One tape contained a second "Yes" reply followed by "Thank you." The rapidity of these last two utterances precluded identification of the speakers.

11. The F-104 cockpit section beginning with the radome attach point back to a station immediately aft of the seat was found severely crushed and burned. There was no useful information to be derived from the instruments. The UHF control panel was severely crushed and burned. The control knobs were still in evidence although partially melted. By comparing knob positions with a serviceable article the manual frequency selected was 316.6. The last mode selection matched the T/R (Transmit/Receive) position.

12. The second keyed carrier immediately before "Mid-air" transmission, and which sounded like a microphone picking up noise from an open cockpit, could possibly have resulted from the last action on the part of Mr. Walker pressing his microphone button. No other member of the formation remembered actuating their microphone buttons at this particular time.

13. The emergency radio beacon installed in the capsule was a Telephonics Model 40023. It worked as designed, transmitting a signal on 243.0 mcs. after automatic operation of the power switch by the parachute mechanism. It was heard by a pilot engaged in another mission. It was turned off by rescue personnel after being advised of its operation. During the emergency, there was an apparent lack of knowledge of the existence of the beacon since it was not mentioned when efforts were being made to locate Mr. White.

[redacted]

14. The integrity of the airborne voice recorder, cockpit camera and telemetry transmitting equipment is considered a good example of attaining necessary data from crashed aircraft. The voice recorder was not housed in a crash-resistant package. The tape survival may be attributed to its location in the forward portion of the extremely long fuselage which provided isolation from the fuel fire. The flat ground strike, with little movement in any direction could also have contributed to the tape survival.

14. There was no evidence to indicate a failure of the electronic system of either aircraft.

DATA SYSTEMS

16. Reference is made to Atch 2, TRANSCRIPT OF AIR/GROUND COMMUNICATION AND INTERPHONE CONVERSATION DURING LAST FLIGHT OF XB-70 NR 20207. Pacific Daylight times given therein are accurate to within plus or minus one second for the air/ground communication. The accuracy of times given for interphone conversation (INTPH) are considered to be within plus or minus three seconds. The air/ground communication times were derived from playback of the original tapes on the Ampex recording equipment in Edwards Data Control. Time information on the tapes is accurate to International Radio Instrumentation Group (IRIG) standards and digital time display progresses with tape movement. Times for the interphone conversation were dubbed in by use of an elapsed time indicator, timing from a known starting time of an air/ground communication sequence.

17. Since there was no evidence of questionable occurrences that were recorded on the voice tapes earlier in the flight, the transcript was begun at a real time of 0908:54, at which time Mr. White invited Major Cross to take control of the airplane. Mr. White is believed to have taken control again at 0918:20. Mr. White's testimony indicated that he was controlling the airplane at the time of collision. The transcript was ended at 0932:15, at which time the capsule was known to have touched down (given as 32 minutes past the hour as observed by Colonel Cotton).

18. There were some interphone sequences that were garbled to the extent that transcription was impossible. The corresponding times are given to indicate interphone conversation but without the transcription. The garbled portions, as well as those portions that could be transcribed, sound normal and unexcited prior to collision.

19. Examination of segments of tape from the original voice tape of the B-70 after return from the FBI on 25 June, showed approximately fifteen inches of overheated tape. This is equivalent to 14 seconds of recording time at 15/16 inch per second. It is estimated that one-half of the damaged tape contained intelligence. One piece, with leaders attached to each end, was manipulated through a recorder head by hand feeding. It contained garbled intelligence. The remaining pieces were believed too badly damaged to retain magnetic properties.

20. The FBI was furnished with the end of the B-70 voice tape (together with damaged pieces) beginning with Mr. Walker's last known transmission at 0922:47. This transmission had already been transcribed from recordings of air/ground communication. It was also clear on the original portion returned by the FBI but this sequence was not included in the transcript furnished by the latter. In the tape analysis, it was found advantageous to re-record slow moving voice tape on a recorder that operates at the highest speed possible. The playback at the higher speed enabled greater readability in past instances as in this case. The FBI reply and transcription is Atch 3.

LABORATORY TEST REPORT Page 1 of 3 Pages	Report Nr. -236	Date 21 Jun 66
Requesting Organization (Symbol and/or Name) FTUM-1 (M&M Hangar)	Name of Requestor Major Sandrock	Phone No. 8-2647

Sample, Test or Project

Hydraulic Fluids from A/C F-104 #813

Work Required

Determine contamination.

TEST DATA

RESULTS:

A. Particle Count:

#1 Stab. Act. (4.5-milliliter sample)

Particle Range	Count
Over 100 microns	6
50-100 "	38
25-50 "	113
15-25 "	724
5-15 "	12,088
Fibers	5

The largest particles are mostly resinous (plastic). One metal particle was 275 microns in length. Smaller particles are metal and carbon with a few particles of sand.

NOTE: This is the least contaminated of the four samples. The normal sample size for hydraulic fluid is 100 milliliters (cubic centimeters), approximately 20X more than this sample to give more representative results. Any particle greater than 100 microns classifies the fluid as outside the procurement specification. [redacted] the filters used provide 10-micron nominal filtration with removal of 100% of all particles over 25 microns. On this basis none of the four hydraulic fluid samples was within the use specification.

#2 ~~Rad.~~ Rud. Servo (5-milliliter sample)

Particles were too numerous to count with predominance of metallic and carbonaceous materials. Balance were resinous, fibers and sand. At least 82 particles were greater than 100 microns. Largest metal particle was 250 microns.

#2 ~~Lc.~~ Aileron Servo. Oil (4-milliliter sample)

Particles were too numerous to count. Resinous particles and synthetic

9

Sample, Test or Project

Work Required

TEST DATA

fibers predominated. Sand was prevalent. Smaller particles were mostly finely divided metal and carbon. At least 91 metal particles were greater than 100 microns; one was 750 x 50 microns; one was 125 x 125 microns.

#2 Stab. Act.

Particles were too numerous to count. This sample contained less but more varied particulate matter than the other #2 system samples. More sand and resinous material was found. Largest metal particle was 550 microns; several were over 200 microns; one was 400 x 75 microns.

NOTE: Both service carts and the 55-gallon drum contained particles in excess of 100 microns.

All samples submitted in screw-cap bottles were contaminated somewhat with particles from the cap liner. The use of immaculately clean bottles with polyethylene-lined caps, and at least 100 milliliters of sample (if possible), is the minimum standard sampling procedure. The laboratory can supply proper sampling equipment and skilled personnel for critical samples such as these.

B. Chemical Contamination:

By infrared spectoscopy and gas chromatography the presence of trichloroethylene ("trike") was established in each of the four hydraulic samples from the F-104. Also, "trike" was found in each of the reference samples submitted, i.e., 1-gallon can, 55-gallon drum, service carts #487 and #520. Inquiry determined that sample containers were flushed with "trike" before samples were taken. In an effort to determine whether "trike" was present in the F-104 hydraulic system at the time of the accident, a second set of reference samples from the carts (without flushing the sample containers with "trike") and containers was requested, and results are as follows:

10

LABORATORY TEST REPORT	Page 3 of 3 Pages	Report Nr. -236	Date
Requesting Organization (Symbol and/or Name)		Name of Requestor	Phone Number
Sample, Test or Project			
Work Required			

TEST DATA

Sample	Finding
1-gallon can	No trichloroethylene.
55-gallon drum	" "
Carts #487 and #520	2×10^{-3}% (vol.) trichloroethylene plus 10^{-3}% of another volatile halogenated solvent.

A chemist was sent from the Rocket Site to the wreckage in the M&M Hangar to assure getting uncontaminated (with trichloroethylene) samples of hydraulic fluid from the same points as before (#1 Stab. Act., #2 Rud. Servo, #2 Lt. Servo Oil and #2 Stab. Act). No more fluid was available from these sources. The chemist was informed that no part of the plane wreckage could be moved (tilted) to collect more sample by draining. However, he did collect a few drops of hydraulic fluid from the right wing aileron system for analysis.

Results:

2×10^{-3}% (vol.) trichloroethylene

2×10^{-4}% (vol.) perchloroethylene

1×10^{-3}% (vol.) - a more volatile halogenated solvent.

NOTE: 10^{-3}% (volume) is equivalent to several drops of trichloroethylene per one gallon of Mil-5606 hydraulic fluid. The boiling point of trichloroethylene is 188°F; that of perchloroethylene is 249°F. Unless trichloroethylene vapor is no problem in the hydraulic systems at flight temperatures, purging of systems with nitrogen is suggested until a test of the effluent purging gas indicates a tolerable level of solvent vapor. Samples submitted for contamination analysis must be in containers free of chemical contamination (solvents, water, insoluble and soluble particulate matter).

It is certified that this is an accurate report of test or analysis performed by the Chemical & Materials Branch.

Performed By		Signature of Approving Official
Name E. M. Dalaba	Name L.A. Dee	Name JOHN T. NAKAMURA
Name	Name	Title Chief, Analytical, Section
		Chemical & Materials Branch

RPL FORM 31

FLIGHT CONTROLS, PNEUDRAULICS AND MECHANICAL LINKAGE ANALYSIS REPORT

1. The XB-70 was in stabilized straight and level flight at the time of F-104 impact. Analysis of all available information indicates that the mechanical and hydro-mechanical flight control functions were operating in a normal and satisfactory manner prior to and during the impact by the F-104. The XB-70 flight control system is powered simultaneously by two hydraulic systems. Each of these systems is capable of providing satisfactory control of the aircraft. Telemetering data indicate control elevon motion for approximately 22 seconds after the loss of the L. H. vertical. These data prove that at least one of the two hydraulic systems was intact after impact and that the mechanical inputs to the elevon surfaces from the cockpit were transmitted satisfactorily. With the loss of the L. H. wing both primary flight control hydraulic systems would be lost in approximately 3 to 4 seconds due to fluid loss through broken tubing along the rear spar. With the loss of all primary flight control power the XB-70 would be uncontrollable.

2. CONCLUSIONS:

All XB-70 flight control functions both mechanical and hydro-mechanical were operating satisfactorily in straight and level flight at time of F-104 impact. Loss of a portion of the R. H. vertical and complete loss of the L. H. vertical did not lose XB-70 mechanical or primary flight control hydraulic power, since the elevons responded to pilot demand for approximately 22 seconds after loss of the L. H. vertical. The power systems and mechanical control functions except for the vertical actuator surface attach points were completely operable after impact. The primary loss of control of XB-70A was caused by the loss of required vertical aerodynamic surfaces.

3. RECOMMENDATIONS:

None.

Vernet V. Poupitch

VERNET V. POUPITCH, GS-14
Group Leader Directorate Aerospace Safety

FLIGHT CONTROLS, PNEUDRAULICS AND MECHANICAL LINKAGE ANALYSIS REPORT
F-104 Lockheed S/N 683C-4058 NASA 813

1. Analysis of all available information and recoverable wreckage indicates that the mechanical and hydro-mechanical flight control functions were operating in a normal and satisfactory manner prior to impact with the XB-70.

2. Aileron, stabilizer, rudder, flap system, hydraulic system, systems in general and flight records were inspected.

3. Cockpit: The cockpit controls were so severely damaged and consumed by fire that no significant conclusions could be drawn except that the few connections remaining were intact.

4. Aileron: The aileron control is a double cable system and was demolished and subjected to fire. All observable connections were intact and properly secured. The cable strands observable were frayed and separated in tension. Pushrod in the R. H. wing was bent upward and forward at the inboard end at the connection to the torque tube. The right hand torque tube was separated from its mounting and the bell cranks from the aileron cable and the autopilot actuator were severed by a force in the upward and forward direction. This occurred when the inverted aircraft impacted the ground. The right hand pushrod parted at the point of wing breakage at wing station 91.0 in a negative direction breaking the aileron servo bell crank off near the connection.

The ailerons, stabilizer and rudder surfaces are free to move in any position within the limits of the actuating cylinder stroke when there is no hydraulic pressure. The position of the surfaces as found may not indicate their position at the time of the collision. Air loads could cause the surfaces to assume any position when the hydraulic lines are severed. Thus, the position of the recovered surfaces has little or no significance.

Both aileron trim jackscrews were examined and had failed in tension at the thread root. The trim motor drive unit actuator position was determined from the limit switch position. The trim position was less than .50 degree from neutral trim. Total trim travel is $\pm$ 5.0 degrees. The aileron trim was in normal position and was not a causal factor.

The aileron autopilot actuator pushrod was severed and with the loss of hydraulic fluid the position it assumes would not be significant.

5. Stabilizer Controls:

Cable System and Pushrods

The pitch control cables were broken in tension aft of the cockpit at the time of separation of the cockpit section from the fuselage. The pushrods aft of fuselage station 603 were flattened by impact of the engine. The aircraft impacted the ground in an inverted position.

Stabilizer Trim System

The trim jackscrew was broken from the drive motor and gearing at the first thread. The position of the jackscrew nut indicated a trim position of 3° leading edge down.

6. Rudder Controls:

Cable System and Pushrods

The rudder control cables were broken in tension aft of the cockpit at the time of the separation of the cockpit section from the fuselage. The rudder cable system through the fuselage was destroyed, except for a few strands at the aft end at the connection to the cable quadrant. The cables were broken at this point in tension by separation of the empennage from the fuselage.

Rudder Trim System

The position of the nut on the jackscrew indicated a trim position of .18° right rudder. Total trim travel is ± 4°.

7. Flap System

The leading edge flap actuators were both broken in tension due to the impact load on the top surface of the wing at the time of gound impact of the wings and fuselage while the aircraft was inverted. The tension failure is evidenced by the condition of both L. E. flap actuators. The R. H. leading edge flap actuator housing was pulled apart by stripping of the large (approximately 3.5" dia.) threads connecting the jackscrew nut to the main gearbox housing. This housing was broken from its supporting structure at the attaching lug.

The left hand L. E. flap actuator was separated at the connection of the aft attaching lug to the main gearbox housing by breakage in tension of six .25" internal wrenching bolts.

HYDRAULIC FLUID SAMPLES

8. Hydraulic fluid samples for analysis were taken from components which were severed from the aircraft and were lying in ash debris. In all instances the hydraulic lines were severed and exposed to crash contamination. The very small amounts of fluid samples were taken in every instance upstream of the unit filter. The samples were poured into glass bottles washed with "trike".

Samples of hydraulic fluid were taken to the Rocket Propulsion Laboratory, Edwards AFB for analysis. Laboratory Test Report Nr. 236 (TAB J) covers the results of test from aircraft F-104 #813 and sample tests from the NASA servicing equipment.

High particulate count of contaminants in the sample fluid reported in the laboratory analysis apparently was introduced when the lines were severed and the components were exposed to fire and ground handling. Visual examination of the fluid trapped in the components before it was poured into specimen bottles disclosed no contamination. Presence of solvents as reported in the fluid from the NASA servicing facilities and the components would not have deteriorated the fluid to contribute to the cause for the accident. Presence of solvents in hydraulic fluid over an extended period might deteriorate hydraulic component "O" rings. This was not evident.

9. Autopilot and Aileron Systems - Hypothetical Assumptions.

Assuming the autopilot was operating (considered very unlikely) and a malfunction occurred, the following is submitted:

a. Assuming an aileron autopilot hardover signal someway was transmitted to the autopilot actuator, then the stick force required to override the autopilot actuator would be a maximum of 22 lbs near neutral, and 32 lbs at extreme travel. The surface rate as a result of autopilot actuation is 13 degrees per second. The surface rate obtainable by manual manipulation of the control stick is 40 degrees per second. Hence, the pilot could sense and arrest the tendency to roll.

10. Stabilizer System

a. Assuming a spurious stabilizer autopilot hardover signal caused actuation of the autopilot actuator, the stick force required to override a nose up hardover would be a maximum of 25 lbs and to overcome a nose down hardover would be 22 lbs. The surface rate of the stabilizer autopilot actuator is 8 degrees per second, compared to 15 degrees per second manual rate. The pilot could in this case also sense and arrest the tendency to pitch up.

11. Stick Pusher

a. Assuming either a legitimate actuation of the auto-pitch actuator due to aerodynamic actuation of the angle of attack vane, or an inadvertent actuation due to a spurious electrical signal to the actuator, the effect would be to nose the F-104 down. The stick force to override the auto-pitch control system is 40-60 lbs and this condition is more difficult to arrest but at no time was the aircraft prior to collision reported to pitch down.

12. Conclusions:

From observation and study of the available evidence in the wreckage of the F-104 aircraft, it is concluded that the aileron, stabilizer, and rudder primary control systems, the respective trim systems, the flap actuating system, the hydraulic system, and the general systems, were in normal operable condition ath the time of the collision.

13. Recommendations:

None

Vernet V. Poupitch

VERNET V. POUPITCH, GS-14
Flight Controls, Pneudraulics and Mechanical Linkage
Group Leader, Directorate Aerospace Safety

STRUCTURAL REPORT

1. The F-104 aircraft left horizontal stabilizer tip upper surface contacted the XB-70 wing folding tip at the outboard aft end. The wing tip light fairing on the XB-70 failed in an upward direction, the leading edge of the XB-70 wing honeycomb and leading edge extrusion adjacent to the wing tip also failed in an upward direction.

2. The F-104 left wing contacted the XB-70 right wing folding tip leading edge approximately 30 inches inboard of the F-104 wing tip, and cut through the upper surface of the F-104 aileron near the inboard end. The F-104 wing moving upward through the XB-70 wing crushed and tore upward the steel honeycomb. Deposits of F-104 wing paint were found on the lower surface face sheet of the XB-70 wing folding tip. The F-104 left hand wing tip tank contacted the XB-70 leading edge forward of the hole cut into the XB-70 wing. The forward portion of the tip tank tore off, bending inboard and upward with respect to the F-104 airplane. This portion then separated and struck the leading edge of the F-104 wing and the leading edge of the F-104 vertical. The remainder of the F-104 left tip tank moved up through the XB-70 leading edge full depth honeycomb panel, rolled and moved aft embedding several portions of the lower F-104 tip tank to wing seal strip in the honeycomb at the aft end of the hole torn in the XB-70 wing.

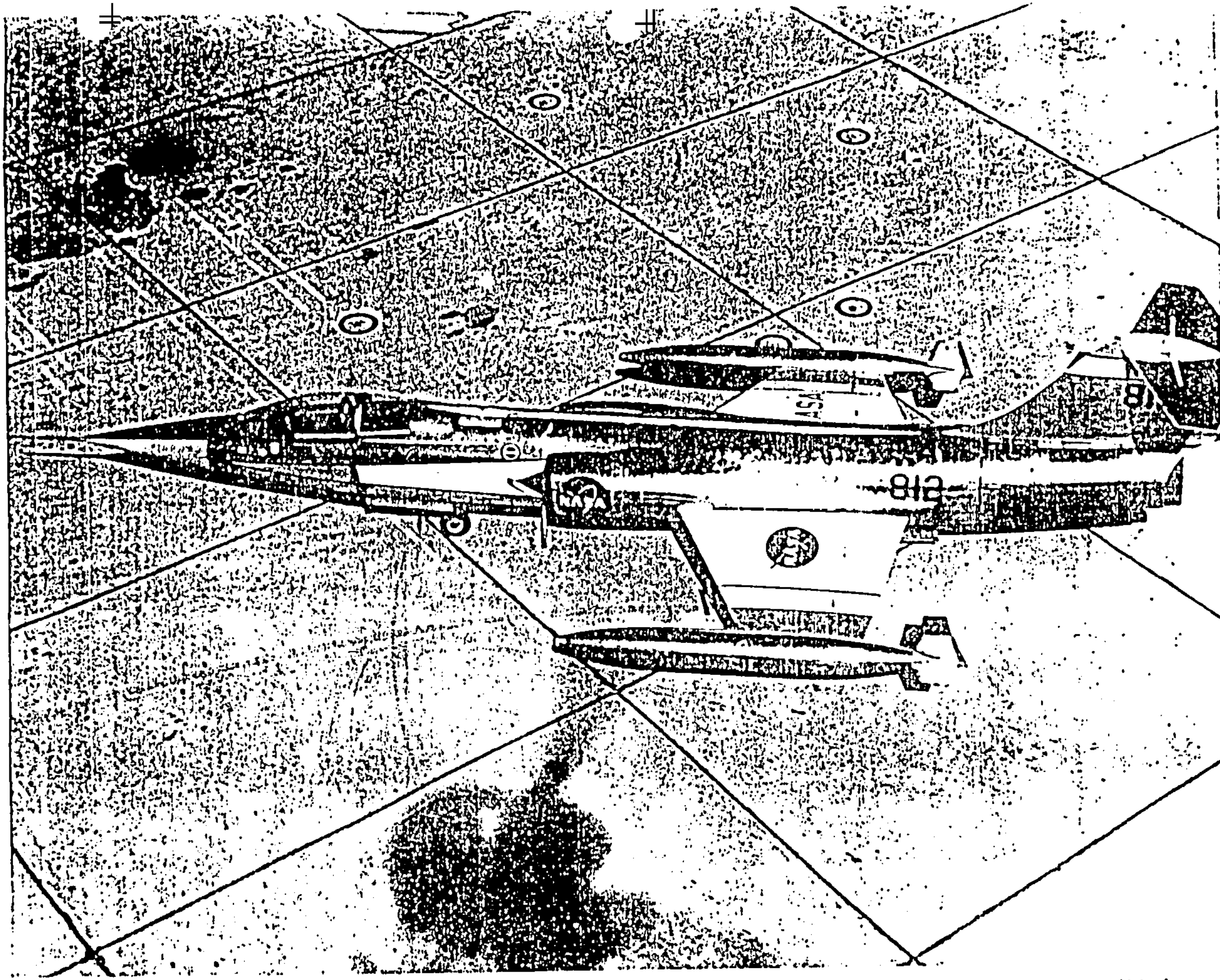
3. The F-104 empennage contacted the XB-70 right hand movable vertical at approximately mid-span, the upper portion of the XB-70 movable vertical failed in twisting motion and bending aft. The F-104 right hand aft portion of the horizontal stabilizer was bent downward. A piece of steel honeycomb and attached face sheet of the XB-70 vertical and a portion of the F-104 right hand stabilizer skin was jammed into the aft face of the stabilizer main span. There was also a small piece of steel honeycomb jammed into the aft portion of the centerline rib of the F-104 horizontal stabilizer and another piece jammed into the outboard left hand tip section of the horizontal stabilizer. The left hand horizontal stabilizer was separated approximately twenty inches outboard of the F-104 centerline. The entire F-104 empennage failed in an upward and forward motion with a left to right motion.

4. The upper left side of the F-104 fuselage behind the cockpit section struck the leading edge of the left hand XB-70 movable vertical approximately at the hinge line failing it from right to left with respect to the hinge point. The F-104 cockpit and radome nose section struck the upper surface of the left hand inboard wing of the XB-70 just outboard of the left hand vertical and slid across and aft on the wing surface at approximately a 30° angle to the elevon hinge line. Deposits of paint, their relative spacing, along with depression on the upper surface of the XB-70 wing match the left side of the F-104 fuselage and windshield mold line. This contact crushed and tore through the honeycomb panel of the upper cover in the XB-70 left wing. There was a two foot long crease in the XB-70 left hand wing upper surface perpendicular to the other marks and extended forward and outboard ending in a corner tear and cut in the aft inboard corner of the wing folding tip hinge inboard fairing door number 533. The XB-70 forward inboard upper corner of the first elevon just outboard of the wing fold hinge line was flattened and had F-104 paint deposits.

5. The upper honeycomb panel of the XB-70 left wing in the area of fuselage station 2084 was locally crushed and torn through, starting at the wing-to-fuselage stub joint extending outboard approximately five feet.

Ray C. Gordon Jr

RAY C. GORDON Jr
Lt Col, USAF
Material Factors Group


NASA
812

AFFTC FLIGHT SCHEDULE/ORDER
Edwards Air Force Base, California

ORGANIZATION: FTTO
DATE EFFECTIVE: 8 June 1966
PAGE 2 OF 7 PAGES

NR	CREW MEMBERS: GRADE - NAME - SERVICE NUMBER	POS	TYPE	NUMBER	ETD	ATD	ETE	ATE	FREQ	MISSION	REMARKS	LINE ITEM CODE
10			F104A	817	1100		1:00			Sonic Boom	Tail Ch - 748 Cx - XB-70 Crash	
11			F104A	755	1100		1:00			Sonic Boom	Cx - XB-70 Crash	
12			F104D	314	0800		1:00			F4C 169	Cx - Proj	
13	Sorlie D M Lt Col FR38652 Malewiski E D A1C AF16402434	P AF	F104D	316	0910	0830	1:00	0:50		F4C 169	Tail Chs 314, 315	3097
14			T38A	134	0600		0:50			Sawtooth Climbs	Cx -Mx	
15			T38A	134	1400		1:10			Gear Retraction Tests	Cx - Mx	
16	Hoag P C Cpt FR51499 Cotton J F Col FR10232	P CP	T38A	601	0845	0650	1:00	0:50		XB-70 Ch #1 T.O.	Rschd to 0645 A/C Chs T38 194, F104 755	1070
17	Hoag P C Cpt FR51499 Cotton J F Col FR10232	P CP	T38A	601	1045	0830	1:00	1:30		XB-70 Ch #1 Lndg	Rschd to 0845 A/C Chs T38 600, F104 744	
18	Butler J J Lt Col FR14361	P	T38A	194	0630	0700	1:00	1:20		F-5 371 & XB-70		4223 1070

AFFTC FLIGHT SCHEDULE/ORDER
Edwards Air Force Base, California

ORGANIZATION: FTTO | DATE EFFECTIVE: 8 June 1966 | PAGE 5 OF 7 PAGES

NR.	CREW MEMBER: GRADE - NAME - SERVICE NUMBER	POS	TYPE	NUMBER	ETD	ATD	ETE	ATE	FREQ	MISSION	REMARKS	LINE ITEM CODE
37	Doryland C J Maj FR250?6 Schiele J S Lt Col FR 7921	P IP	T37B	492	0830	0835	1:30	1:00		Stan/Eval		0497
38			B47		0900		2:30			Stan/Eval	Cx - No A/C Avail	
39			C130		0905		3:00			Stan/Eval	Cx - No A/C	
40			B57	505	2045		4:00			Project Locator	Cx - Proj	
41			T37B	492	0830		1:30			XC-142 925	Cx - Proj	
42			HC130H	852	0200		20:0			Performance Flt Test	Cx - Proj	
43	White A S Civ NAA Cross, C S Maj FR41721	P CP	XB70	207	0900		3:00			Flt 2-46 Local	Rschd 0700 A/C crashed at Barstow, Cal	1
44			TB58	662	0845		2:30			XB-70 Ch #1	Cx - A/C Mx	
45			HC130	982	0800		3:00			ARRS Crew Recov Tng	Cx - Proj	

AFFTC FLIGHT SCHEDULE ORDER
Edwards Air Force Base, California

ORGANIZATION: FTTO | DATE EFFECTIVE: 8 June 1966 | PAGE 7 OF 7 PAGES

NR	CREW MEMBERS GRADE - NAME - SERVICE NUMBER	POS	TYPE	NUMBER	ETD	ATD	ETE	ATE	FREQ	MISSION	REMARKS	LINE ITEM CODE
55			H21B	389	0900		1:00			Local X-15	Cx - Proj - Wx	
56	Thomas D W Cpt FV2212076 Loveless A M A1C AF16580543	P HM	H21B	389	0700	0650	1:00	1:00		XB-70 Stdby		1070
57	Basquez J G Cpt FR47775 Graham W Maj 074075 USA	P CP	CH3C	577	0530	0640	1:00	1:30		Perf	Rschd to 0630	4850
58			CH3C	577	1330		1:00			Sea Lvl Perf	Cx - Proj	
59			H21B	361	0600		5:00			X-15 Uprange	Broke at Nellis	
60			H21B	389	0630		1:00			M-2	Cx - Proj	
61	Basquez J G Cpt FR47775 Cretney F D S/L 2607830	P CP	CH3C	577	1600	1600	2:00	1:20		Search & Rescue		
62	Dennie R F Cdr USN 505153 Odneal B L Lt Col 062065 USA	P CP	H21B	855	1030	1030	1:45	3:00		Search & Rescue		
63	Cretney F D S/L 2607830 Doryland C J Maj FR25056	IP P	C130A	131	0830	0955	3:00	4:00		XB-70 Rescue Spt	Airborne Cap	1070
64	Schiele J S Lt Col FR17921 Jones G E Maj FR26495	IP P	C130	526		1330		3:00		XB-70 Rescue Spt	Airborne Cap	1070
65	Basquez J G Cpt FR47775 Fulton F L Lt Col FR36417	P CP	H21B	389		1000		3:00		XB-70 Rescue Spt		1070

Crew members listed above will proceed from Edwards AFB in aircraft indicated, to perform mission requirements and return. Variations in itinerary authorized. All cross country flights will be covered by separate order (AF Form 615, Flight Order) to show cause and authority.

FOR THE COMMANDER
JAMES J. [illegible], JR., Lt Colonel, USAF
Director, Flight Test Operations

DATE OF ORDER: 9 June 1966 | ORDER NUMBER: 323

AFFTC FORM 34 PREVIOUS EDITION OF THIS FORM IS OBSOLETE.

WEDNESDAY

WEEKLY AIRCRAFT AND AIR/GROUND SUPPORT REQUIREMENTS SCHEDULE

6 June 1966

WEEK OF (Monday thru Sunday): 6 June thru 12 June 1966

DATE	AIRCRAFT T/M/S	AIRCRAFT NR	TIME TO	TIME FLIGHT	FUEL	MISSION	COMM FREQ	RANGE REQUIREMENTS	SPACE POSITIONING RADAR	SPACE POSITIONING PHOTO OPTIC	SPACE POSITIONING THEOD	PHOTO GROUND	PHOTO AERIAL	CRASH EQUIPMENT FIRE	CRASH EQUIPMENT AMB	CRASH EQUIPMENT RECOV	TELEMETRY FREQ	TELEMETRY READ OUT	TELEMETRY TAPE	LIC
BARR	B52B	379	1400			Barrier						7 CAMS		x	x	x	253.[illegible] (ALL DAY)			9352
GE	F5A	989	0800	1400		Transient Eval	266.3						[illegible]							
	T38	610	0800			Phase 989														
	F4C	201	0830	1230		Spec Range														9141
DOUG	DC8	70U	0630	4.0		8-10 Cont T.O.'s	327.6				x									9318
	DC8	70U	~~1400~~	1.0		Wt & Bal														9318
	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]														[illegible]
NORAIR	F5	371	0630	1.0		Flutter														4223
	T-38	194	0630	1.0		Chase														
	F5	517	0700	1.0		Gun Firing		Cuddeback												4225
	F5	372	0845	1.0		Stab & Con														9379
	F5	371	0900	1.0		Flutter														4223
	F104	~~705~~	0900	1.0		Chase														
	F5	517	0930	1.0		Gun Firing		Cuddeback												4225
	F5	517	1200	1.0		Gun Firing		Cuddeback												4225
	F5	372	1245	1.0		Stab & Con														9379
	F5	517	1430	1.0		Gun Firing		Cuddeback												4225
	F5	517	1700	1.0		Gun Firing		Cuddeback												4225

AFFTC FORM MAR 63 16

School

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

[illegible]

WEDNESDAY

WEEKLY AIRCRAFT AND AIR/GROUND SUPPORT REQUIREMENTS SCHEDULE 8 June 1966

WEEK OF (Monday thru Sunday) 6 June thru 12 June 1966

AIRCRAFT AND AIR SUPPORT — GROUND SUPPORT

DATE	AIRCRAFT T/M/S	AIRCRAFT NR	TIME TO	TIME FLIGHT	FUEL	MISSION	COMM FREQ	RANGE REQUIREMENTS	SPACE POSITIONING RADAR	SPACE POSITIONING PHOTO OPTIC	SPACE POSITIONING THEOD	PHOTO GROUND	PHOTO AERIAL	CRASH EQUIPMENT FIRE	CRASH EQUIPMENT AMB	CRASH EQUIPMENT RECOV	TELEMETRY FREQ	TELEMETRY REAL O/T	TELEMETRY TAPE	LIC
FRI-SER	XC142	921	0600	1.00		Pt. Mugu Ops				2		16C24	16C40							4269
	H-21	855	0600	1.00		Photo Chase 921														
	XC142	925	0830	1.30		Pilot Fam						16C24	16C40							
	H-21	389	0830	1.30		Photo Chase 925														
	T-37	492	0830	1.30		Chase 925														
PERF	HC130H	852	0200	20.00		Perf Flt TST Range Man [illegible]														4011
	T38A	~~914~~	0600	.50		Saw-Tooth Climb Eng Problems														9111
	H21					Standby with Medic														
	T38A	~~914~~	1400	1.10		Gear Retraction Times Eng Problems														9111
	T33	~~999~~	1400			Photo Chase														
NAA	XB70	207	0900	2.00		Flt 2-46 [illegible]	351.4 316.6	DATA CONTROL RM TV [illegible]	x S/B NASA T/O [illegible] H1 Range		x T/L		X	x	x	x	228.2 250.7 235.5	x	x	1070
	TB58	662	0845	2.30		Chase #1														
	T38	104	0845	1.00		Chase #2 (T/O)														
	T38	600	1045	1.00		Chase #3 (Lndg)														
	C130	[illegible]	0830	3.00		Rescue Spt & Para Medics														
	H21	389				Rescue (Standby) [illegible]														
	[illegible]					[illegible]	[illegible]	[illegible]												

AFFTC FORM 16 — PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

AIRCRAFT AND AIR/GROUND SUPPORT REQUIREMENTS SCHEDULE

8 June 1966

WEEK OF (Monday thru Sunday): 6 June thru 12 June 1966

AIRCRAFT AND AIR SUPPORT								GROUND SUPPORT												
DATE	AIRCRAFT		TIME		FUEL	MISSION	COMM FREQ	RANGE REQUIREMENTS	SPACE POSITIONING			PHOTO		CRASH EQUIPMENT			TELEMETRY			LIC
	T/M/S	NR	TO	FLIGHT					RADAR	PHOTO OPTIC	THEOD	GROUND	AERIAL	FIRE	AMB	RECOV	FREQ	READ OUT	TAPE	
CAT II	F111	~~773~~	0800	1.30		Transition NORSG		EBR-RDR PLTS	S/B	0900-0930			16C24							3065
	T33	~~900~~	0830	1.00		Photo Chase 773														
	F111	~~774~~	0900	1.30		Transition Class II MOD		EBR-RDR PLTS	S/B	1000-1130										3065
	T33	~~997~~	0930	1.00		Photo Chase 774														
	F111	~~773~~	1100	1.30		Transition NORSG		EBR-RDR PLOTS		1200-1230			16C24							3065
	F104	~~314~~	1130	1.00		Photo Chase 773														
	F111	~~774~~	1200	1.30		Transition Class II MOD		EBR RDR PLOTS		1300-1330										3065
	T33	~~997~~	1230	1.30		Photo Chase 774														
	F111	~~773~~	1400	1.30		Transition ~~NORSG~~		EBR-RDR PLOTS	✓ ✓	1400-1430			16C24							3065
	F104	317 ~~314~~	1430	1.00		~~Photo~~ Chase 773 ✓														
	F111	~~774~~	1500	1.30		Transition Class II MOD														
	F104	~~315~~	1500	1.00		Photo Chase 774														
NASA	LLRV		0530	✓		FLT (S. BASE)	287.0							x	x		256.2			9325
	LLRV		0730	✓		FLT (S. BASE)	287.0							x	x		256.2			9[illegible]
	LLRV		0930	✓		FLT (X. BASE)	287.0							x	x		256.2			[illegible]

AFFTC FORM MAR 65 16

School

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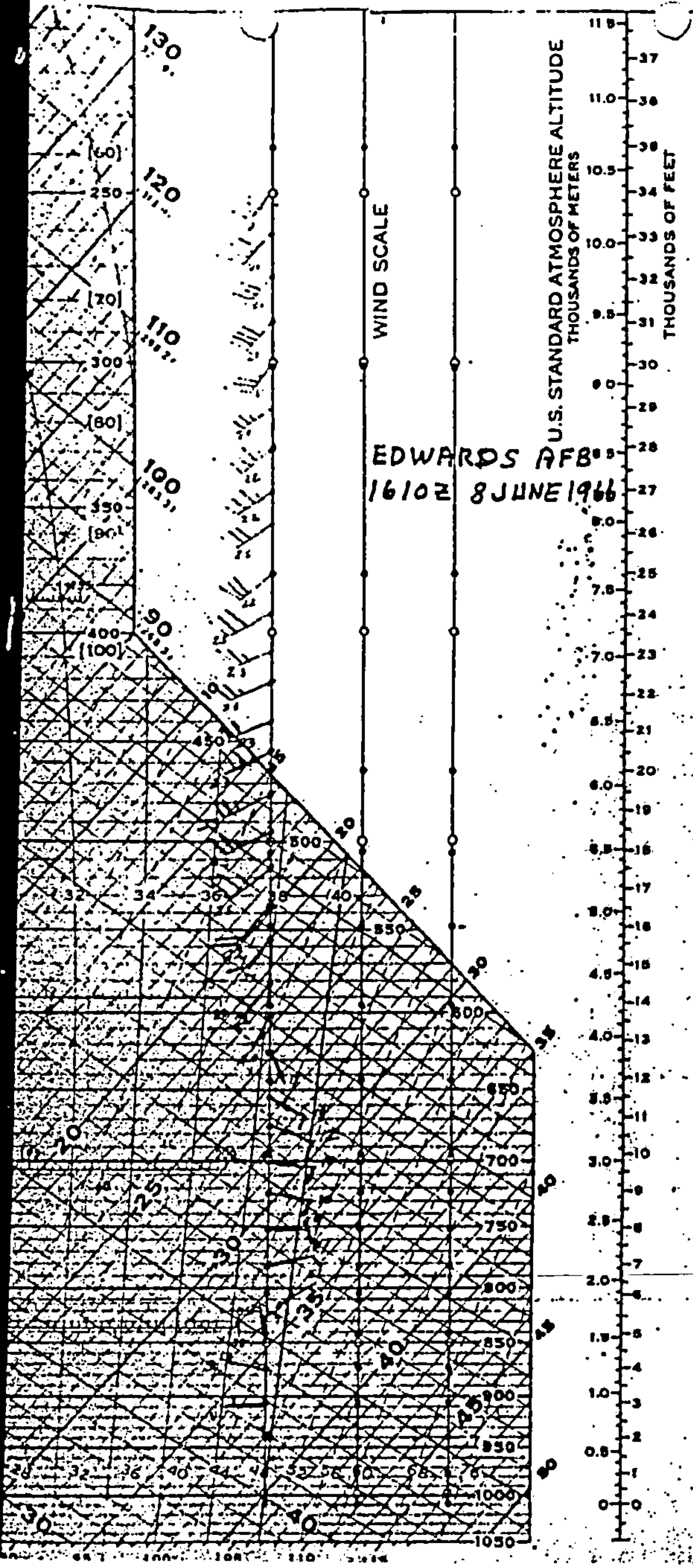


All heights in this diagram are in geopotential feet

SKEW T, LOG P ANAL

TIME	TIME
AIRMASS ANALYSI	
TYPE BOUNDARY ——— FT. TYPE BOUNDARY ——— FT. TYPE	
FREEZING LEVEL(S)	
INVERSIONS	
FRONTAL	
RADIATION	
SUBSIDENCE	
TROPOPAUSE	
L.C.L.	
C.C.L.	
L.F.C.	
SIGNIFICANT WI	
MAX.	
MIN.	
LEVELS OF SHEAR	
STABILITY INDEX	
TO	
TO	
TO	
CLOUDS	
TYPE	
AMOUNT	
BASES	
TOPS	
ICING	
TYPE	
SEVERITY	
BOUNDARIES	
CONTRAILS	
PERSISTENCE	
HEIGHT	
TURBULENCE	
DEGREE	
HEIGHTS	
MAX WIND GUSTS	
HAIL SIZE	
TEMPERATURE	
MAX.	
MIN.	
CUMULUS CLOUD FORMATION AT TEMP	
DISSIPATION OF LOW LEVEL INVERSION	
REMARKS	
FORECASTER	FOREC

ED

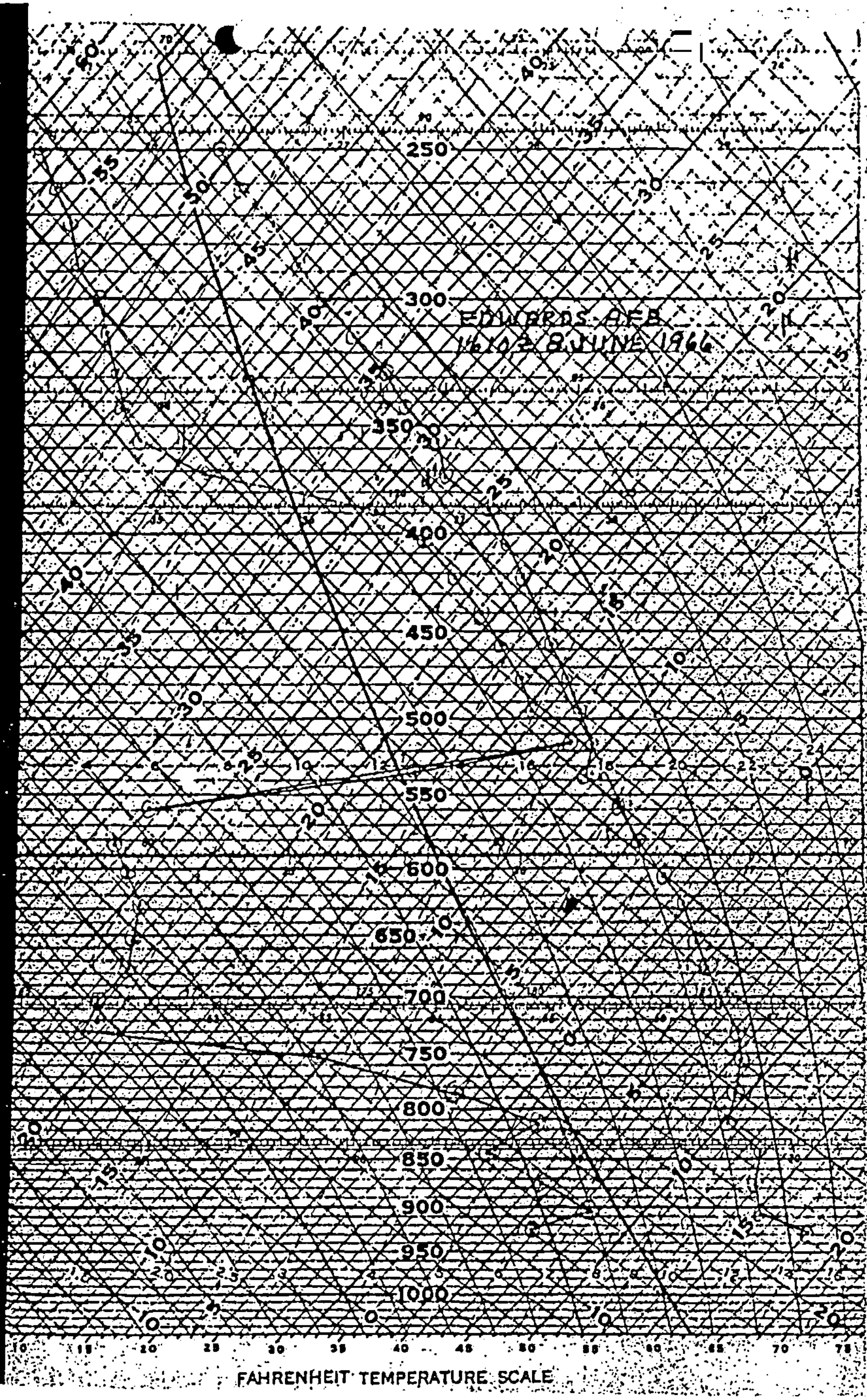
NUMBER

1610Z 8 JUN

TIME (GCT) DATE (GCT)

TIME (GCT) DATE (GCT)

TIME (GCT) DATE (GCT)


EDWARDS AFB
1610Z 8 JUNE 1966
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
10 15 20 25 30 35 40 45 50 55 60 65 70 75
FAHRENHEIT TEMPERATURE SCALE

Time entries on this form are 120th meridian time
To convert to G.C.T. (add) 8 hours
Height of barometer 2316 feet (MSL)

SURFACE WEATHER

Type (1)	Time (LST) (2)	Ceiling and Sky (3)	Visibility (miles) (4)	Weather and obstructions to vision (5)	Sea level press. (mbs.) (6)	Temp (°F) (7)	Dew pt (°F) (8)	Wind direction (9)	Speed (knots) (10a)	MAG direction (10b)	Character and gusts (11)	Altimeter setting (in.) (12)	Remarks and supplemental coded data (13)
R	1155	○	15+		099	55	45	23	10	21		988	MAG21 / 707
R	[illegible]	-⦶	15+			55	45	24	11	22		987	MAG22
R	[illegible]	-⦶	15+			53	45	21	08	19		987	MAG19
R	0257	U⦶	15+		097	52	45	21	07	19		987	MAG19 / 607 1006 52
RS	[illegible]	E200⦶/⊕	20			54	45	21	09	19		988	MAG19
R	[illegible]	E150⦶/⊕	20			56	46	21	10	19		988	MAG19
[illegible]	[illegible]	E15[illegible]⦶/⊕	15		100	61	47	21	08	19		988	MAG19 / 102 1037
R	[illegible]	A130⦶/⊕	20			65	47	23	08	21		988	MAG21
[illegible]	[illegible]	E130⦶/⊕	15			67	46	21	08	19		988	MAG19 (ACFT MISHAP)
C	[illegible]	E[illegible]⊕	15			68	46	24	[illegible]	22		[illegible]	MAG22
R	[illegible]	E[illegible]⊕	15		103	70	46	24	10	22		985	MAG22 / 203 105/ 52
R	[illegible]	E110⦶140⊕	15			72	46	27	07	25		988	MAG25
[illegible]	[illegible]	E[illegible]⦶1[illegible]⦶/⊕	15			74	46	26	[illegible]	24		987	MAG24
R	[illegible]	110⦶E140⦶/⊕	15		097	75	45	24	05	22		986	MAG22 CU SW-W / 810 1177
R	[illegible]	15⦶110⦶140⦶/-⊕	15			77	45	24	07	22		984	MAG22
[illegible]	1455	15⦶140⦶/-⊕	20			79	45	25	12	23		983	MAG23
RS	1555	70⦶140⦶U⊕	15		079	80	46	26	14	24	G20	982	MAG24 / 610 1477 80
R	1657	110⦶140⦶U⦶	12			78	46	28	13	26		982	MAG26 CB NNE TCU NE-N
R	1756	90⦶120⦶/⦶	10			73	46	31	13	29		983	MAG29 CB MOVD NE H ALQDS
RS	1555	90⦶120⦶U⦶	10		081	70	46	29	12	27		983	MAG27 / 302 1062
R	1955	90⦶120⦶U⦶	10			69	46	30	12	28		985	MAG28
R	2057	90⦶120⦶/-⦶	10			64	47	23	09	21		986	MAG21
R	2155	120⦶/-⊕	12		091	66	46	25	07	23		986	MAG23 / 110 1062 80
R	2255	120⦶/-⦶	12			67	45	21	10	19		987	MAG19
R	2357	120⦶/-⦶	15			60	45	21	05	19		986	MAG 19 (PK WND 28/24 [illegible])

OBSERVATIONS

U CY

STATION EDWARDS AFB
MONTH XIII DAY 02 YEAR 1962
LAT. 34°55' LONG. 117°54'

Time (L.S.T.)	Station Pressure (in.)	Dry Bulb (°F)	Wet Bulb (°F)	Rel. Humidity (%)	Total Sky Cover	Net 3-Hour Change	9/A
[illegible]	27475			69			23[illegible]
[illegible]	27470			61	2		2345
[illegible]	27470			74	5		2345
[illegible]	27470			77	7		2345
[illegible]	27480			71	10		2325
[illegible]	27475			69	10		2340
[illegible]	27475			60	10		2340
[illegible]	27480			52	10		2345
[illegible]	27.4[illegible]			45	10		2340
[illegible]	27.485			42	10		2330
10	27479			39	10		[illegible]
11	27.470			37	10		2345
[illegible]	27.455			34	10		[illegible]
[illegible]	27440			32	10		2375
[illegible]	27430			28	10		2325
[illegible]	27425			30	10		2290
[illegible]	27420			32	7		2395
17	27430			38	5		2385
[illegible]	2743[illegible]			42	6		2385
[illegible]	27445			44	8		2370
[illegible]	27460			54	8		2355
[illegible]	27460			48	10		2355
[illegible]	27465			46	5		2350
[illegible]	27455			57	4		2360

SYNOPTIC OBSERVATIONS

STATION PRESSURE COMPUTATION

SUMMARY OF DAY (MIDNIGHT TO MIDNIGHT)

REMARKS, NOTES AND MISCELLANEOUS PHENOMENA

FLIGHT WEATHER BRIEFING | AIRCRAFT NO.: 207 | BRIEFING NO.: 80 | DATE: 8 June 66

I. TAKEOFF DATA

RUNWAY TEMP.	PRESSURE ALT.	[illegible]	[illegible]	[illegible]	DENSITY ALTITUDE
+55°F	+2340 FT	—	—	—	—

CLIMB WINDS: EDW surface 240/10; Climb 230/10

REMARKS: NONE

II. ENROUTE DATA

FLIGHT LEVEL: 200 | TEMPERATURE: — | WINDS: EDW - TPH - EDW 300/15 -18°C

CLOUDS AT FLIGHT LEVEL 200: ☐ YES ☑ NO ☐ IN AND OUT

VISIBILITY AT FLIGHT LEVEL 10+: ☐ HAZE ☐ DUST ☐ SMOKE ☐ PRECIPITATION

MINIMUM CEILING ENROUTE: CAIF 25000 FT AGL Nevada | MAXIMUM CLOUD TOPS: CAH 30000 FT MSL Nevada | MINIMUM FREEZING LEVEL: 10100 FT Nevada

THUNDERSTORMS	TURBULENCE	PRECIPITATION	ICING
✓ NONE	NONE	✓ NONE	✓ NONE
FEW	✓ CAT / ✓ LGT	RAIN / DRZL	CLEAR / LGT
SCATTERED	TSTM / ✓ MOD	SHOWERS / SNOW	RIME / MOD
NUMEROUS	SVR	FREEZING	MIXED / SVR
HAIL			IN CLOUDS
	LGT-MOD TURB over mtns. SFC to 14000 FT during landing, take off due to gusty sfc winds		

III. TERMINAL DATA

[illegible]

FORECAST: EDW 250-⊕10+ 240/10G15 ALTG 29.90 (1520 Z TO 1720 Z)

[illegible]

FORECAST: (Z TO Z)

IV. COMMENTS/REMARKS

VALID TIME: Hr 5 B 0000 Z | EXTENDED TO: — | FORECASTER: J.A. Van Brunt, 1st Lt USAF

V. TELEVISION/TELEPHONE BRIEFING RECORD

WEATHER FACILITY:

TAPE NO.	START	STOP	PHONE CHARGE

DD Form 1 NOV 64 175-1

V3C TAFJR 13139 V3C 63605 3505/ 88705 73263 QNH 2992 CIG 3 V6
GRADU 1517 63510 QNT 16 6603// X6710 720// X6360 764 QNH 2996
GRADU 2022 63410 6603/ 68708 720// X3360 764// QNH 2994

RIV TAFJR 13139 RIV 69902 6005/ 64620 73 062 56640 757// QNH 2991
GRADU 1517 49905 6101/ 84350 753// QNH 2993
GRADU 1921 23210 QNT16 6101/ 62650 760// QNH 2965
GRADU 0204 03206 6101/ QNH 2969
GRADU 0707 69905 6103/ 88712 720// QNH 2967

V CV TAFJR 13139 VCV 62010 7403/ 86270 76061 QNH 296 9
GRADU 1712 42010 QNT20 7401/ 84070 780// QNH 2965
GRADU 0103 22005 7401/ 62070 760// QNH 2968

AMA TAFJR 13139 AMA 12415 7402/ 81075 73061 QNH 2979
GRADU 1820 33215 QNT25 7403/ 62650 765// X3075 730// QNH 2965

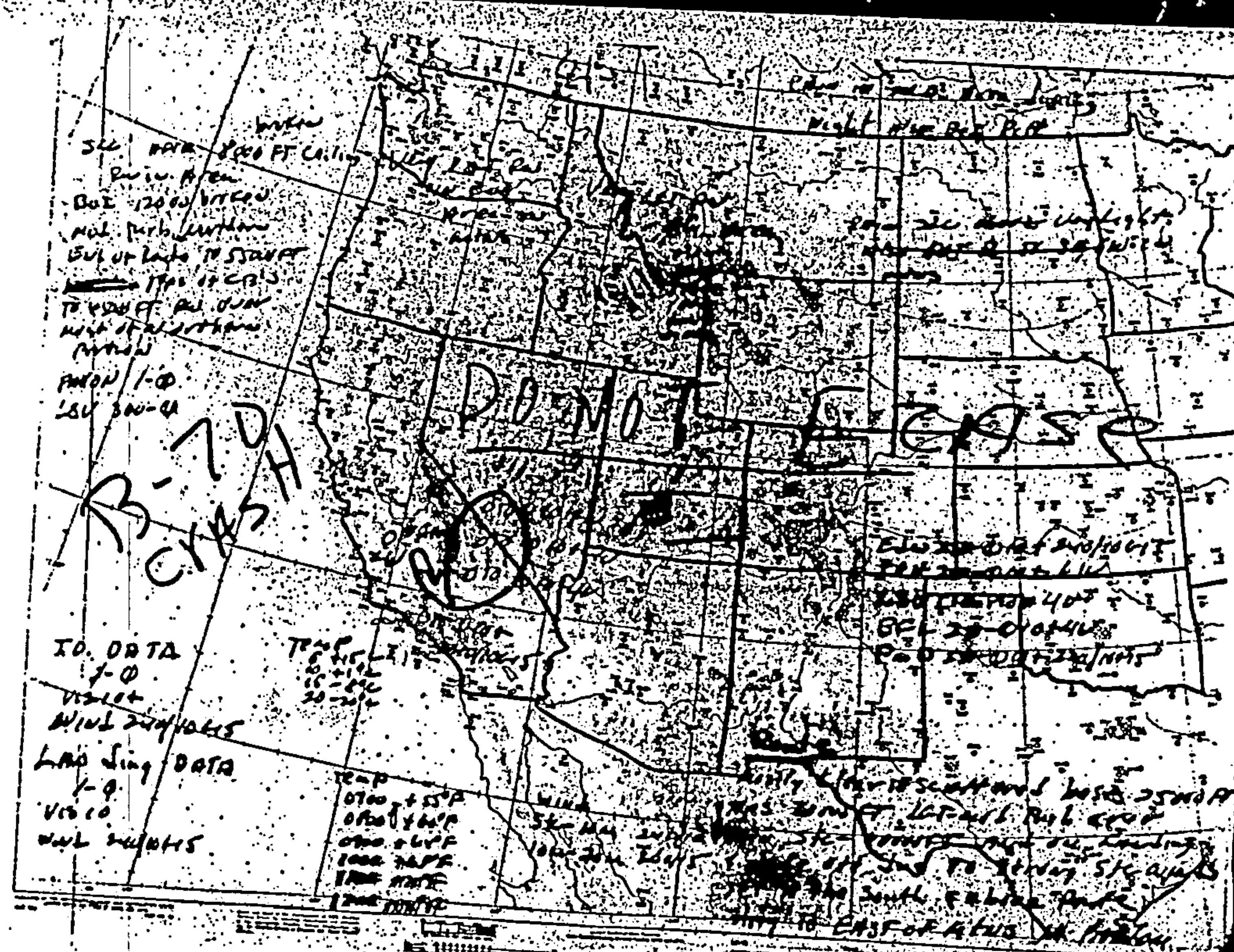
VCV TAFJR 07073 VCV 12008 7402/ 61075 7605 9 QNH 2997
GRADU 1921 42015 QNT20 7403/ 64075 760// QNH 2968
GRADU 0103 0200 5 7401/ QNH 2960

AMA TAFJR 07073 AMA 21615 QNT25 7402/ 62075 77761 QNH 2970
GRADU 42415 7403/ 64075 777// QNH 2963

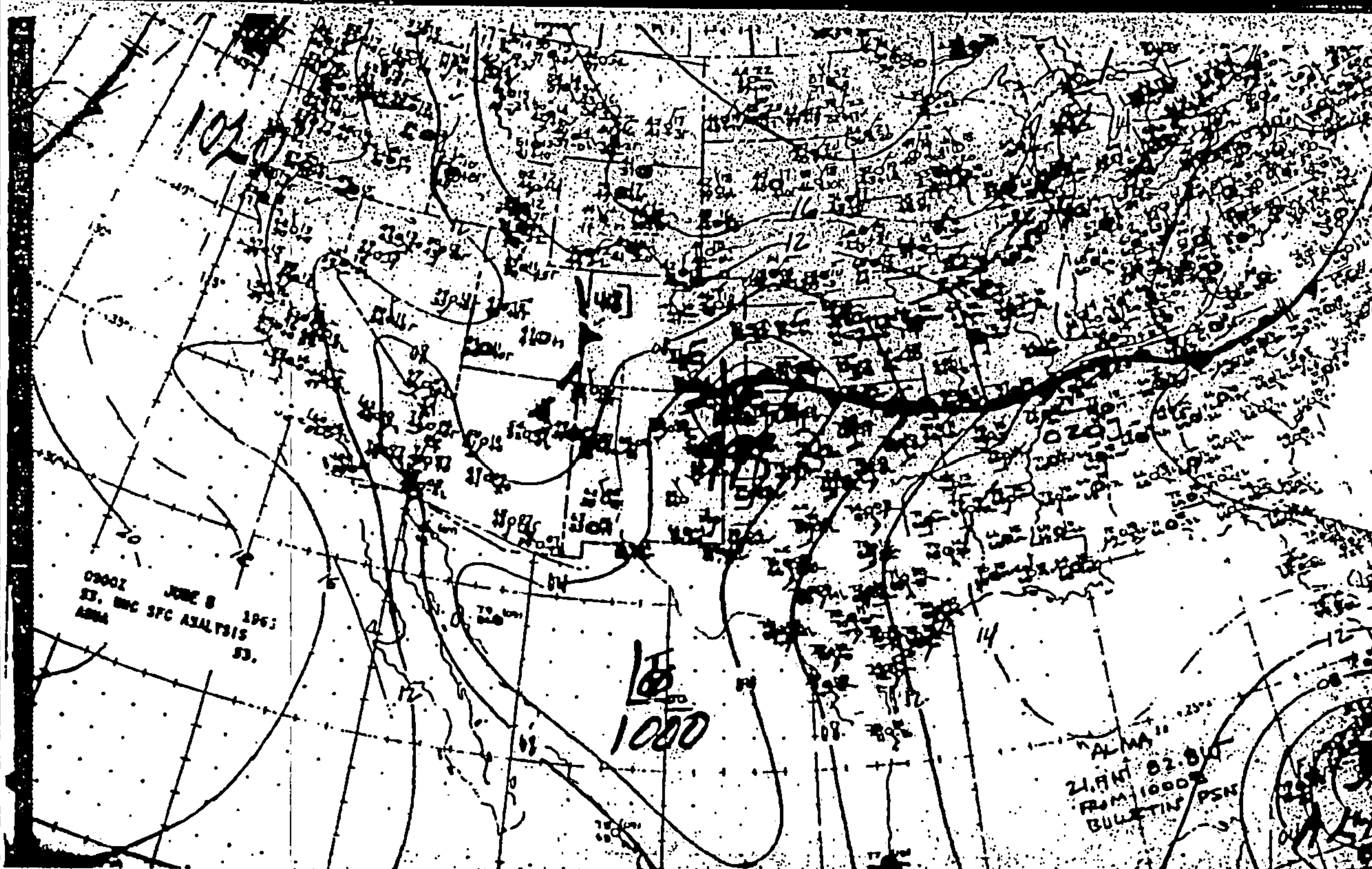
WNNRSUS 250 KXR F 08/1233Z
V ALID 081300 Z TO 091300Z
EDN 200015 9910 QNH 2967
16Z 200-015 9910 QNH 2983
04Z 015 0 QNH 2967 FIRST

LSV FTUS 250 081200Z
260015+ 1505 QNH 2960
17Z 260015+ 1710G15 QNH 2978
02Z 0 15+ 0405 QNH 2960 FIRST

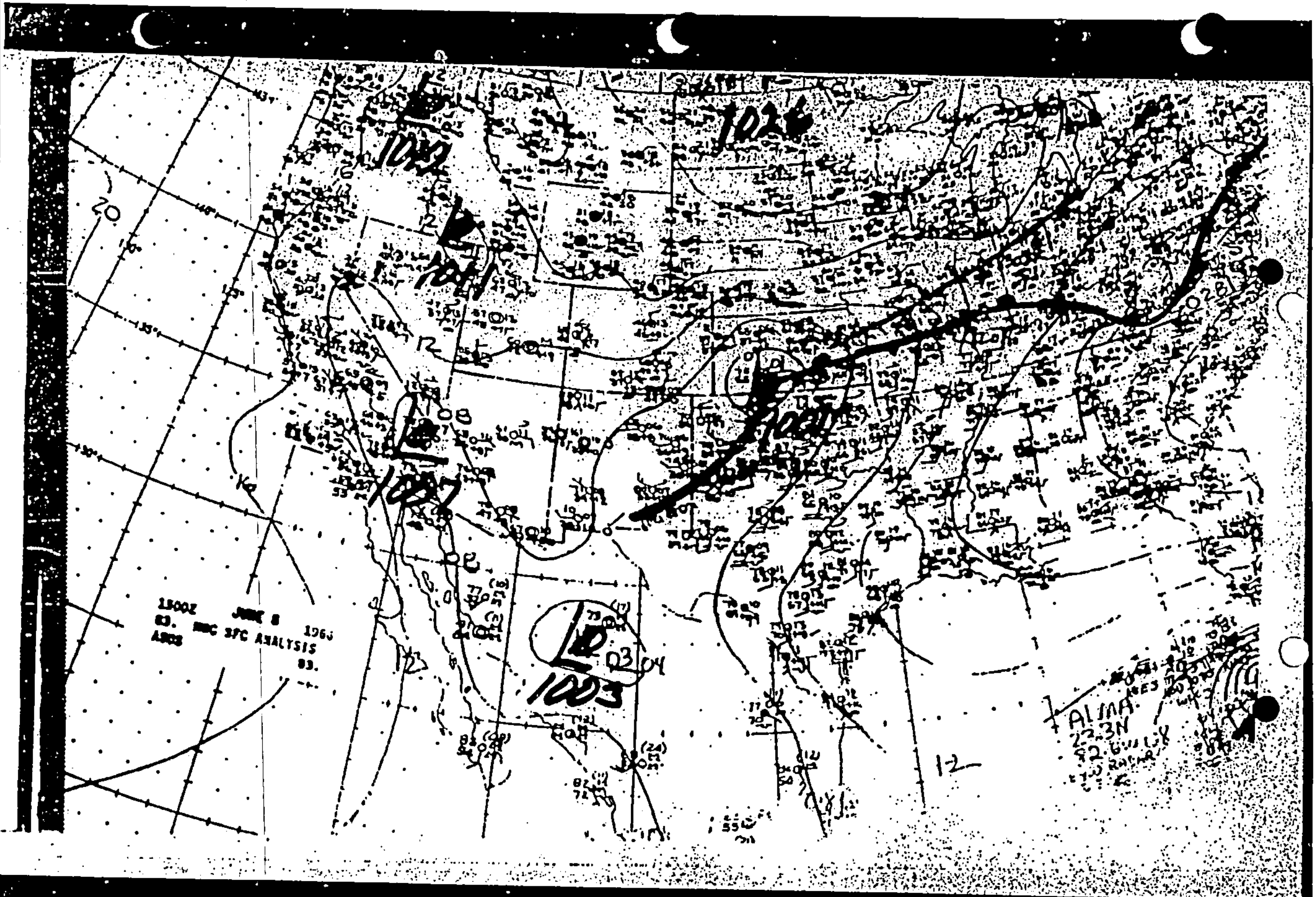
FTUS 250 080000Z
L SV 015+ 9905 QNH 29.76
07Z 015+ 0210G18 QNH 29.80
13Z 260-015+ 1710G15 QNH 29.82 LAST

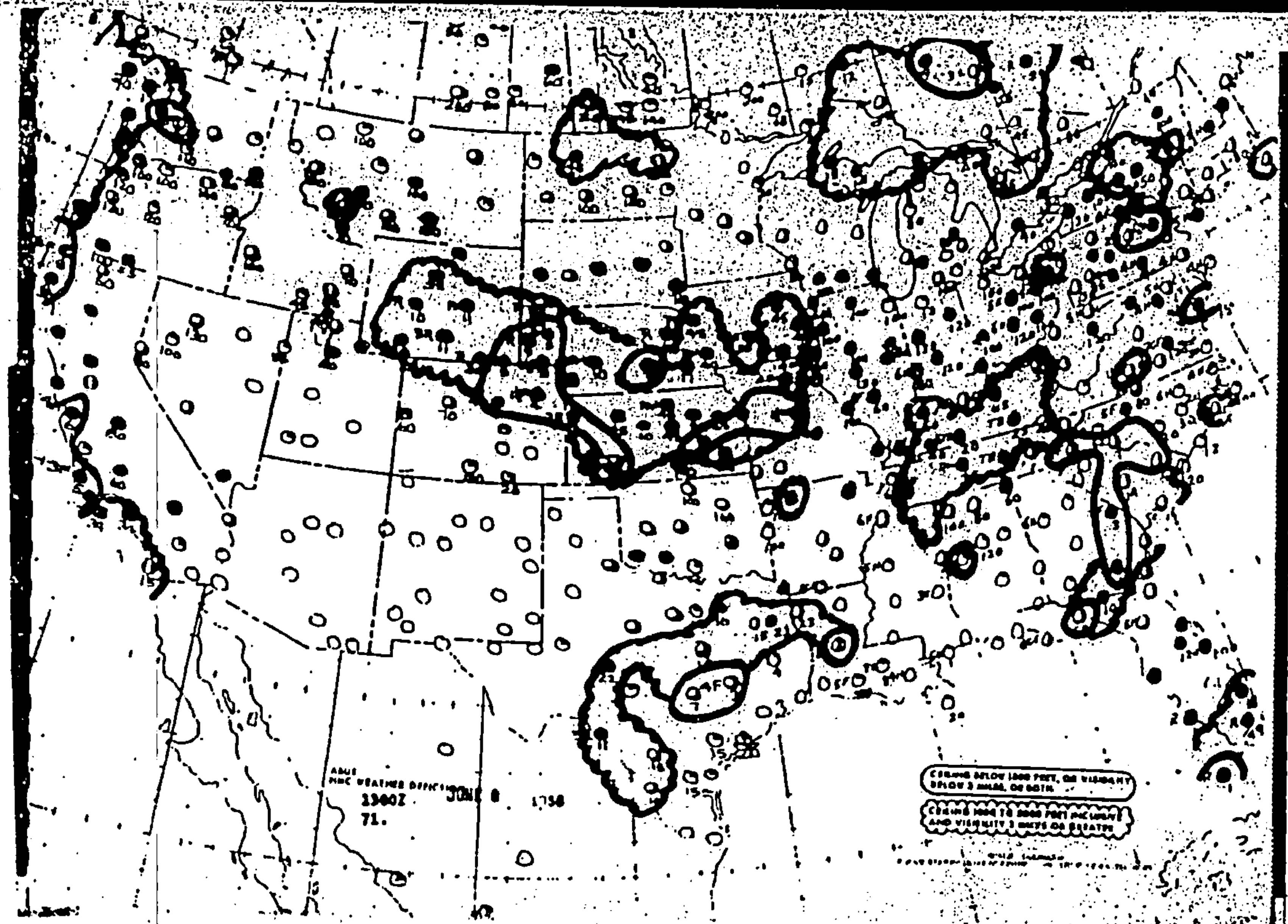


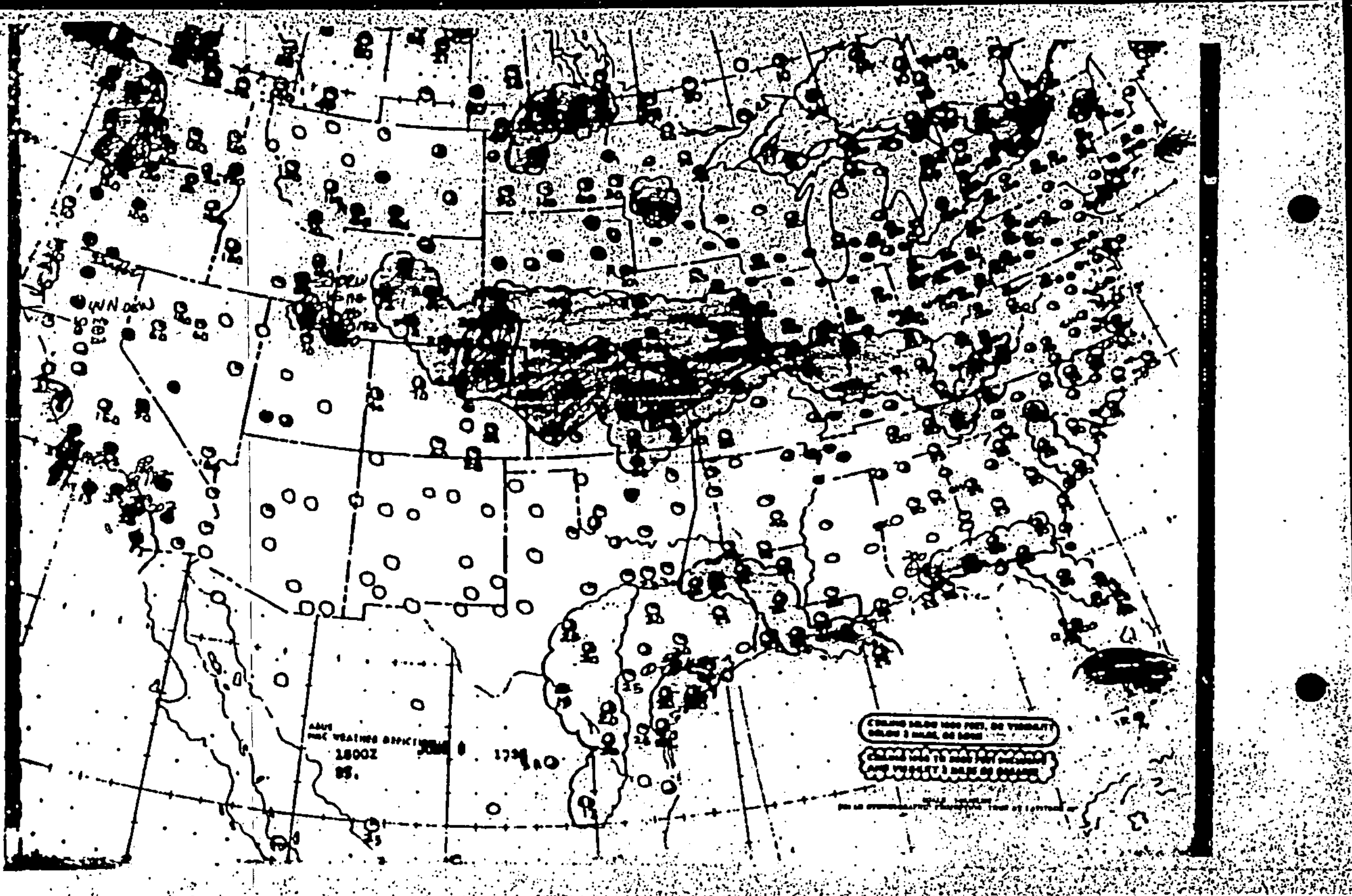
PRE TAKEOFF WEATHER BRIEFING BOARD

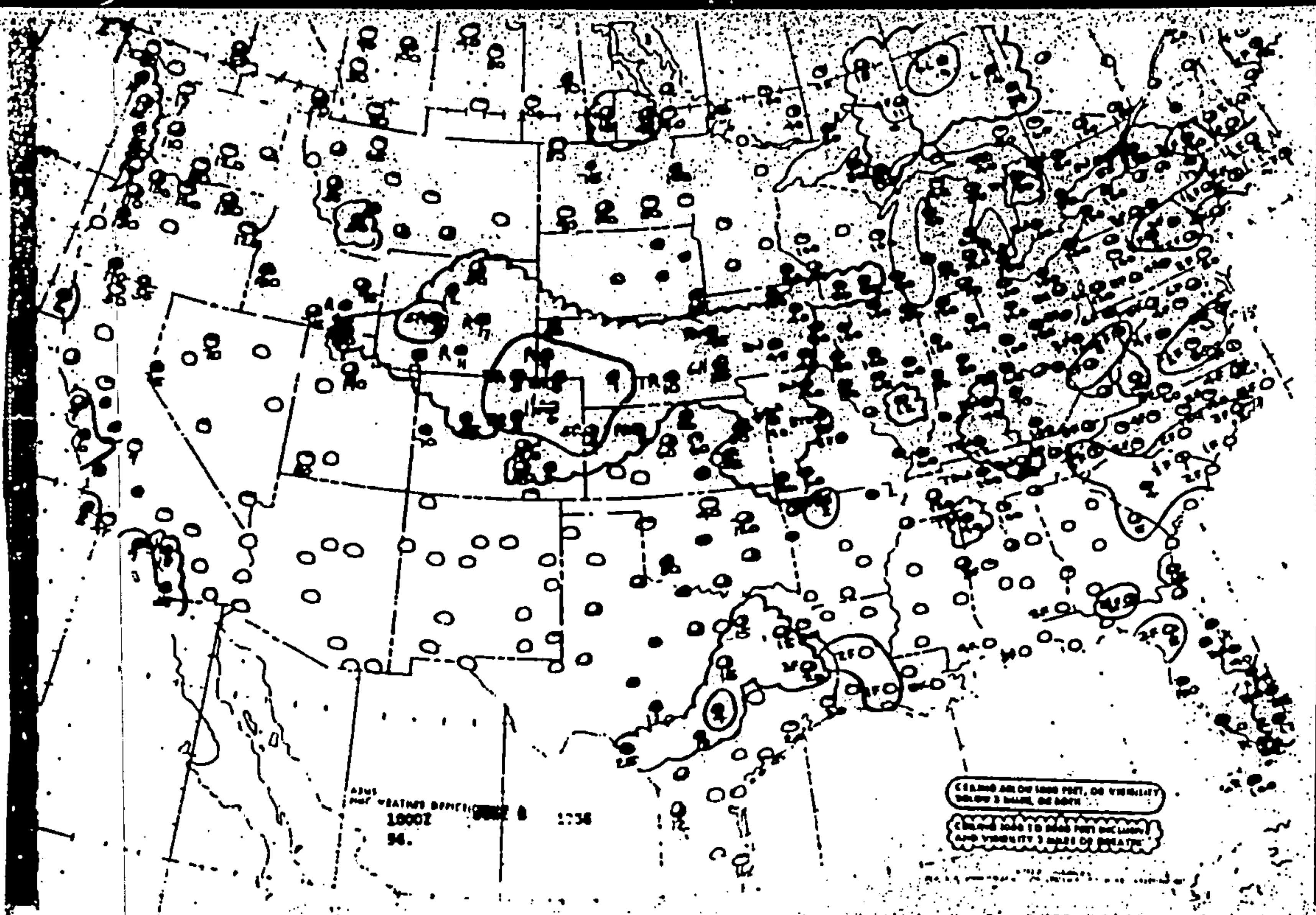


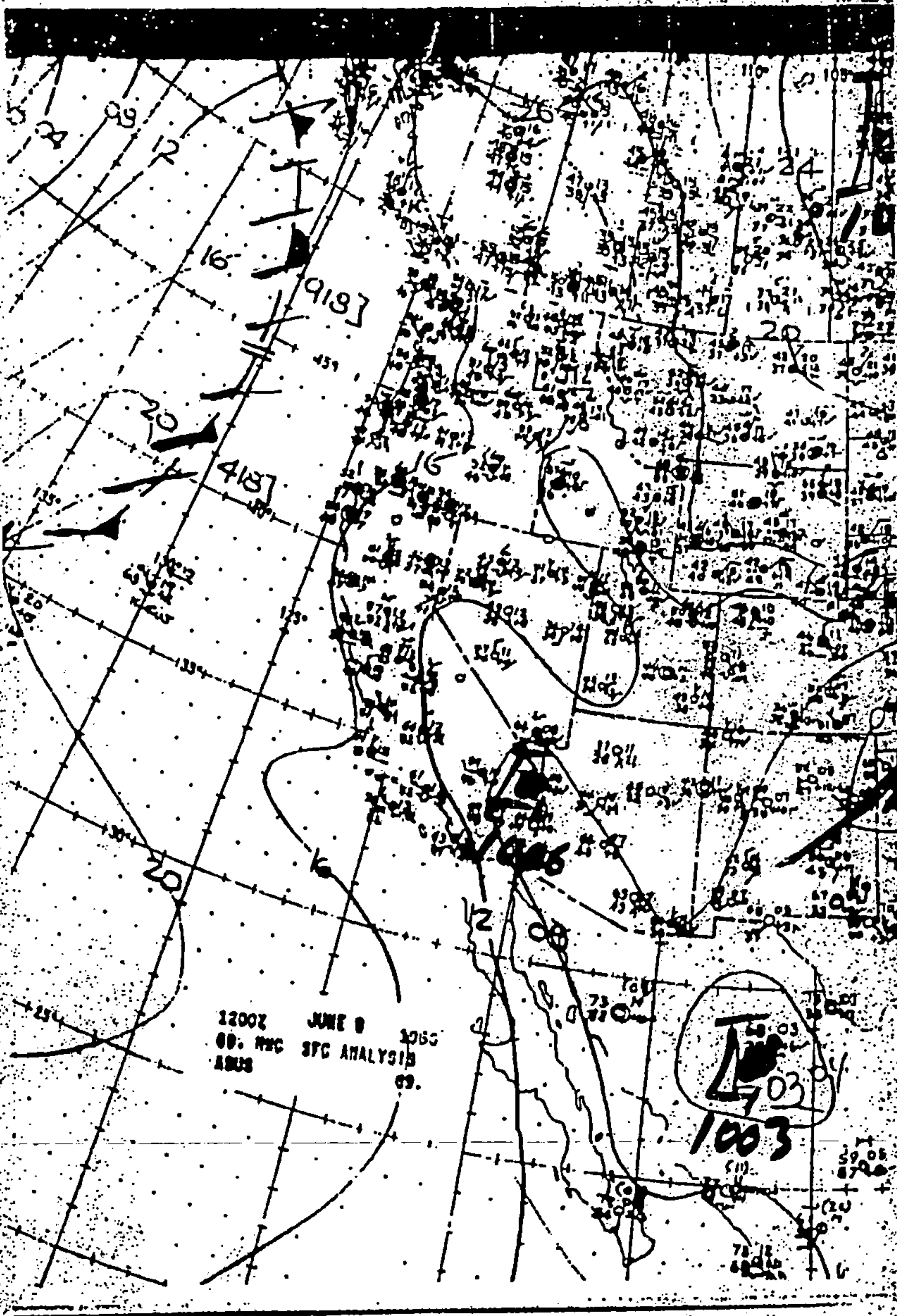
0000Z JUNE 8 1963
SFC ANALYSIS
"ALMA"
L
1000

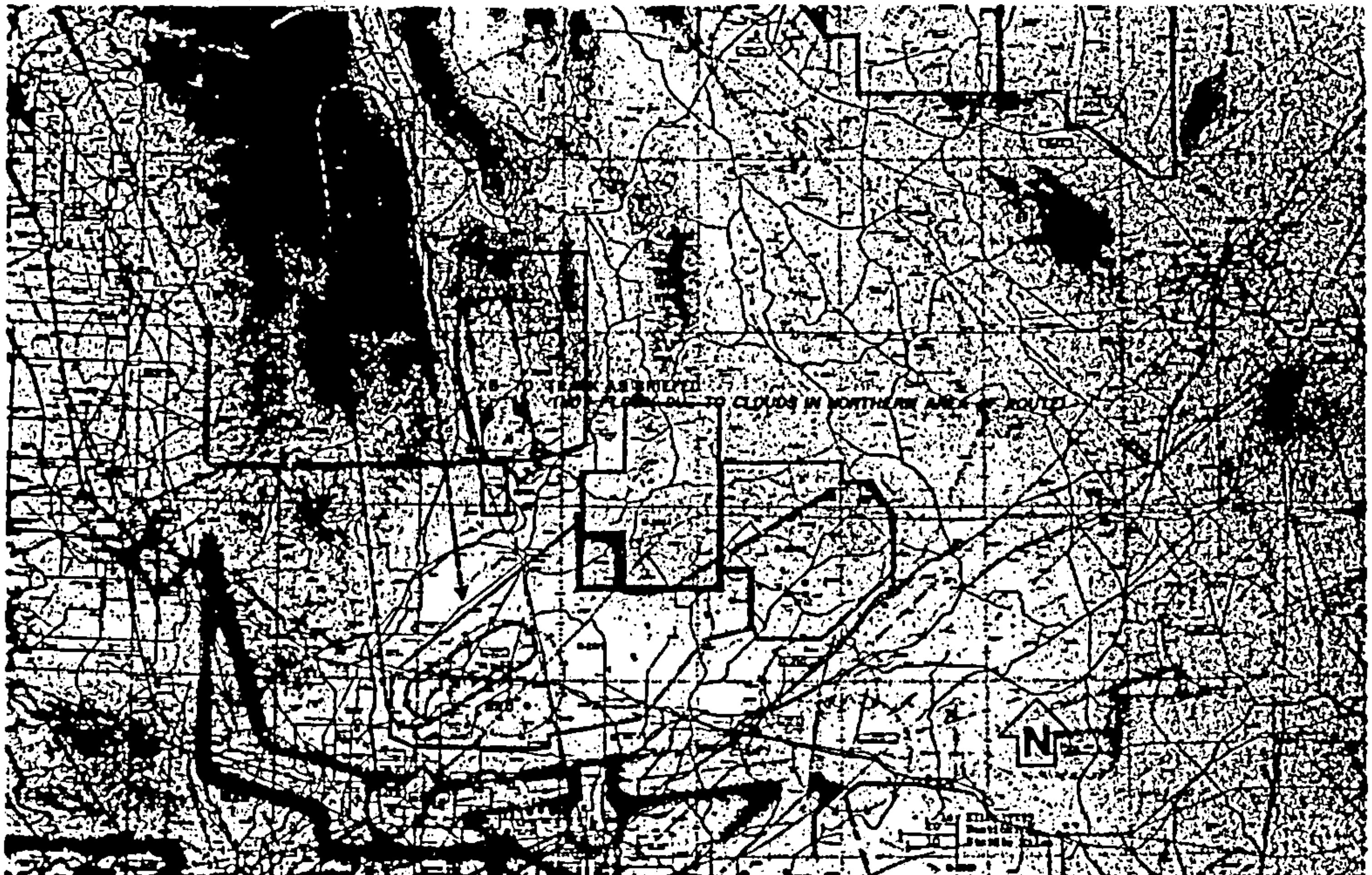

1500Z
SFC ANALYSIS
83.
1003
ALMA

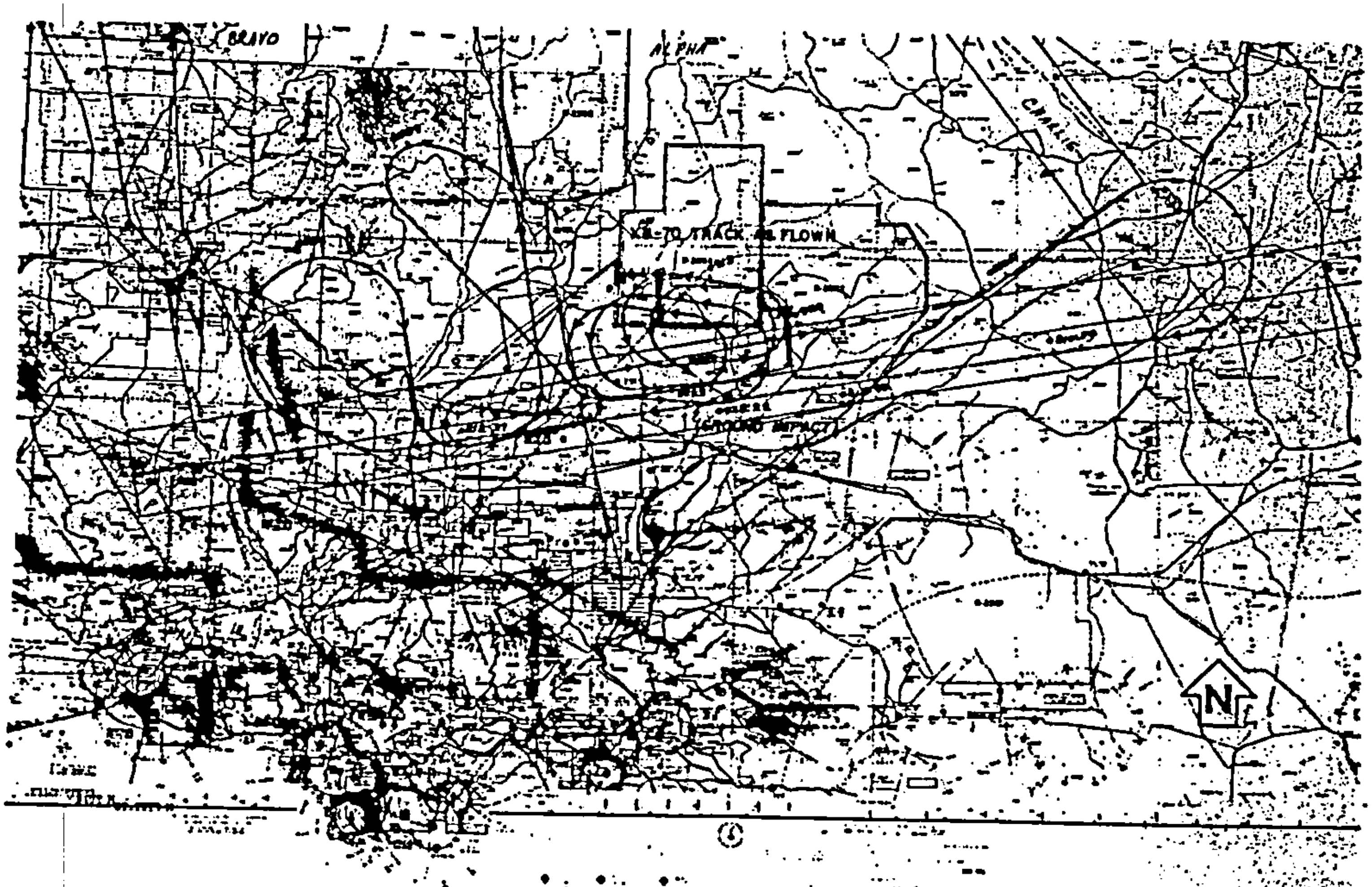

1300Z
71.

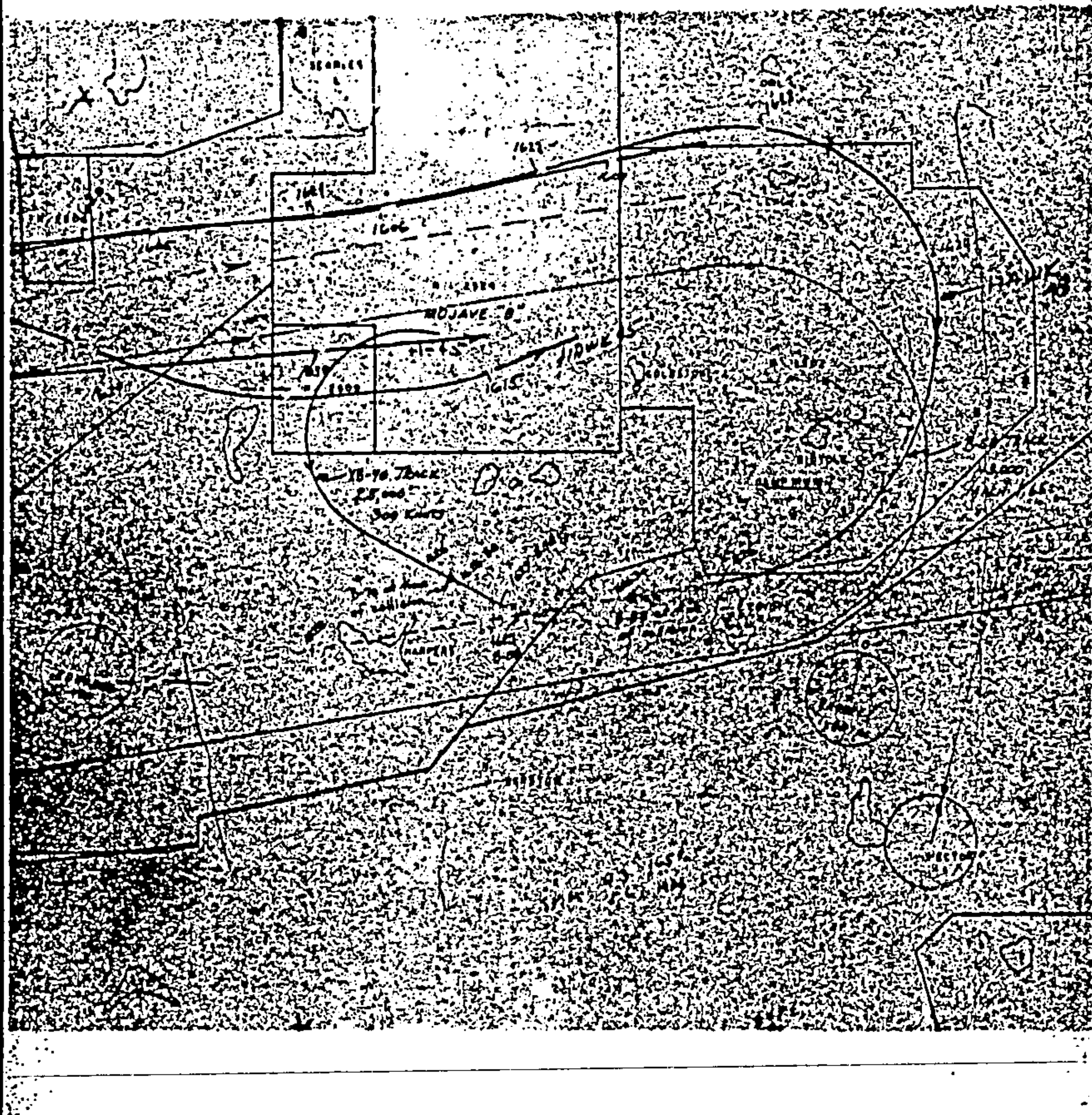

1800Z


1000Z


1200Z JUNE
SFC ANALYSIS
1003


CLOUDS IN
N


BRAVO
ALPHA
CHARLIE
TRACK
FLOWN
GROUND IMPACT
N


MOJAVE "B"

WRECKAGE DIAGRAM POINT DESCRIPTION

1.	B-70	Main Impact Area
2.	B-70	Left Wing Section
3.	F-104	Fuselage and Engine
4.	F-104	Cockpit Section
5.	B-70	Left Rudder Section
6.	F-104	Tail Section
7.	F-104	Left Tip Tank, Aft Section
8.	F-104	Fuselage Tanks
9.	F-104	Right Tip Tank
10.	F-104	Right Wing Outboard Section
11.	F-104	Air Conditioning Package
12.	F-104	Fuselage Nose Cone
13.	F-104	Nose Gear

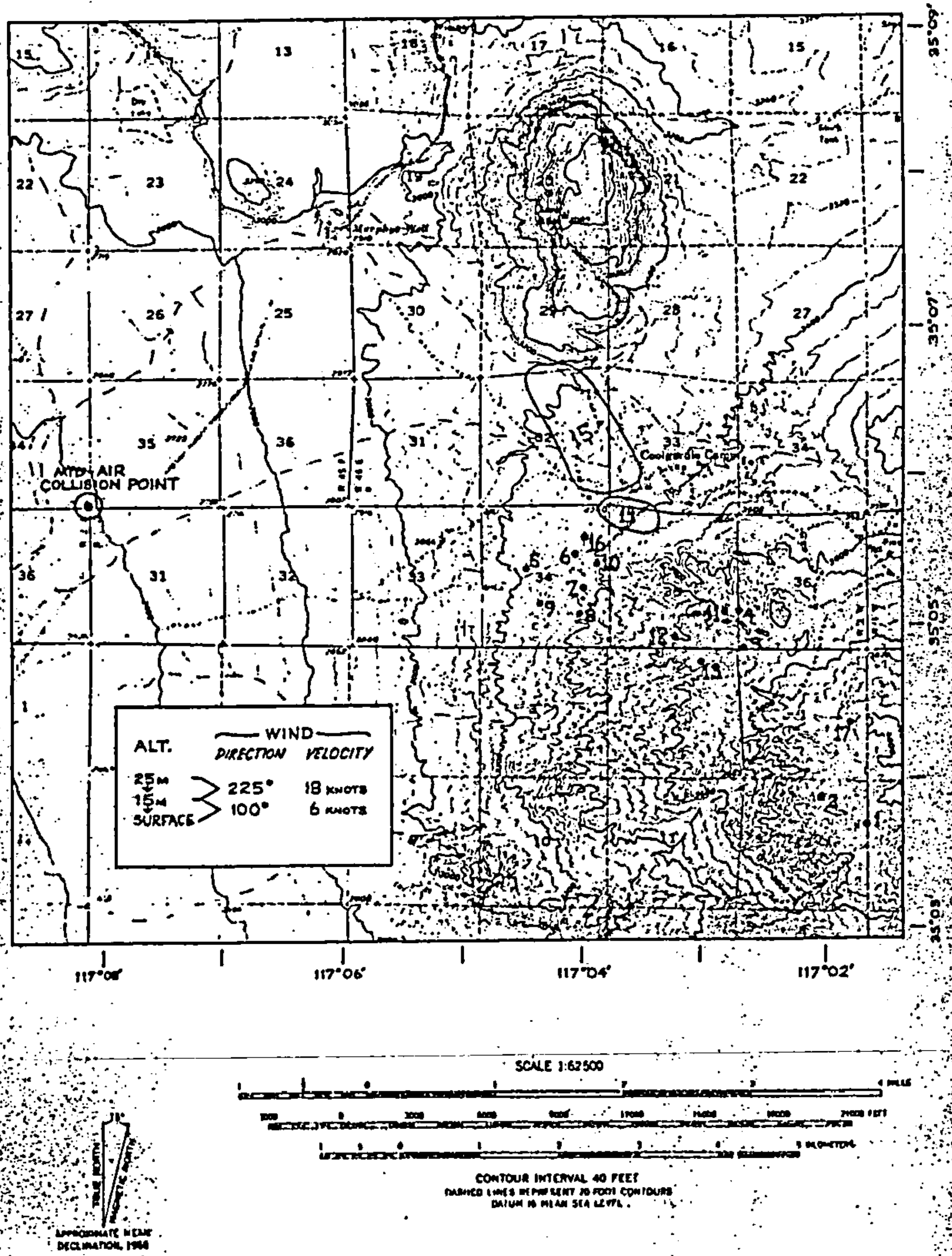
14. Area Containing -
- B-70 Right Rudder Tip
- B-70 Rudder Structure
- F-104 Fuselage, E-Bay Sect.
- F-104 Fuselage Skin Structure
- F-104 Misc. Fuselage Structure and Components

15. Area Containing -
- B-70 Rudder Structure and Misc. B-70 Pieces
- F-104 Fuse Structure and Misc. F-104 Pieces including F-104 Outboard left Stabilizer tip.

16. F-104 Pilot's Helmet

17. B-70 Pilot Capsule

FOR OFFICIAL USE ONLY. (SPECIAL HANDLING REQUIRED: See AFR 127-4)



MID-AIR
COLLISION POINT
ALT.
WIND
DIRECTION
VELOCITY
25M
15M
SURFACE
225°
100°
18 KNOTS
6 KNOTS
117°06'
117°04'
117°02'
35°09'
35°07'
35°05'
SCALE 1:62500
CONTOUR INTERVAL 40 FEET

PART NAME	PART NR	INSTALLED MAX TIME	INSTALLED AT
Door Closure Sensing Valve	257-735922	3 yrs	1964
Ejection System			
Mech. Initiator	2037-01A	4 yrs	1964
Pressure Initiator	2037-09	4 yrs	1964
Initiator Tripper Assembly	257-735629	4 yrs	1964
Initiator Tripper Assembly	257-735649	4 yrs	1964
Delay Pressure Initiator	2037-03	4 yrs	1964
Manual Control			
Mech. Initiator	2037-02A	4 yrs	1964
Mech. Initiator	2037-01A	4 yrs	1964
Electrical Seat Adjuster	4130	4 yrs	1964

RUN	TESTS & DATA	CARD NO. 1

1 Climb & Accel to (380)

.Hydraulics - Check
.Gear - UP (L 270)
.Flaps - UP (L 270)
-Data - OFF
.Elec & Hyd - Check
.Wing Tips - 1/2 (L 400 Tips UP
.Cabin Alt & Oxy - Check
.Aux Cool - OFF if EE Temp Green
.Ammonia, Water, O_2 and LN_2 - Check
.Fuel Sys - Check
.Elec & Hyd - Check
.[illegible] - ON

2 Tower Flyby — AIRSPEED CALIB

.Gear & Flaps UP; Tips 1/2

VGH REC ON EACH PASS

380 400 420 440 460

SEE CARD 2

360 340 320 300 280 260

3 Join Up with G.E. Formation

.Approx 9:15 EAFB - Lake Isabella
UHF Prime 351.4 Alt 316.6 VHF 123.15

XB-70 207
B-58 662
F-4C
F-104
T-38
Photo T-38

RUN	TESTS & DATA						CARD NO.
FUEL REM	GR. WT.	FLARE	MIN T.D.	FUEL REM	GR. WT.	FLARE	MIN T.D.
185	450	225	209	55	320	194	178
135	400	214	198	45	310	192	175
115	380	209	193	35	300	189	173
95	360	205	189	25	290	186	170
75	340	200	184	15	280	183	167

NOTE: 8 KIAS added to Handbook Figures.

1. Prior to Landing Checklist

2. Landing - Data ON Continuous
   - Jettison Chute 50 KIAS
   - After Landing Checklist

3. -VGH Recorder - ON
   - Flaps UP - Time History of Full Throws.
   - VGH Recorder - OFF

4. Taxi and Shut Down

   Prior to Shut Down:
   - Check Rain Removal - 2 Eng 87%
   - Throats - CLOSED }
   - Bypass - OPEN } IDLE power
   - Elevon Trim - Full UP
   - Nose Ramp - UP

NOM	FMP 2-40 TESTS & DATA 6-5-66 RICHTER CARD NO.
1	**Before Engine Start** .Reset Counter .Time Hack -Data Burst -ADI Switch - Stnby
2	**After Engine Start** - Data Burst
3	-VGH Recorder - ON -Full Control Motions Flaps Up - Cont Data -VGH Recorder - OFF
4	**Prior to Power Advance** .Flaps DOWN .Reset Counter .Fuel Readings .Cockpit Camera Rdy -Interval - Short -Mag Reading
5	**Takeoff Checklist**
6	-Data ON -All Engines MIL -All Engines 85% -A/B Lites 2 Eng at a Time -Countdown & Brake Release

TANK	READ
1	
2	
3	
4	
5	
6L	
6R	
7L	
7R	
8L	
8R	
TOTAL	

TEMP			
TIME 70-150			
REFUSAL			
ROTATE			
T.O.			
T.O. DIST			

T.O. ______ LD ______ TOT ______

M1 ______ to ______ TOT ______

M2 ______ to ______ TOT ______

M2.5 ______ to ______ TOT ______

M3 ______ to ______ TOT ______

MAX ALT ______ MAX Mn ______ MAX SPEED ______

MAX TT ______

AICS Ground Setting Prior to Engine Start

-Trim Power ON

-LH Dev 995

-RH Dev 995

June 17, 1966

F104 A/C	759,929.00
Engine	161,788.00
Quick Engine Kit (Starter, Generator, etc)	8,570.00
MH-97 Autopilot & LN-3 Navig Sys.	202,766.00
	1,133,053.00

Rose Lynch
for
J K Yoshida

FOR OFFICIAL USE ONLY. (SPECIAL HANDLING REQUIRED: SEE AFR 127-4)

AIRCRAFT MAINTENANCE/MATERIEL REPORT

Use this form when AF aircraft accident/incident involves inadequacy, malfunction or failure of AF materiel.

1. AIRCRAFT MD & SERIAL NUMBER	2. SPECIAL REPORTS DATA	
F-104N-LO NASA 813 LOCKHEED 4058	a. Were Previous UR's Submitted on Factor(s) Involved? ☐ Yes ☒ No	b. No. and Date of UR's Submitted as Result of This Accident (Attach copy) N/A
	c. Is TDR Requested? See Tab J ☒ Yes ☐ No	d. No. of T.O.'s Not Complied With at Time of Accident (List T.O. Nos. and titles on separate sheet(s)—Tab K) Aircraft - 22 Engine - 10

3. AIRCRAFT HISTORICAL DATA

Item	Aircraft	Part, Component or Accessory
Identification of Aircraft/Part, etc.	NASA 813	
xxxx Acceptance Date (NASA)	10 Oct 63	
Total Flight Hours	627.7	
Last Overhaul Date	N/A	
Overhauling Activity (Name and location)	N/A	
Hours Since Overhaul	N/A	
Hours Since Last Periodic Inspection	26.3	
Date of Last Periodic Inspection	2 May 66	
Type of Last Periodic Inspection	200 Hr (#3)	

4. ENGINE HISTORICAL DATA

(Complete a separate column for each engine involved. Also, complete a separate column for each power plant component involved.)

Installed Position	N/A			
Engine Model and Series	J-79-GE-11A			
Engine Serial Number	411-722			
Total Engine Hours	227.8			
Number of Major Overhauls	N/A			
Hours Since Last Major Overhaul	N/A			
Date of Last Overhaul	N/A			
Overhaul Activity	N/A			
Date Last Installed	2 May 66			
Hours Since Last Installed	26.3			
Date of Last Periodic Inspection	29 Apr 66			
Type of Last Periodic Inspection	200 Hr			
Fuel (Type and octane rating)	JP-4			

5. FIRE DATA

(To be completed when fire or chemical explosion occurs, not resulting from ground impact. Indicate: P—Probable or K—Known, in squares below.)

a. MATERIEL FAILURE CAUSING THE FIRE				b. IGNITION SOURCE				c. COMBUSTIBLE MATERIAL			
Electrical System		Propulsion System		Electrical System		Static Electricity/ Lightning		Cargo		Hydraulic Fluid	P
Fuel System		Other (Specify)		Pneumatic System		Other (Specify)		Electrical Insulation		Lubricating Oil	P
Hydraulic System		Structural breakup in mid-air collision	K	Propulsion System		Result of mid-air collision	K	Explosives		Other (Specify)	
Pneumatic System		Unknown				Unknown		Fuel	P	Unknown	

d. AIRCRAFT FIRE EXTINGUISHING SYSTEM	Fixed	Portable		Fixed	Portable	e. FIRE/OVERHEAT WARNING	Fire Detector	Overheat Indicator
Extinguished Fire	N/A	N/A	Not Activated and Not Near Fire	N/A	N/A	Operated Properly	N/A	N/A
Reduced Fire	N/A	N/A	If Discharged, Chemical Used	N/A	N/A	Not Operated, but Near Fire	N/A	N/A
No Effect When Discharged	N/A	N/A	If Discharged, Amount of Chemical Used	N/A	N/A	Not Operated and Not Near Fire	N/A	N/A
Activated but Did Not Discharge	N/A	N/A	Other Pertinent Info.	N/A	N/A	Not Installed	N/A	N/A
Not Activated but Near Fire	N/A	N/A		N/A	N/A	Other (Specify)	UNKNOWN	

f.	SHUT OFF PROCEDURE	RESULTS OF ALLOWING FIRE TO BURN OUT	g. EFFECT OF FIRE	MARK ONE
Extinguished Fire	N/A		Catastrophic	
Reduced Fire	N/A		Increased Severity of Mishap	
No Effect	N/A		No Change in Severity of Mishap	X
Not Accomplished	N/A		Unknown	
Unknown	N/A			

AF FORM DEC 62 711c PREVIOUS EDITION OF THIS FORM IS OBSOLETE.

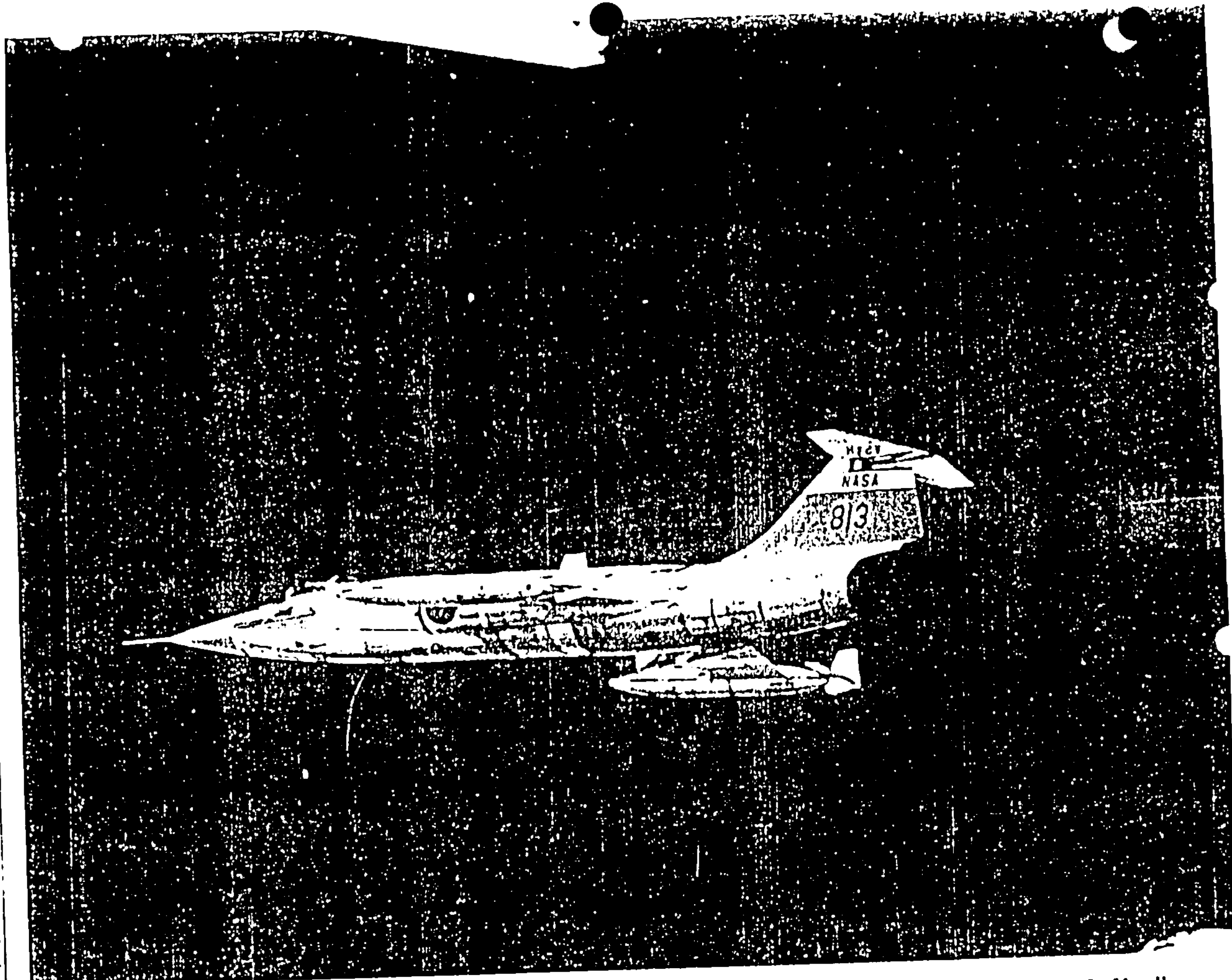
6	LOCATION OF INITIAL FIRE							
	Known	Probable		Known	Probable		Known	Probable
Baggage Compartment	N/A	N/A	Aft of Firewall	N/A	N/A	Wheel Well	N/A	N/A
Bomb Bay	N/A	N/A	Forward of Firewall	N/A	N/A	Cargo-Passenger Compartment	N/A	N/A
Cockpit/Crew Quarters	N/A	N/A	Rocket Pod	N/A	N/A	Other (Specify)	N/A	N/A
Engine Section	N/A	N/A	Tire/Wheel/Brake	N/A	N/A	Unknown ☐		

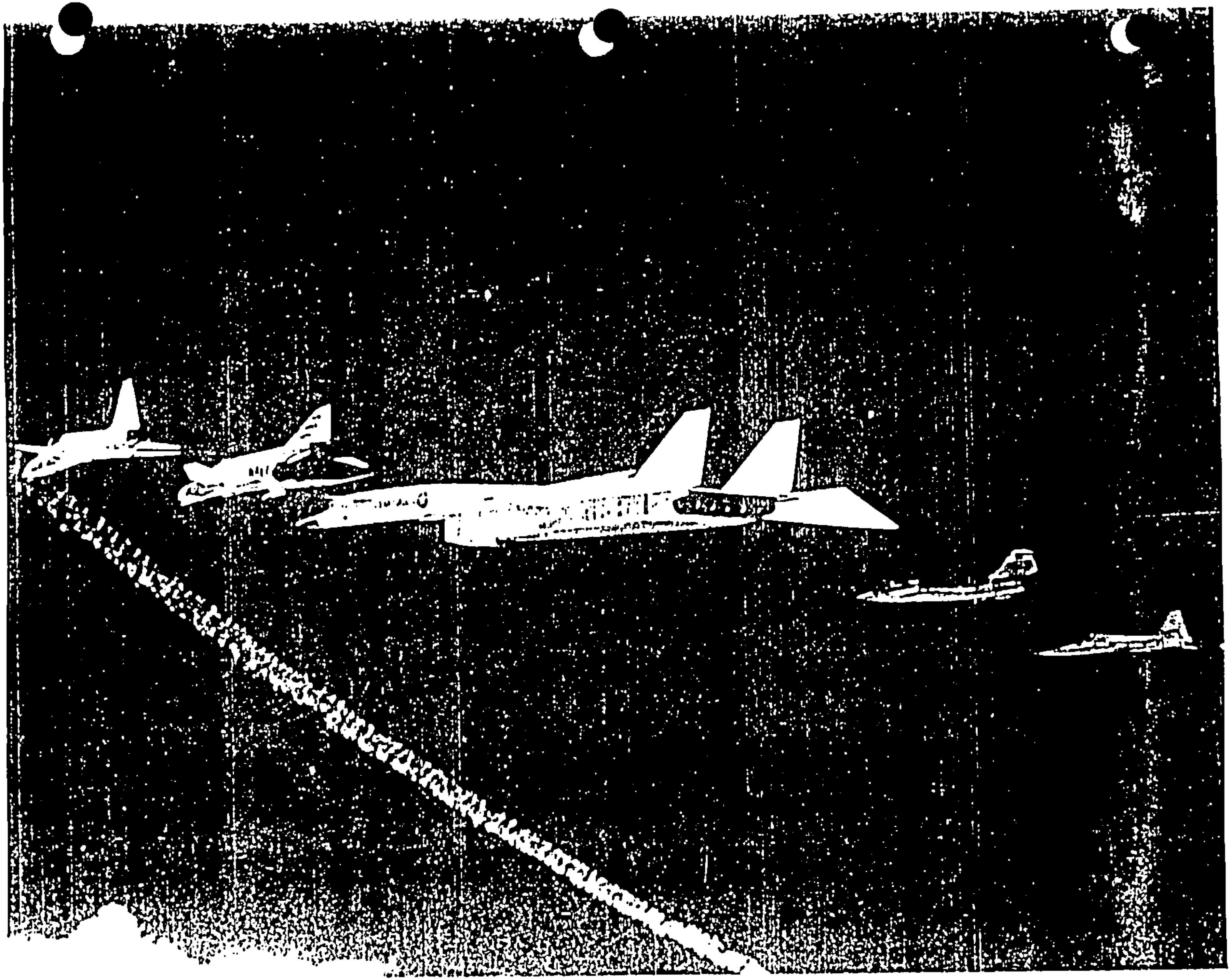
7.	MISCELLANEOUS CHEMICAL EXPLOSION DATA				
	Known	Probable		Known	Probable
Initial Ignition Occurred in an Explosive Manner Prior to Ground Impact.	N/A	N/A	Intensity of Explosion Was Sufficient To Cause or Appreciably Contribute to In-Flight Airframe Break-Up.	N/A	N/A
Explosion Occurred After Fire and Before Ground Impact.	N/A	N/A	Other Significant Data (Specify)	N/A	N/A
Explosion Occurred Subsequent to Ground Impact.	X		Unknown or Not Available.		

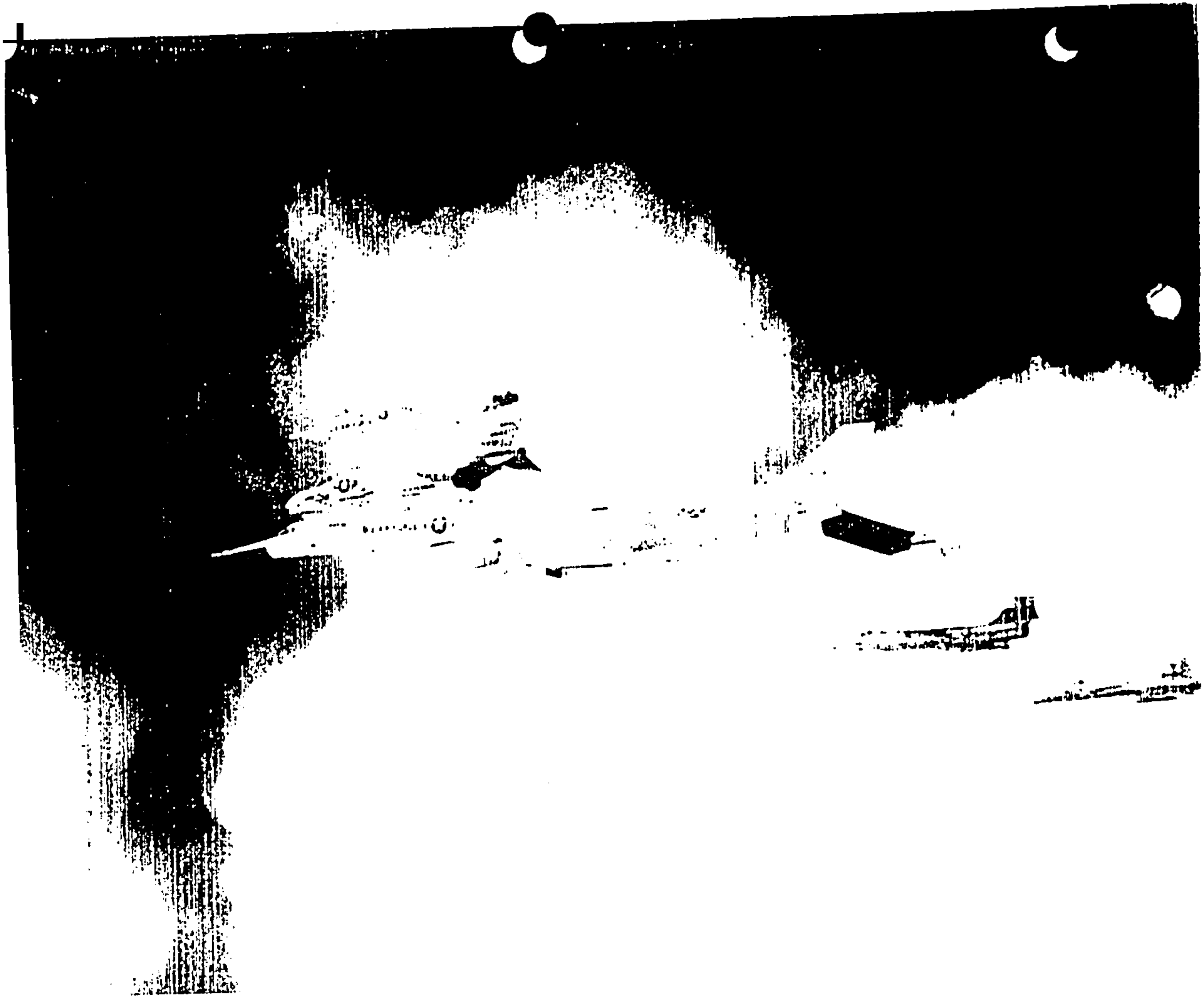
8. AIRCRAFT MAINTENANCE OFFICER'S ANALYSIS AND SPECIFIC ACTION TAKEN

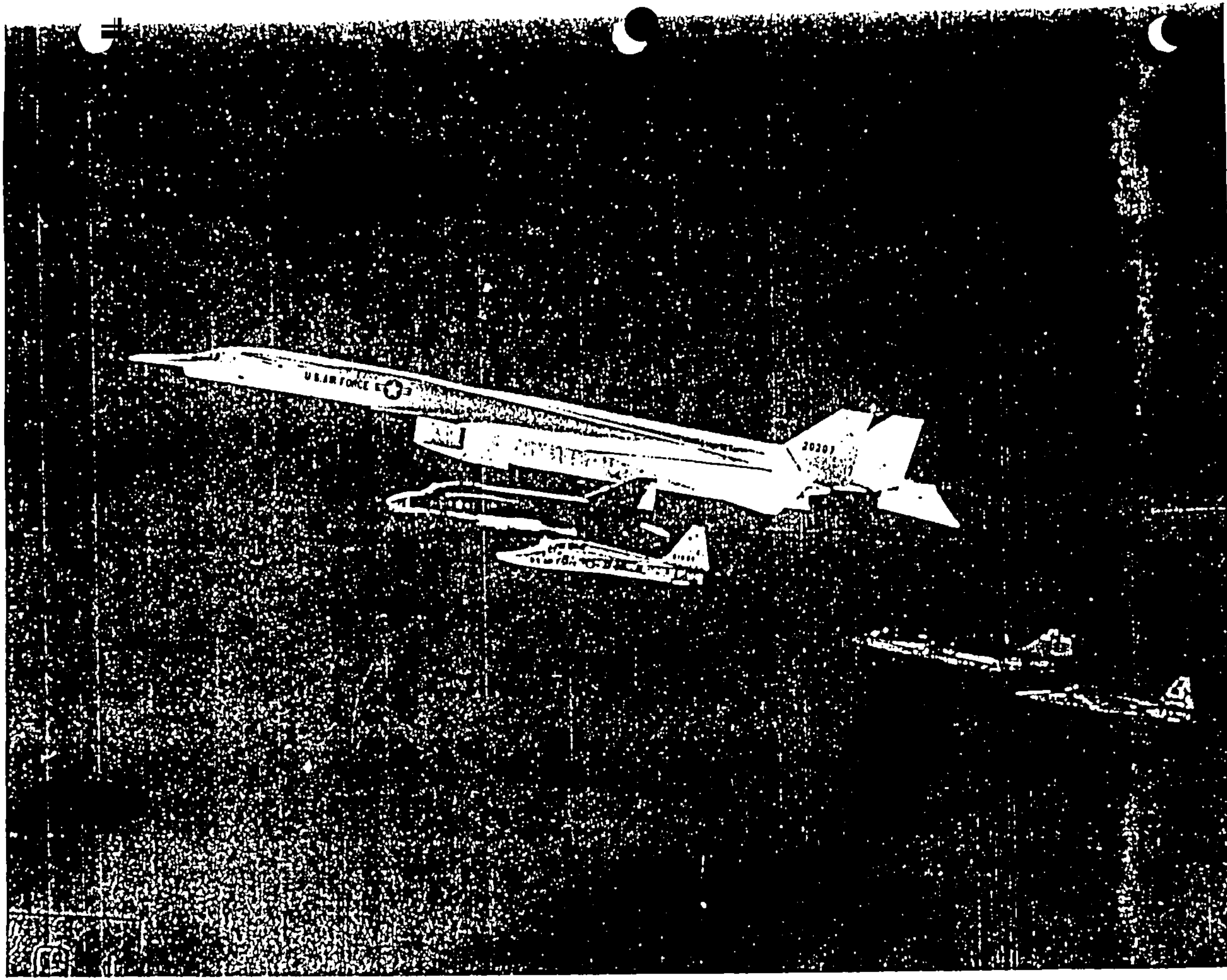
Describe deficiencies involved and relationship of the various components to the accident. Describe specific action taken. For Fire Data describe the fire and/or chemical explosion. Cover in detail any noted deficiencies, malfunctions of fire detecting and extinguishing equipment, or questionable procedures. When discussing specific equipment, give the name of manufacturer, part numbers, etc., and state whether or not a UR has been submitted. Include any additional information or opinion of possible value to future technical analysis of this report.

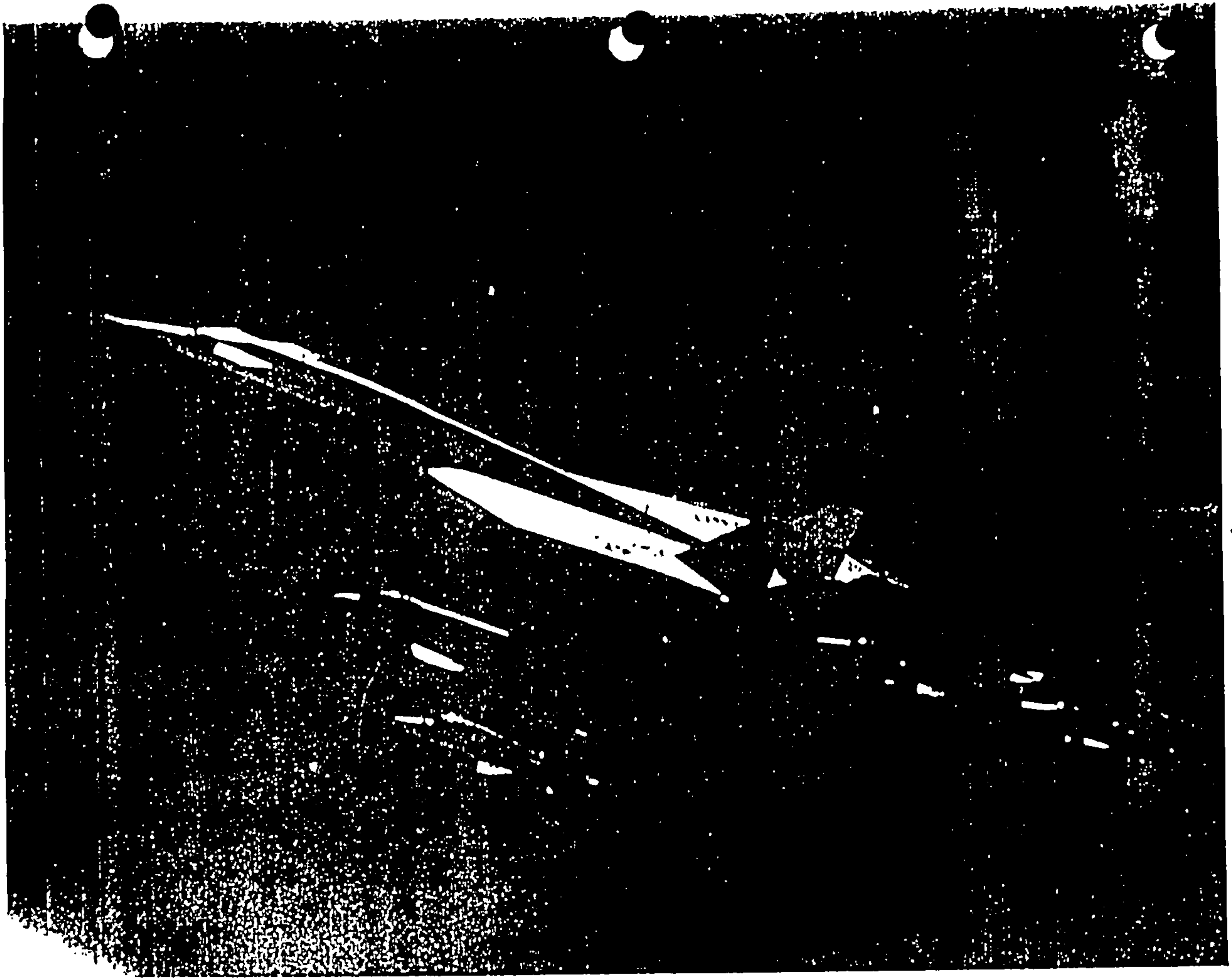
[redacted]

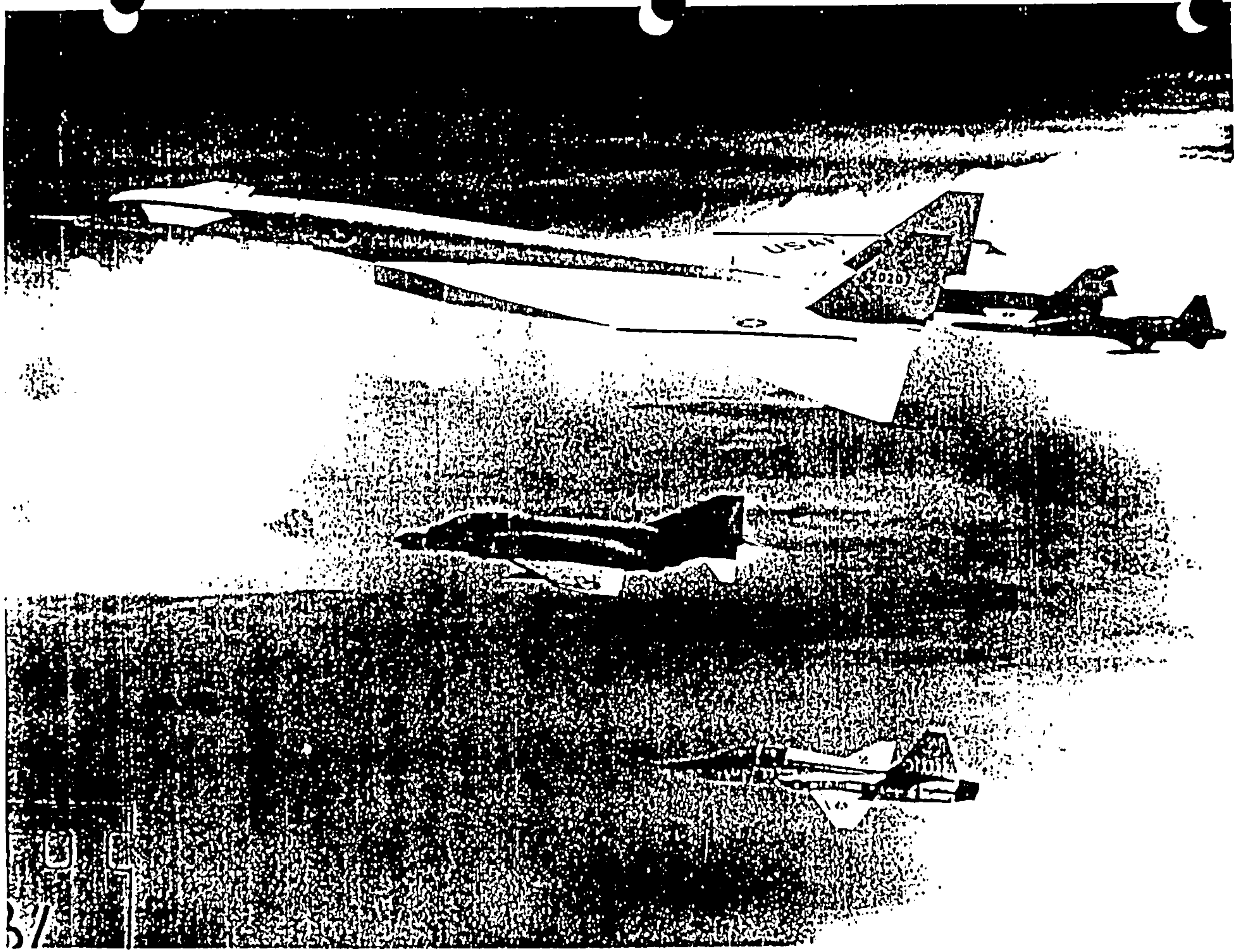

NASA
813






U.S. AIR FORCE

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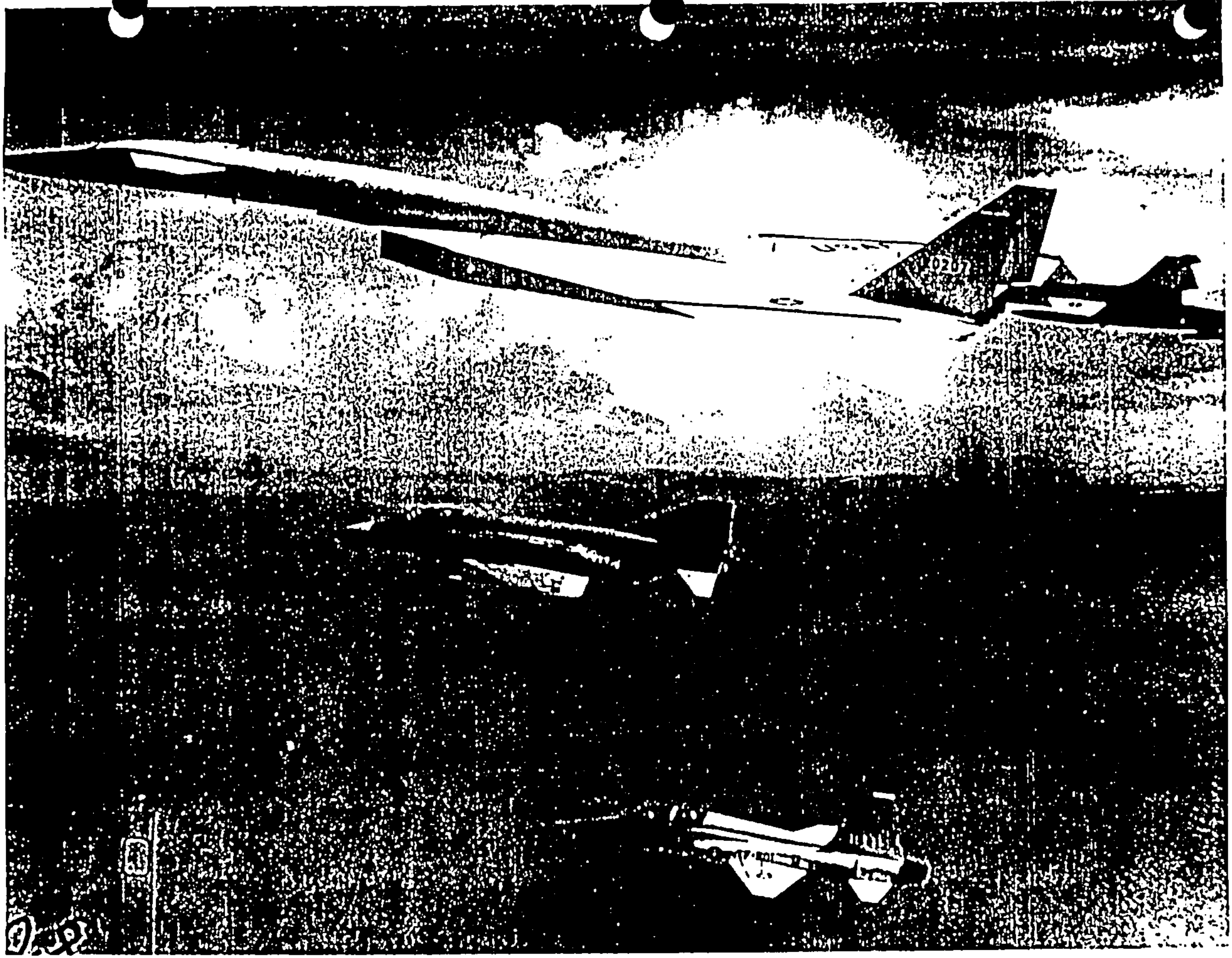

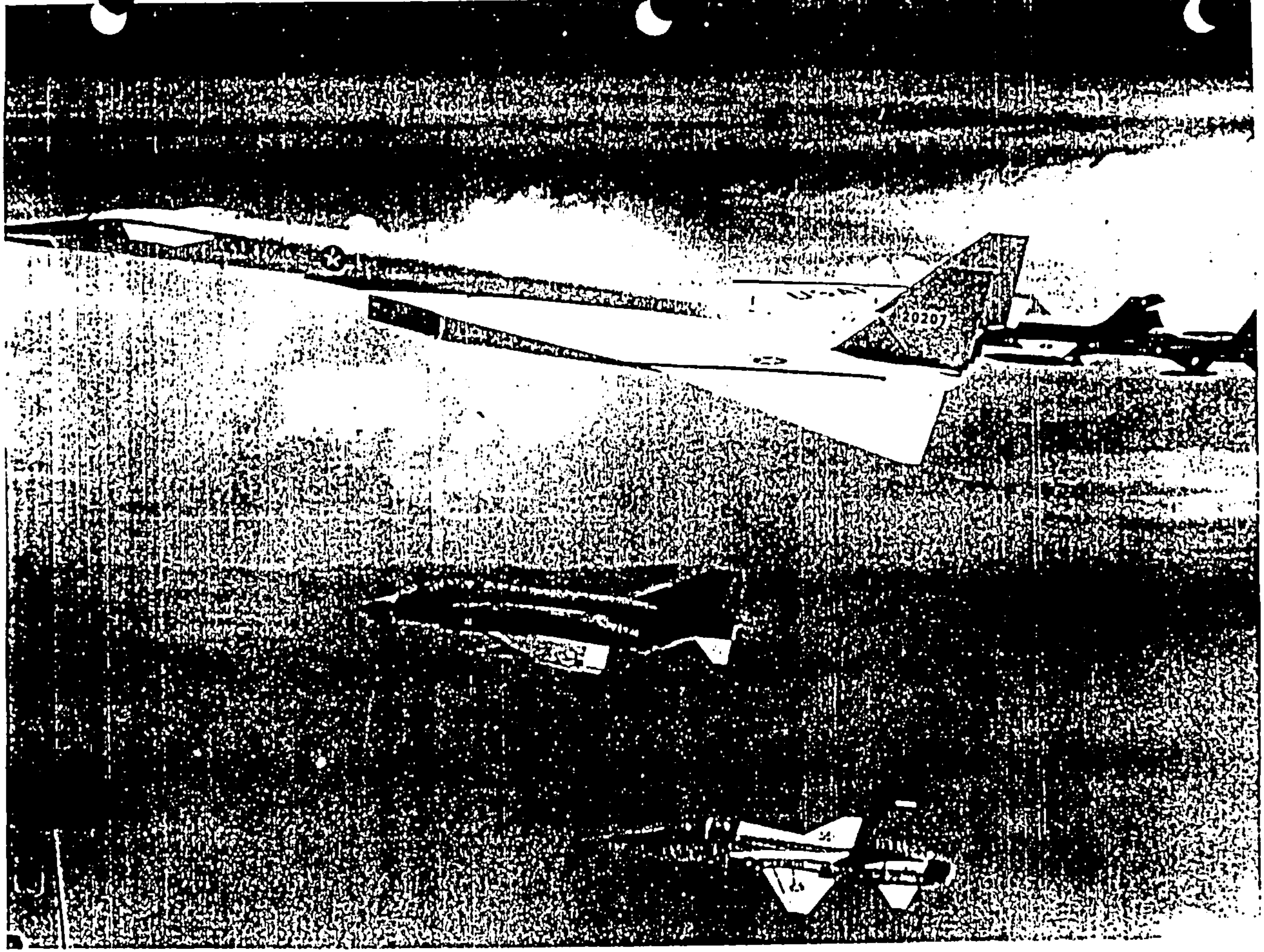
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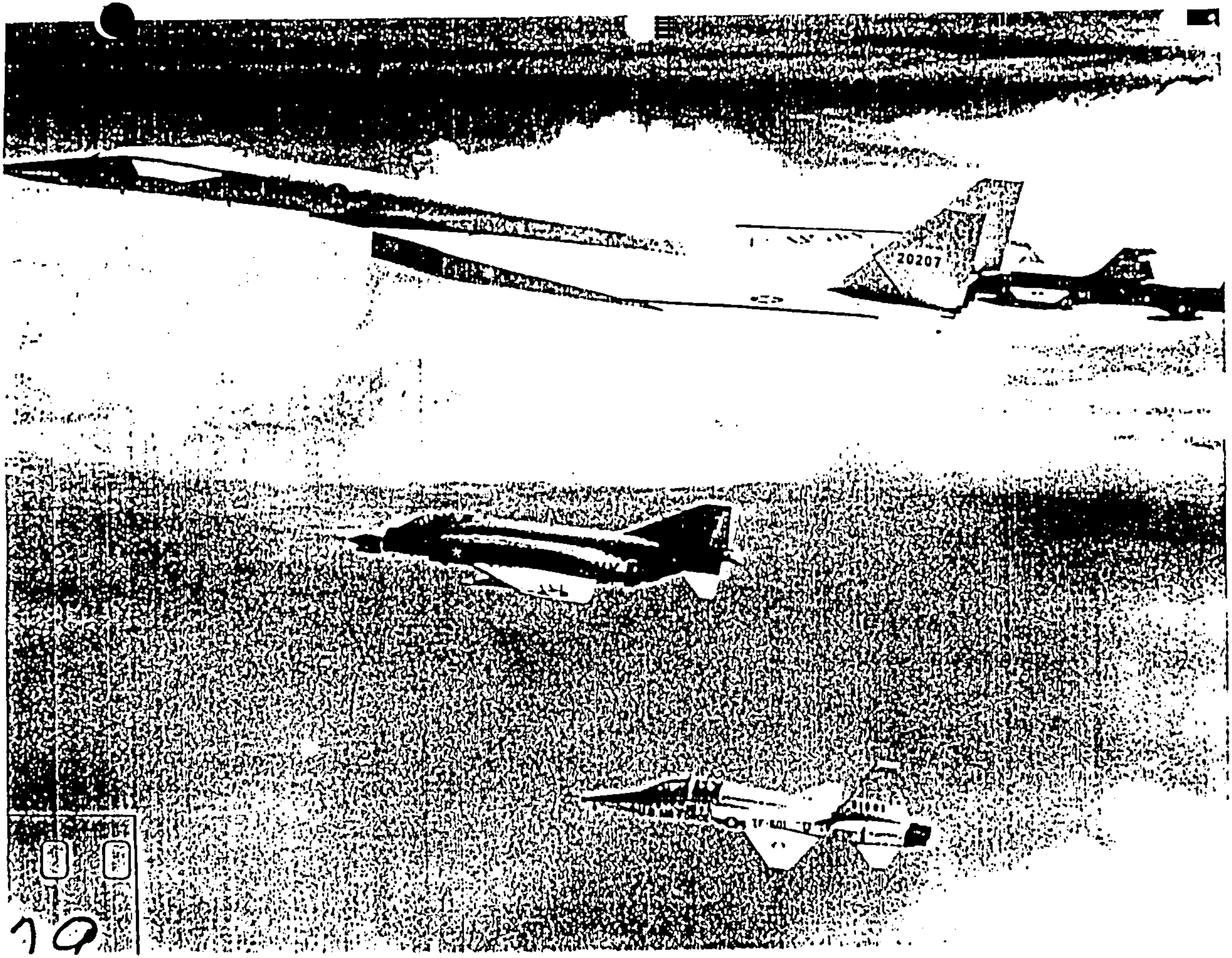
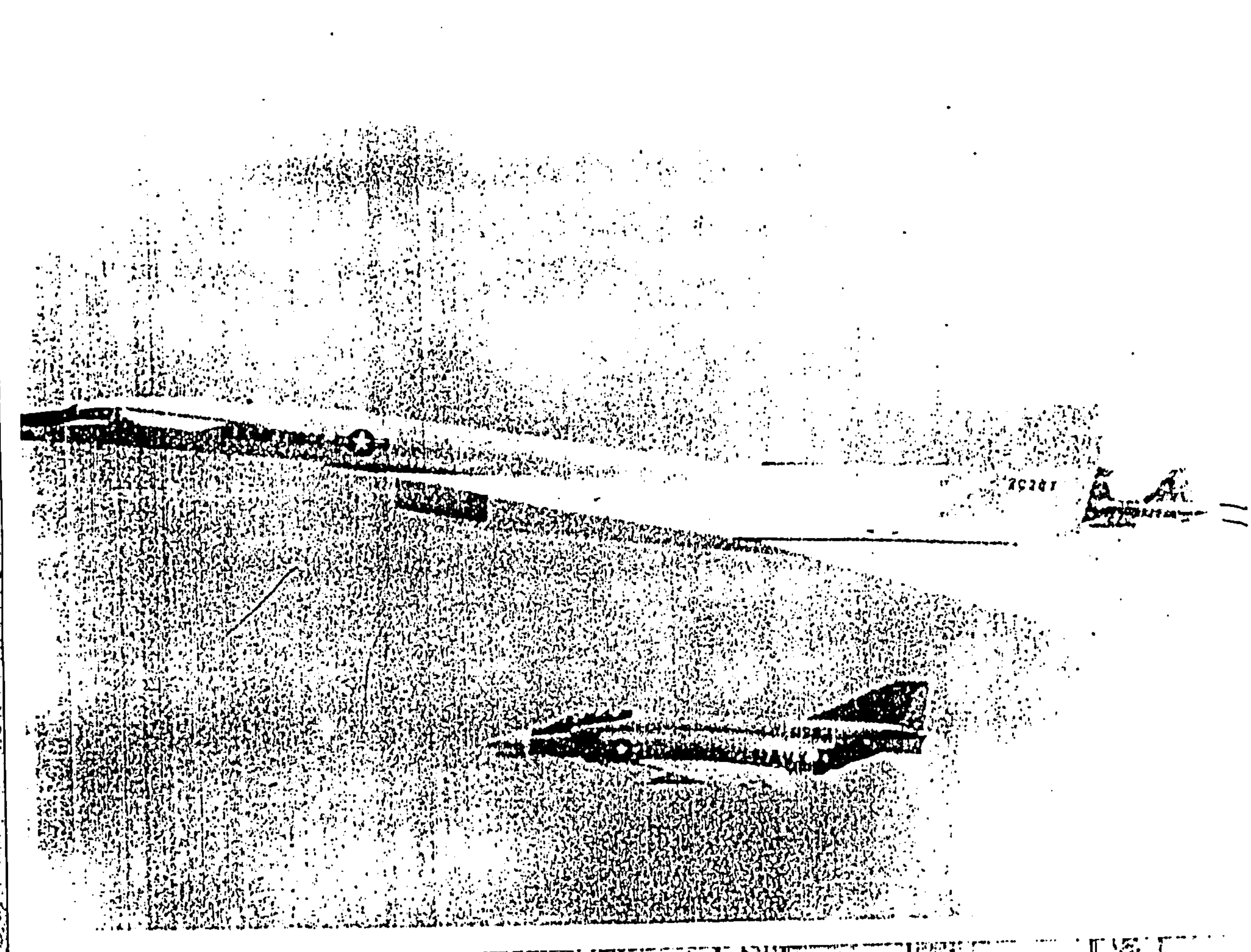
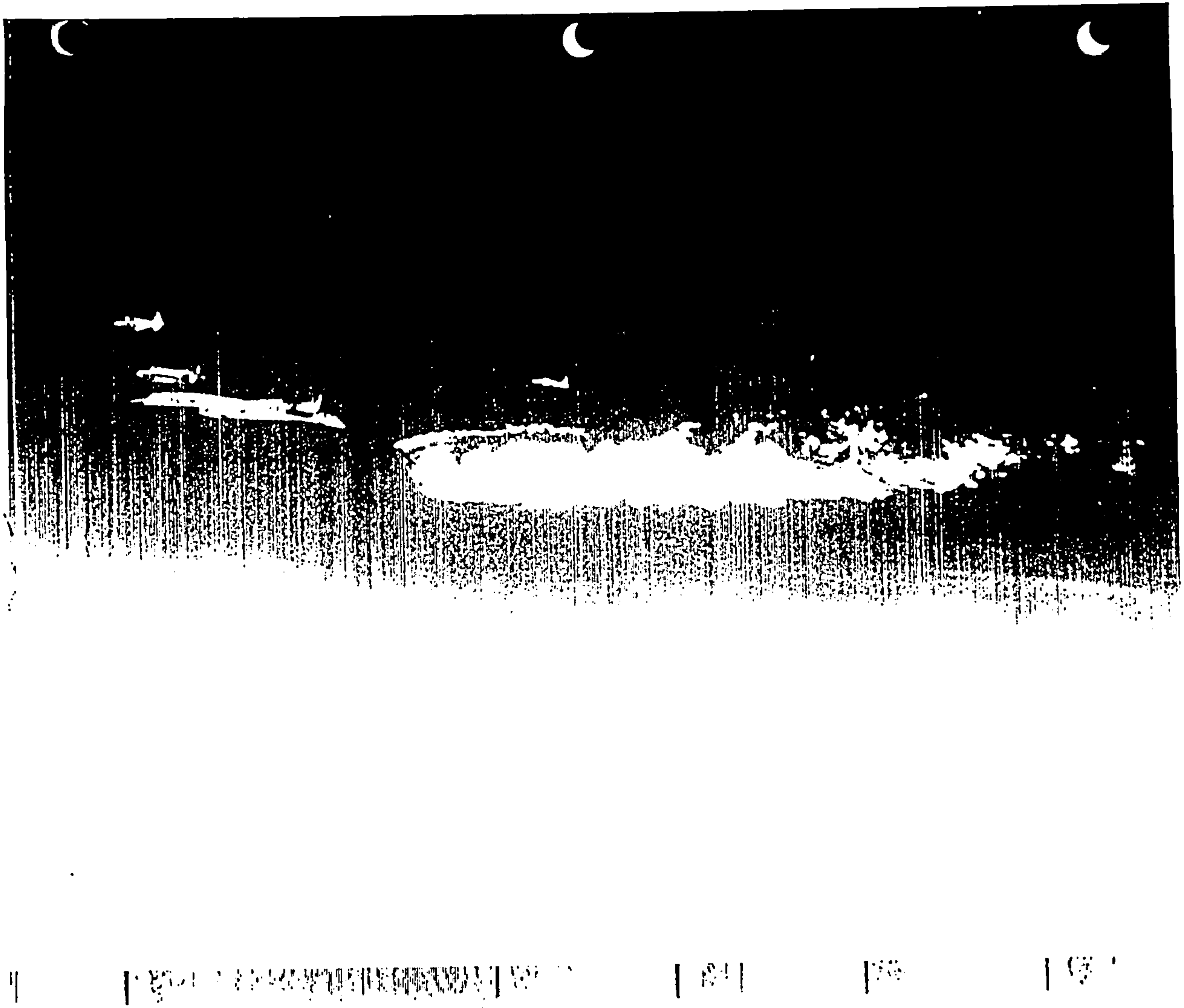
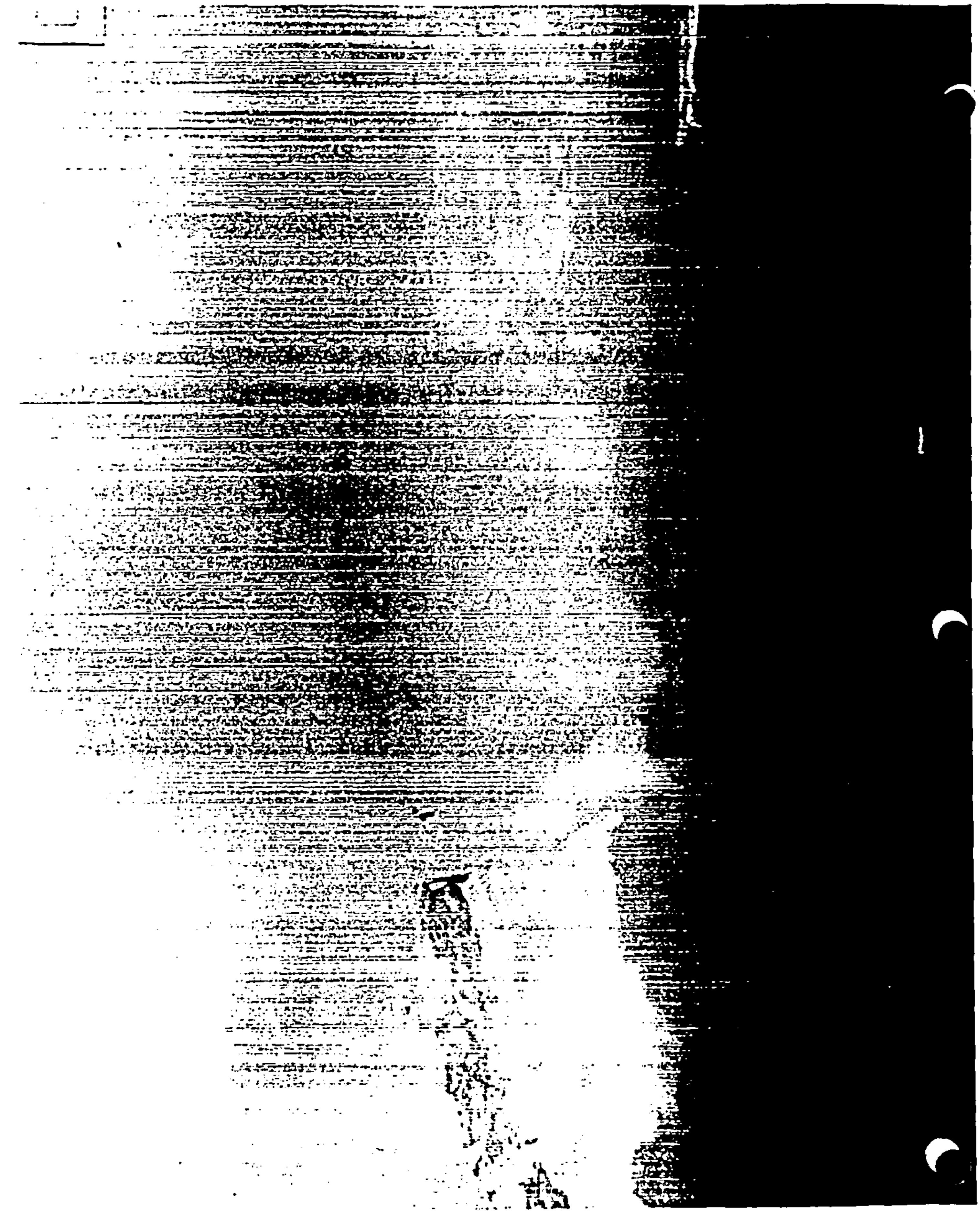
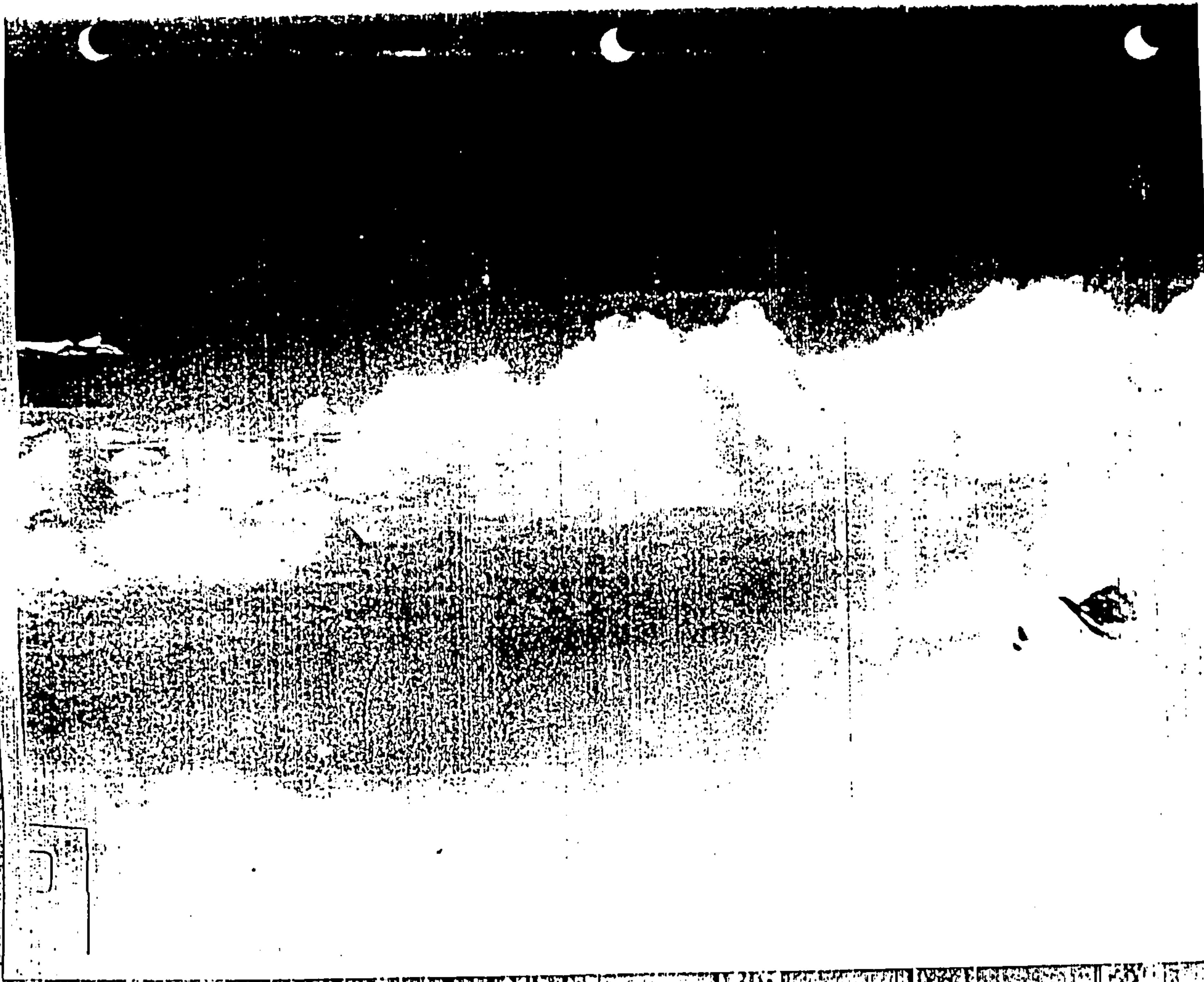
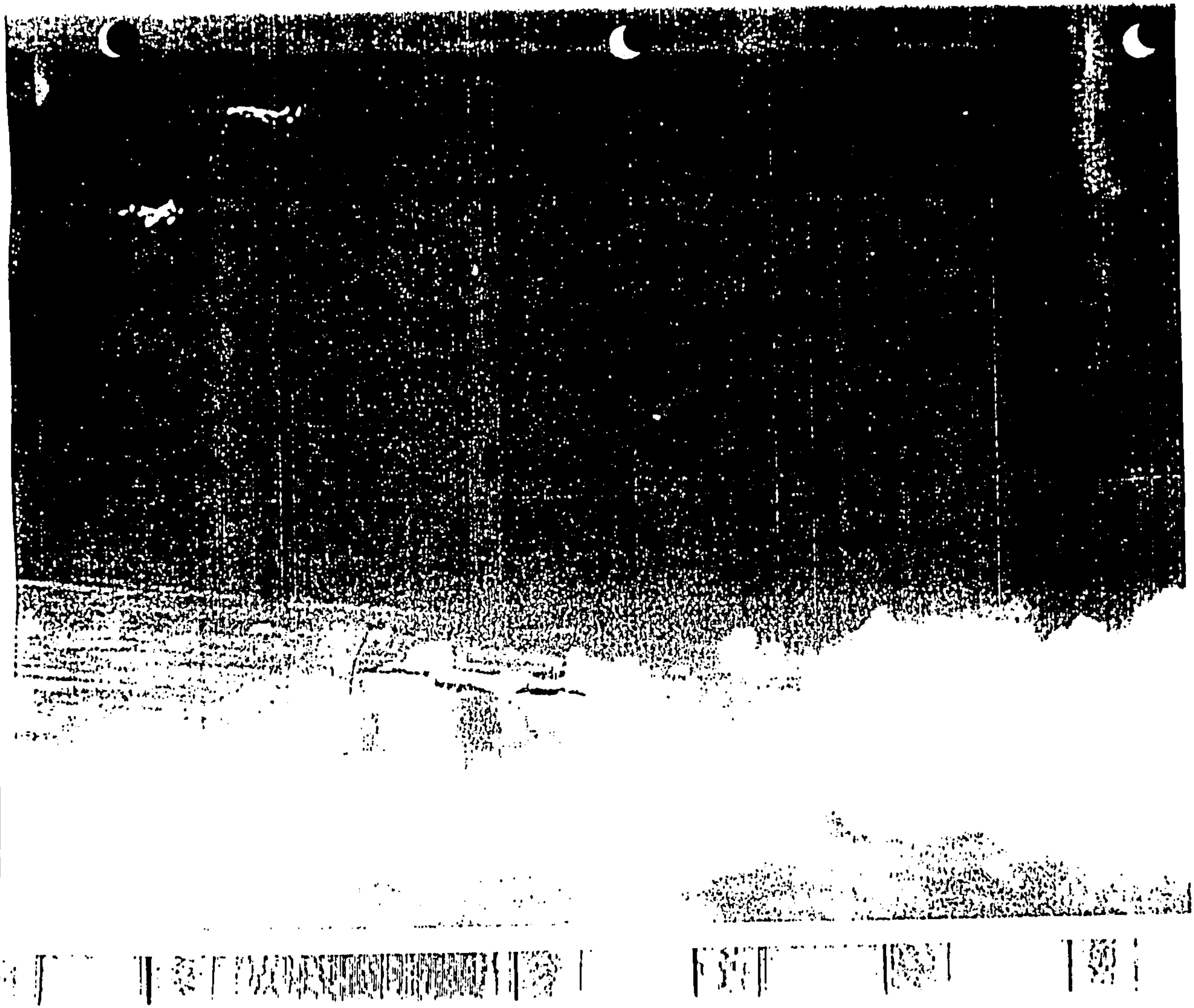

20207

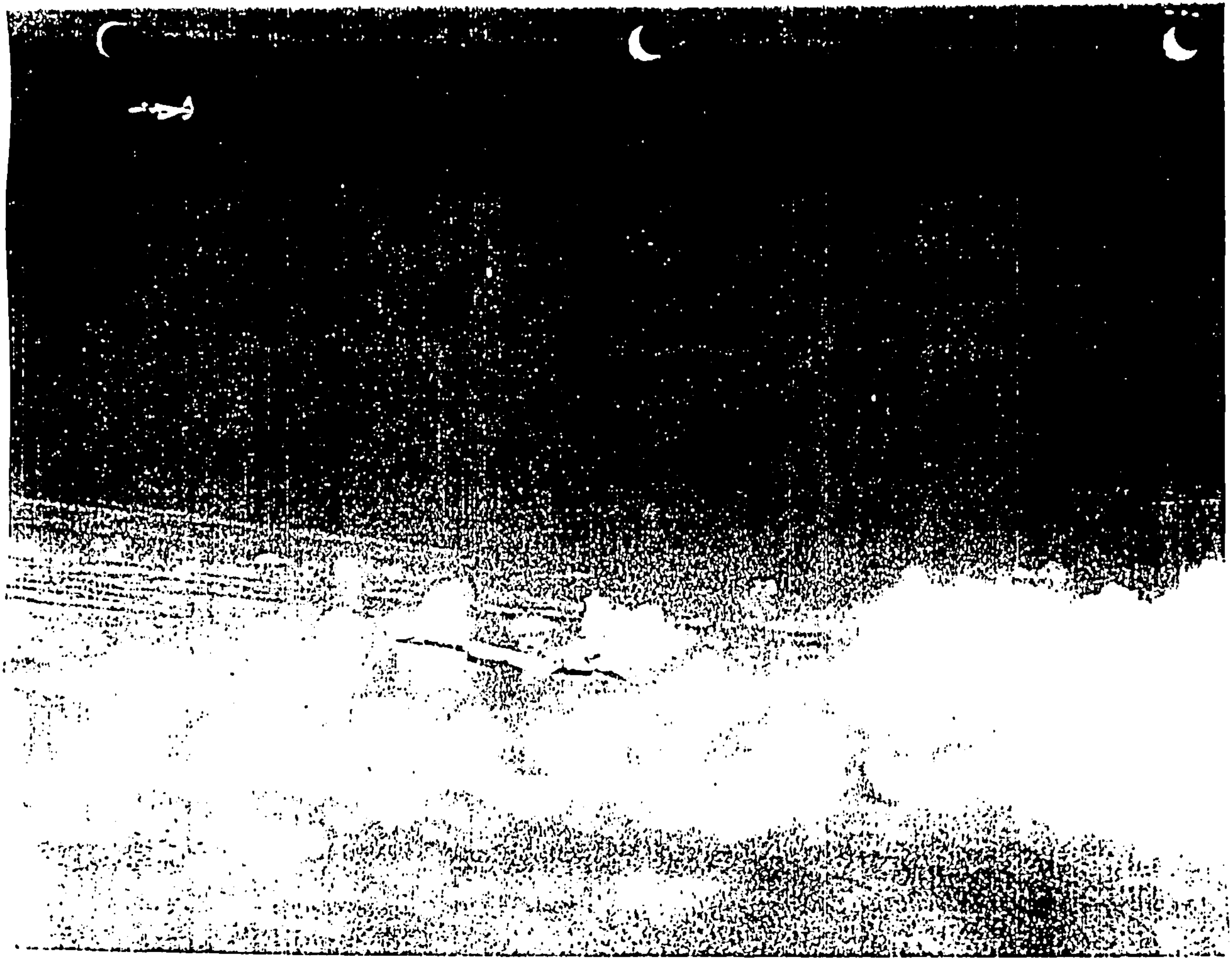


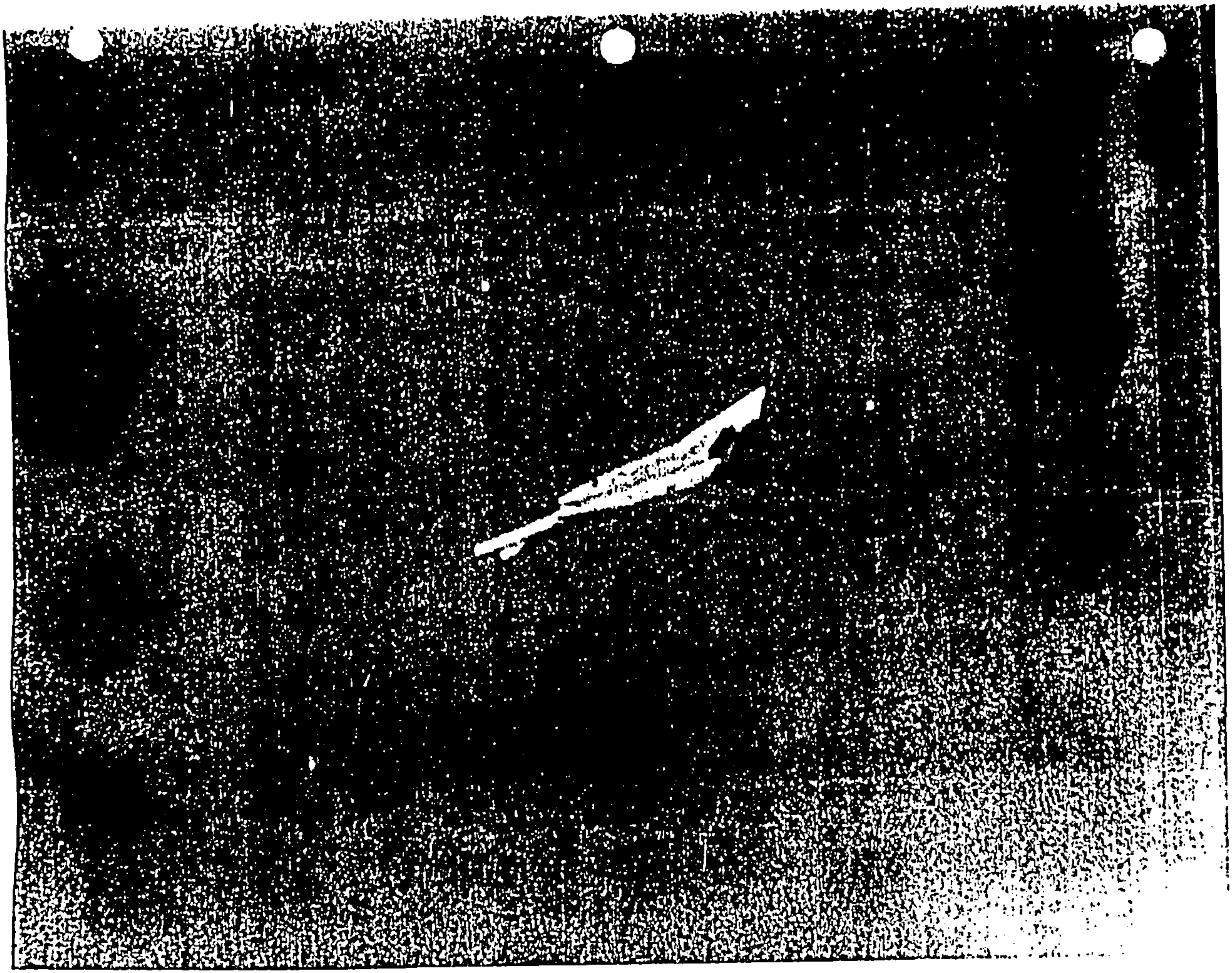


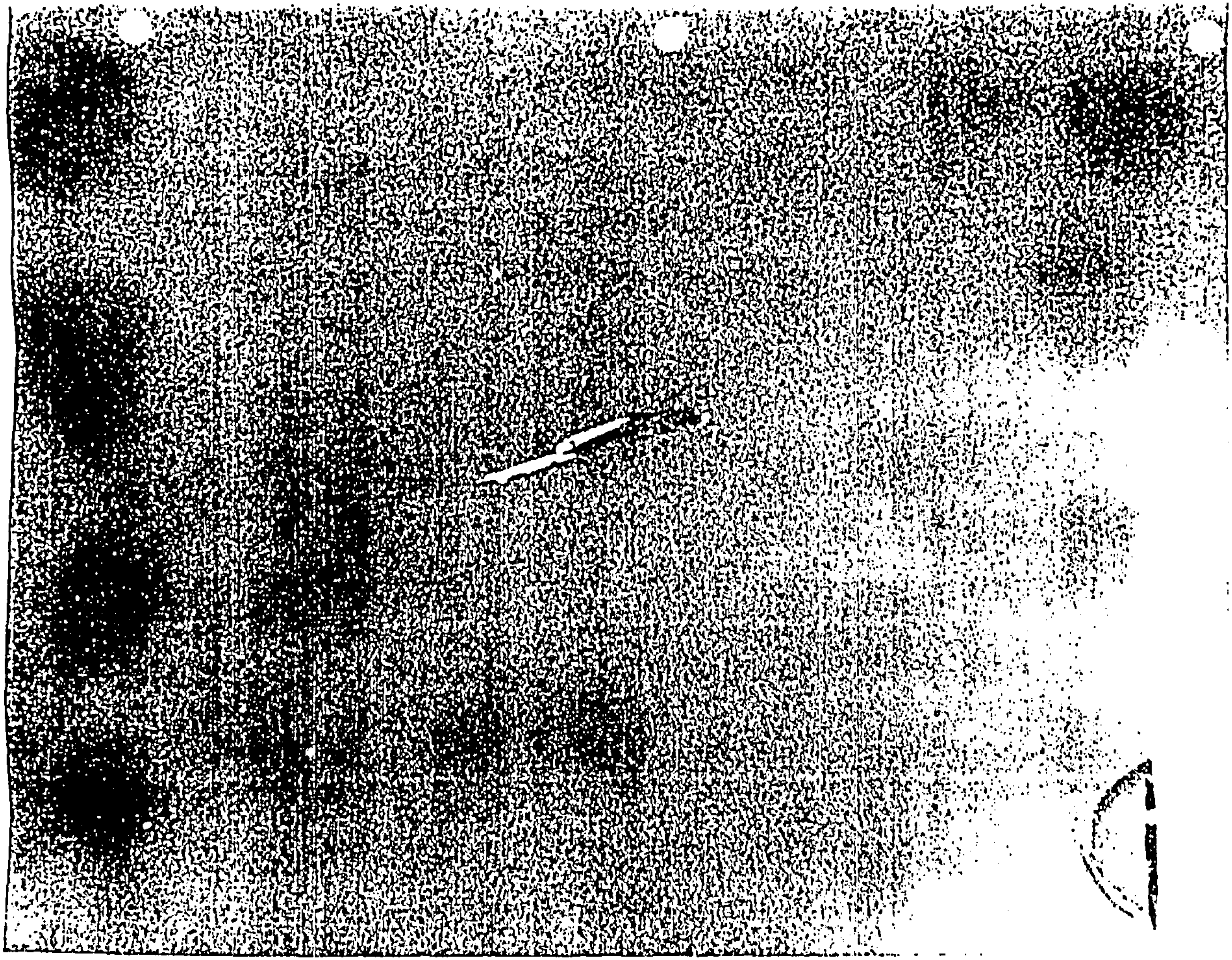


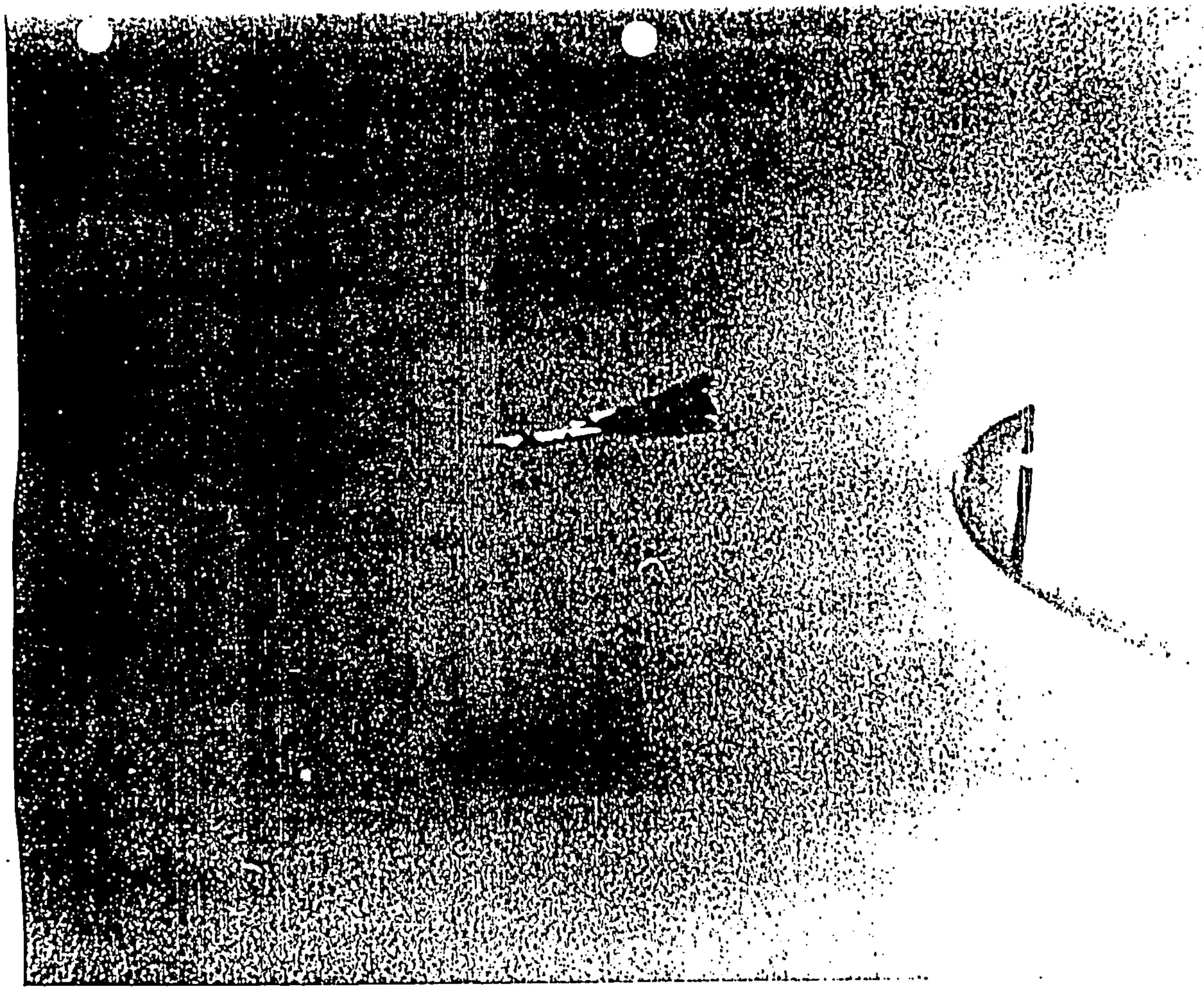


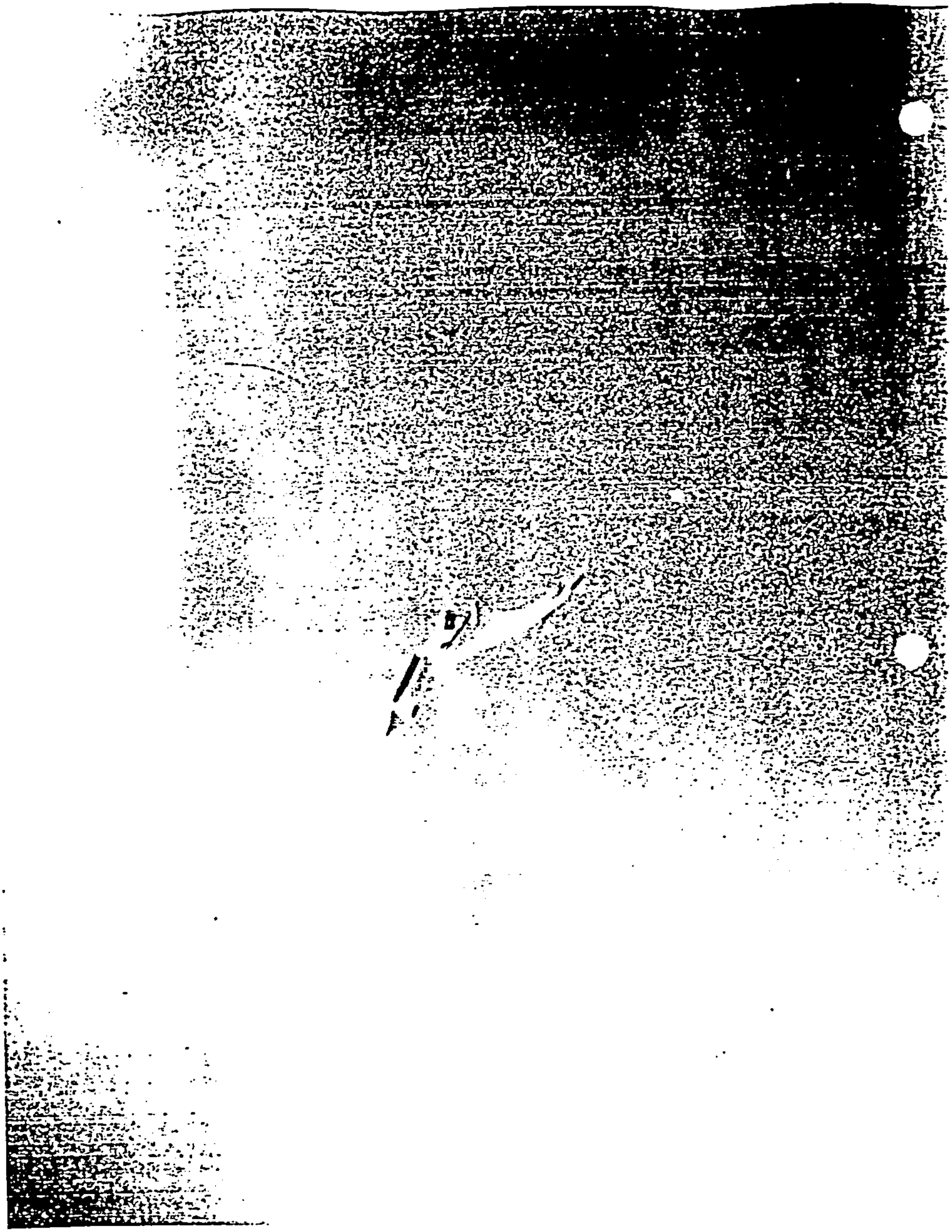


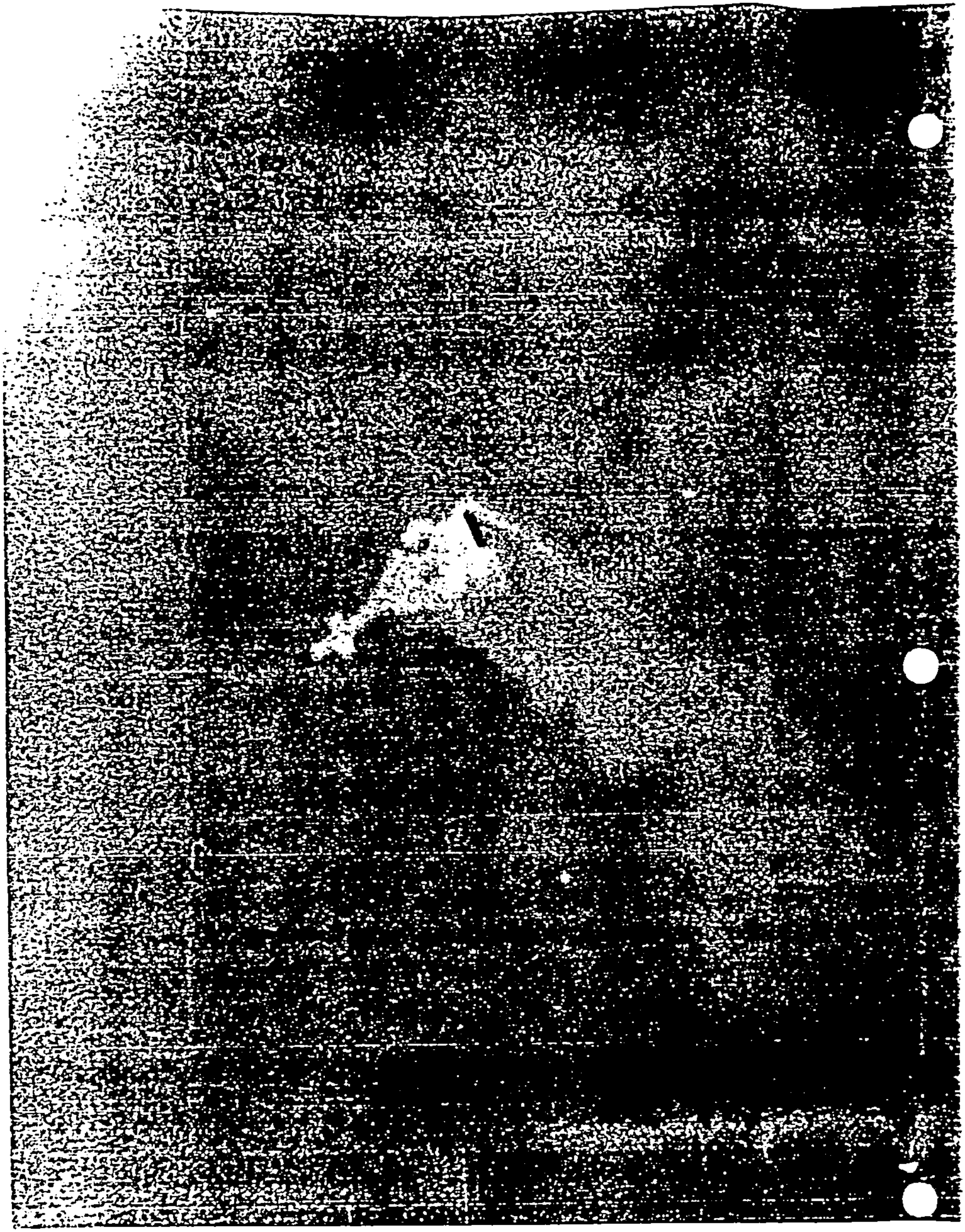


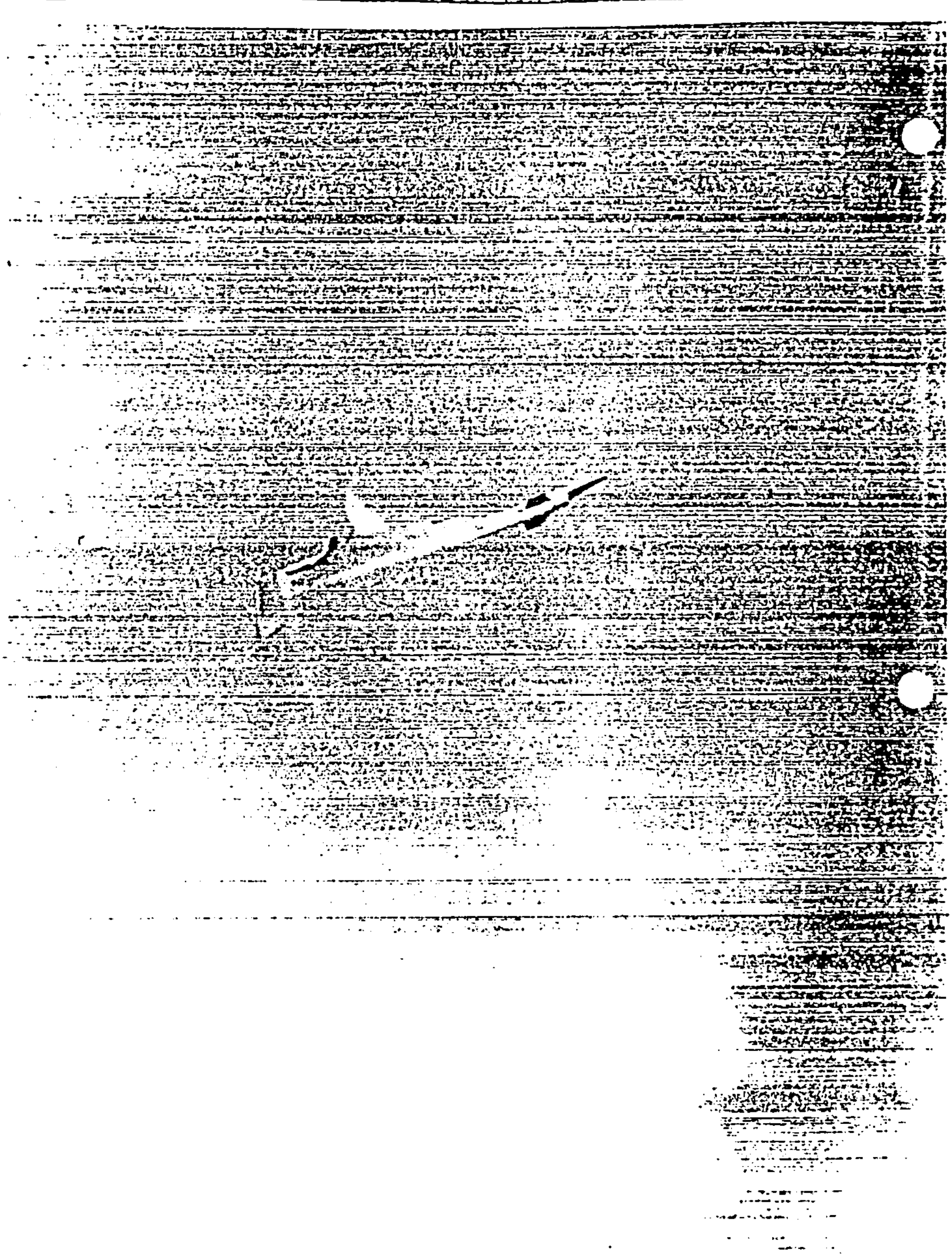


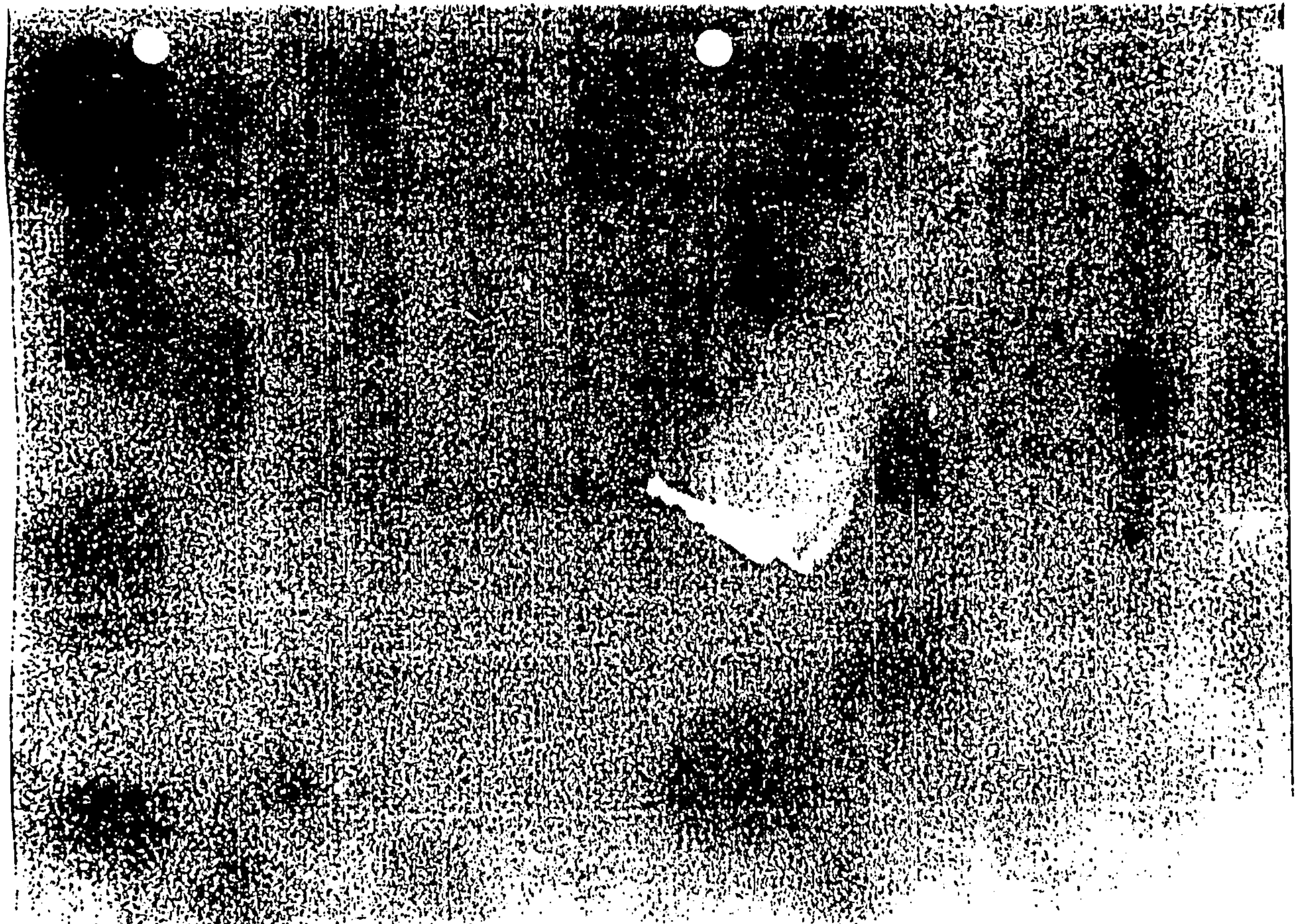


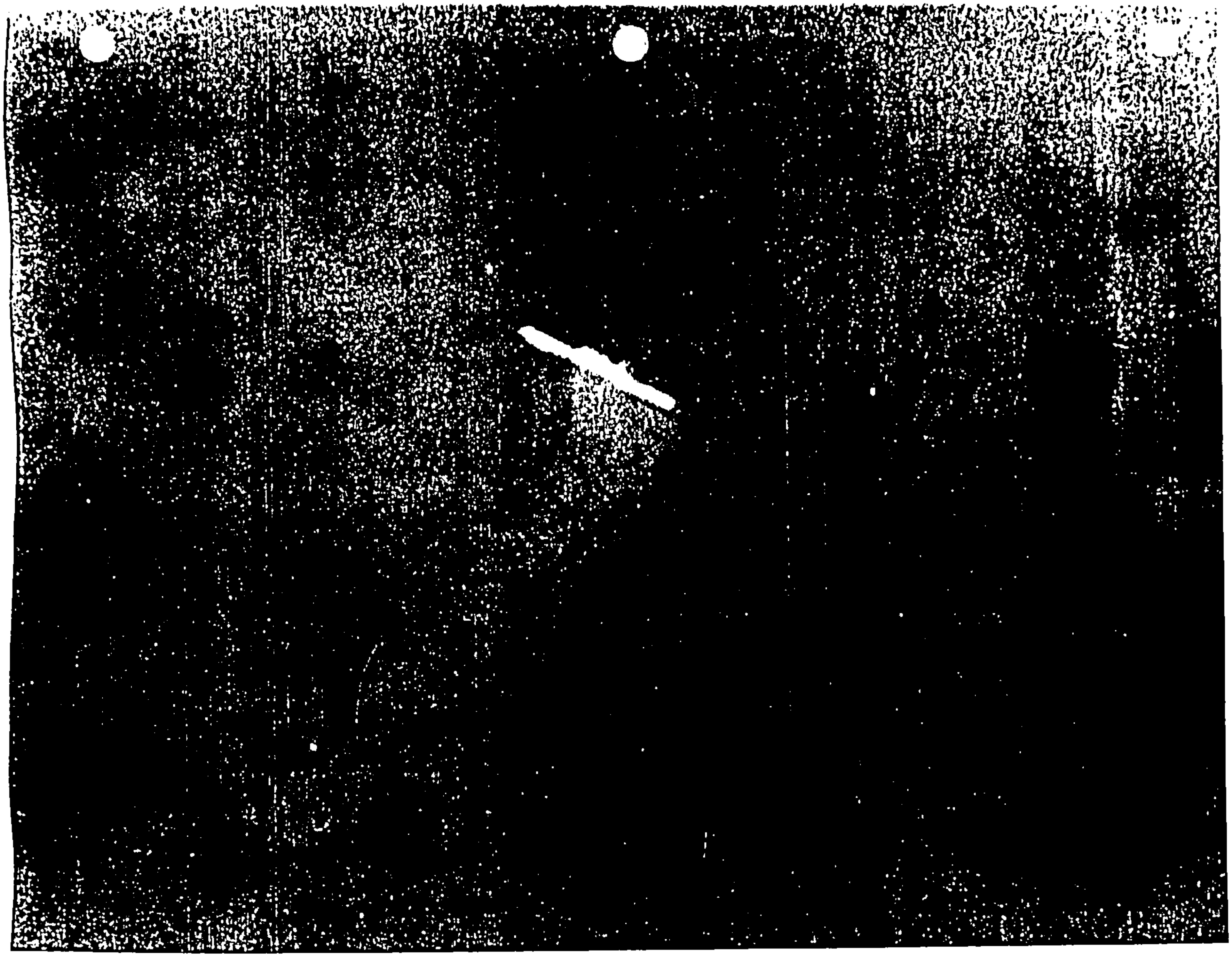












29

12/21/64
01/19/67

air-to-ground stores.

On December 21, 1962, the Air Force amended the Letter Contract that had initially covered General Dynamics' second competitive proposal and initiated procurement of 18 F-111As (serial numbers 63-9766/9782) and 5 F-111Bs (BuNos 151970/151924). These were to be exclusively research, development, test, and evaluation (RDT&A) aircraft.

Plans originally envisaged using titanium for almost all the airframe in order to save weight, but this proved to be too costly and more conventional materials had to be used.

Since General Dynamics lacked any experience with carrier-based fighters, it teamed with Grumman for the integration of the naval electronics package and Grumman was to assemble and test the entire F-111B aircraft. In addition, Grumman would build the aft fuselage and the landing gear of the F-111A aircraft.

The F-111A mockup was inspected in September of 1963.

By the spring of 1964, AiResearch, AVCO, Bendix, Collins Radio, Dalmo Victor, General Electric, Hamilton Standard, Litton Systems, McDonnell, Texas Instruments and seven other major subcontractors had become involved with the F-111 project. An associate prime contract for the F-111B's Phoenix missiles had been awarded to Hughes. These major subcontractors were doing business with no less than 6703 suppliers located in 44 states. The TFX project became a close approximation to the ideal weapons project--one with at least one contractor located in each Congressional district. :-)

The first test F-111A (serial number 63-9766) rolled out of the General Dynamics Fort Worth, Texas plant on October 15, 1964, 37 months after the OSD go-ahead decision, 22 months after the program's actual beginning, and two weeks ahead of schedule. It was powered by YTF30-P-1 turbofans. Pending the availability of the escape capsule, it was fitted with a pair of conventional ejector seats.

63-9766 took off on its maiden flight from Carswell AFB, Texas on December 21, 1964. Dick Johnson and Val Prahl were at the controls. Although the flight was shortened to 22 minutes because of a flap malfunction, the results were generally satisfactory. On its second flight, on January 6, 1965, the wings were swept from the minimum 16 degrees to the full aft 72.5-degree position. During early flight testing, the F-111A achieved a speed of Mach 1.3. A second F-111A took off on its maiden flight on February 25, 1965.

In 1965, a cost rise from an estimated 4.5 to 6.3 million dollars per aircraft caused the Defense Department to cut the F-111 program sharply. A contract for 431 production aircraft was placed on April 12, 1965. This was more than 50 percent less than the amount originally planned. Eleven production F-111As were added to the extensive test and engineering program.

The ninth aircraft (63-9775) crashed on approach to Edwards AFB on January 19, 1967. The aircraft landed short of the runway due to the wings being accidentally swept in the wrong direction.

The escape capsule was first fitted to F-111A number 11 (63-9777)

The Pratt & Whitney TF30-P-1 turbofan was first flown on an F-111A on July 20, 1965. The first 30 F-111As were equipped with this engine, but they experienced numerous engine compressor stalls, particularly at high speeds and at high angles of attack. These necessitated a change to the 18,500 lb.s.t. TF30-P-3 and to new "Triple Plow I" variable-geometry inlet ducts with larger areas. This engine was later retrofitted in several of the first 30 F-111As. These changes did not entirely cure the stall problems, but the did help somewhat. Many fixes and many years of hard work were necessary before the appropriate air intake geometry was finally found.

Movable underwing pylons were introduced from the fourth production aircraft onward, and from the eleventh production aircraft onward a 20mm M61A1 Vulcan cannon was installed in the internal weapons bay in place of two 750 lb. bombs. However, this cannon was rarely carried by actual operational aircraft, the space in the weapons bay being used for bombs, fuel, or electronics.

In the spring of 1967, a series of tests known as *Combat Bullseye I* were carried out with test F-111As. They confirmed the superior bombing accuracy of the aircraft's radar.

A total of 141 production F-111As were delivered from July 17, 1967. The electronics package was known as the Mk I avionics system. It included a Litton AJQ-20 inertial navigation and attack system, a General Electric AN/APQ-112 attack radar, a Honeywell APN-167 pulsed-type radar, a Texas Instruments AN/APQ-110 terrain-following radar, and Collins ARC-109 UHF and ARC-112 HF radio transceivers.

The underside of the central fuselage of the F-111A was occupied by a giant airbrake which was forced open by a large hydraulic jack. Together with the main landing gear, the presence of this airbrake precluded carrying any bombs or fuel tanks underneath the fuselage. The massive main landing gear had two huge low-pressure tires which, together with the long-stroke legs that are pivoted near the aircraft centerline, enabled no-flare landings to be made at high weights. The large airbrake helped to cover the main gear retraction bay, and wasactually partially extended when the main gear was down. The nose landing gear had twin wheels and was hydraulically steerable.

The Triple Plow I air intakes for the TF30 turbofans were mounted underneath the

12/ /1969

B-57
Canberra
12/1969

Martin B-57 Canberra - *Chapter 9*

B-57G 12/1969 / 1964 Dayton

B-57G

Last revised: 29 May 1998

Martin B-57 Canberra
Martin B-57 Canberra - Chapter 8: General Dynamics RB-57F
Martin B-57 Canberra - Chapter 10: B-57 with Pakistan

The B-57G was the designation assigned to sixteen B-57Bs that were modified as night intruders for use in Vietnam under a project known as *Tropic Moon.*

Late in 1967, three of the 3rd Bombardment Group's B-57Bs (52-1518, 52-1580 and 52-3860) were experimentally fitted with a low light level television system carried in a pod underneath the port wing. Operational trials with this equipment took place in Southeast Asia between December 1967 and August 1968, mostly over the Ho Chi Minh Trail. The results of the trials were sufficiently encouraging that the USAF awarded a contract to Martin and Westinghouse to modify 16 B-57Bs as night intruders under the designation B-57G.

Early in 1969, the Westinghouse sensor system was installed in a new nose section designed by Martin. The new nose contained a low light level television camera plus a forward-looking infrared (FLIR) set and a laser guidance system. This new equipment was operated by a specialist sitting in the rear cockpit. The relevant information was fed by the system operator into the pilot's cockpit so that he could select the appropriate combination of weapons to attack the target. The laser guidance system now made it possible to carry four 500-lb "smart bombs" on the underwing pylons. To compensate for the extra weight of the sensor equipment, the wing-mounted 20-mm cannon were deleted. The modified aircraft were redesignated B-57G, and they were easily recognizable by their bulbous "chins" that contained the low light level television equipment.

The first B-57G was taken on charge by a reactivated 13th Bomb Squadron at MacDill AFB in Florida in July of 1969. One aircraft was retained by Martin for various trials. This aircraft crashed in December of 1969 during an asymmetric approach, killing test pilot Robert Turner.

The 13th Bomb Squadron deployed to Ubon in Thailand with eleven B-57Gs in September of 1970. When it arrived there, it became part of the 8th Tactical Fighter Wing. Four B-57Gs remained at MacDill AFB for conversion training with the 4424th Combat Crew Training Squadron. They went into action over the Ho Chi Minh Trail. They used laser-guided smart bombs, often achieving an accuracy of 15 feet. One B-57G was lost on December 12, 1970 while operating over southern Laos at night. The crew successfully ejected to safety and were recovered. They believed that they had been hit by antiaircraft fire. However, a Cessna O-2A FAC aircraft failed to return from the same area that night, and it was concluded that the two aircraft had collided in the darkness.

Operations with the B-57G continued until April 1972, when the 13th BS was withdrawn from service in Vietnam and deactivated once again. The operation of these B-57Gs proved to be expensive, and the aircraft were hard to maintain in the field. Nevertheless, the B-57G was one of the first self-contained

USAFE operations. All RB-57D operations were under heavy security and very little information ever leaked out about their early operations. They presumably carried out ELINT/SIGINT missions along the East German border and over the Baltic. Since the missions were carried out under an atmosphere of high secrecy, RB-57s returning from missions over the Baltic were often intercepted by RAF Hunters just to make sure that they were not Soviet aircraft.

In 1958, the Central Intelligence Agency started sponsoring a program known as *Diamond Lil,* in which Chinese Nationalist pilots were trained to fly RB-57Ds. In early 1959, three RB-57Ds were ferried to Taoyuan AB on Taiwan. During early 1959, they carried out deep penetration reconnaissance flights over the Mainland. They flew in Nationalist Chinese markings, being painted white on top and black on the bottom with lettering stenciled in red. RB-57D "5643" piloted by Capt. Ying-Chin Wang was shot down on October 7, 1959 by a People's Liberation Army SA-2 missile, which was incidentally the first (or among the first) kills ever achieved by a SAM. It seems that the pilot had made a premature descent while returning to Taiwan. The program ended around 1964, when fatigue problems with the wing spars forced the retirement of the two survivors, which were returned to the USA. They were replaced by four Lockheed U-2s, all of which were subsequently lost in operations over the Chinese mainland.

Wing failures gradually took their toll, and these had caused SAC to place several RB-57Ds into storage by early 1959. The 4025th SRS was deactivated in June of 1959, and the Rhein-Main based RB-57Ds were reassigned to a new unit, the 7407th Support Squadron, which continued to carry out some ELINT/SIGINT missions. Some of the RB-57Ds that had been operating with the 4025th SRS were adapted to other specialist roles. Some were used by NASA for high-altitude flight testing and terrain mapping, whereas four were assigned to the 4677th Radar Evaluation Squadron for calibration duties. Six more RB-57Ds were used to monitor the last series of American atmospheric nuclear tests which took place in 1962. Three RB-57Ds were assigned to the 1211th Test Squadron (Sampling) of the USAF Weather Service at Kirtland AFB in New Mexico and were re-designated WB-57D.

In 1964 53-3973, which was operating on test flights out of Wright-Patterson AFB, lost its wing at high altitude over Dayton, Ohio and crashed into a school yard. Fortunately, no-one was injured and the pilot was able to eject safely. This finally forced all the surviving RB-57Ds to be withdrawn from service and grounded. A few were rebuilt as RB-57Fs.

However, this was not yet to be the end of the line for the RB-57D. In 1966, Martin received a contract to rebuild the wings of eight stored RB-57Ds. These aircraft were fitted with electronic countermeasures equipment and were assigned to the 4677th Defense Systems Evaluation Squadron at Hill AFB, Utah for use in the training of jet interceptor crews. When fitted with ECM gear, they were redesignated EB-57D. However, their service was destined to be brief. They were once again placed in storage in 1970, this time for good. Most of them were scrapped. One RB-57D is on display at the Pima Air Museum in Tucson, Arizona.

The Bell X-16, the RB-57D's early rival, was never actually produced. Clarence "Kelly" Johnson of Lockheed had gotten wind of the *Bald Eagle* project, and submitted an unsolicited proposal on his own which eventually edged out the Bell design, resulting in the famous U-2.

Serials of RB-57D:

```
53-3963/3982        Martin RB-57D-MA
                            - 3963 was RB-57D-1, retired to MASDC
                            - 3964 was RB-57D-2, to MASDC in 1972
                            - 3965 was RB-57D-2, to MASDC in 1972
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02/16/1968

B 727-200

Hard landing

http://www.ntsb.gov - SEA68A0052NTSB Identification: SEA68A0052
14 CFR Part 91 General Aviation
Event occurred Friday, February 16, 1968 in SEATTLE, WA
Aircraft: BOEING 727, registration: N7270L
FILE DATE LOCATION AIRCRAFT DATA INJURIES F
LIGHT PILOT DATA F S M/N PURPOSE
3-3500 68/2/16 SEATTLE,WASH BOEING 727 CR- 0 0 18 MIS
CELLANEOUS AIRLINE TRANSPORT, AGE48, 7496 TOTAL HOURS, 648
DamaGE-SUBSTANTIAL TIME - 0942 N7270L OT- 0 0 0 I
N TYPE, INSTRUMENT RATED.
NAME OF AIRPORT - KING COUNTY TYPE OF ACCIDENT PHASE OF OPERATION HARD
LANDING LANDING: LEVEL OFF/TOUCHDOWN
PROBABLE CAUSE(S) COPILOT - IMPROPER OPERATION OF FLIGHT CONTROLS FACTOR(S)

MISCELLANEOUS ACTS,CONDITIONS - OVERLOAD FAILURE
REMARKS- FAA CERTIFICATION TEST. PLT ALLOWED NOSE WHEEL TO TOUCH DOWN TOO HA
RD. DAMAGED UPPER FUSELAGE.

05/05/1969

Aero Commander

NTSB Identification: FTW69A0080
14 CFR Part 91 General Aviation
Event occurred Monday, May 05, 1969 in ROSEDALE, OK
Aircraft: AERO COMDR 690, registration: N9001N

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FILE    DATE          LOCATION          AIRCRAFT DATA       INJURIES      FLIGHT                         PILOT DATA
                                                             F  S M/N     PURPOSE
--------------------------------------------------------------------------------------------------------------------
3-2434  69/5/5     ROSEDALE,OKLA        AERO COMDR 690    CR-  2  0  0  MISCELLANEOUS           COMMERCIAL, AGE 36, 
        TIME - 1400                     N9001N            PX-  1  0  0  TEST                    TOTAL HOURS, 11 IN T
                                        DAMAGE-DESTROYED  OT-  0  0  0                          INSTRUMENT RATED.
        DEPARTURE POINT               INTENDED DESTINATION
          NORMAN,OKLA                   NORMAN,OKLA
        TYPE OF ACCIDENT                                       PHASE OF OPERATION
           STALL: SPIN                                            IN FLIGHT: OTHER
        PROBABLE CAUSE(S)
           PILOT IN COMMAND - FAILED TO OBTAIN/MAINTAIN FLYING SPEED
        FACTOR(S)
           PILOT IN COMMAND - LACK OF FAMILIARITY WITH AIRCRAFT
         FIRE AFTER IMPACT
        REMARKS- EXPERIMENTAL TEST FLT FOR STALLS AND VMC. ACFT LOADED TO AFT CG. STRUCK TREES DURING SPIN RECOVERY
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