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Operation UPSHOT-KNOTHOLE

NEVADA PROVING GROUNDS

March - June 1953

Project 6.11

INDOCTRINATION OF TACTICAL AIR COMMAND AIR CREWS IN THE DELIVERY AND EFFECTS OF ATOMIC WEAPONS

Classification ~~(Cancelled)~~ (Changed to CONFIDENTIAL
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OPERATION UPSHOT-KNOTHOLE

Project 6.11

INDOCTRINATION OF TACTICAL AIR COMMAND AIR CREWS IN THE DELIVERY AND EFFECTS OF ATOMIC WEAPONS

REPORT TO THE TEST DIRECTOR

by

John W. Rawlings, Jr., Lt. Col., USAF

December 1953

[redacted]

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Tactical Air Command
Langley Air Force Base, Virginia

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ABSTRACT

During Operation UPSHOT-KNOTHOLE, Tactical Air Command (TAC) participated in Shots 2, 4, and 9. The purpose of this project was to indoctrinate TAC fighter bomber and tactical reconnaissance pilots in the delivery and effects of atomic weapons.

Twenty-nine TAC pilots and four alternates who were to participate in later shots were positioned approximately 10 miles from the point of detonation of Shot 2 to indoctrinate them in the flash effects of an atomic explosion.

For Shot 4, seven T-33 aircraft carrying 14 pilots simulated a delivery maneuver from a position in the drop aircraft formation. This was accomplished by performing a diving turn shortly after release so that at burst time they were on a radially outbound heading in a slight climb from the point of burst.

For Shot 9 a similar number of aircraft and pilots simulated a delivery maneuver from a position approximating that in Shot 4. This maneuver was more nearly that prescribed by TAC SOP's for the delivery of an atomic weapon by the dive bombing technique. It was accomplished by performing a dive straight ahead, immediately after release of the bomb, directly over ground zero and a pull-up to a slight climb just prior to detonation.

Approximately 2 hr after detonation (Shot 9) three RF-80 aircraft proceeded to make two photographic runs each over ground zero at altitudes ranging from 500 to 30,000 ft absolute. These photographs were used for bomb damage assessment purposes.

Since the objectives were accomplished, the results were considered satisfactory.

Considering the fact that this was the first opportunity for TAC to participate in an atomic test program, it was very successful. However, it is obvious that participation in future tests is in order. More realistic operations including shorter slant ranges, higher speeds and lower altitudes should be permitted. This can be accomplished easily by using high speed jet bomber or fighter bomber aircraft for delivery of the weapons.

It is recommended that:

1. During the next series of atomic tests within the continental U. S., any stockpile weapons utilized for military effects tests be delivered by a fighter bomber aircraft using LABS and dive bombing techniques.

2. Fighter bomber aircraft simulating the delivery of an atomic weapon be positioned on the 6 calorie thermal envelope.

[redacted]

FOREWORD

This report is one of the reports presenting the results of the 78 projects participating in the Military Effects Tests Program of Operation UPSHOT-KNOTHOLE, which included 11 test detonations. For readers interested in other pertinent test information, reference is made to WT-782, Summary Report of the Technical Director, Military Effects Program. This summary report includes the following information of possible general interest.

a. An over-all description of each detonation including yield, height of burst, ground zero location, time of detonation, ambient atmospheric conditions at detonation, etc., for the 11 shots.

b. Compilation and correlation of all project results on the basic measurements of blast and shock, thermal radiation, and nuclear radiation.

c. Compilation and correlation of the various project results on weapons effects.

d. A summary of each project, including objectives and results.

e. A complete listing of all reports covering the Military Effects Tests Program.

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CONTENTS

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ILLUSTRATIONS

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CHAPTER 1

INTRODUCTION

1.1 OBJECTIVES

The objectives of this project were:

1. The indoctrination of Tactical Air Command (TAC) fighter bomber pilots in the thermal, radiological, and blast (gust) effects of an atomic explosion while performing a simulated tactical delivery.

2. The indoctrination of TAC tactical reconnaissance pilots in the techniques of photographing areas subjected to atomic weapons effects.

1.2 BACKGROUND

Although TAC had not participated in any atomic tests prior to Operation UPSHOT-KNOTHOLE, a tactical atomic program has been in operation in TAC since late 1950. Since that time SOP's have been established, an air division (subsequently deployed to an overseas command) and a unit in place overseas have been trained in the delivery of atomic weapons, a document has been published entitled <u>Operational Concept for Tactical Employment of Atomic Weapons</u>, and plans have been completed to train additional units in an atomic capability. The accomplishments just listed plus many others of lesser importance have placed TAC in a position of having a definite atomic capability. All this, however, was without benefit of any realistic training or indoctrination during an actual nuclear explosion. Prior to UPSHOT-KNOTHOLE, participation in similar tests was impossible due to aircraft non-availability, time scales for deployment of units, and the level of unit training attained at the time of the tests. Therefore, it was evident to TAC that the indoctrination of operational personnel in the actual problems involved with the delivery and effects of atomic weapons should not be delayed any longer, and UPSHOT-KNOTHOLE would, at least partially, provide this indoctrination.

[redacted]

1.3 GENERAL

It was apparent to TAC that participation in this series of tests be on a reduced scale and that the method of operation could not be completely realistic. However, it was also apparent that this operation offered an opportunity to demonstrate that fighter bomber pilots can perform the necessary test procedures in a satisfactory manner so that, for future tests, more realistic operational flight patterns would be permitted. It was originally planned to use operational aircraft, but for reasons of maximum aircrew indoctrination, slippages in aircraft production schedules, and safety considerations, two-place jet trainers were substituted for the fighter bombers. However, operational aircraft were used for the reconnaissance phase.

Since it was evident that there was some concern that the aircrews might be blinded by the flash or, being unfamiliar with a nuclear explosion, might anticipate the effects incorrectly, it was decided to provide all pilots and alternates with an initial indoctrination by observing the pre-dawn detonation of Shot 2. In addition, it was decided to provide the final fighter bomber indoctrination in the two airdrops (Shots 4 and 9) and the tactical reconnaissance indoctrination in Shot 9 only.

[redacted]

CHAPTER 2

OPERATIONS

2.1 SHOT 2

Twenty-nine TAC fighter bomber and tactical reconnaissance pilots and four alternates observed Shot 2 from a position approximately 10 miles from the point of detonation. No special equipment was used or precautions taken other than those employed for other official and technical observers. However, it was recommended that the fighter bomber pilots who were to act as safety pilots during Shots 4 and 9 wear the 4.2 density goggles so that they would be familiar with the flash intensity under those conditions. All the pilots were impressed with the magnitude of the explosion, but they were also more confident in their ability and the capability of their aircraft to escape the effects of such an explosion after delivery.

2.2 SHOT 4

2.2.1 Staging

Seven TAC T-33 aircraft staged from Indian Springs AFB where installation of temperature tapes, crew briefings, issuance of special equipment and minor aircraft maintenance were accomplished.

2.2.2 Operations

The take off was in elements of two aircraft each at H-01:17:00, H-01:16:50, H-01:16:40 and H-01:16:30. (Only one aircraft in the last element.)

The seven TAC aircraft joined the B-50 drop aircraft at approximately H-00:40 and proceeded with that aircraft through three dry runs and the final live run. The bombing altitude was 33,192 ft MSL (mean sea level).

The formation used by the TAC T-33's on all bomb runs was two flights of four and three aircraft respectively from right to left flying a stepped down modified echelon away from the B-50. Each flight

[redacted]

was 200 ft aft and 200 ft to either side of the drop aircraft. The right element was 200 ft above and the left element 200 ft below the drop aircraft.

At bomb release plus 10 sec the right flight rolled into a 90° bank, dropped dive brakes, applied 100 per cent power and commenced a 2.5 g diving turn to the right. At release plus 13 sec the left flight performed a similar maneuver falling into trail with the right flight until after detonation. Pull-out was accomplished at 22,000 ft MSL on a heading of approximately 120° to the axis of attack. At H hour all aircraft were in a 20° climb outward bound on a radial heading from the point of detonation.

At H-5 sec all safety pilots placed the 4.2 density goggles over their eyes and at H + 2 sec removed them.

At approximately H + 10 sec dive brakes were retracted, normal fighter formation was resumed, and all aircraft proceeded directly to George AFB for decontamination, interrogation, and removal of temperature tapes and VHF crystals. Landing time was H + 00:35.

2.2.3 Special Equipment

2.2.3.1 Temperature Tapes

These tapes, provided by Wright Air Development Center, were placed on 50 representative locations on each aircraft both on internal and external surfaces of the aircraft skin. The purpose of these tapes was to measure the temperature rise of the aircraft skin to obtain additional information on the susceptibility of the aircraft to thermal radiation, and so that the aircrews could be informed of the amount of thermal energy their aircraft received.

2.2.3.2 Dosimeters

Two pocket chambers were provided each crew member for the purpose of measuring any radiological contamination which might be received.

2.2.3.3 High Density Goggles

High density (4.2) goggles were provided each safety or rear cockpit pilot. Goggles were to be removed immediately after the flash in preparation for the safety pilot to take control of the aircraft in case the first pilot was blinded.

2.2.3.4 VHF Crystals

Since all radio frequencies used during UPSHOT-KNOTHOLE were classified, special VHF crystals were provided for the TAC aircraft.

[redacted]

2.2.3.5 Precautions

Special precautions were taken to avoid any possibility of fire in the aircraft due to thermal radiation. Examples of these were removal of all inflammable material possible from the aircraft and crews such as papers, maps, cigarettes, lighters, and matches. Also all rear view mirrors were taped over to reduce the flash blindness hazard.

2.3 SHOT 9

2.3.1 Fighter Bomber Participation

2.3.1.1 Staging

Seven TAC T-33 aircraft staged from Indian Springs AFB where the same support was rendered as for Shot 4.

2.3.1.2 Operations

Take off in elements of two aircraft each at H-01:05, H-01:04:50, H-01:04:40 and H-01:04:30. (Only one aircraft in the last element.)

The seven TAC aircraft joined the bombing formation consisting of the B-50 drop aircraft and three additional B-50 blast aircraft flying a vee formation 200 ft behind and 200 ft below the drop aircraft. The join-up took place at approximately H-00:40 at 22,135 ft MSL. Three dry and one live runs were accomplished.

The formation used on all bomb runs was two flights of four and three aircraft respectively from right to left flying a stepped down modified echelon away from the bombers. Each flight was 200 ft aft, 200 ft below and 200 ft to each side of the wing B-50's of the bomber formation.

At release each flight leader, followed by his wingmen, commenced a 55° dive straight ahead at 85 per cent power to a minimum altitude of 17,000 ft MSL at which time the attitude was changed to a 15° climb directly away from the point of detonation. This was the approximate attitude at burst time.

At H-5 sec all safety pilots placed the 4.2 density goggles over their eyes and at H + 2 sec removed them.

At approximately H + 15 sec normal fighter formation was resumed and all aircraft proceeded directly to George AFB for decontamination, interrogation, and removal of temperature tapes and VHF crystals. Landing time was H + 00:50.

2.3.1.3 Special Equipment

2.3.1.3.1 Temperature Tapes

Due to the negative results obtained from the temperature tapes on Shot 4, it was decided to eliminate all tapes that could be reached by the sun's direct rays. Consequently, only 26 tapes were placed on each aircraft. Installation was not made until late evening prior to the scheduled shot date.

2.3.1.3.2 <u>Thermal Panels</u>

To assist Project 5.2 in their efforts to obtain more accurate information on the ability of aircraft fabric to resist high temperatures under flight conditions, a fabric panel approximately 15 in.sq was bolted to a lower wing panel of the first and last aircraft in each flight. The leading edge of each panel was faired into the wing with masking tape. These panels were constructed of aircraft fabric stretched tightly over both sides of a 1 in.tubular frame.

2.3.2 <u>Tactical Reconnaissance Participation</u>

2.3.2.1 <u>General</u>

Three TAC RF-80 aircraft staged from George AFB where all necessary support was rendered. No special instrumentation was necessary for these aircraft; however, each pilot carried two pocket chambers (dosimeters) to record radiological contamination. Each aircraft carried normal photographic equipment. The first two aircraft were equipped with 6, 12, and 24 in.focal length vertical cameras for high and medium altitude photography. The third aircraft was equipped with a 12 in.focal length vertical camera and a 12 in.focal length oblique camera for medium and low altitude photography.

2.3.2.2 <u>Operations</u>

Take off was accomplished immediately after being alerted by the Ninth Air Force project officer. All aircraft proceeded to an orbit point at 30,000 ft MSL directly above Indian Springs. Contact was established with the Control Point at approximately H + 02:00.

On receipt of approval from the Control Point the first RF-80 proceeded to make a photographic run on the target array at 30,000 ft and returned at 20,000 ft. The second RF-80 made the first run at 10,000 ft and returned at 5000 ft. Third RF-80 made the first run at 3000 ft and returned at 500 ft. All runs were made over ground zero on cross wind headings at absolute altitudes and were controlled directly by the Control Point.

After rendezvousing again over Indian Springs all three aircraft proceeded directly to George for decontamination, interrogation and film processing.

The same procedure was employed by these aircraft on a rehearsal (4 May 1953) and on Shot 9. During the rehearsal prestrike photography was accomplished while during Shot 9 the photographs were taken for bomb damage assessment (BDA) purposes.

[redacted]

CHAPTER 3

RESULTS

3.1 SHOT 2

The TAC participation in Shot 2 was considered successful since the results desired were to acquaint the participating aircrews in the flash effect of an atomic explosion and in so doing decrease their natural apprehension toward this effect. This attitude was obtained as a result of the participation in Shot 2.

3.2 SHOT 4

3.2.1 Operations

The results of this phase of the project were considered satisfactory. Although photographs were obtained in an attempt to pinpoint the position of the TAC aircraft at burst time, they showed negative results. Consequently, an accurate determination was impossible. However, it was estimated that the slant range at H hour was approximately 17,000 ft which placed these aircraft slightly outside the 1 cal/cm^2 thermal envelope. It was further estimated that the slant range at shock arrival was approximately 20,000 ft resulting in an overpressure of 0.25 psi.

3.2.2 Instrumentation and Special Equipment

3.2.2.1 Temperature Tapes

Negative results were obtained due primarily to the low yield of the weapon and the excessive slant range from the aircraft to the point of detonation. The temperature rise indicated was not in excess of that which could have been caused by the direct and reflected solar heat on the parked aircraft.

3.2.2.2 Dosimeters

Negative results again were experienced due to the low yield and excessive slant range.

[redacted]

3.2.2.3 High Density Goggles

The greatest light intensity visible through these goggles was described as only a "slight glimmer."

3.2.3 Aircrew Reaction

The following are extracted comments from the interrogation forms on aircrew reactions to the thermal and blast effects of this test and general impressions and recommendations as a result of their participation:

(1) Thermal Effects

No. 1 aircraft. "Both pilot's continuous impression was that bomb was either a dud or of less than briefed yield. No restriction to or interference with pilot's vision. No thermal perceived."

No. 2 aircraft. "Co-pilot could see flash through F-2 goggles, but was very weak. The flash did not bother pilot who had eyes open and was watching leader, no glasses. Pilot said flash was as bright as flash bulb (going off behind him), but at no time lost sight of leader."

No. 3 aircraft. "Light of blast did not bother pilot, similar to flash bulb. Co-pilot reported only glimmer through F-2 goggles."

No. 4 aircraft. "Pilot reported intensity less than that of a flash bulb. Slight reflection off bottom of No. 3 aircraft. Co-pilot reported he did not know when the explosion occurred."

No. 5 aircraft. "Flash blindness nil. Goggles not needed."

No. 6 aircraft. "No blindness nor heat experienced."

No. 7 aircraft. "No heat or blindness experienced."

(2) Blast Effects

No. 1 aircraft. "Two very slight thumps experienced. Would not have recognized first shock wave, had second one not occurred. Both pilots thought first shock wave was dive brakes retracting."

No. 2 aircraft. "Two impacts described as mild turbulence - less than ½ g."

No. 3 aircraft. "Pilot felt two shock waves, co-pilot only one."

No. 4 aircraft. "Reported two shock waves. Very slight shock, like concussion of gun blast."

No. 5 aircraft. "Two distinct shock waves, but very slight."

No. 6 aircraft. "Two distinct shock waves felt, but were very mild."

No. 7 aircraft. "Very slight. No difficulty controlling aircraft."

[redacted]

(3) General Impressions and Recommendations

No. 1 aircraft. "Both pilots believe slant range can safely be reduced. Thermal, blast and flash effect on pilots completely negligible under conditions existing on this mission. No reflection experienced from any part of aircraft."

No. 2 aircraft. "Both crew members stated they felt they could have been at least twice as close without damage to aircraft or crew. Crew seemed well composed and were disappointed in the blast and flash."

No. 3 aircraft. "Crew recommended that a higher airspeed be used by the drop aircraft on future tests. Speed flown was very near and often on stalling."

No. 4 aircraft. "When the eyes are accustomed to daylight, the flash is of no consequence. A night explosion would be rough. Believe could have been at least 5000 ft closer to blast without ill effects."

No. 5 aircraft. "Pilot states that the effects of this explosion were nil as far as pilots are concerned."

No. 6 aircraft. See Thermal and Blast Effects.

No. 7 aircraft. See Thermal and Blast Effects.

3.3 SHOT 9. FIGHTER BOMBER PARTICIPATION

3.3.1 Operations

The results of this phase of the project were excellent. Photographic coverage (Figs. 3.1 - 3.4) showed the TAC aircraft until H-4.16 sec. A good approximation of aircraft position was made. It is estimated that the slant range to the nearest aircraft at H hour was 13,000 ft which placed this aircraft slightly outside the 3 cal/cm^2 thermal envelope. Slant range at shock arrival time was estimated to be 18,000 ft resulting in an overpressure of from 0.75 - 1.0 psi.

3.3.2 Instrumentation and Special Equipment

3.3.2.1 Temperature Tapes

Although precautionary measures were taken to eliminate a skin temperature rise due to direct and reflected solar heat, a 24 hr postponement of the shot made these measures relatively ineffective. Some temperature rise was indicated by the tapes, but it is impossible to determine how much, if any, was due to the thermal energy released by the atomic explosion.

3.3.2.2 Dosimeters

Although readings ranged from 0 - 400 milliroentgens on the pocket chambers, they are not considered accurate enough to form any

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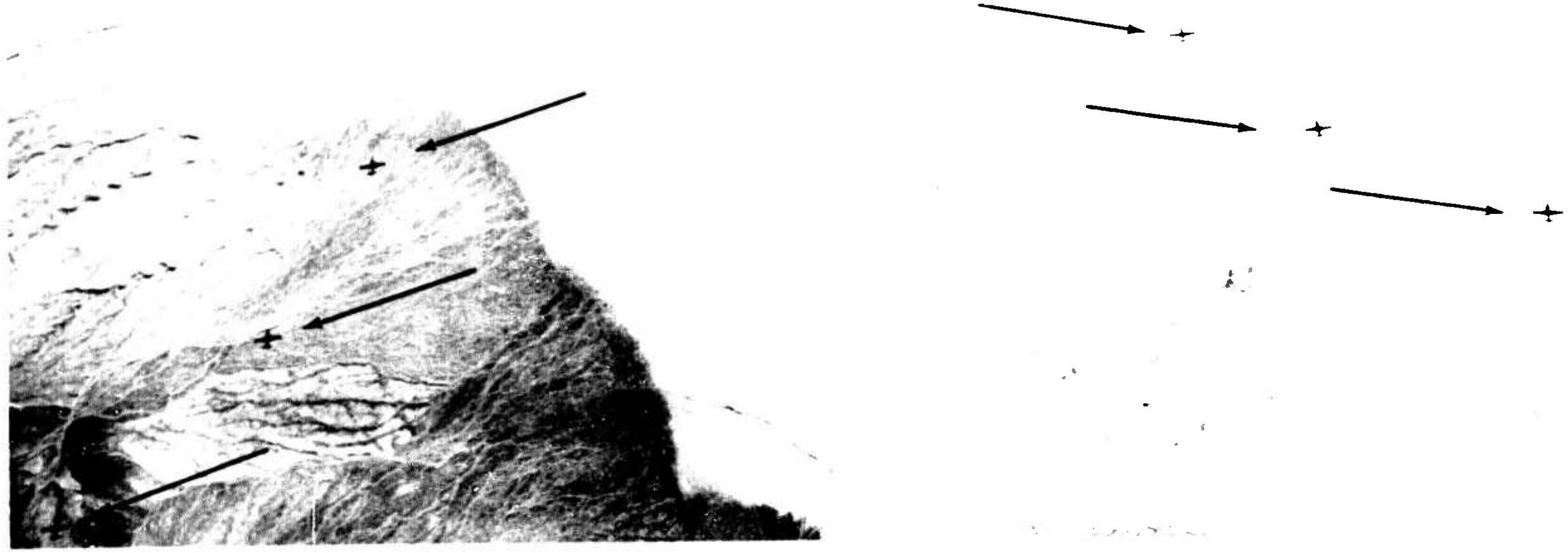

Fig. 3.1 Aerial View of T-33 Aircraft Performing Escape Maneuver at H-16.16 Sec, Shot 9.

Fig. 3.2 Aerial View of T-33 Aircraft Performing Escape Maneuver at H-10.15 Sec, Shot 9.

[redacted]

Fig. 3.3 Aerial View of T-33 Aircraft Performing Escape Maneuver at H-6.15 Sec, Shot 9.

[redacted]

Fig. 3.4 Aerial View of T-33 Aircraft Performing Escape Maneuver at H-4.15 Sec, Shot 9.

conclusions as to the actual dosages received. This is borne out by the fact that the highest reading was indicated on a chamber carried by the lead aircraft which was the fartherest away from the point of detonation.

3.3.2.3 High Density Goggles

Very little light intensity was perceptible to the pilots wearing these goggles.

3.3.2.4 Thermal Panels

Although no scorching or burning was indicated, all four panels were stretched varying amounts from a slight ripple to a rectangular depression ½ in.deep and covering approximately 50 per cent of the external forward section of the panel. It can not be determined whether this stretching was caused by the shock wave or the resultant pressure exerted on the panels during the 3 - 4 g dive recovery.

3.3.3 Aircrew Reaction

The following are extracted comments from the interrogation forms on aircrew reactions to the thermal and blast effects of this test and general impressions and recommendations as a result of their participation:

(1) Thermal Effects

No. 1 aircraft. trouble from flash although much brighter than that from 6 April 1953 blast. No loss, or partial loss, of vision as result by pilot. Co-pilot, with goggles, observed only pale green light for split second."

No. 2 aircraft. "Terrific flash was noted, but no blindness experienced. With first flash, crew felt a distinct heat wave. Only one was felt. Pilot stated that it was a kind of enveloping warmth."

No. 3 aircraft. "Pilot reported no blindness in spite of the very bright light. Was wearing P-8 goggles. Felt some heat. Co-pilot wearing 4.2 goggles could tell when burst occurred, also felt heat (slight)."

No. 4 aircraft. "Pilot felt distinct warmness on face and neck at time of explosion. Reported intense white light, but only an instant (less than 1 sec)of partial blindness. Was wearing green goggles. Co-pilot reported very little heat. Wore 4.2 goggles and reported no excessive flash."

No. 5 aircraft. "Pilot stated extremely bright flash, blinded for approximately 2 sec. Wearing green (actually amber) helmet shield. Reported no after effects of blindness. No reported heat. Co-pilot wearing 4.2 goggles knew when bomb exploded."

No. 6 aircraft. "No blindness, but moderate heat felt, e.g., walking past a steam radiator."

No. 7 aircraft. "Fireball observed just after explosion. No blindness experienced. Formation made wide sweeping turn (180° to dive direction) and pilot felt heat (gradual warmth after about 2½ or 3 min.) Definitely noticeable."

(2) Blast Effects

No. 1 aircraft. "Shock wave perceived clearly both visually and physically. Visibility increased at instant shock wave was felt. Shock wave jolt can be likened to moderately turbulent air. No lateral deviation requiring control compensation."

No. 2 aircraft. "Two distinct shock waves were felt underneath and from rear of aircraft. No difficulty was encountered in controlling aircraft."

No. 3 aircraft. "Two definite shocks felt. Described as intensity of rough air."

No. 4 aircraft. "Reported two shock waves. The second a few seconds after the first shock. Pilot reported 5 g's on meter, but no difficulty in controlling aircraft. Shock reported as severe, but of short duration.

No. 5 aircraft. "Pilot reported two definite shock waves approximately 5 sec apart. No control problem, similar to rough air."

No. 6 aircraft. "Definite shock waves (two) felt, both equal in intensity, from rear of plane, about 5 sec after blast."

No. 7 aircraft. "Felt two distinct shock waves of equal intensity. Wave felt straight from rear. No difficulty controlling aircraft."

(3) General Impressions and Recommendations

No. 1 aircraft. None.

No. 2 aircraft. "Two dry runs with bomber should be the maximum before drop time."

No. 3 aircraft. None

No. 4 aircraft. "Crew reported as anticipating shock, said light and shock were as expected."

No. 5 aircraft. "Pilot reported he felt the aircraft could have been much closer without damage."

No. 6 aircraft. "Altitude could be lowered (at burst time). Unless viewed directly (explosion) goggles not needed."

No. 7 aircraft. None.

3.4 SHOT 9. TACTICAL RECONNAISSANCE PARTICIPATION

3.4.1 Operations

The results of this phase of the project were excellent. All sorties were flown as scheduled with excellent photographic results (Figs. 3.5 - 3.19). One camera malfunction occurred which partially reduced the coverage obtained by the third aircraft on the 3000 ft run.

[redacted]

The 6 in.focal length vertical camera photography was considered inadequate for BDA purposes when used at medium and high altitudes (from 5000 - 30,000 ft absolute) for the type of target array available during the test. The photographs taken at 500 and 3000 ft absolute with the 12 in.vertical and 12 in.oblique cameras were useful for photo interpretation; however, it did not adequately cover the large array. A large scale mosaic would have allowed more detailed BDA and would have required fewer flight lines across the target area.

3.4.2 Special Equipment

Although the pocket chambers carried by the pilots in the first and third aircraft indicated excessively high dosages (85 and 37 roentgens) respectively, it was obvious that some major discrepancy existed either in the method of taking the reading or in the chambers themselves. This was substantiated by a complete lack of measurable contamination on any part of the aircraft and further a lack of evidence of film fogging even though the cameras were not sealed.

Fig. 3.5 Aerial View of Target Array Prior to Detonation, Shot 9. Photograph taken from 500 ft above target with 12 in. focal length oblique camera.

[redacted]

Fig. 3.6 **Aerial View of Target Array Prior to Detonation, Shot 9. Photograph taken from 3000 ft above target with 12 in. focal length vertical camera.**

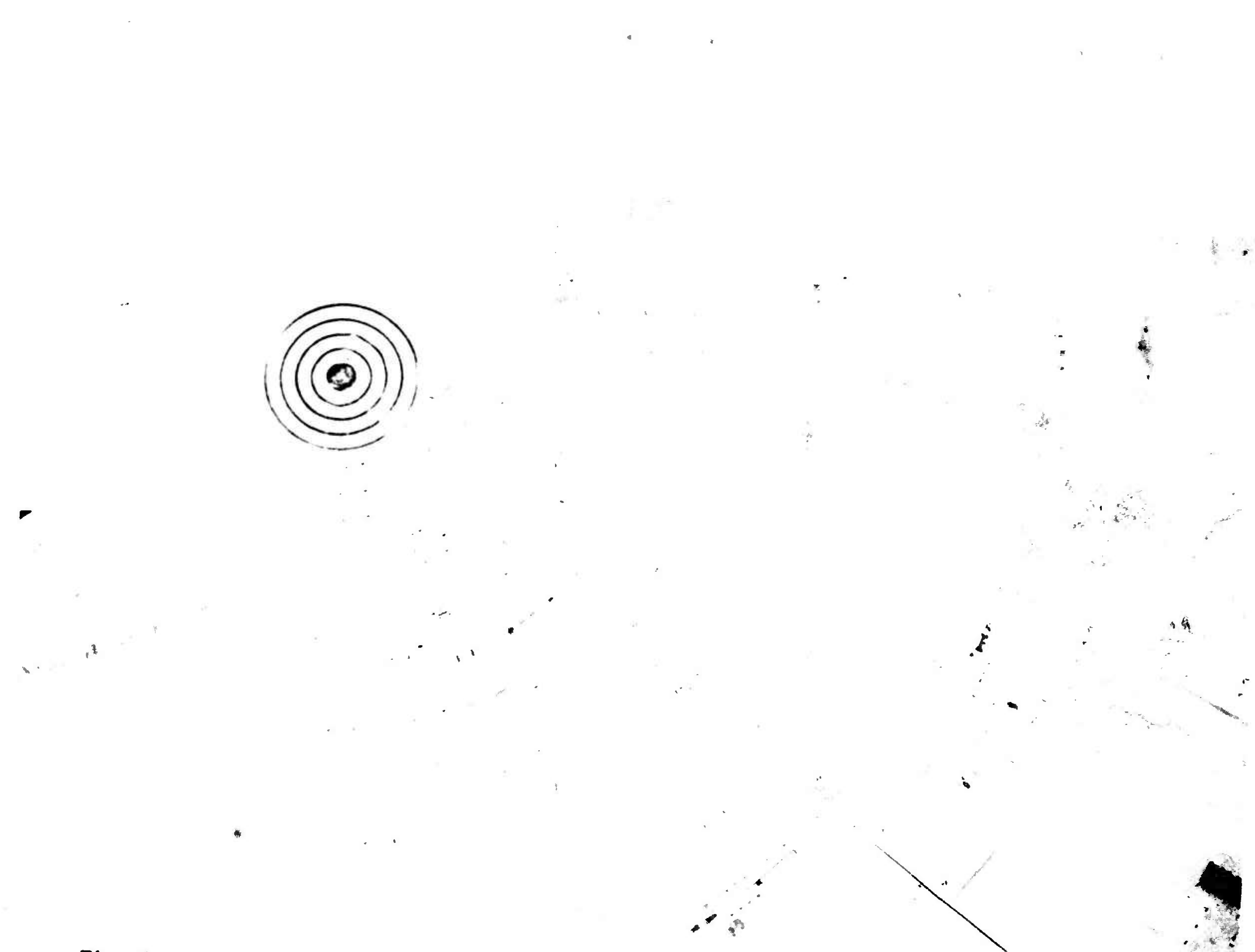

Fig. 3.7 Aerial View of Target Array Prior to Detonation, Shot 9. Photograph taken from 5000 ft above target with 6 in. focal length vertical camera.

Fig. 3.8 Aerial View of Target Array Prior to Detonation, Shot 9. Photograph taken from 10,000 ft above target with 24 in. focal length vertical camera.

[redacted]

Fig. 3.9 Aerial View of Target Array Prior to Detonation, Shot 9. Photograph taken from 20,000 ft above target with 12 in. focal length vertical camera.

[redacted]

Fig. 3.10 Aerial View of Target Array Prior to Detonation, Shot 9. Photograph taken from 30,000 ft above target with 6 in. focal length vertical camera.

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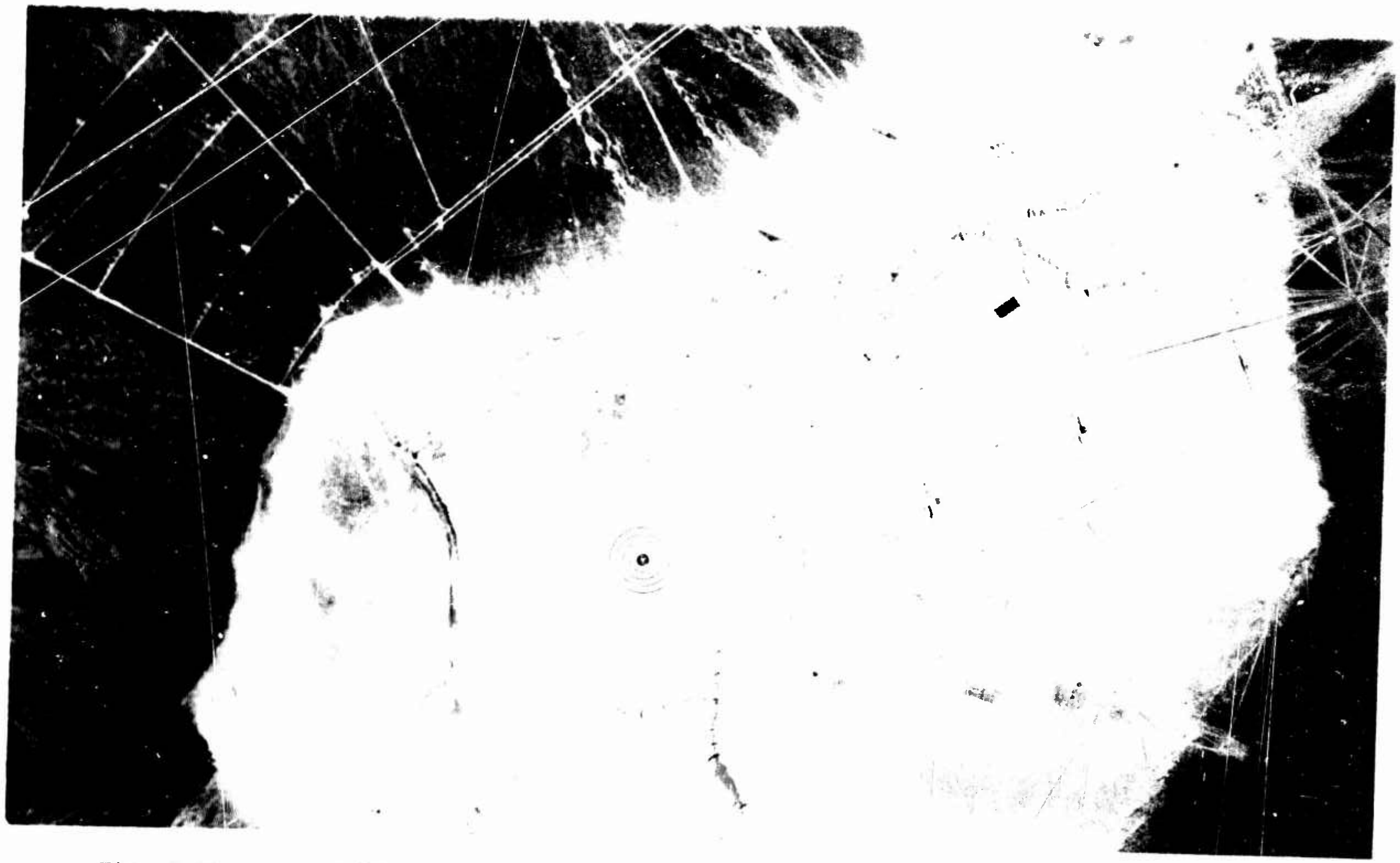

Fig. 3.11 Aerial View of Target Array Prior to Detonation, Shot 9. Photograph taken from 30,000 ft above target with 12 in. focal length vertical camera.

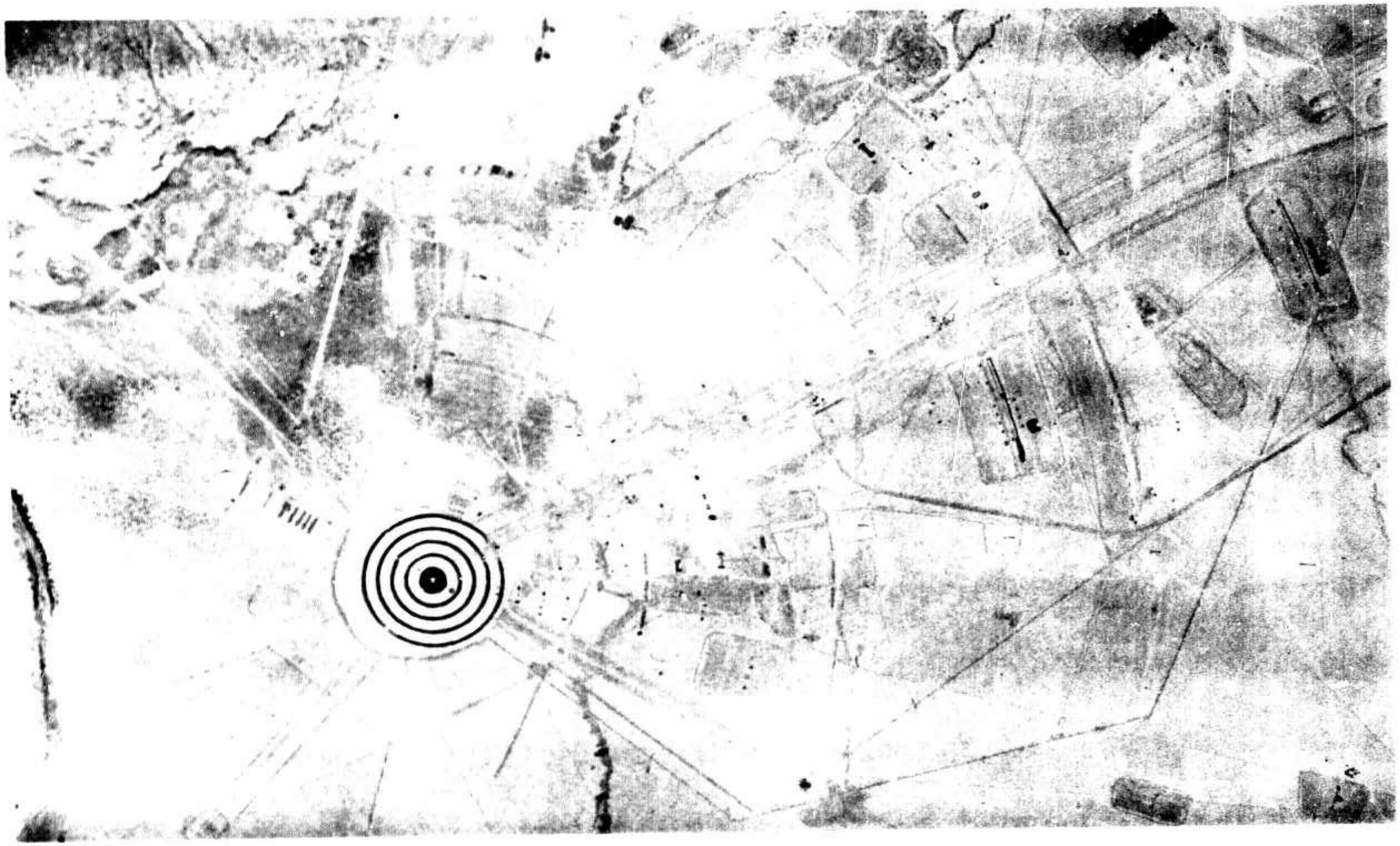

Fig. 3.12 Aerial View of Target Array Prior to Detonation, Shot 9. Photograph taken from 30,000 ft above target with 24 in. focal length vertical camera.

[redacted]

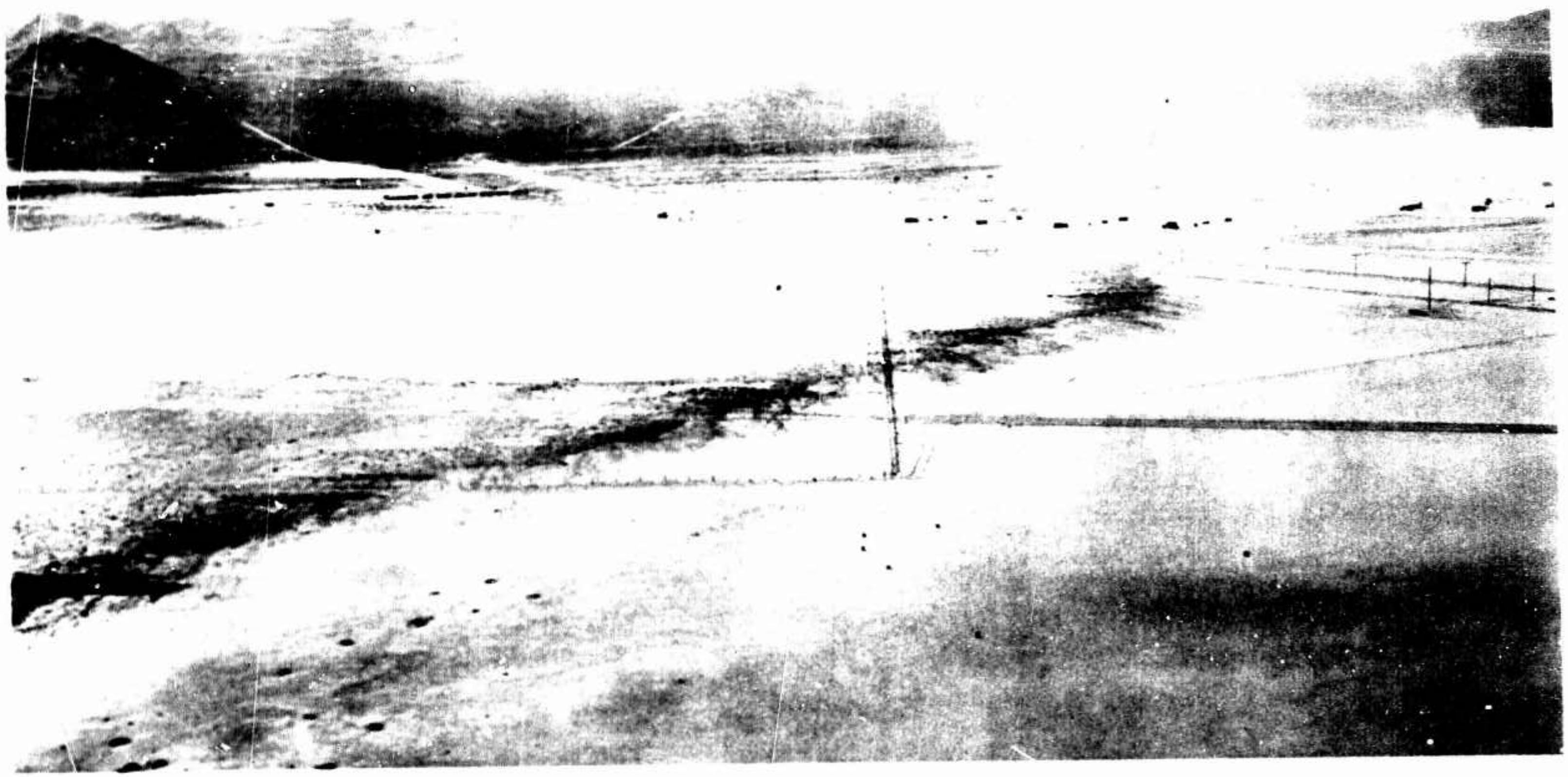

Fig. 3.13 Aerial View of Target Array Subsequent to Detonation, Shot 9. Photograph taken from 500 ft above target with 12 in. focal length oblique camera.

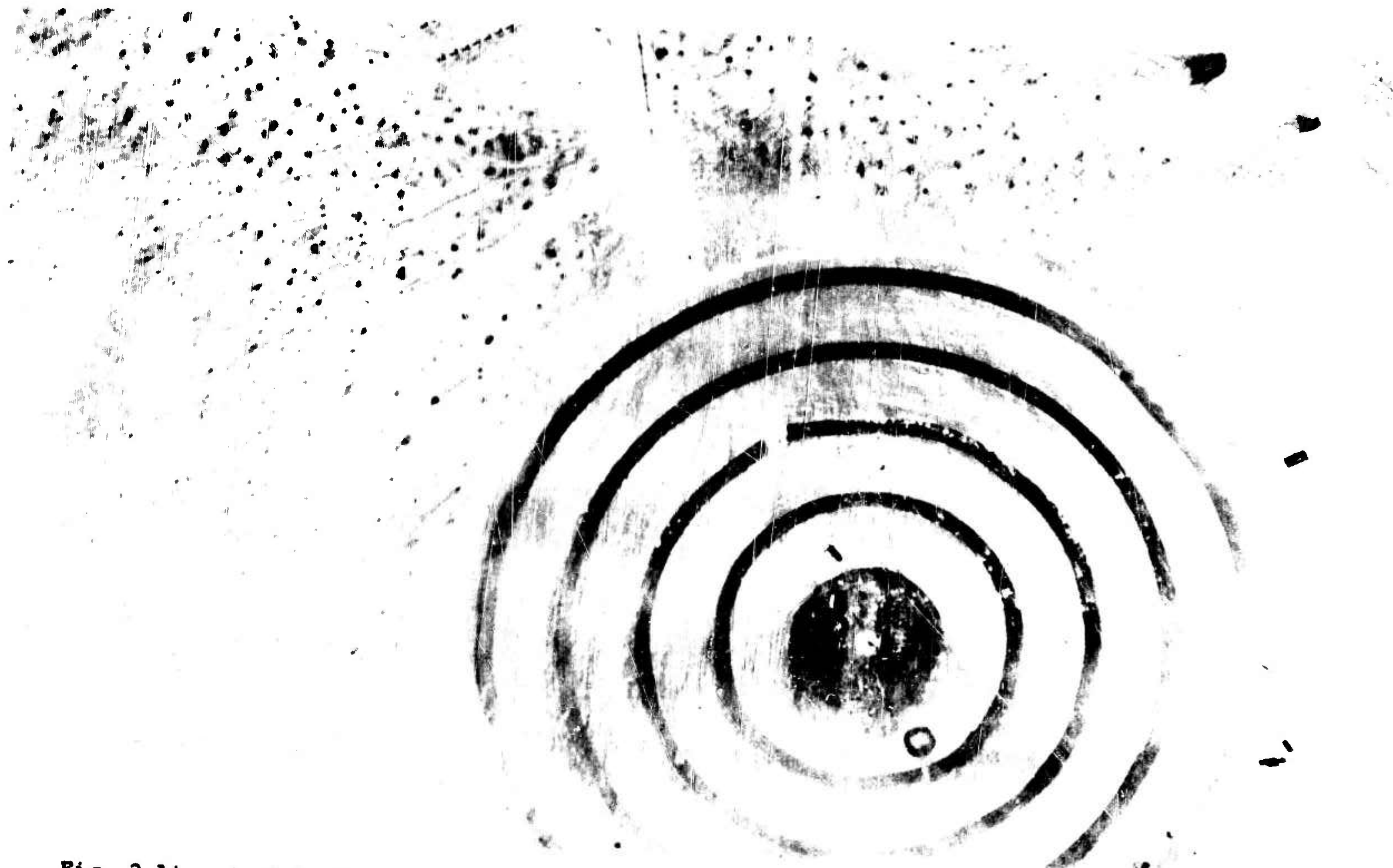

Fig. 3.14 Aerial View of Target Array Subsequent to Detonation, Shot 9. Photograph taken from 3000 ft above target with 12 in. focal length vertical camera.

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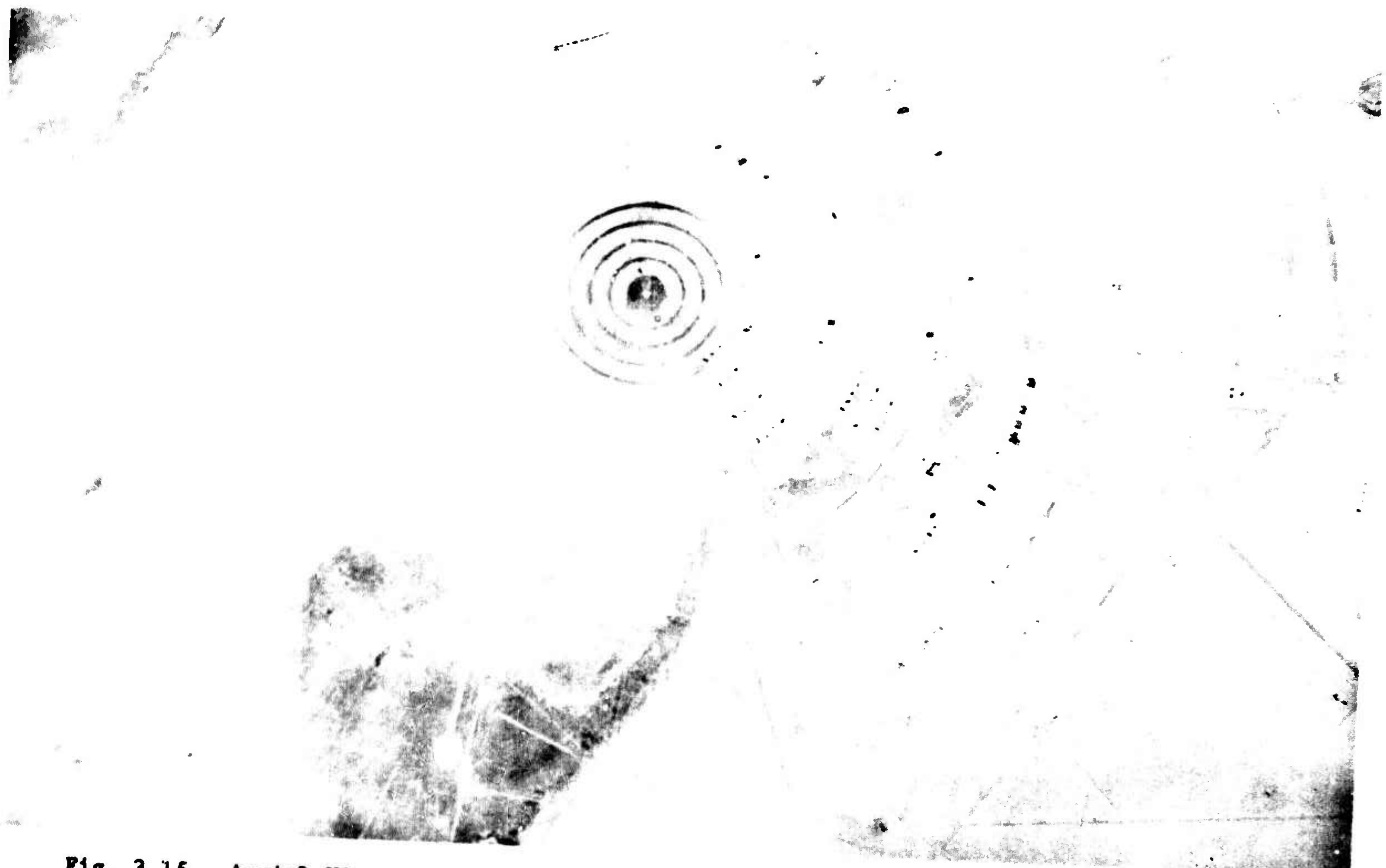

Fig. 3.15 Aerial View of Target Array Subsequent to Detonation, Shot 9. Photograph taken from 5000 ft above target with 6 in. focal length vertical camera.

[redacted]

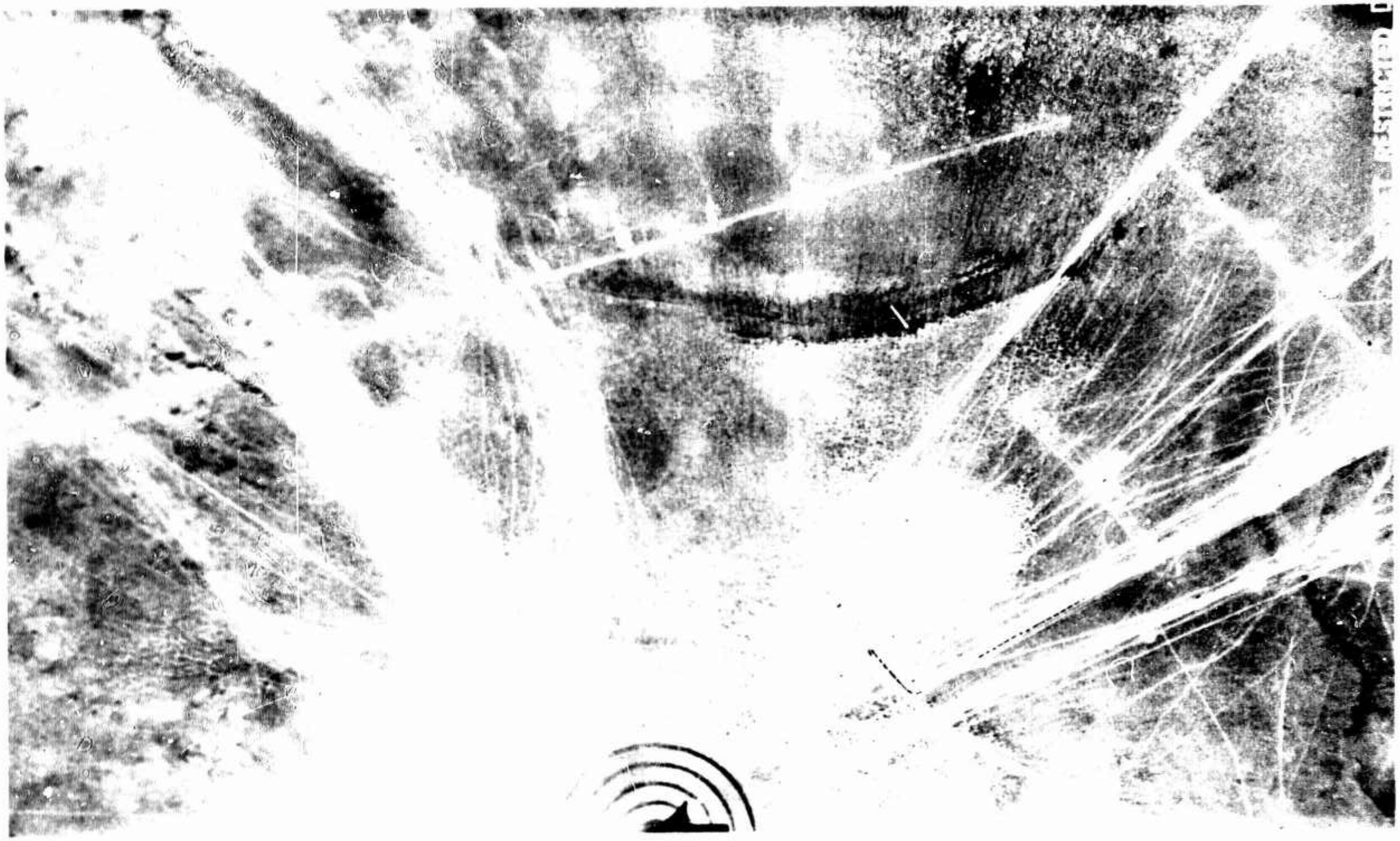

Fig. 3.16 Aerial View of Target Array Subsequent to Detonation, Shot 9. Photograph taken from 10,000 ft above target with 12 in. focal length vertical camera.

[redacted]

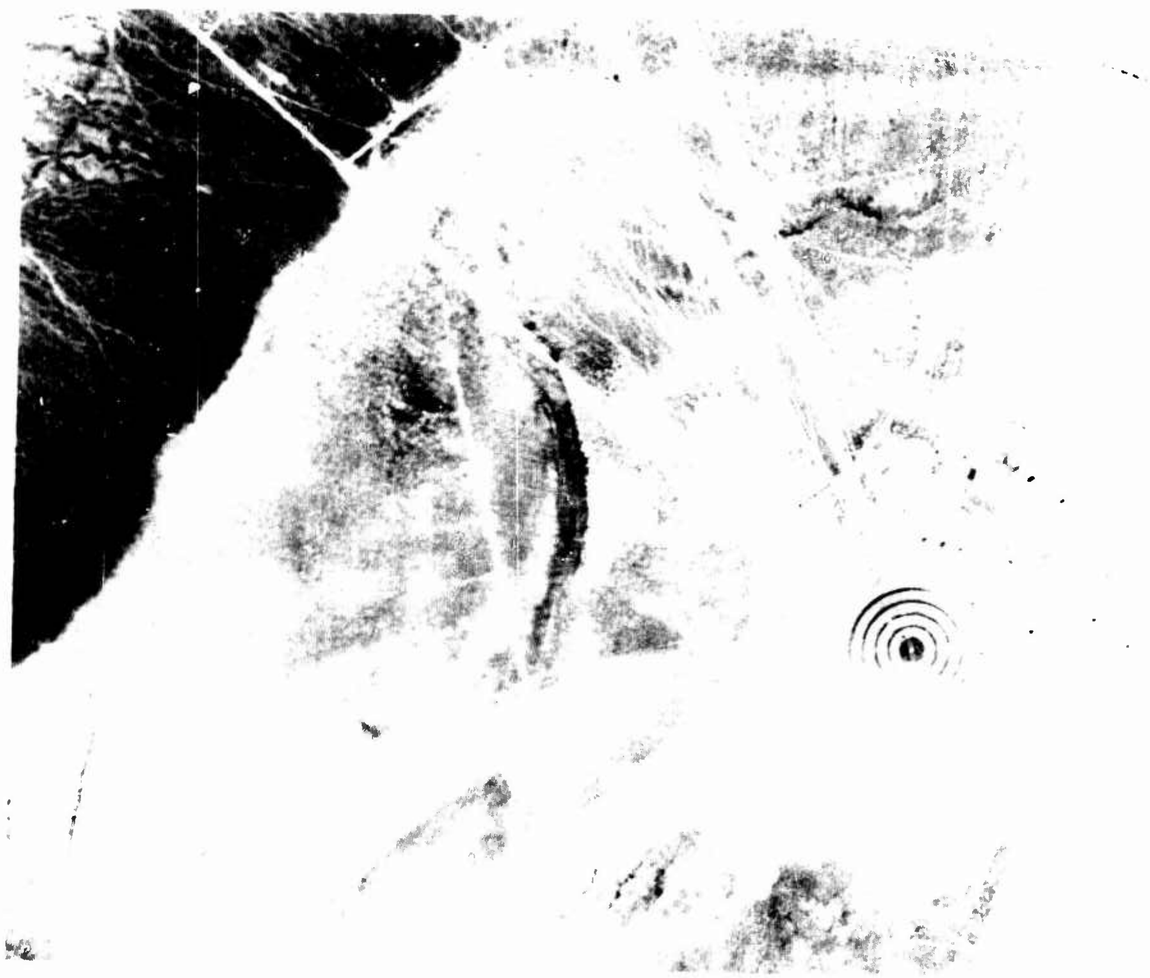

Fig. 3.17 Aerial View of Target Array Subsequent to Detonation, Shot 9. Photograph taken from 20,000 ft above target with 12 in. focal length vertical camera.

Fig. 3.18 Aerial View of Target Array Subsequent to Detonation, Shot 9. Photograph taken from 30,000 ft above target with 6 in. focal length vertical camera.

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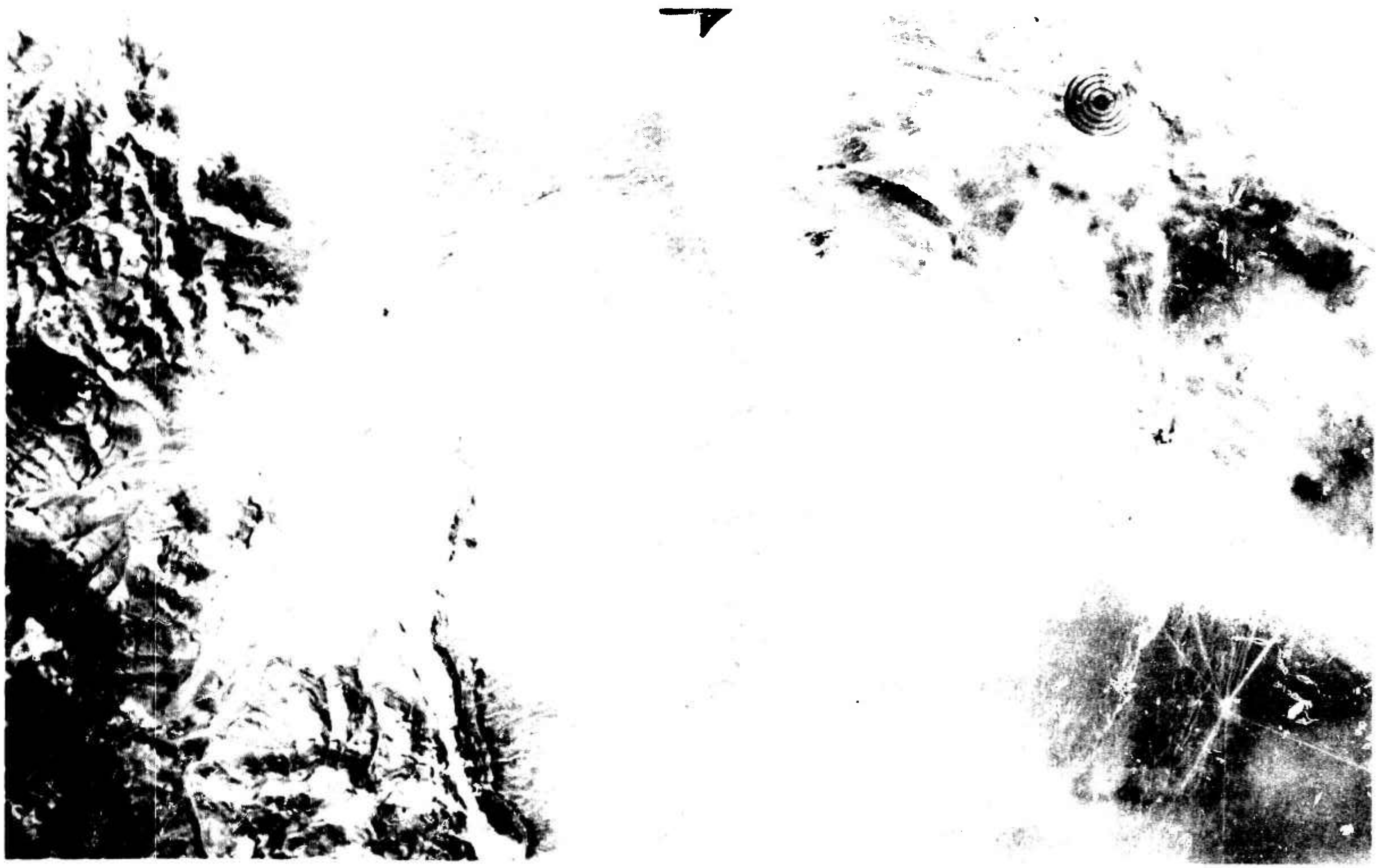

Fig. 3.19 Aerial View of Target Array Subsequent to Detonation, Shot 9. Photograph taken from 30,000 ft above target with 12 in. focal length vertical camera.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

4.1.1 Fighter Bomber

4.1.1.1 General

The indoctrination of the TAC fighter bomber pilots was extremely successful during the participation in Shots 2 and 9; however, it can be considered only partially successful during Shot 4 due to the very slight effect received from such a low yield weapon at extreme slant ranges.

4.1.1.2 Shots 4 and 9

The results of the T-33 participation in Shots 4 and 9 have proven conclusively that:

Fighter bomber pilots have no cause to fear any form of flash blindness during the delivery of an atomic weapon under daylight and CAVU (ceiling and visibility unlimited) conditions providing they do not look directly at the explosion until after the initial flash. Therefore, operational fighter bomber aircraft, with a single pilot, can fly in close formation and perform delivery combat maneuvers during actual or simulated delivery of atomic weapons without any reduction in safety due to impairment of vision.

Fighter bomber aircraft, in a tail-on position to the explosion, are completely safe from thermal radiation at slant ranges down to 13,000 ft for yields in the 30 KT range. Since the criterion used by TAC for aircraft and pilot is an allowable 6 cal/cm^2 and the maximum obtained during these tests was slightly under 3 cal/cm^2 without adverse effect, the slant range could have been reduced considerably.

The amount of thermal energy released during an atomic explosion is the limiting factor for similar yields with regard to the employment of fighter bomber aircraft in the atomic weapons delivery system.

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4.1.1.3 Future Tests

Successful indoctrination of fighter bomber pilots in the delivery and effects of atomic weapons by actual participation in atomic tests is extremely important to operational units since it is obviously impossible to allow each pilot to expend an atomic weapon with a nuclear reactior for training purposes. It is, therefore, desirable to participate further in future tests. However, more realistic operations including shorter slant ranges, higher speeds, and lower altitudes should be permitted. This can be accomplished easily by using high speed jet bomber or fighter bomber aircraft instead of obsolete propeller driven aircraft for delivery of the weapons.

4.1.2 Tactical Reconnaissance

The indoctrination of the TAC tactical reconnaissance was very successful on both Shots 2 and 9.

Reconnaissance aircraft can operate safely over ground zero at H+02:00 at all altitudes from 500 - 30,000 ft.

One flight strip over ground zero will not normally cover the entire area at a suitable scale for BDA purposes.

The most useful photography of an area subjected to the effects of an atomic explosion would be a large scale mosaic of the entire affected area and low altitude oblique photo of individual targets within that area.

Photography of less than a 1/12,500 scale is of very little value in detailed photo interpretation of areas subjected to an atomic attack.

4.2 RECOMMENDATIONS

4.2.1 Actual Delivery

It is recommended that, during the next series of atomic tests within the continental United States, atomic weapons be delivered by a fighter bomber aircraft using the LABS and dive bombing techniques, if, for the selected drop, predicted delivery accuracy is acceptable.

4.2.2 Simulated Delivery

It is recommended that fighter bomber aircraft simulating the delivery of an atomic weapon be positioned on a more realistic thermal envelope consistent with actual delivery techniques.

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