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B-52D MOBILE FLIGHT SIMULATOR  
FLASHBLINDNESS EXPERIMENT

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**JAMES E. HAMILTON, CAPTAIN, USAF, BSC**

## FOREWORD

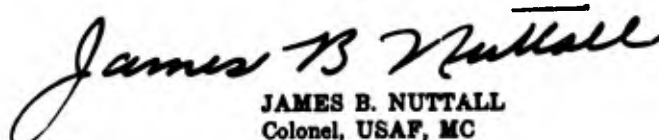
This report was prepared in the Oculo-Thermal Section of the Ophthalmology Branch. The experiment was accomplished at Altus AFB, Okla., during the month of October 1966 and the study was carried out between July 1966 and March 1967. This work was in support of project No. 6301 and task No. 630103 and was partially funded by the Defense Atomic Support Agency under project No. 5710 and subtask No. 03.003. The paper was submitted for publication on 19 May 1967.

The author gratefully acknowledges the professional assistance of Dr. Bryce O. Hartman and Richard C. McNee, and the technical assistance of Joe N. Boyd and Airman First Class Peter C. Hesslink.

Thanks are offered also to the pilots of the 11th Strategic Aerospace Wing at Altus AFB, Okla., to the personnel who maintained and operated the B-52D mobile flight simulator from the 6th Strategic Aerospace Wing at Walker AFB, N. Mex., for their cooperation in participating in the flashblindness experiment; and to Major Frank J. Garcia, the designated liaison project officer at Altus AFB.

The operational maneuver performed in this experiment was specifically designed for this research project and does not represent any known profiled escape maneuver following delivery of a nuclear weapon.

This report has been reviewed and is approved.

  
JAMES B. NUTTALL  
Colonel, USAF, MC  
Commander

## ABSTRACT

Thirty-five B-52 pilots were used in a study to obtain quantitative performance data on the effect of flashblindness on aircraft control and to measure visual recovery time from flashblindness during a series of flights in the B-52D mobile aircraft simulator. A Honeywell Strobolar model 65-C flashlamp was mounted in front of the pilot in order to produce flashblindness under simulated nighttime cockpit conditions. Data on aircraft attitude or recovery time were analyzed at four 6-second intervals and at recovery time after the flash.

The effect of flashblindness on aircraft control was measured by the comparison of control (nonflashed) and experimental (flashed) flights. The variables analyzed were bank error (deviation from  $30^\circ$ ), indicated airspeed error (deviation from 270 knots), pitch error (deviation from  $0^\circ$ ), altitude error (deviation from 6 km. (20,000 ft.)), and recovery time (seconds).

## B-52D MOBILE FLIGHT SIMULATOR FLASHBLINDNESS EXPERIMENT

### I. INTRODUCTION

*Flashblindness* may be defined in a practical sense as a temporary inability to see in a given light environment because of brief visual exposure to a high-intensity light source (1).

Many studies in the past decade have been made concerning eye protection from flashblindness and retinal burn. The problem of preventing flashblindness or retinal burn from the detonation of a nuclear weapon to the dark-adapted eye of an aircraft pilot has not been satisfactorily solved (2).

The purpose of this study was to obtain quantitative performance data on the effect of flashblindness on aircraft control and to measure visual recovery time from flashblindness in the B-52D mobile aircraft simulator (fig. 1). The study was accomplished by using a high-intensity light source (fig. 2) mounted before the pilot in the simulator to simulate light from a nuclear detonation occurring at some distance in front of the aircraft at night.

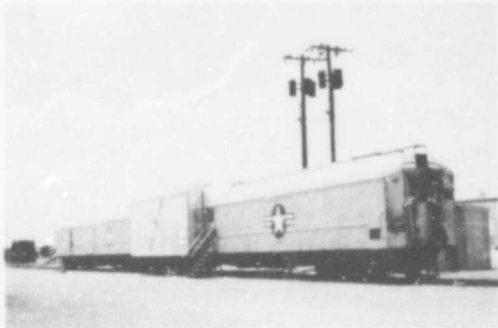


FIGURE 1

*B-52D mobile aircraft simulator in railroad car.*

The subjects (fig. 3) for the experiment were B-52 pilots and copilots of the 11th Strategic Aerospace Wing, Altus AFB, Okla.

This report is a continuation of the flashblindness studies related to the C-131/T-29 flight simulator (3), the F-101/F-106 simulator (4), the F-4C flight simulator (5), and the F-106B aircraft (6). The data from this study are compared with those of previous studies.

Hill and Chisum (7) have indicated that a blindfolded pilot would have a minimum of 5 seconds to recover useful vision in order to prevent disorientation (fig. 4). This time was obtained during the most complicated maneuver encountered under their experimental conditions in which the pilot was blindfolded.

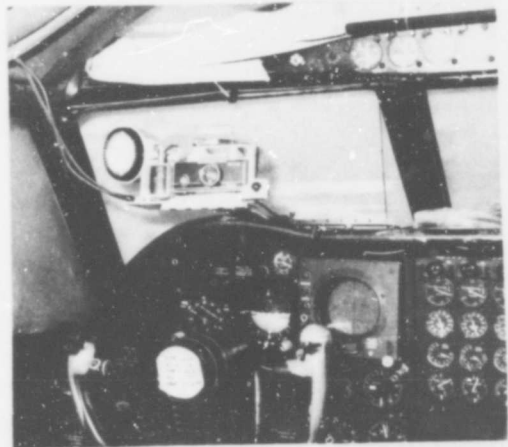


FIGURE 2

*High-intensity light source and subject-monitoring camera.*



FIGURE 3  
Subject experiencing flashblindness.

There is some doubt, however, that the conditions of being flashblinded and blindfolded have comparable effects on the pilot's capability for aircraft control.

Earlier aircraft simulator flashblindness studies (3, 4, 5) indicated that flashblindness recovery time can be reduced from a mean 26 seconds to a mean 10 seconds by floodlighting the aircraft instrument panel with 1,080 lux (100 ft.-c.) of illumination during nighttime conditions; however, instrument-panel floodlighting was not used in this study.

The earlier aircraft simulator flashblindness studies indicated that approximately 40% of the flashblinded pilots tested did not accomplish the programmed experimental maneuver. There was no detectable relationship between recovery time and the number and type of errors in aircraft control in the studies in the high-performance jet fighter aircraft simulator as there was in the study by Alder (3) in the C-131/T-29 simulator. There has been some

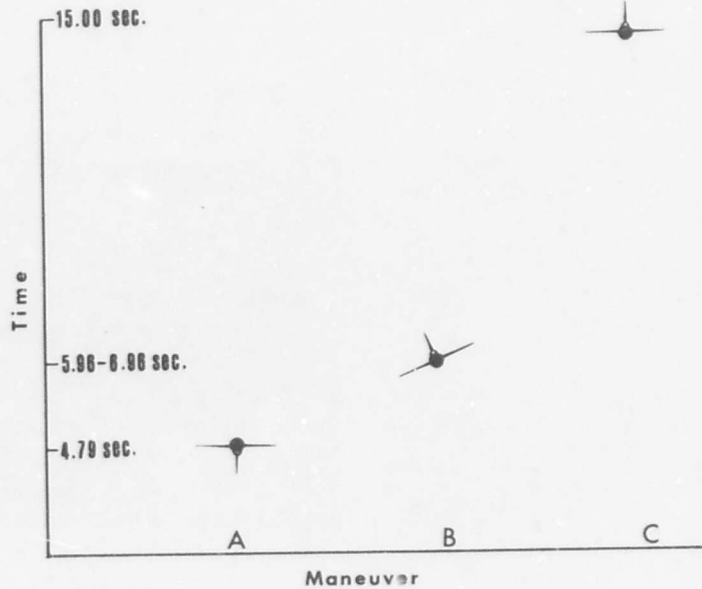


FIGURE 4  
Time that a blindfolded pilot can control aircraft. A. At 180° point of slow roll. B. Maintained turn. C. Straight and level flight.

evidence that flashblinded pilots can fly a programmed experimental maneuver in an actual aircraft without a significant amount of disorientation (6).

## II. APPARATUS

One portable flyaway visual flash-source kit, like the one used in the previous simulator experiments (4, 5) (fig. 5), was attached to the B-52D mobile simulator in October 1966 for the purpose of obtaining data on flashblindness and aircraft control. The kit contained the following items: 1 Honeywell Strobonar, model 65-C electronic flash lamp; 1 Kodak Instamatic camera and triggering solenoid (fig. 2); 3 Sylvania sun lamps; 1 Weston illuminometer; 1 console panel containing switches, lights, and wiring; instrument-connecting cable with proper plugs and sockets; 1 package of assorted attachment brackets; 3 carrying cases; and 1 Automax motion picture camera, which was added to the kit for this experiment (fig. 6). The cameras were used to monitor the subject when the flash occurred and to record the data after the flash.

Flight and weapons release in the simulator may be monitored and controlled on a separate control panel in the compartment behind the cockpit (fig. 7). Component parts of the visual flash-source kit were designed to be quickly attached to specific areas of the simulator and controlled from the console panel within the portable case (fig. 5). The size of the case is 0.42 by 0.27 by 0.76 m. (16½ by 10½ by 30 in.).

The visual flash-source kit was connected to the weapons release system of the simulator so that when bombs are salvoed by the pilot or the simulator operator, the electronic flash lamp positioned above the aircraft instrument panel (fig. 2) was triggered to produce the simulated light from a nuclear weapon somewhere ahead of the aircraft. A time delay switch allowed 5 seconds to elapse between the bomb salvo and the light flash. The flash was not intended to simulate light from the detonation of the bombs that had just been released by the pilot or the simulator operator.

The electronic flash lamp was positioned at a mean distance of 0.508 m. (20 in.) from the

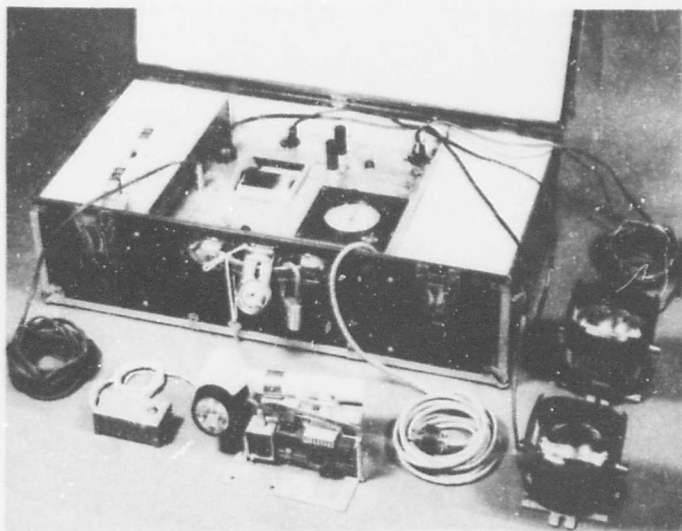


FIGURE 5

*Visual flash-source kit.*

eyes of the pilot. At the time of the electronic lamp flash, a sun lamp (fig. 8) also flashed with a pulse duration of 1 second. This lamp was positioned outside the front canopy to diffuse the light through the frosted glass that surrounded the cockpit. It simulated light produced by reflection from clouds and other

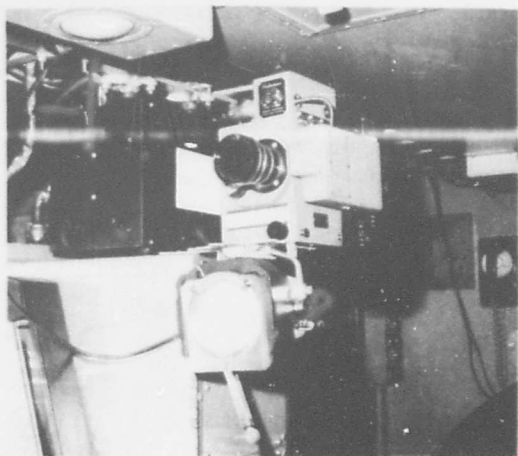


FIGURE 6

*Aircraft instrument-monitoring camera.*

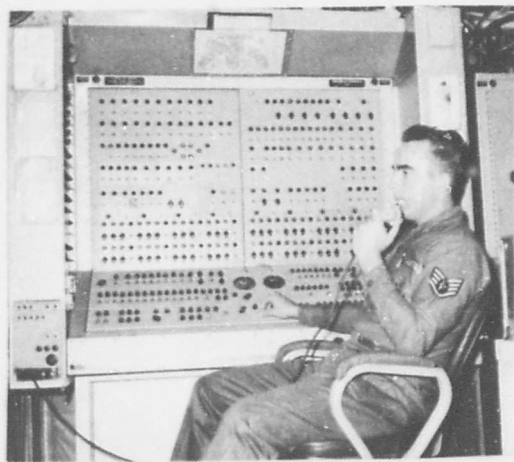


FIGURE 7

*B-52D simulator control panel.*

gaseous particles composing the denser atmosphere near the surface of the earth. The pulse duration and intensity of the electronic flash lamp were not equal to the pulse duration and intensity of a nuclear weapon, but did produce a significant amount of flashblindness when the subject viewed the light directly. It would not produce a retinal burn. The simultaneous flashing of these two lamps produced an artificial double-pulse flash. The light source which was used to simulate the flash of a nuclear weapon was a Xenon photographic flash lamp with a reflector 5 cm. in diameter. The total radiant emittance was  $0.394 \text{ cal./cm.}^2$  on a.c. operation (8).

At the time both lamps flashed, a camera attached to the electronic flash lamp (fig. 2) photographed the subject. The camera lens was 0.508 m. (20 in.) from the pilot's eyes. From each photograph taken by the camera, it could be determined whether the subject had his eyes open and was looking directly into the electronic flash lamp when the flash occurred. If he blinked or was not looking directly at the lamp, data obtained during the exposure were disregarded. The camera operated automatically since it contained a spring-winding automatic film transport and was connected to an electric motor which released the shutter mechanism when the lights were pulsed.

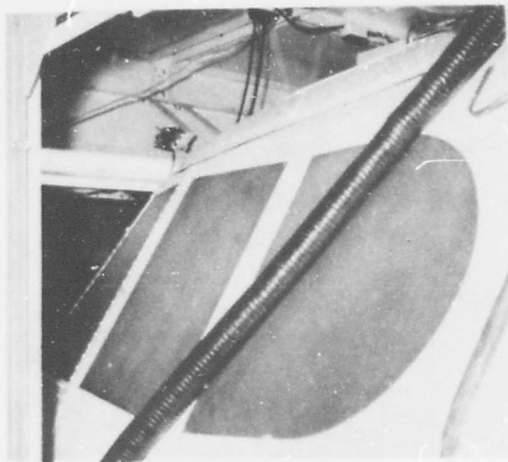


FIGURE 8

*Forward sun lamp.*

The time clock on the control panel of the visual flash-source kit and the time clock on the aircraft simulator instrument panel being monitored for data were automatically activated at the time the electronic flash lamp, the camera, and the sun lamp were activated. The time clocks were manually stopped at the control panel by the investigator when the pilot recovered sufficiently from flashblindness to read his gyrocompass heading and to report it verbally to the kit operator.

A second Sylvania sun lamp with rheostat control which had been mounted to the rear and right of the pilot in the previous simulator experiments was not used in this study. It had been used earlier to collect data concerning the decrease of flashblindness recovery time by floodlighting the instrument panel.

The aircraft instrument-monitoring camera (fig. 6) was mounted in the rear of the B-52D simulator to photograph a remote set of the simulator's aircraft instruments at regular intervals of 2 frames per second from the onset of the flash. Manual stoppage of the clocks simultaneously stopped action of the motion picture camera. A toggle switch on the console panel of the visual flash-source kit could be activated to flash a dim red light attached to the camera. This light was used as a signal to initiate a control run and did not activate the subject-monitoring camera; however, it did activate simultaneously with the time clocks so that all control runs could be measured for an arbitrary period of time.

Lights on the control panel of the kit indicated when a.c. and d.c. power was applied to the visual flash-source system, when bombs were salvoed, and when flash occurred. After the bombs were salvoed, the kit was reset for another firing by a reset button on the device control panel. The time clocks were reset manually. The kit was wired directly to the bomb salvo system, to the 27-v. d.c. power system located outside the simulator, and to the items inside the simulator which were controlled from the kit console panel.

### III. PROCEDURE

It was observed in a preliminary pilot study for this experiment that the pilots were flashblinded for a mean time of 27.3 seconds under nighttime cockpit conditions. Evidence was also produced at the time that flashblindness may have no significant effect on aircraft control during flashblindness in the aircraft simulator. Consequently, it was desirable to test the hypothesis that flashblindness had no significant effect on aircraft control in the B-52D aircraft simulator.

A controlled maneuver was made without the flash and an experimental maneuver was made with the flash under the same conditions. One-half of the subjects were given the controlled maneuver first; the remaining half were given the experimental maneuver first. Each pilot had one experimental maneuver and one controlled maneuver only. Thirty-five pilots participated in the study.

The measured attitude variables for this study were bank error (deviation from 30°), indicated airspeed error (deviation from 270 knots), pitch error (deviation from 0°), altitude error (deviation from 6 km. (20,000 ft.)), and recovery time (seconds). Heading was used in the study only to subjectively verify flashblindness recovery time of the pilot.

Lighting was controlled within the cockpit throughout the study. Illumination of the instrument panel was not measurable with the Weston illuminometer. A mean luminance of 0.236 ft.-L. was measured by using the low-intensity model Spectra brightness spot meter on different instrument dials which were illuminated in red only. The overhead red dome lights had a mean luminance of 9.684 ft.-L. Mean illuminance at the eyes was 2.49 ft.-c.

All subjects were given the same preflight briefing concerning the profile to be flown.

The approach to the target on control maneuvers and experimental maneuvers was performed as follows: approach with an altitude of 6 km. (20,000 ft.), attain a gyrocompass heading of 360°, and establish an indicated

airspeed of 270 knots in straight and level flight.

At this point the pilot was asked to view the light. The bombs were salvoed by the simulator operator. At 5 seconds from the salvo time, the electronic flash lamp was activated on the experimental maneuver. Immediately after the flash occurred, the pilot attempted to place the aircraft into a 30° left bank and maintain his altitude and indicated airspeed. At the same time he verbally reported his gyrocompass heading to the operator of the flash-source kit as soon as he could see through the afterimage. As soon as he read it correctly, the kit operator manually stopped the time clocks and recorded flashblindness recovery time. During this time the instrument-panel monitoring camera had taken pictures of the aircraft instruments constantly at 2 frames per second between the flash and recovery time. The pictures were marked and monitored later to determine aircraft attitude during the first three 6-second intervals of time (at 6, 12, and 18 seconds) and for maximum time (the last reading before recovery) for each of the four error variables. In addition, those pilots who had not yet recovered from flashblindness by 24 seconds were compared at that interval of time.

The same technic was used for the control maneuver, except that the signal to begin the controlled bank was the activation of a small, dim red light on the camera, and the aircraft instruments were photographed for a standard time of at least 36 seconds. The pilot was not asked to report his gyrocompass heading on the nonflashed run. When the instrument-panel monitoring camera was stopped manually after the 36-second period, the maneuver was terminated by request from the operator. After completing one control maneuver and one experimental maneuver the pilot was asked to continue his regular simulator training.

#### IV. RESULTS AND CONCLUSIONS

Differences between the experimental and the control data were analyzed by the sign test for each of the first three intervals of time and for maximum time (the last reading before

recovery) for each of the four attitude error variables of bank, airspeed, altitude, and pitch. No differences were detected for pitch, indicated airspeed (IAS), or altitude error at any interval, using the .05 level of significance. No difference was detected at the 6-second interval for bank error, but there was a significantly larger error in the experimental group at the 12-second interval, 18-second interval, and at the maximum time ( $P < .01$ ). The means for each group at each time interval are given in table I (9). From this study, there was no indication that airspeed, altitude, or pitch error could not be controlled (i.e., would increase under flashblindness) in the B-52 simulator during flashblindness for a period of time up to 18 seconds; however, after 6 seconds of flashblindness, bank error was greater on experimental maneuvers than during controlled maneuvers.

TABLE I

Mean error for each time for each variable  
( $N = 35$ )

Error (sec.)	Control	Experimental
<i>Bank</i>		
6	9.7°	9.7°
12	3.4°	9.7°
18	0.7°	6.8°
Max.	1.6°	7.1°
<i>Pitch</i>		
6	0.9°	1.4°
12	0.8°	1.2°
18	1.0°	1.5°
Max.	1.6°	1.8°
<i>Indicated airspeed</i>		
6	4.7 kn.	4.4 kn.
12	4.3 kn.	4.8 kn.
18	3.9 kn.	4.7 kn.
Max.	4.1 kn.	5.9 kn.
<i>Altitude</i>		
6	93 ft.	79 ft.
12	109 ft.	126 ft.
18	141 ft.	166 ft.
Max.	143 ft.	297 ft.

The number of pilots who had a larger error for control, the number who had a larger error for experimental, and the number who had the same error on both flights for each of the times analyzed for each variable are given in table II.

The 28 pilots who had not yet recovered from flashblindness at the 24-second interval were compared at that interval (table III). The control and experimental errors were not significantly different at the .05 level for indicated airspeed or altitude, but were different for bank and pitch ( $P < .05$ ). This is in agreement with the results of the other analyses except for the difference detected in the pitch errors (9). From these data, there was no indication that airspeed and altitude error could not be controlled even at the 24-second time interval, but it was indicated that pitch error could not be controlled at this point.

Whether the pilots flew the control flight first or the experimental flight first did not significantly affect any of the variables analyzed.

The light source produced a mean recovery time from flashblindness of 31.9 seconds under the conditions of this experiment. The standard deviation was 8.82 seconds. Mean recovery time may be compared with that of earlier studies (fig. 9).

TABLE II  
*Distributions of differences of error*

Error (sec.)	C > E	C < E	C = E
<i>Bank</i>			
6	9*	15	11
12	5	27	3
18	2	19	14
Max.	4	21	10
<i>Pitch</i>			
6	8	9	18
12	8	12	5
18	6	14	15
Max.	10	13	12
<i>Indicated airspeed</i>			
6	15	16	4
12	16	13	6
18	12	16	7
Max.	11	16	8
<i>Altitude</i>			
6	15	16	4
12	15	20	0
18	14	19	2
Max.	14	20	1

C > E: Control error greater than experimental error.

C < E: Control error less than experimental error.

C = E: Control error and experimental error equal.

\*Number of subjects.

TABLE III  
*Summary of pilots with recovery times longer than 24 seconds  
(results at 24 seconds)*

Maneuver	Means		Distribution		
	Control	Experimental	C > E	C < E	C = E
Bank error	1.4°	5.4°	5*	14	9
Pitch error	1.1°	1.9°	4	13	11
IAS error	3.9 kn.	5.7 kn.	10	14	4
Altitude error	153.0 ft.	192.0 ft.	15	13	0

\*Number of subjects (N = 28).

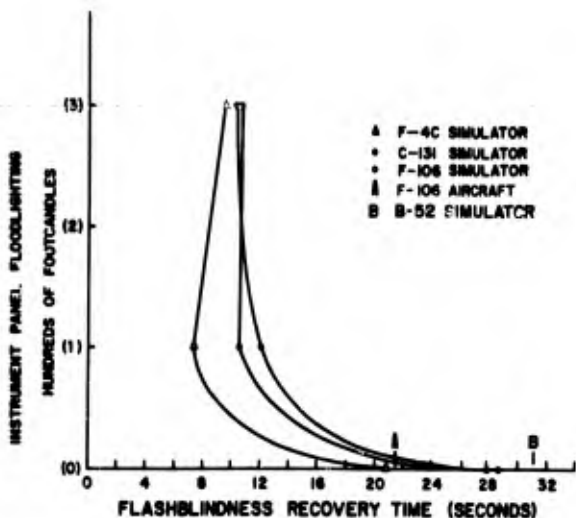


FIGURE 9  
Flashblindness recovery time.

In summary, it has been shown that pilots generally deviated more from flight attitudes dictated by this study in the B-52 simulator during flashed maneuvers than during non-flashed maneuvers. In a comparison study of these two maneuvers, there was an indication that bank error could be controlled for 6 seconds, pitch error for 18 seconds, airspeed error for 24 seconds, and altitude error for 24 seconds, while the pilots were flashblinded during the experiment. It was unknown whether airspeed and altitude could be controlled for periods of time longer than 24 seconds. Average recovery time from flashblindness was 31.9 seconds. Further studies of this kind need to be made in the aircraft cockpit.

#### REFERENCES

1. Alder, A. V. Effect of flashblindness on aircraft control. Paper presented at the AGARD Symposium on Loss of Vision from High Intensity Light, NATO Building, Paris, France, 16-17 Mar. 1966.
2. Hamilton, J. E. A summary of eye protection devices against nuclear explosions. SAM-TR-66-235, May 1966, DDC AD485877L (FOR OFFICIAL USE ONLY).
3. Alder, A. V. C-131A/T-29 flight simulator flashblindness study. SAM-TR-65-75, Oct. 1965, DDC AD577332L (FOR OFFICIAL USE ONLY).
4. Hamilton, J. E. F-101/F-106 flight simulator flashblindness experiment. SAM-TR-65-82, Dec. 1965, DDC AD628552.
5. Hamilton, J. E. F-4C flight simulator flashblindness experiment. SAM-TR-66-72, Aug. 1966, DDC AD642749.
6. Alder, A. V., and J. E. Hamilton. F-106B aircraft flashblindness experiment. SAM-TR-67-41, May 1967.
7. Hill, J. H., and G. T. Chisum. Eye protection from nuclear weapons delivery pilots, inflight research studies to obtain quantitative performance data. Aviation Medical Acceleration Laboratory, U.S. Naval Air Development Center, Johnsville, Pa., Progress Report, 21 Sept. 1960, Report No. NADC-MA-L6035, DDC AD257374, p. 4, par. 9.
8. Alexander, T. A., R. L. Bessey, E. R. Lawler, Jr., W. R. Bruce, and R. G. Allen, Jr. A study of the production of chorioretinal lesions by thermal radiation. SAM-TR-66-105, Dec. 1966.
9. McNee, R. C. Biometrics Branch, USAF School of Aerospace Medicine. Mathematical statistical report to J. E. Hamil' 1, 17 Feb. 1967.

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13. ABSTRACT Thirty-five B-52 pilots were used in a study to obtain quantitative performance data on the effect of flashblindness on aircraft control and to measure visual recovery time from flashblindness during a series of flights in the B-52D mobile aircraft simulator. A Honeywell Strobolar model 65-C flashlamp was mounted in front of the pilot in order to produce flashblindness under simulated nighttime cockpit conditions. Data on aircraft attitude or recovery time were analyzed at four 6-second intervals and at recovery time after the flash.  The effect of flashblindness on aircraft control was measured by the comparison of control (nonflashed) and experimental (flashed) flights. The variables analyzed were bank error (deviation from 30°), indicated airspeed error (deviation from 270 knots), pitch error (deviation from 0°), altitude error (deviation from 6 km. (20,000 ft.)), and recovery time (seconds).			

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14. **KEY WORDS:** Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.