

ADDRESS REPLY TO:
THE CHIEF, ARMED FORCES
SPECIAL WEAPONS PROJECT

SWPAN 921.1

27 MAR 1959

MEMORANDUM FOR: DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

SUBJECT: Survey of Effects of Nuclear Detonations on the Eye (U)

1. Objective

To review the status of knowledge of dazzle effect and retinal burns, as requested by the Director of Defense Research and Engineering at the Armed Forces Special Weapons Project briefing on 21 January 1959.

2. General Background

a. Effects on the eyes caused by thermal radiation from nuclear detonations may be divided into two categories, (1) dazzle effects (including after-image), which is a transitory loss of vision and (2) chorioretinal burns, which constitute permanent injury to the retina of the eye.

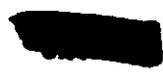
(1) Dazzle effect is defined as that condition in which the vision is impaired by an excess of, or overpowered by, light. The extent of dazzle is determined primarily by the intensity of the illumination and is not directly dependent upon orientation with respect to the light source. The after-image is a special dazzle effect which depends upon orientation, since by definition the image of the luminous source must fall upon some part of the retina in order for the temporary scotoma, or blind spot, to occur. Dazzle effect is a blanching of the visual purple, a photochemical process.

(2) Chorioretinal burn is a lesion in the retina and underlying vascular pigmented chorioid. The extent of the lesion depends upon the area of the image focused on the retina and upon the heat generated in the pigmented layers, which is a function of the incident radiant intensity. The lesion is a permanent scar and causes loss of vision in that portion of the visual field.

b. The nuclear fireball has the capability of causing dazzle effect (after-image), or a retinal burn if the fireball is in the forward field of vision. The existence of these phenomena has been recognized since Operation TRINITY, when observers wore high density goggles for the purpose of viewing the burst directly.

Declassified by DNA, Chief, ISTS
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SWPAN 921.1

SUBJECT: Survey of Effects of Nuclear Detonations on the Eye (U)

c. In general, under daylight conditions dazzle effect is not an important factor in estimating effects on personnel. If the flash occurs during daylight hours in the forward field of vision, impairment to precise vision does not persist for more than two or three minutes, and there is no impairment to ability to move around. If the flash is not in the forward field of vision, no impairment is encountered. During darkness, impairment of vision varies with the amount of illumination on the objects viewed. Time after burst required for personnel to read red-lighted instrument panels is 15 to 30 seconds.

d. When the fireball is in the forward field of vision, retinal burns with some degree of permanent loss of visual acuity may occur at relatively great distances from the detonation. The degree of permanent loss of acuity is dependent upon the area of the lesion and its location on the retina. If the lesion is located on the sensitive fovea the loss of acuity will be great.

e. The blink-reflex of man is considered to be between 100 and 150 milliseconds. This reflex cannot be considered a safety factor (for retinal burns) for small weapons (below 50 KT) in general. Furthermore, even weapons in the megaton range emit the major portion of their thermal yield at lower times when burst at ultra high altitude, such as TEAK event at 250,000 feet.

3. Unknown Factors

a. Currently there is only limited information available to enable accurate prediction of the distance to which retinal burns will occur in relation to weapon yield, fireball altitude, and target altitude.

b. Operation HARDTACK, Phase I furnished limited data on the following:

- (1) Fireball size in relation to yield, altitude, and time.
- (2) Thermal emission in relation to yield, altitude, and time.

c. Information is needed on the following:

- (1) Atmospheric attenuation as a function of altitude, slant range, and geographical area.
- (2) Threshold conditions for burn---no burn conditions.

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SWPAN 921.1

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4. Service Requirements

a. The Services are interested in the effects of the flash of an atomic detonation upon the ability of military personnel to carry out their assigned tasks when such tasks involve the use of vision. In general three types of visual tasks are involved in military operations: (1) reading of instruments in ships, aircraft, tanks and vehicles; (2) central acute vision at low levels of illumination; (3) peripheral vision at very low levels of illumination.

b. In order to reduce to a minimum the effects of dazzle and retinal burns on Service personnel in combat conditions, it is necessary that the Services be able to accurately predict these criteria in order that precautionary measures may be taken.

5. Present Program

The current research program may be divided into three areas of interest; namely, basic research, protective device research, and atmospheric attenuation. Research in each area of interest is as follows:

a. Basic Research

(1) Post irradiation follow-up of past tests. See Inclosure 1 for a summary of past test projects in this area.

(2) U. S. Navy - Navy Material Laboratory is preparing a proposal to:

(a) Measure thermal flux at the eye position of rabbits, as support for the threshold criteria studies being proposed by the School of Aviation Medicine (see below) for Operation WILLOW.

(b) Develop a device to simulate the retina and the blink-reflex, in order to conduct laboratory tests on retinal burns.

b. Protective Device Research

U. S. Air Force - Wright Air Development Center is continuing research on shutter devices. These are primarily applicable to the nuclear weapon delivery pilot situation.

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SWPAN 921.1

SUBJECT: Survey of Effects of Nuclear Detonations on the Eye (U)

c. Atmospheric Attenuation

U. S. Air Force - School of Aviation Medicine is preparing a proposal for studies of atmospheric attenuation and threshold criteria for retinal burns, to be investigated in Operation WILLOW.

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1 Incl
Summary of Past
Test Projects,
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