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FLASH PHOTOGRAPHS OF BULLET PENETRATION  
IN BRITISH PLASTIC ARMOR

by

C. W. Curtis

R. G. Stoner and John Pittenger

TECHNICAL REPORT  
NO. 102  
ARMED PROOFING GROUP  
STEAP-31

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NATIONAL DEFENSE RESEARCH COMMITTEE, DIVISION A  
2101 Constitution Ave., Washington, D. C.

December 14, 1942

Ballistics Research Laboratory  
Aberdeen Proving Ground  
Aberdeen, Maryland

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Division A

To: Dr. Duane Roller, National Defense Research Committee,  
2101 Constitution Ave., Washington, D. C.

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Office of Scientific Research and Development  
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Sincerely,

Duane Roller,  
Chief Technical Aide,  
Division A

To: Dr. Duane Roller, National Defense Research Committee,  
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NATIONAL DEFENSE RESEARCH COMMITTEE

MEMORANDUM NO. A-60M

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FLASH PHOTOGRAPHS OF BULLET PENETRATION

IN BRITISH PLASTIC ARMOR

by

C. W. Curtis

R. G. Stoner and John Pittenger

3 copies

Approved on November 20, 1942  
for submission to the Section Chairman

Walter B. Bleakney  
W. Bleakney, Vice Chairman  
Section B, Division A

Approved on November 27, 1942  
for submission to the Division Chairman

John E. Burchard  
John E. Burchard, Chairman  
Section B, Division A

Approved on November 27, 1942  
for submission to the Committee

Richard C. Tolman  
Richard C. Tolman  
Chairman, Division A

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## Preface

The work described in this memorandum is pertinent to the projects designated by the War Department Liaison Officer as CE-5 and CE-6, to the project designated by the Navy Department Liaison Officer as NO-11 and to Division A projects PA-111 and PA-118.

Lieutenant Commander A. H. Laurie on behalf of the British Admiralty Delegation requested that the group engaged in work on bullet penetration at Princeton University under contract No. OEMsr-260 take the photographs which appear in this memorandum. The group at Princeton was well equipped to obtain these photographs which it is hoped will prove helpful in understanding the behavior of the British plastic armor.

Distribution of copies of the memorandum. -- The editorial staff of Division A completed preparation of the memorandum for duplication on November 28, 1942. The initial distribution of copies was as follows:

Copies No. 1 to 24, inclusive, to the Office of the Secretary of the Committee for distribution in the usual manner;

Copy No. 25 to Lt. Comdr. A. H. Laurie, British Admiralty Delegation;

Copies No. 26 and 27 to the National Research Council, Canada (Attention: Messrs. W. Gallay and Schnarr);

Copy No. 28 to the Corps of Engineers (Attention: Lt. Col. F. J. Wilson);

Copy No. 29 to the Bureau of Yards and Docks (Attention: Lt. Comdr. Q. C. Ayres);

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Copy No. 41 to W. Bleakney, Vice Chairman, Section B, Division A;

Copy No. 42 to R. A. Beth, Consultant, Section B, Division A;

Copy No. 43 to R. J. Slutz, Technical Aide, Section B, Division A;

Copy No. 44 to E. H. Land, Official Investigator for Contract OEMsr-213;

Copy No. 45 to C. W. Curtis, Coauthor;

Copy No. 46 to J. T. Pittenger, Coauthor.

FLASH PHOTOGRAPHS OF BULLET PENETRATION IN BRITISH PLASTIC ARMOR

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Abstract

The accompanying flash photographs show the behavior of British plastic armor at successive stages of penetration by caliber .30 ammunition.

Microflash photographs have been taken of bullets penetrating slabs of plastic armor of a type developed by the British.<sup>1/</sup> Two slabs were used,<sup>2/</sup> both of which contained trap rock aggregate. Each slab was 2 ft square and  $2\frac{1}{2}$  in. thick, and had a  $\frac{3}{16}$ -in. mild steel backing plate. Slab No. 155A contained no expanded metal, while No. 155D did. The front of the slab was painted white in each case, to provide a suitable background for the bullet in the photographs and to make the crater formation easily distinguishable.

One set of photographs was taken for each slab. In the case of slab No. 155A two photographs were taken for each shot. Thus Figs. A-1(a), A-2(a) and A-3(a) show the bullet or the debris in motion, whereas Figs. A-1(b), A-2(b) and A-3(b) are still pictures showing the crater after penetration was completed. The conditions under which the photographs were taken are given in Table I.

Both sets of photographs seem to indicate the same sequence in crater formation. Immediately after impact very little movement

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<sup>1/</sup> See R. J. Emrich and R. A. Beth, Tests of plastic armor received from the National Research Council of Canada, NDRC Memo. A-50M (OSRD No. 821).

<sup>2/</sup> These specimens were made by the Flintkote Company, Rutherford, N. J.

Table I. Conditions under which photographs were taken.

Fig. No.	Slab No.	Projectile Type	Velocity (ft/sec)
A-1(a)	155A	Caliber .30 A. P.	2235*
A-1( <u>b</u> )			2235*
A-2(a)			1295*
A-2( <u>b</u> )			1295*
A-3(a)			1300**
A-3( <u>b</u> )			1300**
D-1	155D	Caliber .30 ball	1600**
D-2			1200**
D-3			1200**
D-4			1200**

\*Chronograph measurement.

\*\*Estimate from powder load.

of target material is evident (Fig. D-2). After the bullet has penetrated an appreciable fraction of its own length, the hole is seen to be larger than the bullet itself; pulverized target material can be observed emanating backward at a small angle with respect to the normal to the target face [Figs. D-3, D-4 and A-2(a)]. Only after considerable time has elapsed do cracks begin to appear, indicating the formation of sizable craters [Fig. A-3(a)], but even at this late stage the pictures do not indicate craters of the size that finally result [Figs. A-1(b), A-2(b) and A-3(b)].

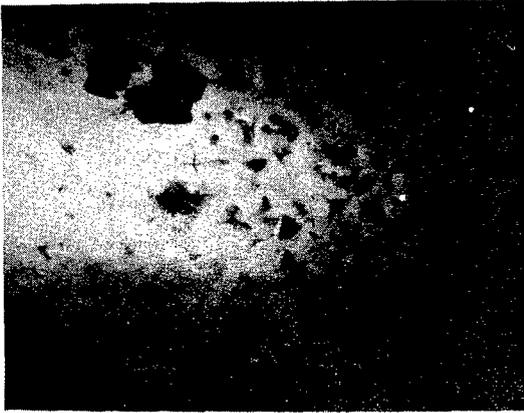


FIG. A-3(a)

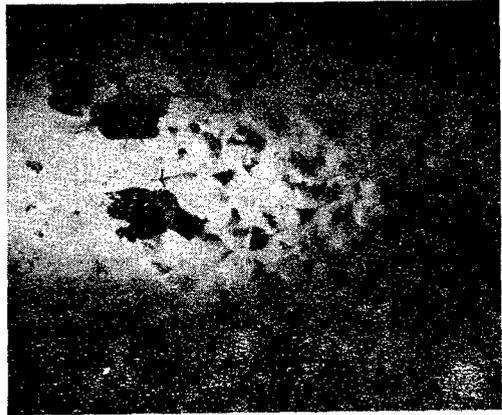


FIG. A-3(b)

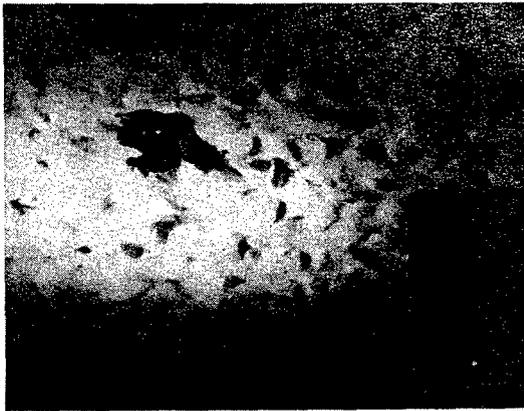


FIG. A-2(a)



FIG. A-2(b)



FIG. A-1(a)

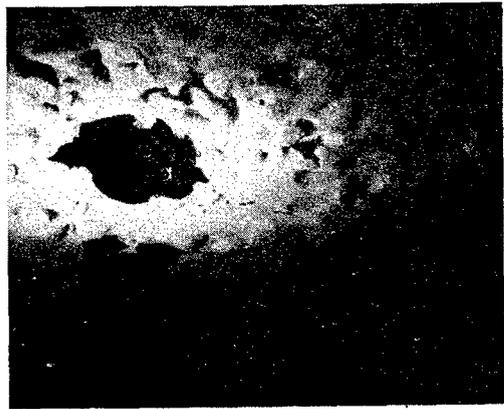


FIG. A-1(b)



Fig. D-1



Fig. D-2



Fig. D-3



Fig. D-4