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WATERTOWN ARSENAL
LABORATORY

MEMORANDUM REPORT

NO. WAL 710/636

Resistance of Four Types of Thin Aluminum

Alloy Sheet to Perforation by Fragment-

Simulating Projectiles

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BY

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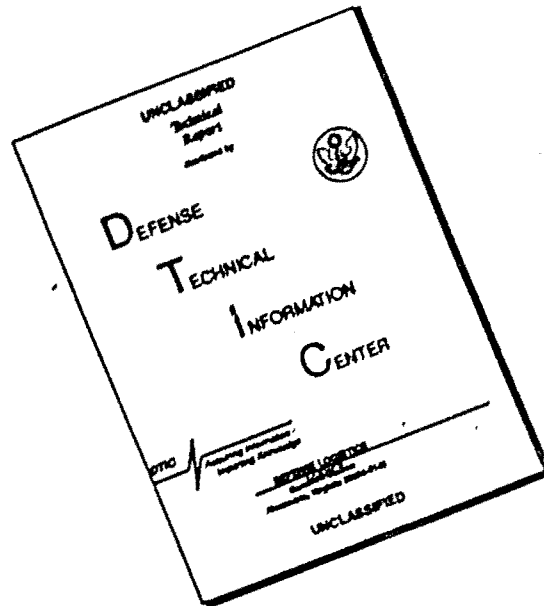
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WATERTOWN ARSENAL LABORATORY

Memorandum Report No. WAL 710/636

Ninth Partial Report on Problem B-8.2

20 May 1944

Resistance of Four Types of Thin Aluminum

Alloy Sheet to Perforation by Fragment-

Simulating Projectiles

1. In conjunction with a program of development of improved body armor components which is being conducted at this arsenal in response to a request of the Office, Chief of Ordnance^{1,2}, samples of four aluminum alloys have been tested in thin (.125") sheet form.

2. Of the four alloys tested (R-301T, R301W, 14S-W, 24S-RT) the resistance of the 24S-RT sample to perforation by caliber .45 (steel jacketed) ball projectiles and by a light-weight (17 grain) fragment simulator² was highest and that of the R-301T sample lowest. However, as compared with that of Hadfield manganese steel of equivalent weight the resistance of all these alloys was remarkably poor.

3. After determining the weight ratios of these alloys duplicate samples were clamped rigidly to wooden ballistic frames which allow 8"x8" areas to remain unsupported from the rear. Into these areas there were then directed impacts of caliber .45 (steel-jacketed) ball projectiles and of caliber .22 fragment-simulating projectiles. The results of these tests are summarized in Table I.

4. Under impact of caliber .45 ball ammunition there was no great spread in resistance to perforation, limit velocities ranging from 715 feet-per-second to 780 feet-per-second. The average limit velocity for Hadfield manganese steel of the same gauge is about 940 feet-per-second.

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1. O.O. 422.3/71(c) - Wtn 470.5/7443(c) dated 28 September 1943.
 2. WAL Memorandum Report No. 762/253(c) - "Development of a Projectile, to Be Used in Testing Body Armor, to Simulate Fragments of a 20 mm. H.E. Projectile" - 7 January 1944.

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5. Under impact of projectile G-2, the spread of limit velocities is somewhat greater (764 feet-per-second to 874 feet-per-second), but the general resistance of all types is astoundingly low as compared with that of Hadfield manganese steel of similar gauge (1600 feet-per-second).

6. Under both types of attack the resistance of the 24S-RT sample was highest and under test with the G-2 projectile the R-301T sample was poorest.

7. The ability of all samples to resist failure by punching was exceedingly low. It is felt that in order to most successfully combat fragment impact a material of high ductility as well as high tensile strength is required. Although these two attributes are generally considered incompatible, it is contended that that material which most successfully combines the two will prove to be the most highly resistant to fragment perforation. Hadfield manganese steel which at this writing appears to be the most promising material for this purpose, remains extremely ductile (50% elongation) while maintaining a moderately high tensile strength (135000 p.s.i.). Its ability to combine these two characteristics, however, appears to be unique.

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Table I

Summary of Ballistic Tests Conducted at Watertown Arsenal
on Four Types of Thin Aluminum Alloy Sheets

<u>Sample</u>	<u>Equivalent Steel Gauge</u>	<u>Ballistic Limit</u>	
		<u>G-2¹</u>	<u>Cal. .45²</u>
R-301T	.044 ⁿ	764	725
R-301W	.045 ⁿ	842	715
14S-W	.044 ⁿ	842	729
24S-RT	.044 ⁿ	874	780

For Comparison:

Hadfield manganese steel	.044 ⁿ	1660	940
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¹Cal. .22 fragment simulating projectile - 17 grains.

²Cal. .45 (steel jacketed) ball projectile - 230 grains.