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WATERTOWN ARSENAL LABORATORY

MEMORANDUM REPORT

NO. WAL 710/630

Comparison of Resistance to Perforation of
Multiple Layers of Thin Steel Sheets With That of
A Single Sheet of Equivalent Weight

BY

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Watertown Arsenal Laboratory

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First Partial Report on Problem B-8.6

16 May 1944

Comparison of Resistance to Perforation of
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A Single Sheet of Equivalent Weight

1. At the request of the Office, Chief of Ordnance¹⁰, comparative ballistic tests were conducted on five layers of steel .010^m thick, two layers of steel .025^m thick and a single steel sheet .050^m thick. All samples were furnished by the American Steel and Wire Company.
2. Because of the size of the samples no significant test was possible with caliber .45 ball ammunition. On the basis of tests with the caliber .22 fragment-simulating projectile, G-2^{2e}, however, the resistance of a single sheet of thin gauge (.050^m) steel was superior to that of two sheets equivalent in total weight, and the resistance of two sheets of .025^m steel was superior to that of five sheets of .010^m steel. Thus no advantage, but rather a disadvantage, is introduced by distributing a given weight among multiple layers. ←
3. Single sheets (4"x12") of .050" gauge steel and assemblies of two sheets of .025" gauge steel and five sheets of .010" gauge steel were rigidly mounted on a wooden ballistic frame which allowed a 4"x8" area to be unsupported from the rear. Duplicate test pieces were impacted with caliber .45 ball ammunition (steel jacketed) and with caliber .22 fragment simulating projectile, G-2. The results are shown in Table I.

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1. O.O. 400.112/5634, Wtn 400.112/3047(r) dated 24 February 1944.
 2. WAL Memorandum Report No. WAL 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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4. Under impact of the caliber .45 ball projectile the test samples were so severely shocked that only a general qualitative observation could be made. On the basis of a partial penetration on the single sheet at 867 feet-per-second and a complete perforation on the five-layered assembly at 849 feet-per-second it appeared that the use of a single sheet of this gauge (.050") is to be preferred to the use of multiple layers of the same total weight.

5. Under impact of the caliber .22 fragment-simulating projectile, G-2, the single sheet had a ballistic limit of 1574 feet-per-second, whereas the two-layer assembly had a ballistic limit of only 1290 feet-per-second and the five-layer assembly one of 935 feet-per-second. Thus it is apparent that the maximum resistance to perforation from fragments simulated by projectile G-2 will result from the use of a single sheet of this gauge (.050") rather than any multiple-layered equivalence in weight.

6. The steel provided for these tests was extremely brittle and directionally weak and wholly unsuitable for body armor. However, it is felt that the results of the test, although not quantitatively accurate, are nevertheless qualitatively significant and the conclusions entirely valid.

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APPROVED:

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Table I

Summary of Comparative Ballistic Tests of Single Thin Gauge
(.050") Steel Sheets and Multi-Layered Assemblies
of the Same Aggregate Weight

<u>Sample</u>	<u>Ballistic Limit (F/S)</u>	
	<u>Caliber .45¹</u>	<u>G-2²</u>
One .050" sheet	867 (Partial penetration)	1574
Two .025" sheets	---	1290
Five .010" sheets	849 (Complete perforation)	935

¹Standard caliber .45 ball ammunition (230 grains - steel jacketed)

²Caliber .22 fragment-simulating projectile - 17 grains.