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Fig # 3a

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WATERTOWN ARSENAL LABORATORY

MEMORANDUM REPORT

NO. WAL 710/712

710/712

Resistance of Various Thicknesses of Hadfield Manganese Steel
to Perforation by Various Projectiles

BY
J. F. SULLIVAN
Asst. Engineer

UNCLASSIFIED

DATE 5 January 1945

WATERTOWN ARSENAL
WATERTOWN, MASS.

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WATERTOWN ARSENAL LABORATORY

MEMORANDUM REPORT NO. WAL 710/712

29th Partial Report on Problem B-8.2

5 January 1945

Resistance of Various Thicknesses of Hadfield Manganese Steel
to Perforation by Various Projectiles

1. At the request of the Office, Chief of Ordnance¹, samples of Hadfield manganese steel, of various thicknesses, have been subjected to tests at this arsenal with various fragment-simulating projectiles.

2. As indicated in earlier work at this arsenal² variations in the quality of Hadfield manganese steel may well be reflected in the resistance characteristics of the material. Although no metallurgical investigation of the subject samples was made it is apparent from certain discrepancies in the resistance of various samples that the quality of the pieces was not constant.

3. Samples, after thickness and hardness measurement, were clamped rigidly to wooden ballistic frames and impacted fairly with appropriate projectiles. The projectiles used were the cal. .30 fragment-simulators, G-1-S and G-1-A;³ the cal. .22 fragment-simulator, G-2;⁴ the cal. .45 steel-jacketed ball projectile; the cal. .30 ball projectile M2 and the cal. .30 carbine ball projectile. The results of the tests appear in Table I.

4. Examination of this table discloses several discrepancies. Outstanding is the difference between the ballistic limits of samples 12D-1 and 12D-2, nominally of the same quality, and actually of the same thickness and hardness under impact of the cal. .30 carbine ball projectile. Remarkable also is the very slight difference in resistance to perforation by the cal. .30 ball M2 projectile between the .052"/.053" samples 12B-2 and 12B-3 and the .063" samples 12C-1 and 12C-2.

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1. O.O. 422.3/100 - Wtn 422/9
 2. WAL 710/568
 3. WAL 762/247(c)
 4. WAL 762/253(c)

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5. Material of this type of constant good quality would be expected to show an orderly increase in resistance as its thickness increased, and at any one thickness would be expected to exhibit consistent resistance characteristics against any one projectile. The above results indicate that the quality of the subject samples is somewhat variable and demonstrate the need of rigid application of Specification AXS-1170 in the procurement of material intended for use as components of armor assemblies.

J. F. Sullivan

J. F. Sullivan
Asst. Engineer

APPROVED:

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TABLE I

Summary of Ballistic Tests Conducted at Watertown Arsenal
on Samples of Hadfield Manganese Steel Submitted by
Carnegie-Illinois Steel Corporation

Sample No.	Actual Gauge	Hardness	Ballistic Limits					
			G-1-S ¹	G-1-A ²	G-2 ³	.45 ⁴	.30 Ball ⁵	.30 Carb. ⁶
12-1	.032"	83Rb	815	--	1215	--	--	--
12-2	.032"	85Rb	--	--	--	704	--	--
12A-1	.041"	85Rb	995	--	1600	--	--	--
12A-2	.041"	83Rb	--	--	--	946	--	--
12A-3	.041"	82Rb	--	--	--	--	1040	1248
12B-1	.053"	90Rb	--	--	--	1096	--	--
12B-2	.053"	91Rb	--	--	--	--	1229	1375
12B-3	.052"	91Rb	--	--	--	--	1261	1410
12B-4	.052"	90Rb	--	--	--	1100	--	--
12B-5	.053"	91Rb	1425	--	--	--	--	--
12B-6	.052"	90Rb	--	560	1780	--	--	--
12C-1	.063"	89Rb	--	--	--	1266	1270	1448
12C-2	.063"	87Rb	--	--	--	--	1265	1476
12D-1	.069"	90Rb	--	--	--	--	1344	1618
12D-2	.069"	90Rb	--	--	--	--	--	1433
12E-1	.079"	89Rb	--	--	--	--	1498	1544
12E-2	.080"	89Rb	--	--	--	--	--	1503

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1. Cal. .30 fragment-simulating projectile - 34 grains
 2. Cal. .30 fragment-simulating projectile - 150 grains
 3. Cal. .22 fragment-simulating projectile - 17 grains
 4. Cal. .45 steel-jacketed ball projectile - 230 grains
 5. Cal. .30 ball M2 projectile
 6. Cal. .30 carbine ball projectile