

U.S. NAVY TESTS OF 14" MARK 16 MOD 4 AP PROJECTILES VERSUS CLASS "A" ARMORS

<u>PLATE</u> <u>ID #</u>	<u>T</u> <u>(Inch)</u>	<u>OB</u> <u>(°)</u>	<u>S.V.</u> <u>(F/S)</u>	<u>RESULTS</u>	<u>REMARKS</u>
<i>New Armor Acceptance (Proof) Tests:</i>					
<B>5A323A1	11.84	35	1637	IP-NBe	
Ditto	11.75	31	1533	IP-NBi	
<B>5J686A1	11	35.5	1559	IP-NBe	
<B>5J498A1	11	35	1535	IP-E	
<M>6632	9.66	35	1363	CP-X	
<B>5B764A1	9.66	35	1386	IP-NBe	Plate holed
<B>2B213A1	9.56	35	1375	IP-NBe	
<C>EE122	9.56	35	1362	IP-NBe	
<M>9234	9.18	34.5	1340	IP-NBe	
<B>6B181A1	17.92	28	1984	CP-E	Barbette (curved) plate; 3 impacts; no projectile breakage
<B>6B288A1	17.78	29.5	2153	PP-X	Retest plate for lot with 6B181A1 above; passed
Ditto	17.6	28.5	2021	CP-NXi	
Ditto	17.78	29	1924	CP-NBi	
Ditto	17.74	30	1810	IP-NBi	
<B>6C020A1	17.61	29	1969	IP-BFe	Barbette plate; button started
Ditto	17.5	30	2125	CP-BBe	
<C>EE694	17.37	29.5	2061	CP-NBe	Barbette plate; 2 impacts; not enough projectile breakage
<C>EE747	17.5	30	2121	IP-NXi	Retest plate for lot with EE694 above; passed; 2 impacts
<B>2B583A1	17.5	30	2146	CP-BFe	Barbette plate
Ditto	17.5	30	1991	IP-NBe	
<B>6B190A1	17.43	29.5	2090	IP-X	Barbette plate
Ditto	17.5	28.5	2070	CP-BFe	
Ditto	17.3	30	1984	IP-X	
<B>1B385A1	17.36	29.5	2102	IP-NBe	Barbette plate
Ditto	17.22	27.5	2018	CP-NCe	
<M>6727	17.08	29	2038	CP-NR	Barbette plate; no test (projectile damage not determined)
<M>6741	16.93	29.5	2068	CP-NR	Retest plate for lot with 6727 above; no test again
Ditto	17.23	29.5	2086	IP-NBe	Passed
<B>4A288A1	17.08	29.5	2052	CP-NBi	Barbette plate; low NBL
<B>4A279A1	17.08	30.x	2085	IP-NBi	Retest plate for lot with 4A288A1 above; passed
Ditto	17.08	30.x	2119	CP-B2i	
<C>EE125	15.26	32	1929	CP-NBe	Barbette plate
<C>JJ63	13.55	29	1684	IP-NBi	2 impacts
<C>EE90	12.56	30	1615	IP-NBi	
<B>2A642A1	12.5	31	1625	IP-NBe	
<B>4A712A1	12.46	31	1586	IP-NBe	
<B>2B160A1	12.46	30	1595	IP-NBe	Plate holed
<M>6711	12.25	30	1585	IP-NBe	
<M>7596	12.18	30	1573	IP-NBe	Plate holed
<M>6704	12.18	30.5	1578	IP-NBi	
<B>1B134A1	12.18	30	1563	IP-NBe	Plate holed
<M>8600	12	30.5	1556	IP-NBi	Barbette plate; plate holed
<C>EE161	11.38	31	1492	IP-NBe	
<C>EE273	11.34	29.5	1470	IP-NBe	Plate holed

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<i>New Armor Acceptance (Proof) Tests (Continued):</i>					
<M>8915	11.06	30.8	1444	IP-NXe	Barbette plate
Ditto	11.03	30	1437	CP-NXe	
<B>3B187A	17.68	27.5	2032	CP-NBi	Barbette plate; barely over NBL
<M>7596	12.32	25	1462	CP-E	Barely over limit
<M>7016	12.32	25	1485	IP-E	Plate holed
<C>EE548	12.18	24.5	1447	IP-NBe	
<M>8039	11.76	25	1435	IP-E	Plate holed
<B>8915	17.3	15	1820	CP-BFe	Barbette plate; barely over NBL
Ditto	17.43	15	1710	IP-E	
Ditto	17.36	29.5	2102	IP-NUe	2 impacts
<M/B>4077	13.5	30	2007	CP-BBe	Projectile acceptance test
Ditto	13.5	30	2018	CP-NBe	Ditto
<M/B>4053	13.5	30	1985	CP-BDe	Ditto
<i>Experimental Projectile &amp; Armor Tests:</i>					
<B>4C209A1	9.81	35	1387	IP-NBi	33% face; TS=98000psi; grooves in back surface; button thrown
Ditto	9.84	36	1409	CP-NBe	2 impacts
<B>53C078A1	9.69	35	1355	CP-NBe	Original plate: 43.5% face; TS=91000psi
Ditto	9.65	35	1395	IP-NBe	Retreated plate: 62% face; TS=108000psi; plate holed; 2 impacts
<B>3B642A1	9.63	34.5	1369	CP-NBe	Original plate: 36% face; TS=92000psi
Ditto	9.8	35	1396	IP-NBi	Retreated plate: 68.5% face; TS=94500psi; 2 impacts
Ditto	9.74	35	1425	CP-NBi	Ditto
<C>EE537	9.66	34	1369	IP-NBe	50% face; plate holed
<B>34C250A1	9.56	35.5	1344	CP-BDe	Original plate: 39% face; TS=91000psi
Ditto	9.21	34	1302	IP-NBe	Retreated plate: 76% face; TS=98000psi
Ditto	9.52	34	1356	CP-NBe	Ditto
<C>EE940	17.32	30	2110	IP-X	Barbette plate; 49.5% face; TS=100000psi; 2 impacts
Ditto	17.36	30	2163	CP-BDe	
<C>EE183	17.19	28.5	2068	CP-NR	Barbette plate; 40% face
<B>3B253A1	16.3	30	2002	CP-NR	Barbette plate
<M>6156	14.81	30	1843	SIP-NBe	53% face; TS=97000psi; cemented layer about 1.5" thick
Ditto	15.06	30	1988	CP-E	
<C>EE879	13.13	30	1685	IP-NBe	Barbette plate; 49% face; 2 impacts
<C>EE829	12.38	29	1612	IP-NBe	48% face; plate holed
<M>7331	11.97	31	1576	IP-NBe	50% face; plate holed
<B>5A306A1	11.37	20	1392	CP-E	48% face
Ditto	11.37	30	1578	IP-NBe	
Ditto	11.44	30	1654	CP-NBi	
Ditto	11.24	35	1680	IP-X	2 impacts
<M>8558	10.68	31	1422	CP-NBi	Barbette plate; 49.5% face; retreated plate
<M/B>4126	13.5	30	1789	CP-BBe	Midvale test projectile with 15% AP cap
<M/B>4233	13.5	30	1800	IP-NBe	Cr-Ni-Mo alloy test projectile
Ditto	13.5	30	1830	CP-BBe	Midvale test projectile with 15% AP cap
<M/B>4441	13.5	30	1819	CP-E	Test projectile with 10% AP cap & decreased depth of body hardness
Ditto	13.5	29.5	1815	CP-BCi	Midvale test projectile with 15% AP cap

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KEY:

<B> = Bethlehem  
<C> = Carnegie-Illinois  
<M> = Midvale  
<M/B> = Bethlehem Thin Chill (15-20% face) 1921-25 Class "A" armor made by Midvale under license

RESULTS = AA-BBc

AA = CP = Complete penetration (nose, body, and base of projectile passed entirely through plate)  
AA = IP = Incomplete penetration (no part of projectile behind plate; may or may not make a hole in plate)  
AA = PP = Partial penetration of broken/shattered projectile (upper body/nose if under 45 degrees obliquity)  
AA = SIP = Stuck In Plate = Projectile punched hole in plate and remained imbedded (damaged or intact)

BB = B2 = Projectile broke into 2 big pieces roughly in the middle (usually exposes filler cavity)  
BB = BB = Body bent roughly in the middle  
BB = BF = Base flattened on side where it hit plate face  
BB = BD = Body dented/gouged on one side where it hit plate face  
BB = NU = Nose upset/compressed  
BB = NO = Nose offset/bent  
BB = NB = Nose broken off of projectile (as one piece or into several large pieces)  
BB = BC = Base cracked  
BB = NC = Nose cracked  
BB = NX = Nose shattered/chewed off (broken into small pieces)  
BB = X = Projectile nose and body shattered into many pieces (projectile rendered ineffective)  
BB = E = Projectile intact with no significant damage ("excellent")  
BB = NR = Not recovered (penetrating projectile ended up in Potomac River and was not found)

(Note that more than one can happen simultaneously, but Dr. Hershey only listed worst projectile damage.)

c = e = Projectile filler cavity remains intact, fuze undamaged, and base plug still tight ("effective")  
c = i = Projectile filler cavity no longer intact or base plug &/or fuze damaged or knocked out  
("ineffective") (U.S. Explosive "D" filler is absolutely inert under all impact conditions)

Plug Out = Base plug and fuze torn out of projectile due to damage  
Base Ring Off = Projectile base enclosing base plug torn off at driving band score (usually projectile was rendered ineffective--British Hadfield Relief Base Plug designed to correct this problem)  
Button Thrown = Plate holed and armor plug punched out plate back during an IP or PP impact (always if CP)  
Button Started = Plate holed, but armor plug still partially attached to plate back (IP only)

Face depth percentage is to point where ductile back and face merge, measured from face surface  
Average U.S. Navy post-1930 'Thick Chill' Class "A" armor has about 55% face depth (thickest in WWII)  
Tensile Strength (TS) is the average normal to the plate back surface at the back surface