ARMOR PENETRATION BALLISTICS ACCEPTANCE TEST SPECIFICATIONS FOR U.S. NAVY AP PROJECTILES FROM U.S. NAVY BUORD ORDNANCE SPECIFICATION O.S. 696 “ARMOR-PIERCING PROJECTILES”, APPENDICES #1-10

(FINAL REVISION “J” OF 10 JUNE 1943)

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# BASIC BALLISTIC TEST REQUIREMENTS:

In all projectile tests against armor, projectile must completely penetrate the armor plate specified at the obliquity and striking velocity specified with no damage that would reduce the explosive effectiveness of the projectile after penetration (no cracking into or breakage open of the explosive cavity, the base plug still seated tightly, and the fuze still functional--this last was determined in these fuze-less tests by examining the distortion/cracking/breakage of the lower projectile body and base plug after the test).

The tables below give the range of acceptable possible test conditions: Striking Velocities (Vs) in feet/second for given plate thicknesses and impact obliquities (Ob), where right-angles is Ob=0 degrees. Which one to use was determined by the U.S. Naval Proving Ground ballistic test controller at the time of the test.

Only 1 failure allowed in the 3 projectiles fired (retest possible if allowed by test controller).

# 3” AP PROJECTILES MARKS 29 (13.07 LB) & 30 (12.96 LB):

Some Mark 29 & 30 projectiles had no filler or fuze. US Army M66 0.016-delay fuze was used when filler added.

In 10,000 projectile lots (except for initial lots, as specified by BuOrd).

3 projectiles for ballistic test from each lot;

1 projectile for fragmentation test from 1st lot only (unless further tests needed for some reason);

12 projectiles for flight test from 1st lot of new contract (range table verification) and 6 for flight test from each 5th lot thereafter (quality control).

Maximum Striking Velocity (Vs) in any test was 2,550 ft/sec.

**Ballistic Test Against Class “B” Armor (Vs = ft/sec):**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Plate Thickness** | **Obliquity** | | | |
| Normal | 20º | 30 º | 40 º |
|  |  |  |  |  |
| 1.5” | --- | --- | --- | 1,480 |
| 2.0” | --- | --- | 1,620 | 1,860 |
| 2.5” | --- | 1,730 | 1,930 | 2,240 |
| 3.0” | 1,820 | 2,000 | 2,240 | --- |
| 3.5” | 2,050 | 2,270 | 2,550 | --- |
| 4.0” | 2,280 | 2,540 | --- | --- |
| 4.5” | 2,500 | --- | --- | --- |

**Ballistic Test Against Class “A” Armor\* @ 20° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 2.5” | 1,730 |
| 3.0” | 2,000 |
| 3.5” | 2,270 |

NOTE: The Class “A” armor used here was NOT regular U.S. Navy WWII ‘Thick Chill’ Class “A” armor, which was not made in thicknesses under 4” (thinnest part of a 4-6” tapered cruiser belt armor plate) or 5” (uniform-thickness cruiser armor plate). The armor in these tests was US Army light-tank-and-armored-car-type face-hardened chromium-nickel armor which was made using a form of the Harvey process with a cemented (high-carbon- content layer) extremely hard face about 1-1.5” thick and a ductile homogeneous-armor-type normal-carbon-content back layer with a step-function hardness drop at the back of the hard face (no gradual softening in a thick face layer behind the cemented surface layer, as with usual Navy Class “A” armor).

# 6” AP PROJECTILE MARK 35 (130 LB):

In 500 projectile lots (except for initial lots, as specified by BuOrd).

3 projectiles for ballistic test from each lot;

1 projectile for fragmentation test from 1st lot only (unless further tests needed for some reason);

12 projectiles for flight test from 1st lot of new contract (range table verification) and 6 for flight test from each 5th lot thereafter (quality control).

Maximum striking velocity in any test was 2,200 ft/sec.

**Ballistic Test Against Class “B” Armor @ 50° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 1.5” | 930 |
| 2.0” | 1,140 |
| 2.5” | 1,340 |

**Ballistic Test Against Class “A” Armor @ 30° Obliquity**\***:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 3.5” | 1,280 |
| 4.0” | 1,410 |
| 4.5” | 1,550 |
| 5.0” | 1,680 |

These Class “A” tests above were shifted up by Revision “J” due to a 1.025% average resistance increase in the quality of Class “A” armor.

\*See NOTE for 3” Marks 29 & 30 Class “A” ballistic tests concerning use of Army-type Class “A” armor under 4” thick.

# 8” AP PROJECTILES MARKS 19 (260 LB) & 20 (261 LB):

Mark 19 was primarily for guns in older heavy cruisers prior to the BALTIMORE Class (could be used in all U.S. Navy 8” guns, if needed, though). Similar Mark 20 was for U.S. Army 8” Coast Artillery guns (8” Field Artillery did not use AP projectiles), but Navy guns could fire them.

In 500 projectile lots (except for initial lots, as specified by BuOrd).

3 projectiles for ballistic test from each lot;

1 projectile for fragmentation test from 1st lot only (unless further tests needed for some reason);

6 projectiles for flight test from 1st lot of new contract (range table verification) and 3 for flight test from each 5th lot thereafter (quality control).

Maximum striking velocity in any test was 2,500 ft/sec.

**Ballistic Test Against Class “B” Armor @ 50° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 2.5” | 1,160 |
| 3.0” | 1,350 |
| 3.5” | 1,520 |

**Ballistic Test Against Class “A” Armor @ 30° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 5.0” | 1,460 |
| 5.5” | 1,560 |
| 6.0” | 1,670 |
| 6.5” | 1,770 |

These Class “A” tests above were shifted up by Revision “J” due to a 1.025% average resistance increase in the quality of Class “A” armor.

# 8” AP PROJECTILE MARK 21 (335 LB):

These were for the new BALTIMORE and DES MOINES Class heavy cruiser guns only. They were too long and heavy for the older cruisers’ magazines.

In 500 projectile lots (except for initial lots, as specified by BuOrd).

3 projectiles for ballistic test from each lot;

1 projectile for fragmentation test from 1st lot only (unless further tests needed for some reason);

6 projectiles for flight test from 1st lot of new contract (range table verification) and 3 for flight test from each 5th lot thereafter (quality control).

Maximum striking velocity in any test was 2300 ft/sec.

**Ballistic Test Against Class “B” Armor @ 50° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 2.5” | 1,040 |
| 3.0” | 1,190 |
| 3.5” | 1,330 |

**Ballistic Test Against Class “A” Armor @ 30° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 5.0” | 1,290 |
| 5.5” | 1,380 |
| 6.0” | 1,470 |
| 6.5” | 1,570 |

These Class “A” tests above were shifted up by Revision “J” due to a 1.025% average resistance increase in the quality of Class “A” armor.

# 12” AP PROJECTILE MARK 18 (1,140 LB) (NEW IN REV. “J”):

These were for new ALASKA Class cruiser guns only. The remaining 12”-gunned battleships still used their old 12” Mk 15 MOD 6 “Midvale Unbreakable” (1916-vintage) shells, usually with new Mk 21 Base Detonating Fuzes.

In 500 projectile lots (except for initial lots, as specified by BuOrd).

3 projectiles for ballistic test from each lot;

1 projectile for fragmentation test from 1st lot only (unless further tests needed for some reason);

6 projectiles for flight test from 1st lot of new contract (range table verification) and 3 for flight test from each 5th lot thereafter (quality control).

Maximum Striking Velocity in any test was 2,300 ft/sec.

**Ballistic Test Against Class “B” Armor @ 50° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 4.0” | 1,090 |
| 4.5” | 1,190 |
| 5.0” | 1,300 |

**Ballistic Test Against Class “A” Armor @ 35° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 9.0” | 1,580 |
| 10.0” | 1,720 |
| 11.0” | 1,870 |
| 12.0” | 2,010 |
| 13.0” | 2,160 |

# 14” AP PROJECTILE MARKS 16 & 20 (1,500 LB):

Mark 20 had a short windscreen for TEXAS Class magazines.

In 500 projectile lots (except for initial lots, as specified by BuOrd).

3 projectiles for ballistic test from each lot;

1 projectile or fragmentation test from 1st lot only (unless further tests needed for some reason);

6 projectiles for flight test from 1st lot of new contract (range table verification) and 3 for flight test from each 5th lot thereafter (quality control).

Maximum Striking Velocity in any test was 2,500 ft/sec.

**Ballistic Test Against Class “B” Armor: NONE**

**Ballistic Test Against Class “A” Armor @ 35° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 11.0” | 1,810 |
| 12.0” | 1,940 |
| 13.0” | 2,080 |
| 14.0” | 2,210 |
| 15.0” | 2,340 |
| 16.0” | 2,480 |

NOTES:

1. From 1941-43 (NOT Rev. “J”) ballistic acceptance tests were allowed for 14” Mark 16 Mods 7-8 AP projectiles using 1922-25-vintage 13.4-13.8” Midvale-manufactured (under license) very-thin-faced “Bethlehem Thin Chill” (BTC) Class “A” armor at 40° obliquity at Striking Velocities similar to the 13.0” and 14.0” Class “A” WWII plate velocities given above.
2. Also, a number of tests used these Midvale BTC plates for Mark 16 Mods 1-6 projectiles at both 40° & the regular 35° and similar-vintage thicker-faced “Carnegie-Krupp Cemented” (CKC) Class “A” plates for Marks 16 & 20 projectiles at the regular 35°.

# 16” AP PROJECTILE MARKS 5 & 12 (2,240 LB):

Mark 5 were for COLORADO Class guns. Mark 12 were almost identical projectiles for US Army Coast Defense guns (different fuzes and no-dye-bag windscreens). Later, some Mark 12 projectiles were changed back to Navy-standard Mark 5 Mod 6 projectiles with Navy Mk 21 Base Detonating Fuzes.

In 500 projectile lots (except for initial lots, as specified by BuOrd).

3 projectiles for ballistic test from each lot;

1 projectile for fragmentation test from 1st lot only (unless further tests needed for some reason);

6 projectiles for flight test from 1st lot of new contract (range table verification) and 3 for flight test from each 5th lot thereafter (quality control).

Maximum striking velocity in any test was 2,400 ft/sec.

**Ballistic Test Against Class “B” Armor: NONE**

**Ballistic Test Against Class “A” Armor @ 35° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 11.0” | 1,620 |
| 12.0” | 1,730 |
| 13.0” | 1,850 |
| 14.0” | 1,970 |
| 15.0” | 2,090 |
| 16.0” | 2,210 |
| 17.0” | 2,330 |

NOTE: Previously (NOT Rev. “J”), acceptance tests using 13.4-13.8” Midvale BTC & Carnegie CKC plates (see NOTE for 14” Marks 16 and 20) were done at 35° with velocities similar to the 13” & 14” values, above. Also, for some Mark 12 lots, tests with Midvale BTC at 40° similar to the 14” Mark 16 Mods 7-8 acceptance tests were done at velocities close to the above 14” & 15”.

# 16” AP PROJECTILE MARK 8 (2,700 LB):

These were for the new 16”/45 & 16”/50 “light-weight” guns only. At 4.5-calibers in length, they were too long for the COLORADO Class magazines.

In 500 projectile lots (except for initial lots, as specified by BuOrd).

3 projectiles for ballistic test from each lot;

1 projectile for fragmentation test from 1st lot only (unless further tests needed for some reason);

6 projectiles for flight test from 1st lot of new contract (range table verification) and 3 for flight test from each 5th lot thereafter (quality control).

Maximum striking velocity in any test was 2,400 ft/sec.

**Ballistic Test Against Class “B” Armor: NONE**

**Ballistic Test Against Class “A” Armor @ 35° Obliquity:**

|  |  |
| --- | --- |
| **Plate Thickness** | **Striking Velocity (ft/sec)** |
|  |  |
| 11.0” | 1,490 |
| 12.0” | 1,600 |
| 13.0” | 1,700 |
| 14.0” | 1,810 |
| 15.0” | 1,910 |
| 16.0” | 2,020 |
| 17.0” | 2,130 |

NOTE: Previously (NOT Rev. “J”), many acceptance tests using 13.4-13.8” 1922-25 Midvale BTC plates and Carnegie CKC plates (see NOTE for 14” Marks 16 and 20) were done at 35° obliquity with velocities similar to the 13.0” & 14.0”, above. No 40° obliquity tests using Midvale BTC plates were ever done with these projectiles.