**REVISIONS TO INFORMATION PROMULGATED BY BRITISH ADMIRALTY ARMOUR TECHNICAL COMMITTEE MEETING OF 22 JULY 1948**

**(British PRO/TNA Document ADM 281/127 ACSIL/ADM/48/919c (SECRET))**

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# ITEM #4: GERMAN ARMOUR

The information contained in the tables accompanying this set of minutes for U.S. Naval Proving Ground (NPG) tests of German Krupp KC n/A (U.S. Navy Class “A” type) and Wh (U.S. Navy Class “B”/STS type) armors in 1946-47 is incorrect. I have some of the same results direct from U.S. Navy N.P.G. sources that allow me to adjust the table to match correct data. The problem is that the projectiles called out in the German Armor U.S. Navy Test Results table in the British document are wrong for the most part and even when correct, the computations to give the correct velocities were done wrong in most cases. The following document corrects these errors.

The calculations are based on the U.S. Navy ‘Standard’ Major-Caliber (6” AP projectiles and up) Armor Penetration Formula and data set developed in 1931 by Dr. L.T.E. Thompson of the U.S. N.P.G. Armor and Projectile Laboratory. The basic generic formula is called the Thompson “F” Formula and it is given as follows:

V = T.5\*D\*F/[(41.57\*W.5\*COS(O)]

where

F = Velocity Adjustment “Fudge-Factor” (Plate+Projectile Quality Adjustment)

V = Computed Impact Velocity in feet/second using given “F” value

T = Plate Actual Thickness at center of impact in inches

D = Projectile Diameter (usually nominal gun bore diameter) in inches

W = Projectile Total Weight at impact in pounds

O = Impact Obliquity Angle in degrees (zero is normal or right-angles to plate face)

In many cases, V is known and F is computed by rearranging the formula. By using F values instead of V values, small differences in plate and projectile and impact conditions can be adjusted for with negligible effects on the meaning of the results, which makes analysis much easier. F is always in the range of 10,000-99,000, usually near the center of this range.

To allow penetration to be evaluated and estimated, Dr. Thompson also created at the same time a specific formula for computing “F” values from projectile, plate, and impact data based on tests of the very similar post-WWI U.S. Navy BuOrd Class “B” and BuC&R (later, BuShips) Special Treatment Steel (STS) homogeneous, ductile thin and deck armors (equivalent to British “Non-Cemented Armour”) hit by the U.S. Navy 8” AP Mark 11 Mod 1 projectile (the first of the “Midvale Unbreakable” AP projectiles, introduced in 1911 and made by the U.S. Midvale Company – one of the three major makers of armor and projectiles for the U.S. Navy during most of the Age of Ironclads) from 0º to 75º obliquity. The result in velocity terms was known as the U.S. Navy Ballistic Limit (NBL) where the standard projectile was estimated to barely pass entirely through the plate (“perforation”); at under 45º obliquity, with no remaining velocity afterwards. The ‘Standard’ “F”-value used to compute the NBL form of V is found by the formula

F = 6\*[(T/D) - 0.45]\*[O2 + 2000] + 40,000

The condition of the projectile after the penetration is not given by this formula. Also, though the values are supposed to be for Class “B”/STS tests, the NBL computed was also used for tests of U.S. Navy Class “A” face-hardened armor (equivalent more-or-less to British “Cemented Armour”) to act as a comparative standard, though of less actual meaning without interpretation. The results of tests were in many cases, as in this British document, given as “% NBL” values, where the ‘imaginary’ 100% NBL value is the value of V computed from the above Standard “F” equation applied to the generic “F” Formula. This allows “quick-and-dirty” quality comparisons between similar plates prior to a detailed analysis using the “F” values themselves.

It is of course necessary to have the projectile diameter, projectile actual total weight, plate thickness, obliquity angle, and either the “F” or V value, depending on the direction of the calculation, to get any results. The British document had incorrect U.S. AP projectile weights and also made some calculation errors even when the weights were correct in several cases. I have fixed all of this.

The projectiles actually used in the U.S. tests were:

# KC n/A Armor Test Projectiles:

335-lb 8” AP Mark 21 Mod 5 with a super-hard 650-680 Brinell AP cap ( 271.9 lb w/o cap)

1,140-lb 12” AP Mark 18 Mod 1 (ALASKA Class cruiser guns only) (1,002.1 lb w/o cap)

1,500-lb 14” AP Mark 16 Mod 8 (best all-round AP projectile I know of) (1,312.5 lb w/o cap)

# Wh Armor Test Projectiles:

335-lb 8” AP Mark 21 Mod 3 with Navy standard 555-583 Brinell AP cap ( 271.8 lb w/o cap)

12” and 14” AP projectiles are the same as for KC.

No 260-pound 8” AP projectiles (Mark 19 or 20 used by older 8”-gunned U.S. cruisers that could not handle the new, extra-heavy, extra-long Mark 21 AP projectiles) or 870-pound 12” AP projectiles (obsolete WWI 12” Mark 15 Mod 6 “Midvale Unbreakable” projectiles only) were used in these tests. This is the primary British information error – they either were not told or did not understand about the new U.S. 8” and 12” gun ammo. The 8” projectiles' AP cap hardness had noticeable effects here, which is why the improved Mk 21 MOD 5 projectile was used against the KC armor.

Note that a few German plates were so poor compared to the US comparison plates that it was decided that it was not worth finding out how bad they really were, so they merely have “Under XXXX” velocity values, if necessary using the adjustments of the “F” value to calculate the equivalent NBL for a US armor plate of that thickness when a close thickness match was not possible, such as the 11.5” Wh plate (no US Navy STS or Class “B” plate of that thickness was made – after 1930, at least), with 10.7” being the closest US match.

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Please adjust the data you use from the Title British Public Records Office (PRO – now renamed The National Archives (TNA)) Document according to the above and following information.

# THE NEW RESULTS

All “NBL” values computed by the ‘Standard’ “F” equation applied to the generic “F” Formula.

**Corrected 8” Projectile (MOD 5) KC n/A Test Results at 30**º **Obliquity:**

7.6” U.S. Class “**A**” Plate (“best plate” ref): 1,826 ft/sec (112% of 1,630 ft/sec NBL)

(This Carnegie plate was a non-cemented experimental plate; only a deep face chill applied.)

8.5” **KC n/A** Plate (nominal, actual 21.5cm): 2,026 ft/sec (113% of 1,793 ft/sec NBL)**!**

**Corrected 8” Projectile (MOD 3) Wh Test Results at 35**º **Obliquity:**

7” U.S. Class “**B**” Plate (“average plate” ref): 1,728 ft/sec (105.5% of 1,638 ft/sec NBL)

7” **Wh** Plate (nominal, actual 17.5cm): 1,720 ft/sec (105% of 1,638 ft/sec NBL)**$**

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**Corrected 12” Projectile KC n/A Test Results at 35**º **Obliquity:**

8.5” U.S. Class “**A**” Plate (“average plate” ref): 1,328 ft/sec (97% of 1,369 ft/sec NBL)

9” U.S. Class “**A**” Plate (“average plate” ref): 1,391 ft/sec (97% of 1,434 ft/sec NBL)

9.5” U.S. Class “**A**” Plate (“average plate” ref): 1,454 ft/sec (97% of 1,499 ft/sec NBL)

10” U.S. Class “**A**” Plate (“average plate” ref): 1,518 ft/sec (97% of 1,565 ft/sec NBL)

9” U.S. Class “**A**” Plate (“best plate” ref): 1,477 ft/sec (103% of 1,434 ft/sec NBL)

9.5” U.S. Class “**A**” Plate (“best plate” ref): 1,574 ft/sec (105% of 1,499 ft/sec NBL)

8.5” **KC n/A** Plate (nominal, actual 21.5cm): 1,335 ft/sec (97.5% of 1,369 ft/sec NBL)**$**

10” **KC n/A** Plate (nominal, actual 25cm): 1,667 ft/sec (106% of 1,565 ft/sec NBL)**!**

**Corrected 12” Projectile Wh Test Results at 35**º **Obliquity:**

10.7” U.S. Class “**B**” Plate (“average plate” ref): 1,612 ft/sec (97.2% of 1,658 ft/sec NBL)

10.7” U.S. Class “**B**” Plate (“best plate” ref): 1,724 ft/sec (104% of 1,658 ft/sec NBL)

11.5” **Wh** Plate (nominal, actual 29cm): Under 1,656 ft/sec (<93.9% of 1,764 ft/sec NBL)**#**

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10” U.S. Class “**A**” Plate (“average plate” ref): 1,317 ft/sec (87% of 1,514 ft/sec NBL)

10” U.S. Class “**A**” Plate (“best plate” ref): 1,363 ft/sec (90% of 1,514 ft/sec NBL)

10” **KC n/A** Plate (nominal, actual 25cm): Under 1,241 ft/sec (<82% of 1,514 ft/sec NBL)**#**

**Corrected 14” Projectile KC n/A Test Results at 30**º **Obliquity:**

13.5” U.S. Class “**A**” Plate (“average plate” ref): 1,625 ft/sec (90% of 1,806 ft/sec NBL)

17” U.S. Class “**A**” Plate (“average plate” ref): 1,978 ft/sec (90% of 2,198 ft/sec NBL)

13.5” U.S. Class “**A**” Plate (“best plate” ref): 1,680 ft/sec (93% of 1,806 ft/sec NBL)

17” U.S. Class “**A**” Plate (“best plate” ref): 2,110 ft/sec (96% of 2,198 ft/sec NBL)

14” **KC n/A** Plate (nominal, actual 35cm): 1,762 ft/sec (95% of 1,855 ft/sec NBL)**!**

15” **KC n/A** Plate (nominal, actual 38cm): 1,919 ft/sec (97.5% of 1,968 ft/sec NBL)**!**

**Corrected 14” Projectile Wh Test Results at 30**º **Obliquity:**

12” U.S. Class “**B**” Plate (“average plate” ref): 1,551 ft/sec (94.7% of 1,638 ft/sec NBL)

17.5” U.S. Class “**B**” Plate (“average plate” ref): 2,066 ft/sec (91.6% of 2,256 ft/sec NBL)

13.2” U.S. Class “**B**” Plate (“best plate” ref): 1,747 ft/sec (99% of 1,765 ft/sec NBL)

17.5” U.S. Class “**B**” Plate (“best plate” ref): 2,090 ft/sec (95% of 2,256 ft/sec NBL)

12” **Wh** Plate (nominal, actual 30cm): 1,468 ft/sec (89.6% of 1,638 ft/sec NBL)**#**

17.5” **Wh** Plate (nominal, actual 45cm): Under 2,001 ft/sec (<88.7% of 2,256 ft/sec NBL)**#**

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**KEY:** **$** = German plate approximately ***the same*** as closest US armor (1 KC and 1 Wh plate)

**#** = German plate significantly ***inferior*** to closest US armor (1 KC and 3 Wh plates)

**!** = German plate significantly ***superior*** to closest US armor (4 KC and 0 Wh plates)