

# **Chapter 10**

## **Tank Casualties**

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Analysis of 75 mm Sherman Tank Casualties 6th June to 10th July 1944  
(Report No.12)

Analysis of German Tank Casualties in France 6th June to 31st August 1944  
(Report No.17)



# Analysis of 75 mm Sherman Tank Casualties Suffered Between 6th June and 10th July 1944

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## 1. Introduction

The following survey of 75 mm Sherman tank casualties suffered in NORMANDY between 6th June and 10th July deals only with casualties and not with terrain, extent of enemy opposition, etc.

General information on tank casualties is collected by REME on such subjects as total number of tanks damaged, total brew-ups and the seriousness of the damage inflicted, but at the suggestion of SD 2nd Army, more data was collected; in particular the number of hits to knock out a tank, the number of hits which have failed to penetrate, the proportion on front, sides and rear and their angles of penetration.

In order to obtain this information a representative sample of tank casualties was taken from those fronts where 75 mm Sherman tanks fought between 6th June and 10th July, data being collected both from recovered and unrecovered vehicles. To test that the evidence was, as far as possible, representative, the proportion within the sample of brew-ups, mined tanks and AP casualties was also found and this proportion compared with that given by AFV (Tech) and REME, 2nd Army, who had access on these points to all 75 mm Sherman tank casualties. Agreement was good so that any further evidence given in this report on angles of penetration, etc., can justifiably be assumed typical till proved otherwise.

## 2. Data Collected

The data collected is given in the following table:

| <b>Analysis of Sherman Casualties</b>            |                           |     |
|--|---------------------------|-----|
| (i) Total tank casualties analysed:              | 45                        |     |
|  | Proportion of total tanks |     |
| (a) Number penetrated by German AP shot          | 40                        | 89% |
| (b) Number mined                                 | 4                         | 9%  |
| (c) Number damaged, unidentified but "brewed up" | 1                         | 2%  |
| (ii) Total "Brewed up"                           | 37                        | 82% |
| (a) Number penetrated by shot and "brewed up"    | 33                        | 73% |
| (b) Number mined and "brewed up"                 | 3                         | 7%  |
| (c) Number "brewed up" by unknown causes         | 1                         | 2%  |

(Note: In several cases it is difficult to distinguish between penetrations of 75 and 88 mm particularly after the tank had "brewed up." Too much reliance must not be placed on the proportion of such penetrations though the proportion given agrees well with the estimated occurrence of such guns given by GSI(A) 2nd Army, Main HQ)

Estimates by fighting soldiers were found to be unreliable since many reported they had been knocked out by 88 mm, when in fact it had been 75 mm shot, while the reverse mistake has not yet been discovered.

| (iii) Tanks penetrated by German AP shot               |                |                          |
|--|----------------|--------------------------|
|  | Number of hits | Proportion of total hits |
| A. (a) Total hits recorded                             | 65             |                          |
| (i) 75 mm  | 53             | 82%                      |
| (ii) 88 mm   | 12             | 18%                      |
| (b) Number of penetrations                             | 62             | 95%                      |
| (i) 75 mm penetrations                                 | 50             | 77%                      |
| (ii) 88 mm penetrations                                | 12             | 18%                      |
| (c) Number of failures to penetrate                    | 3              | 5%                       |
| (i) 75 mm failures                                     | 3              | 5%                       |
| (ii) 88 mm failures                                    | Nil            | 0%                       |
| (d) Average number of hits to knock out a Sherman tank | 1.63           |                          |
| (e) Proportion of hits which knock out a tank          | 62%            |                          |

| B. Distribution of Hits |       |       |      |       |
|-------------------------|-------|-------|------|-------|
|                         | Front | Sides | Rear | Total |
| Hull                    | 7     | 24    | 6    | 37    |
| Turret                  | 12    | 12    | 4    | 28    |
| Total                   | 19    | 36    | 10   | 65    |

| C. Distribution of Failures |       |       |      |       |
|-----------------------------|-------|-------|------|-------|
|                             | Front | Sides | Rear | Total |
| Hull                        | 0     | 0     | 0    | 0     |
| Turret                      | 1     | 1     | 1    | 3     |
| Total                       | 1     | 1     | 1    | 3     |

| D. Distribution of number of hits required to knock out each tank. |    |    |   |   |   |   |   |   |
|--|----|----|---|---|---|---|---|---|
| Number of hits   | 1  | 2  | 3 | 4 | 5 | 6 | 7 | 8 |
| Tanks knocked out  | 21 | 11 | 2 | 1 | - | - | - | 1 |

| E. Distribution of angles of penetration  |      |       |        |       |
|---|------|-------|--------|-------|
|   | 0-5° | 5-30° | 30-90° | Total |
| Hull  | 20   | 12    | 5      | 37    |
| Turret  | 12   | 11    | 2      | 25    |
| Total   | 32   | 23    | 7      | 62    |
| % Distribution  |      |       |        |       |
| Hull  | 32   | 19    | 8      | 59    |
| Turret  | 19   | 18    | 3      | 40    |
| Total   | 51   | 37    | 11     | 99    |
| F. A further study of tanks that had fought but had not been penetrated was also made |      |       |        |       |
| Total tanks inspected   | 124  |       |        |       |
| Hits failing to penetrate   | 8    |       |        |       |

### 3. Discussion

1. The proportion of brewed up tanks is high and it is therefore important to know whether or not this must always be the case. A more recent examination of later battles, which is not yet complete, has shown that the 1st Bn Coldstream Gds (5 Gds Armd Div) have suffered fewer brew ups than other units, e.g., during operation "BLUECOAT" only 1 in 20 casualties, of which casualties at least 12 were due to penetrations. The unit concerned attributes this to the fact that they carry no extra ammunition outside the armoured bins. It should be recognized that in no recorded case in our sample has the extra outside applique armour resisted any hit, and therefore the protection afforded by keeping all ammunition in the bins is almost certainly due solely to the internal flying fragments failing to penetrate the ammunition.

2. The small number of AP hits failing to penetrate is noticeable. This small number has been confirmed by the opinions of technical adjutants, etc., who agree that the proportion was probably not above 5%. This opinion is in keeping with the calculated expectations of failures based upon penetration figures for 75 mm and 88 mm guns at the ranges of engagement estimated by tank crews. There have also been complaints at the apparently low resisting power of the present Sherman armour. REME, 5 Gds Armd Div state that an AP.300 and an AP.500 Browning, both fired at 100 yds range, penetrated 1/2 and 1 1/2 inches respectively into the turret armour. Added to this, it is at present the practice to recondition for service partially brewed-up tanks whose quality of armour might often be low.

3. From the data collected, it will be seen that the proportion of hits on the sides and front of the 75 mm Sherman tank is more or less equal and therefore, for up-armouring to be effective, a large area would need to be strengthened. For instance, up-armouring the front of the tank so that in the cases considered it would have given 50% protection on this face, would only have decreased penetrations by 15%. In consequence, if changes are required it would appear wiser to use the extra weight-carrying of the 75 mm Sherman to take a better gun; i.e., to make German tanks more vulnerable rather than to attempt to decrease our own vulnerability. This suggestion would appear to be in keeping with present policy.

4. Requests have been made by DTD for any additional battlefield data to assist decide on the optimum thickness of individual armour plates and on their optimum distribution. On the evidence of this report, where tanks are expected to attack in country as, or more, enclosed than Normandy, it is recommended that an almost homogenous defence be assumed (a homogenous defence being defined as a defence where the enemy are able to hold their fire so long, they are as likely to hit from the side or rear as from the front: for the use of this convenient term see DTD armour reports). Therefore, for optimum armour distribution, etc., a "pdv" (probability directional value) for an almost homogenous defence should also be used.

It is considered that present homogenous German defence is due to ease of concealment and that, until better methods of spotting tanks and A/T are found, such a form of defence will continue and can safely be assumed for similar terrain. It should be carefully noted, however, that the present sample of tanks has been taken from a series of battles where our forces were nearly always attacking, and it may well be that, in defence, more frontal hits will be recorded.

# Analysis of German Tank Casualties in France 6 June to 31 August 1944

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## INTRODUCTION

1. The period covered can be divided into two distinct phases, the comparatively static stage between 6th June and 7th August 1944 up to the break through and the stage of exploitation and pursuit between 8th August and 31st August 1944. In the first phase the area covered included the whole of the British and American sectors with the exception of those parts of the American sector south of grid line 86 through CARENTAN. In the second phase the area included only the British sector from the FALAISE pocket up to the SEINE. These two phases are dealt with separately.

The data used in this report have been collected by several observers, but principally by members of No. 2 ORS and No. 20 WTSFF.

## DATA COLLECTED

### The Static Phase (6th June - 7th August 1944)

2. A representative sample of German tank casualties was not obtained as only those which fell into our hands could be examined, no data being available concerning those recovered by the Germans. Owing to lack of personnel no Pz Kw Mk III and only a small proportion of Pz Kw Mk IV were examined, but one or other observer examined every Pz Kw Mk V and VI of which they became aware.

3. In Table I we set out the total number of tanks examined together with the assigned cause of elimination.

| Assigned Cause of Elimination of Tank | No. of Tanks Eliminated |                |       | Total           | % of Grand Total |
|---------------------------------------|-------------------------|----------------|-------|-----------------|------------------|
|                                       | Mk.VI                   | Mk.V           | Mk.IV |                 |                  |
| AP Shot                               | 7                       | 36             | 10    | 53 <sup>1</sup> | 48%              |
| Hollow Charge Projectiles             | -                       | 7              | 1     | 8               | 7%               |
| HE Artillery                          | -                       | 7 <sup>2</sup> | 2     | 9               | 8%               |
| Mines                                 | -                       | -              | 1     | 1               | 1%               |
| Rocket Projectiles from aircraft (RP) | -                       | 6              | 1     | 7               | 6%               |
| Air Cannon                            | -                       | 2              | 1     | 3               | 3%               |
| Bombs                                 | -                       | -              | -     | -               | -                |

**Table I - continued**  
**Enemy Tank Casualties Between 6th June-7th August 1944**

| Assigned Cause of Elimination of Tank | No. of Tanks Eliminated |                 |           | Total      | % of Grand Total |
|---------------------------------------|-------------------------|-----------------|-----------|------------|------------------|
|                                       | Mk.VI                   | Mk.V            | Mk.IV     |            |                  |
| Destroyed by crews                    | -                       | 6               | 1         | 7          | 6%               |
| Abandoned                             | -                       | 3               | 1         | 4          | 4%               |
| Unknown Causes                        | 1                       | 13 <sup>3</sup> | 2         | 18         | 17%              |
| <b>Total</b>                          | <b>8</b>                | <b>82</b>       | <b>20</b> | <b>110</b> | <b>100%</b>      |

<sup>1</sup> A small number of these may have been abandoned before they were hit.

<sup>2</sup> 4 of these were knocked out by 5.5" in one bombardment.

<sup>3</sup> 5 were tanks with AP and Hollow Charge penetrations without evidence as to which was the original cause of elimination.

4. Although the sample cannot be fully representative, the results clearly show that among the several methods by which tanks might have been destroyed, AP shot was by far the most important. Paragraphs 9-23 deal in more detail with tanks knocked out in this way.

**2nd Phase (8th-31st August 1944)**

5. The sample obtained in the 2nd Phase is considered more or less representative of German tank casualties during this period since the proportion of damaged tanks recovered by the Germans was small. The sample is considered to be approximately half the total, and includes a full count of discovered Mk IIIs and IVs.

**Table II**  
**Enemy Tank Casualties Between 8th - 31st August 44**

| Assigned Cause of Elimination of Tank | No. of Tanks Eliminated |             |             |           | Total       | % of Grand Total |
|---------------------------------------|-------------------------|-------------|-------------|-----------|-------------|------------------|
|                                       | Mk.VI                   | Mk.V        | Mk.IV       | Mk.III    |             |                  |
| AP Shot                               | 1                       | 11          | 11          | -         | 24          | 11%              |
| Hollow Charge Projectiles             | -                       | 1           | -           | -         | 1           | 0.4%             |
| HE Artillery                          | -                       | 1           | 3           | -         | 4           | 2%               |
| Mines                                 | -                       | -           | -           | -         | -           | -                |
| Rocket Projectiles from aircraft (RP) | -                       | 2           | 5           | -         | 7           | 3%               |
| Air Cannon                            | -                       | 1           | -           | -         | 1           | 0.4%             |
| Bombs                                 | -                       | -           | 2           | -         | 2           | 1%               |
| Destroyed by Crew                     | 20                      | 44          | 41          | 3         | 108         | 48%              |
| Abandoned                             | 6                       | 30          | 27          | -         | 63          | 28%              |
| Unknown Causes                        | -                       | 6           | 7           | -         | 13          | 6%               |
| <b>Total</b>                          | <b>28</b>               | <b>96</b>   | <b>96</b>   | <b>3</b>  | <b>223</b>  | <b>100%</b>      |
| <b>% of Total</b>                     | <b>12%</b>              | <b>43½%</b> | <b>43½%</b> | <b>1%</b> | <b>100%</b> |                  |



6. During the later stages of the battle for France (8th - 31st August 44) the main causes for the elimination of enemy tanks was the destruction by their own crews and abandonment. This subject has been dealt with in No. 2 ORS Report No. 15, "Enemy Casualties in Vehicles and Equipment during the Retreat from Normandy to the Seine."

### Comparison of Anti-Tank Weapons in the Two Phases

7. In order to compare the effectiveness of various types of A/Tk weapons in *destroying* enemy tanks in the two phases, the enemy's losses due to abandonment and destruction by the crew have been subtracted and the resulting percentages given in Table III.

| <b>Table III</b>                                 |   |                            |
|--|---|----------------------------|
| Assigned Cause of Elimination of Tank            | Percentage of Destroyed Tanks in Each Phase |                            |
|  | 1st Phase<br>(6 June-7 August 1944)         | 2nd Phase<br>(8-31 August) |
| AP Projectiles                                   | 65%   | 63%                        |
| Hollow Charge Projectiles                        | 10%   | 2%                         |
| HE Artillery                                     | 11%   | 10%                        |
| Mines  | 1%  | -                          |
| Rocket Projectiles from aircraft                 | 9%  | 18%                        |
| Air Cannon                                       | 4%  | 2%                         |
| Bombs  | -   | 5%                         |
| <b>Totals from which percentages are derived</b> | 81 Tanks                                    | 39 Tanks                   |

8. It is clear that in both phases AP shot was the principal means of knocking out tanks. The numbers knocked out by Rocket Projectiles, which are comparatively new weapons, were not inconsiderable.

### Analysis of Damage by AP Projectiles

9. Because our own forces often practised AP shooting against knocked out enemy tanks, the detailed analysis of AP rounds has been confined to those tanks where the observer could interview the gun detachment or tank crew which had fired. Only where these accounts agreed with the rest of the evidence has the casualty been accepted. By this new standard the following projectiles are dealt with:

| German Tank | Projectiles |
|-------------|-------------|
| PzKw Mk.IV  | 5           |
| PzKw Mk.V   | 22          |
| PzKw Mk.VI  | 5           |

10. The fact that the sample includes only captured tanks may introduce a bias whose character will depend upon the enemy's choice of vehicles to be recovered. It is not known if this choice was influenced by ease of recovery or ease of repair, or by a combination of both as seems most likely. From theoretical reasoning alone it is impossible to forecast the nature of the bias.

11. Character of shots recorded, their penetrations, and failures.

| <b>Table IV</b>           |                               |                           |              |   |
|---------------------------|-------------------------------|---------------------------|--------------|---|
| <b>Type of Projectile</b> | <b>Number of Penetrations</b> | <b>Number of Failures</b> | <b>Total</b> | <b>% Penetration for Each Type of Gun</b> |
| <b>17-pdr APCBC</b>       | 21                            | 4                         | 25           | 84%                                       |
| <b>3-inch M-10</b>        | 17 <sup>1</sup>               | 5                         | 22           | 77%                                       |
| <b>75 mm</b>              | 5                             | 8                         | 13           | 38%                                       |
| <b>6-pdr DS</b>           | 9                             | 4                         | 13           | 69%                                       |
| <b>6-pdr APCBC</b>        | 9                             | 1                         | 10           | 90%                                       |

<sup>1</sup> Includes 5 engagements against Mk IVs. Records for other guns only include engagements against Mk VIs and Vs

**Comment on Table IV**

12. The samples for each gun are considered too small for the many variables to be sufficiently randomised and that until further figures of a similar character can be added no conclusions should be drawn.

13.(a) Penetrations and Failures of AP Projectiles against various tanks.

| <b>Table V</b>       |                       |                 |               |                                |
|----------------------|-----------------------|-----------------|---------------|--------------------------------|
| <b>Type of Tank</b>  | <b>No. of AP Hits</b> |                 | <b>Totals</b> | <b>Percentage Penetrations</b> |
|                      | <b>Penetrations</b>   | <b>Failures</b> |               |                                |
| <b>PzKw Mk.VI</b>    | 13                    | 8               | 21            | 62%                            |
| <b>PzKw Mk.V</b>     | 42                    | 14              | 56            | 75%                            |
| <b>PzKw Mk.IV</b>    | 6                     | -               | 6             | 100%                           |
| <b>Totals</b>        | 61                    | 22              | 83            | 73%                            |
| <b>(Sherman M-4)</b> | -                     | -               | -             | (95%) <sup>1</sup>             |

<sup>1</sup> All samples quoted in this report for Sherman M-4 tanks are taken from No.2 ORS Report "Analysis of Sherman Tank Casualties in Normandy, 6th June-10th July 44," dated 15th August 1944.

(b) Average Number of Hits to Knock out Each Type of Tank, etc.

| <b>Table VI</b>      |   |   |
|----------------------|---|---|
| <b>Type of Tank</b>  | <b>Average Number of Hits to Knock out a Tank</b> | <b>Average Number of penetrations to knock out a tank</b> |
| <b>PzKw Mk.VI</b>    | 4.2   | 2.6   |
| <b>PzKw Mk.V</b>     | 2.55  | 1.9   |
| <b>PzKw Mk.IV</b>    | 1.2   | 1.2   |
| <b>(Sherman M-4)</b> | (1.63)  | (1.55) <sup>1</sup>                                       |

<sup>1</sup> All samples quoted in this report for Sherman M-4 tanks are taken from No.2 ORS Report "Analysis of Sherman Tank Casualties in Normandy, 6th June - 10th July 1944," dated 15th August 44.

**Comment on Tables V and VI**

14. (a) In these tables the chief advantages gained by the Pz Kw VI and V over the IV and the Sherman lies in their ability to keep out more shots; yet there are indications that they also possess some real advantage in an increased ability to accept penetrations without serious internal damage. It is considered that this important question of the best internal layout of a tank to prevent internal damage should be studied by controlled experiments in England. (see also Para. 18b).

(b) The difficulty of determining how many of the hits or penetrations were necessary to knock out the tank, and how many were subsequent rounds fired by our tank or anti-tank gunners, may make Table VI very misleading. It should be taken as an indication only.

**15. Distribution of Number of Hits Required to Knock Out a Tank**

| <b>Table VII</b>                                     |                                    |                  |                   |                      |
|--|------------------------------------|------------------|-------------------|----------------------|
| <b>Number of Hits required to knock out the tank</b> | <b>Number of Tanks Knocked Out</b> |                  |                   |                      |
|  | <b>PzKw Mk.VI</b>                  | <b>PzKw Mk.V</b> | <b>PzKw Mk.IV</b> | <b>(Sherman M-4)</b> |
| <b>1</b>   | -                                  | 7                | 4                 | (25)                 |
| <b>2</b>   | 2                                  | 6                | 1                 | (11)                 |
| <b>3</b>   | 1                                  | 4                | -                 | (2)                  |
| <b>4</b>   | -                                  | 2                | -                 | (1)                  |
| <b>5</b>   | -                                  | 2                | -                 | -                    |
| <b>6</b>   | 1                                  | -                | -                 | -                    |
| <b>7</b>   | -                                  | 1                | -                 | -                    |
| <b>8</b>   | 1                                  | -                | -                 | (1)                  |
| <b>Total of Tanks</b>                                | 5                                  | 22               | 5                 | (40) <sup>1</sup>    |

<sup>1</sup> All samples quoted in this report for Sherman M-4 tanks are taken from No.2 ORS Report "Analysis of Sherman Tank Casualties in Normandy, 6th June - 10th July 1944," dated 15th August 44.

Comment on Table VII

16. The main advantage the Panther possesses over the Sherman, as shown by this table, is its ability not to be so easily knocked out by the first hit.

17. Tanks Brewed Up When Knocked Out by AP

| <b>Table VIII</b>    |                        |                |   |
|----------------------|------------------------|----------------|---|
| <b>Type of Tank</b>  | <b>Number of Tanks</b> |                | <b>% Brewed up of total for each type of tank</b> |
|                      | <b>Brewed up</b>       | <b>Unburnt</b> |   |
| <b>PzKw Mk.VI</b>    | 4                      | 1              | 80%   |
| <b>PzKw Mk.V</b>     | 14                     | 8              | 63%   |
| <b>PzKw Mk.IV</b>    | 4                      | 1              | 80%   |
| <b>(Sherman M-4)</b> | (33)                   | (7)            | (82%) <sup>1</sup>                                |

<sup>1</sup> All samples quoted in this report for Sherman M-4 tanks are taken from No.2 ORS Report "Analysis of Sherman Tank Casualties in Normandy, 6th June—10th July 1944," dated 15th August 44.

| <b>Table IX</b>      |  |  |
|----------------------|--|--|
| <b>Type of Tank</b>  | <b>Average Number of Hits Received for each Brewed Up Tank</b> | <b>Average Number of Penetrations Received for Brew Up of a Tank</b> |
| <b>PzKw Mk.VI</b>    | 5.25   | 3.25   |
| <b>PzKw Mk.V</b>     | 4.0  | 3.24   |
| <b>PzKw Mk.IV</b>    | 1.5  | 1.5  |
| <b>(Sherman M-4)</b> | (1.97)   | (1.89) <sup>1</sup>  |

<sup>1</sup> All samples quoted in this report for Sherman M-4 tanks are taken from No.2 ORS Report "Analysis of Sherman Tank Casualties in Normandy, 6th June - 10th July 1944," dated 15th August 44.

Comment on Tables VIII and IX.

18. (a) From Table VIII it would appear that the percentage of brew-ups for the Panther (Pz Kw Mk V) is materially less than for the Sherman. Too much importance, however, must not be attached to this difference by itself since British and German gunners may differ in their tendencies to fire.

(b) On the evidence of Table IX it is urged that the causes of brew-ups in tanks are due for detailed research. As shown, the types of tanks studied vary greatly in their susceptibility to catch fire as a result of any single penetration, and this is considered of great importance. This susceptibility depends on both the tank and the projectile and it does not appear that it can be elucidated by further observation on the battlefield but requires detailed research.

19. Distribution of AP Penetrations and Failures on Enemy Tanks

Only the sample for the PzKw Mk.V is sufficiently large to allow for this analysis.

| <b>Table X</b>                            |                           |                                   |                     |                   |                    |                  |              |
|---|---------------------------|-----------------------------------|---------------------|-------------------|--------------------|------------------|--------------|
| <b>PzKw Mk.V</b>                          | <b>Upper glacis plate</b> | <b>Mantlet &amp; front turret</b> | <b>Turret sides</b> | <b>Hull sides</b> | <b>Turret rear</b> | <b>Hull rear</b> | <b>Total</b> |
| <b>Penetrations with:</b>                 |                           |                                   |                     |                   |                    |                  |              |
| <b>17-pdr</b>                             | -                         | 1                                 | 4                   | 9                 | 1                  | 3                | 28           |
| <b>3-inch M-10</b>                        | -                         | -                                 | 1                   | 5                 | -                  | 1                | 7            |
| <b>75 mm</b>                              | -                         | -                                 | 1                   | 4                 | -                  | -                | 5            |
| <b>6-pdr DS</b>                           | -                         | 1                                 | 1                   | 3                 | -                  | 1                | 6            |
| <b>6-pdr APCBC</b>                        | 1 <sup>1</sup>            | -                                 | 3                   | 2                 | -                  | -                | 6            |
| <b>Total</b>                              | 1                         | 2                                 | 10                  | 23                | 1                  | 5                | 42           |
| <b>Failures with:</b>                     |                           |                                   |                     |                   |                    |                  |              |
| <b>17-pdr</b>                             | 2                         | -                                 | 1                   | -                 | -                  | -                | 3            |
| <b>3-inch M-10</b>                        | 1                         | 1                                 | 1                   | -                 | -                  | -                | 3            |
| <b>75 mm</b>                              | 1                         | -                                 | 1                   | 1                 | -                  | -                | 3            |
| <b>6-pdr DS</b>                           | 3                         | 1                                 | -                   | -                 | -                  | -                | 4            |
| <b>6-pdr APCBC</b>                        | -                         | -                                 | 1                   | -                 | -                  | -                | 1            |
| <b>Total</b>                              | 7                         | 2                                 | 4                   | 1                 | -                  | -                | 14           |
| <b>Grand Total of hits</b>                | 8                         | 4                                 | 14                  | 24                | 1                  | 5                | 56           |
| <b>Penetrations to hits on each plate</b> | 12.5%                     | 50%                               | 71.5%               | 96%               | 100%               | 100%             | -            |
| <sup>1</sup> Through M/G mounting.        |                           |                                   |                     |                   |                    |                  |              |

Comment on Table X

20. (a) The small success of our AP projectiles against the sloping glacis plate of the Pz Kw Mk V is outstanding. It is felt to warrant the claim that this plate has proved itself to be adequate for a modern tank and that its qualities and advantages be taken fully into account in deciding future tank design.

(b) It must be remembered that the full advantage of this relative immunity is only shown to a limited extent in a sample of captured tanks since many tanks which are hit only on the glacis plate will escape and in many cases a gunner will not fire against a head-on Panther. The full advantage is certainly greater than that shown in the Table.

(c) The side-hull armour of the Panther is shown to have been extremely vulnerable. This supports present teaching that gunners should if possible attack the hullside of this tank.

21. Distribution of AP Penetrations and Failures in terms of the different aspects of the PzKw Mk.V

| <b>Table XI</b>                                    |                     |       |      |
|--|---------------------|-------|------|
| Number of:-  | Aspect of PzKw Mk.V |       |      |
|  | Front               | Sides | Rear |
| Hits   | 12                  | 38    | 6    |
| Penetrations                                       | 3                   | 33    | 6    |
| Percentage of penetrations to hits for each aspect | 25%                 | 87%   | 100% |

Comment on Table XI

22. (a) Even if a gunner cannot hit any particular part of the side or rear of a Panther, the teaching that a Panther should not if possible be attacked from the front is justified by the above figures.

(b) The further question of how far a gunner or tank commander is justified in taking risks to obtain a side instead of a front attack cannot be answered on the present data alone. The answer depends upon the combined chances of both hitting and penetrating the tank at various aspects, which chances cannot be deduced from the data in this paper. There is evidence that German authorities consider it worth while to collect the additional facts required from their gun detachments in the form of returns of details of all engagements against tanks.

Distribution of Angles of Penetration

23. The following table gives the frequency of the angles of penetration where they could be satisfactorily measured:

| <b>Table XII</b>                                |   |      |               |      |
|---|---|------|---------------|------|
| Angles of penetration to normal of plate struck | Numbers & Percentages of Penetrations on: |      |               |      |
|   | All German Tanks                          |      | (Sherman M-4) |      |
| 0 - 5°  | 20  | 53%  | 32            | 52%  |
| 5 - 30°   | 15  | 39%  | 13            | 37%  |
| 30 - 90°  | 3   | 8%   | 7             | 11%  |
| <b>Total</b>                                    | 38  | 100% | 52            | 100% |