UDK: 623.4.081.2
COSATI: 16-04, 15-03, 19-03

# Probability of Armoured Targets Destruction by Means of Infantry Antitank Weapons

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**The theoretical evaluation of effectiveness is very important for proper preparations and carrying out range tests of infantry antitank weapons in all stages of their development or upgrades. This paper deals with theoretical method of assessing the effectiveness, i.e. armoured targets kill probability, by guided and unguided anti-armour projectiles fired from infantry antitank weapons. The algorithms and mathematical basis of this method, along with an overview of significant parameters, which determine target hit and kill probability, are presented. Those parameters are classified into several main groups covering: launching site characteristics, weapon, gunner, target, firing preparation and firing itself, as well as the characteristics of combat situation in the field. Based on the proposed mathematical model, a program code for computation of armoured targets kill probability was developed. The program capabilities are illustrated by several examples of firing simulation**

*Key words*: **antitank infantry weapon, antitank missile, armoured vehicle, hit probability, kill probability, penetrability efficiency testing, computation technique.**

## Denotations and abbreviations

$a_i$ – parts of the overall tank surface $A$,
$b$, $c$ – lengths of frontal and lateral sides of tank,
$h$ – height of tank,
$d$ – thickness of armour plate,
$l_n$ – nominal (rated) warhead penetrability,
$m_1, m_2$ – number of overlaps obtained when testing the first and the second sample respectively (repeating the test),
$n$ – apothem on the front surface of the armoured target in the point of collision $T$,
$n_1$, $n_2$ – number of projectiles in the first and second sample ($n_1 = n_2 = 10$),
$P_v$ – vulnerability of target,
$p_f$ – functional reliability of fuze,
$p_i$ – vulnerability of the surface part $a_i$,
$q_a$ – maximum permitted relative frequency of no piercing of $n = 10$ tested projectiles ($q_a = 0.2$),
$s$ – projectile symmetry axis,
$r_T$ – firing range,
$\beta$ – inclination of the armoured target glacis plate (plane $\pi_1$),
$\delta$ – angle between the projectile axis plane $\pi_3$ and vertical plane through the collision point $\pi_2$,
$\pi$ – horizontal plane (ground plane),
$\pi_1$ – plane of attacked armoured target surface,
$\pi_2$ – vertical plane through collision point $T$ (parallel to the armoured vehicle symmetrical plane),
$\pi_3$ – projectile axis plane perpendicular on the horizontal plane $\pi$, and
$\theta$ – angle between the horizontal projection of the projectile axis on the vertical plane $\pi_2$ and target surface plane $\pi_1$.

## System of coordinates

$C_{xyz}$ – Descartes immobile coordinate system, related to the gunner position,
$C_{r\varphi z}$ – polar immobile coordinate system, related to the gunner position,
$O_{XZY}$ – mobile coordinate system, related to the tank gravity centre, and
$T_i n_i t_i p_i$ – local (bonded) coordinate system, related to the considered tank surface element $i$.

## Introduction

THE importance of theoretical prediction, concerning the armoured targets kill probability when firing effects from infantry antitank weapons [1,2] or aircraft (airplanes and helicopters [3]), is manifold. It is decidedly significant to high-quality preparations and performance of firing-range tests of infantry antitank weapons and airborne warfare systems throughout all the stages of their development, or in the course of their modifications and upgrade, as well. In both cases the missile systems effectiveness assessment is also rather interesting from the aspect of gunner training and resolving tactical missions in peace time (war games)

To this end, an algorithm has been proposed and a mathematical model made aimed at computing the anti-armour rocket systems effectiveness based on which a numerical program was developed to calculate the armoured targets hit and kill probability. In addition to weapon and projectile characteristics, this program has also taken into consideration the parameters of: launching site, target, weather conditions, gunner’s qualities and specific combat scenarios.

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## Mathematical model of effectiveness computation

Mathematical model for computation of armoured targets kill probability by the use of guided and unguided anti-armour projectiles fired from the infantry antitank weapons (Fig.1) and aircraft or helicopters was elaborated under the assumption that the attack is being launched at the tank glacis plate and sides. This is a justified assumption since the tank roof and rear sides are protected by basic armour of considerably lesser thickness than the one used for glacis armour. However, additional armours of explosive-reactive type [4], or fore-armours, have not been taken into consideration.

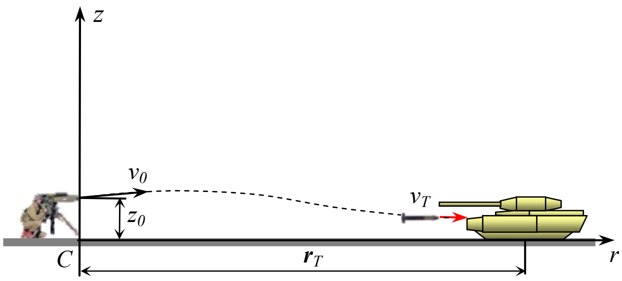


**Figure 1.** Schematic diagram of a tank being hit by an antitank rocket projectile from an infantry weapon

Specifying the probable zones of kill (or putting the tanks out of action) is the main objective of these computations. The issue of establishing the zones of effective firing against specified targets when stationary or on the move within the field of engagement is additionally complicated by the fact that the projectile launching site is most frequently a mobile one. Also, unlike firing from ground fire positions, firing from aircraft is subject to more intense variations of meteo-ballistic conditions.

In order to determine the parameters of contact (collision) between the projectile and the armoured vehicle, the area across which a vehicle is moving has been divided into discreet zones (Fig.2). By coordinate $C$, the launching site has been determined as being in the ground plane, while the coordinate $y$ determines the direction of the symmetry axis of the working area at the moment of the rocket projectile launching.

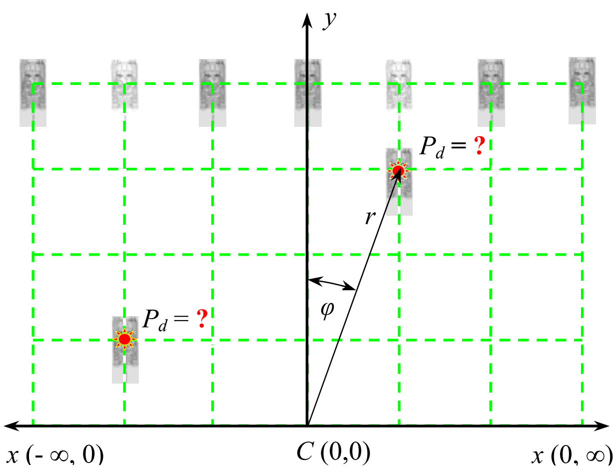


**Figure 2.** Semi plane of armoured target motion divided into discreet zones

The position of the tank (moving in parallel with $y$ axis) compared to point $C$ is determined by nodal points of the working network on the semi-plane divided into discreet zones and expressed in Descartes coordinates $(x,y)$, and polar coordinates $(r,\varphi)$ respectively.

Destroying probability $P_d$ of armoured target is calculated based on the following general equation

$$P_d = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} f(x,y)g(x,y)\,dxdy = \int_{-\infty}^{+\infty}\int_{0}^{2\pi} F(r,\varphi)G(r,\varphi)\,drd\varphi \quad (1)$$

where is:

$f(x,y)$, $F(r,\varphi)$ - unction of target hit probability, and

$g(x,y)$, $G(r,\varphi)$ - function (law) of target destruction.

For each point in the considered area, defined by network $(x_i,y_j)$, and $(r_i,\varphi_j)$ respectively, kill probability of target $P_d$ is determined. By connecting the points with equal values of target kill probability, it is possible to obtain the iso-probable kill ranges [1, 2, 3].

These curves are used to define and evaluate effectiveness that can cover a certain space or area, or determine the radius of effectiveness for the given probability.

## Computation algorithm

The algorithm for computation of armoured target kill probability by the use of guided and unguided anti-armour rocket-projectiles, in cases when the firing is performed from the immobile infantry antitank weapons or mobile platforms (of aircraft or helicopter type) is a relatively complex one (Fig.3).

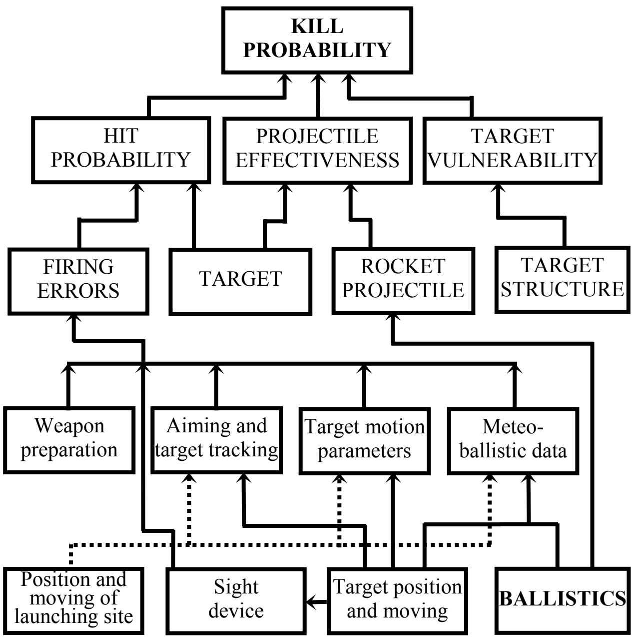


**Figure 3.** Effectiveness computation algorithm

The algorithm is based on the data relative to: firing position, target, information on the weapon and rocket projectile in the combat system, gunner's qualities, method of preparing for firing and the firing itself, and finally the prevailing situation in the field.

## Description of program solution

The program code for computation of target hit and kill probability has been deduced from the algorithm solution, presented in Fig.3, and it is written in FORTRAN program language. The most significant parameters that influence the effectiveness of the shaped charge warhead rocket projectiles against armoured targets have been classified into several categories:

a) Main characteristics of the launching site
- Position,
- Rate of movement, and
- Shape of trajectory.

In this case, it was assumed that the rate of movement of the launching site equals zero.

b) Main target characteristics
- Position and speed,
- Shape of trajectory,
- Dimensions and structure,
- Protective features, and
- Vulnerability.

Table 1 contains an overview of protective features, given by the equivalent thickness of main armour for several technological generations of tanks. This is one of the usual conventional classifications based on [5].

In view of the fact that main armours differ in structure and materials applied, a concept of equivalent armour thickness has been introduced to correspond the equivalent of a homogenous armour made of medium quality rolled steel plate (tensile strength: $r_m$ = min. 900 MPa, Brinell hardness: $HB$ = min. 270).

**Table 1.** Overview of equivalent thickness of basic tank armours[2)]

| Technologic generation of tanks | Time period | Equivalent glacis plate thickness | Equivalent lateral armour thickness |
|---|---|---|---|
| - | Year | (mm) | (mm) |
| I Generation | 1950-1960 | 100 | 20 |
| II Generation | 1960-1970 | 200 | 40 |
| III Generation | 1970-1980 | 400 | 60 |
| IV Generation | 1980-1990 | 600 | 80 |

Target vulnerability signifies the probability of its kill or incapacitation in case of a direct hit. A tank is considered to be a surface target represented by the sum of its surfaces that are characterized by differing vulnerability and exposure parameters in relation to the overall tank surface contour [1,2,6]. Fig.4 shows the tank lateral contour with overall surface of $A$ and its parts with surface of $a_i$ of various vulnerabilities $p_i$.

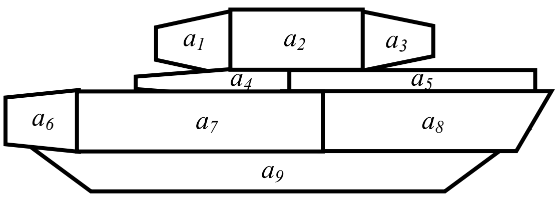


**Figure 4.** Partition of tank lateral contour into surfaces of varying vulnerability and exposure

Being aware of information for $a_i$ surfaces and of relevant values of their vulnerability $p_i$, the tank vulnerability $P_v$, at direct hit with one effective projectile, is computed based on the following equation

$$P_v = \sum_{i=1}^{i=n} \left( \frac{a_i}{A} \right) p_i \tag{2}$$

Very important aspect concerning the tank surfaces exposure must be analysed, as well. The tank surfaces exposure strongly depends on the gunner eye direction $\varphi$ (lateral attack angle). Mathematical interpretation of this dependence was carried out involving the simplified surface model of the considered real tank contour as illustrated in Fig.5.

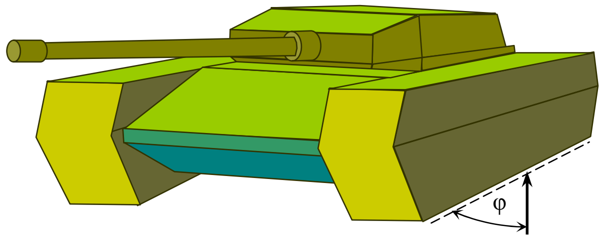


**Figure 5.** Tank surfaces exposure depending on the gunner eye direction ($\varphi$=30º)

c) Errors in preparations and firing itself
- Weapon preparations (sighting device, rectification and bore sighting),
- Evaluation or measuring of ballistic and meteorological parameters,
- Method of tracking and aiming, and
- Evaluations and measuring of target motion parameters.

In this way, especially, the theoretical and experimental research of the launching process optimal sequence as well as the choice and analysis of the command and launch unit optimal solution for the anti-tank unguided and guided rocket projectiles have been performed predominantly. Some of them are given in [7, 8].

d) Main characteristics of the weapon and projectile
- Ballistic parameters (speed, aerodynamic coefficients, dispersion of parameters, etc.),
- Sighting device (mechanical, optical, fire control system),
- Reliability of function, and
- Projectile effectiveness (penetrability, in this case).

Concerning the projectile effectiveness, special attention has been given to developing computation methods, involving new design and materials and machining techniques to produce the shaped charges of highest performances. So, due to enormous effort on part of the researchers and technologists the modern shaped charges achieve penetrability up to 9 calibres and more.

From this point of view, the main task has been to produce the required exit collapsing parameters of metallic liner (final liner collapse angle and liner collapse velocity), and so to reach the maximum velocity of the jet and the highest jet penetrability. Besides the detonation wave of favourable parameters [9], the metallic liner as the most important component of the shaped charge of high technology must be optimised [10].

Typical diagrams showing interdependence between the armoured target hit probability and the range of firing, as far as shaped charge warhead rocket projectiles are concerned [11], are shown in Fig.6.

[2)] Overviews of equivalent thickness of basic tank armours depend on the convenience, and the references frequently offers very different data related to the tank armour thickness.

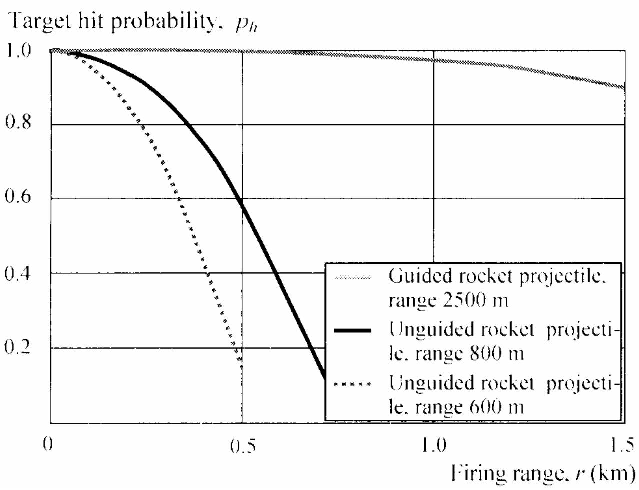


**Figure 6.** Target hit probability depending on range for some types of guided and unguided rocket projectiles

Reliability of warhead function on target is tested on firing ranges in static conditions or by firing. The predominant effect on the reliability of shaped charge warhead function is exerted by the fuze, i.e. the safety-arming device. For modern rocket projectiles, the fuze function reliability requested is at least 98% ($p_f$ = min. 0.98); it is also the reliability of the warhead function.

## Penetrability range testing

For the purpose of regular acceptance in series production, shaped charge warhead effectiveness, i.e. its penetrability, is tested in static conditions (Fig.7) or in dynamic conditions, by firing tests (Fig.8). By using the system of double sampling [12], illustrated in the scheme in Fig.9, and the defined acceptance criteria [13], the probability of the rated penetrability value of min. 80% ($p_p$ = min. 0.8) is achieved.

**Figure 7.** Detail of penetrability testing of shaped charge warhead in static conditions (BUMBLEBEE tandem warhead penetrability testing)

**Figure 8.** Penetrability firing range testing (BUMBLEBEE guided missile launching and flight)

Regardless of the testing conditions, acceptance criterion has been defined through the following parameters: $n_1$, $n_2$, $l_n$, $q_a$, $m_1$, and $m_2$.

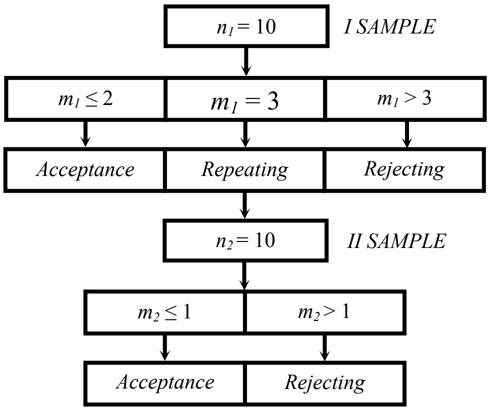


**Figure 9**. Schematic sketch of double sampling while testing shaped charge projectiles penetrability

When testing the penetrability of a series of shaped charge projectiles according to the above stated sampling plan, the following events are possible, their probabilities being defined by relevant equations [14]:

- *Event A*: the series is accepted after the I test

$$P(A) = p^{n_1} + \binom{n_1}{1} p^{n_1-1} q^1 + \binom{n_1}{2} p^{n_1-2} q^2 \tag{3}$$

- *Event B*: the series is rejected after the I test

$$P(B) = 1 - P(A) - P(C) \tag{4}$$

- *Event C*: the test is repeated

$$P(C) = \binom{n_1}{3} p^{n_1-3} q^3 \tag{5}$$

- *Event D*: the series is accepted after the II test (for the repeated test $P(C)$=1)

$$P(D) = P(C)\left[ p^{n_2} + \binom{n_2}{1} p^{n_2-1} q^1 \right] = P(D/C) \tag{6}$$

- *Event E*: the series is rejected after the II test

$$P(E) = 1 - P(D) = \overline{P(D/C)} = 1 - P(D/C) \tag{7}$$

**Table 2.** Survey of events occurrence probability depending on the rejections percentage in serial production

| No | $q$ | $q_1 = 1\%$ | $q_2 = q_d = 2\%$ | $q_3 = 3\%$ |
|---|---|---|---|---|
| | $n_1 q$ | 0.1 | 0.2 | 0.3 |
| | P | - | - | - |
| 1. | P(A) | 0.9298 | 0.6778 | 0.3828 |
| 2. | P(B) | 0.0128 | 0.1210 | 0.3504 |
| 3. | P(C) | 0.0574 | 0.2013 | 0.2668 |
| 4. | P(D) | 0.7361 | 0.3758 | 0.1493 |

$q$ - percentage of rejections, in total
$n_1 q$ - relative frequency of no-piercing
$P$ - probability of events

Based on data from Table 2, some very interesting statements can be made:

- With a relatively slight drop in the production quality (i.e. increased rate of rejects) the probability of the series being accepted in the first test drops abruptly (from

0.9298 for the percentage of rejects $q_1$ = 1% to 0.3828 for the percentage of rejects $q_3$ = 3%), and

- With a hypothetical production quality where the percentage of rejections is $q_1$ = 1%, the probability of the series being accepted even after the repeated test ($P(D)$ = 0.7361) is greater than in the case of acceptance of a series with somewhat higher percentage of rejections $q_2$ = 2% (which still represents the value of permitted rejections) after the first test ($P(A)$ = 0.6778).

According to the above-mentioned principle, the quality of warhead functional characteristics is checked in dynamic conditions, i.e. by firing from static firing post, for example by means of infantry antitank weapons, or from moving firing post, for example from aircraft or helicopters. Unlike penetrability tests in static conditions, where the position of the warhead compared to the surface of the main armour is strictly controlled, in the case of dynamic tests, it is quite a complex issue to determine the colliding parameters between the projectile and the tank.

## Determination of colliding parameters

In terms of kinematics, the collision between the rocket missile and the armoured target (Fig.10) is determined by the following parameters:

- Position of the point of impact, i.e. coordinate of the collision point $T$ ($X_T$,$Y_T$,$Z_T$),
- Projectile impact velocity ($v_T$),
- Projectile angular velocity ($\omega_T$), and
- Projectile angle of attack ($\alpha_T$).

To be able to measure the listed parameters, the range testing centres must have at their disposal good quality equipment for acquisition and tracking of the rocket projectile and special video and/or film cameras (recording speed min. 200 frames per second) for the needs of photographic analysis of geometric parameters of the collision between the missile and the armoured target.

Processing the registered data requires appropriate hardware and software support, as well.

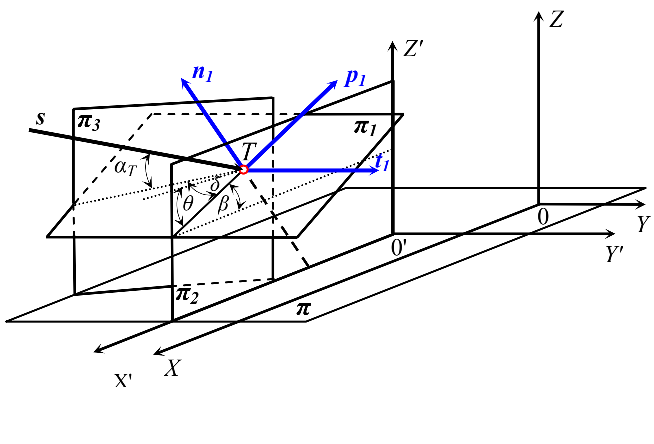


**Figure 10.** Scheme of kinematics' parameters defining the collision in the referential coordinate system

By registering the kinematics' parameters of collision and by determining the values of angle $\alpha_T$, it is possible to define the relative length of the armoured target $d'$ (to be traversed by the shaped charge jet in order to penetrate the armour) for the known armour thickness $d$. Relative thickness of armour $d'$ is calculated based on the equation

$$d' = d\sqrt{1+\frac{1}{tg^2\alpha_T}} \tag{8}$$

## Computation examples

Some examples of how to compute guided and unguided shaped charge warhead rocket projectiles effectiveness are presented in the paper.

Two types of mobile targets, i.e. the so called "middle" and "heavy" tank have been subjects of the analyses. The main parameters are given in Table 3.

**Table 3.** Main parameters of the middle and heavy tank

| Type of target | Parameter | | | | | | |
|---|---|---|---|---|---|---|---|
| | Frontal side | | | Lateral side | | | Velocity |
| | $b$ | $h$ | $d$ | $c$ | $h$ | $d$ | $v$ |
| - | (m) | (m) | (mm) | (m) | (m) | (mm) | (km/h) |
| Middle tank | 2.3 | 2.3 | 200 | 4.6 | 2.3 | 120 | 30 |
| Heavy tank | 2.3 | 2.3 | 300 | 4.6 | 2.3 | 200 | 30 |

At same time it was assumed that the firing was carried out at standard weather (meteo) conditions and normal daily visibility, that the firing post was stationary ($v_c$=0), and gunner's qualities were very good.

A typical family of iso-probable lines of destruction of heavy and middle tanks, when firing with unguided rocket projectile from infantry anti-tank weapons are presented in Figures 11 and 12.

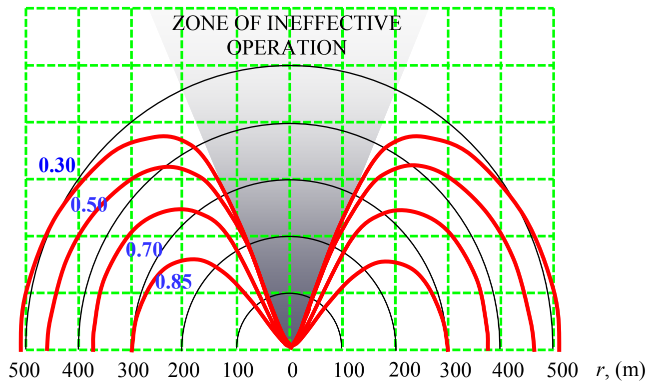


**Figure 11.** Iso-probable destroying ranges of heavy tank by firing unguided rocket projectile of 250 mm penetrability

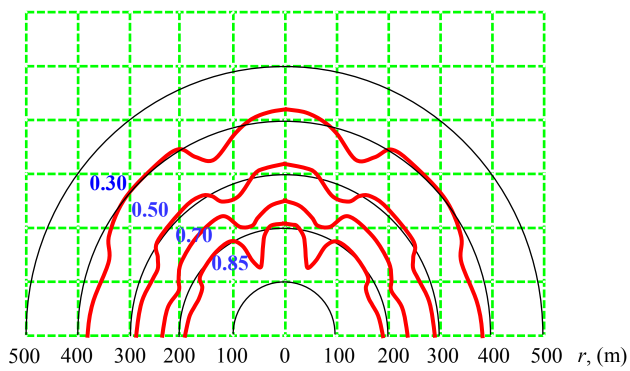


**Figure 12.** Iso-probable destroying ranges of middle tank by firing unguided rocket projectiles of 400 mm penetrability

It is interesting to note that when firing an unguided rocket projectile at heavy tank there is an area of ineffective operation (Fig.11), i.e. an area where the projectile hits the tank with high probability but cannot penetrate the armour.

The results of computation of iso-probable lines under equivalent firing conditions for the unguided rocket projectile with shaped charge warheads of 300 mm and 600 mm penetrability are shown in Figures 13 and 14, respectively.

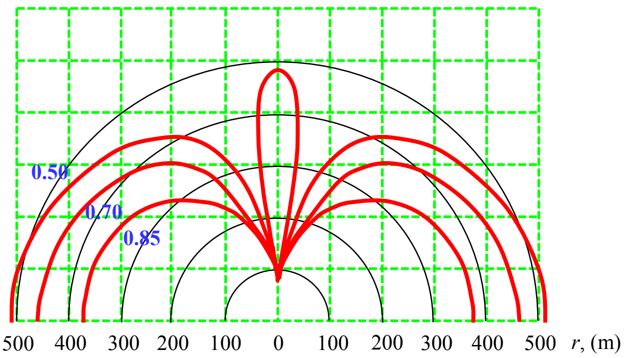


**Figure 13.** Iso-probable destroying ranges of heavy tank by firing unguided rocket projectile of 300 mm penetrability

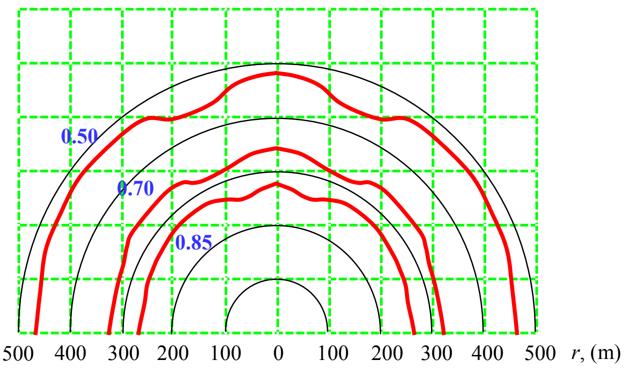


**Figure 14.** Iso-probable destroying ranges of middle tank by firing unguided rocket projectiles of 600 mm penetrability

A difference of destruction capability between the unguided rocket projectiles with the existing shaped charge warhead and other one with new upgraded warhead of highest penetrability is illustrated in Fig.15. Diagram shows the same iso-probable destruction ranges of a middle tank $P_{de}$ for an old warhead (penetrability $l_n$=400 mm) and $P_{du}$ for new upgraded shaped charge (penetrability $l_n$=460 mm).

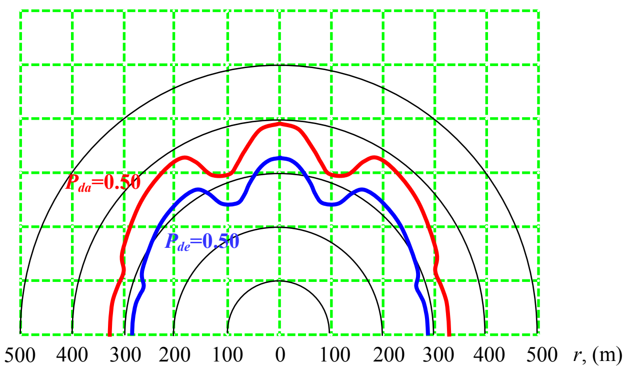


**Figure 15.** Homothetic iso-probable destroying ranges of a middle tank $P_d$=0.5 for rocket projectile with old warhead ($P_{de}$ for $l_n$=400 mm) and for upgraded warhead ($P_{du}$ for $l_n$=460 mm)

Finally, program code provides possibilities to analyse the destruction probability of the guided rocket projectiles.

Diagram in Fig.16 illustrates iso-probable destruction ranges for the guided and unguided rocket projectiles. The computation example treats iso-probable ranges for destruction probability $P_d$=0.95 hit by rocket projectiles with shaped charge warhead of 460 mm penetrability. Evidently, the ranges of middle tank destruction for the same destruction probability rapidly increases due to the use of the system for control and guidance and consequently highest hit probability.

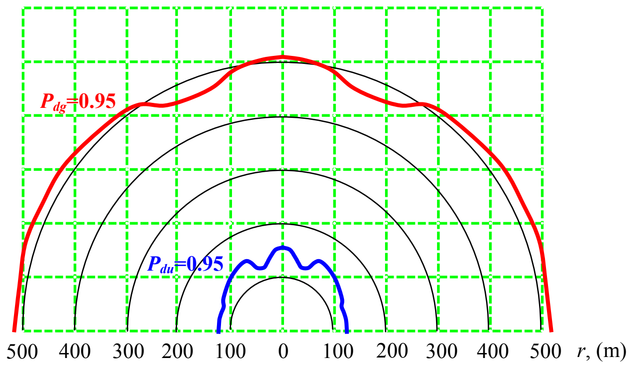


**Figure 16.** Homothetic iso-probable destruction ranges of middle tank $P_d$=0.95 for guided $P_{dg}$ and unguided $P_{du}$ rocket projectiles with shaped charge warhead ($l_n$=460 mm)

Furthermore, let it be emphasised once again: the presented results assume that the firing takes place on a flat terrain without vegetation, that it is done by a well-trained gunner, and that the target moves at the rate of 30 km/h.

Verification of the computation results of the tank kill probability with rocket projectiles fired from infantry anti-tank weapons have not been fully completed at the firing range. The tests were performed for certain types of unguided rocket projectiles. In these tests, like in the case of experimental verification of the computation results of the target kill probability by firing from small arms [15], the quality of the created software has been confirmed. In the tests carried out on the firing range, the discrepancy between the computation and experimental results varied in the range from 1 to 5%.

At the end, it could be interesting to mention the study of a semi-destructive penetrability testing method without using a target presented in [16]. The method offers significant reduction the testing costs. It is based on the application of the complex random functions theory and the digital processing of the experimental data obtained by high-speed radiography techniques. The presented method would be favourable to test the shaped charge of very high penetrability, with more then 1000 mm thickness of homogenous armour steel. Apart from the mentioned jet penetrability test, it was shown that, due to the known values of the complex random function parameters, the method provides the possibility to evaluate more reliably the quality of this type of warheads.

## Conclusions

In order to solve the task of evaluating the effectiveness of guided and unguided rocket projectiles with shaped charge warhead fired from infantry antitank weapons, the algorithm has established what served as a basis for developing a numerical program for computation of armoured ground targets hit and kill probability. The program uses the basic data on weapon and projectile parameters, launching position, target, meteorological conditions, gunner qualities and elements of the specific combat situation.

By giving the examples of effectiveness computation where firing at armoured targets with rocket projectiles with different penetrability was simulated, the iso-probable curves were obtained. These curves are of particular interest for defining and evaluating the efficiency of the specific infantry antitank weapons within the given zone of operations. The computation results are certainly important for the proper groundwork and performance of range tests with infantry anti-armour systems in all stages of development or modification.

The given model and software have solved the basic problem of evaluation of effectiveness, i.e. determination of armoured targets kill probability when firing unguided and guided rocket anti-armour weapons. Given that, in addition to development of new infantry or airborne missile systems and their upgrades, the tactical use of the equipment progresses with time, a continuous need is present for permanent supplementing, upgrading and verifying of the executed software based on firing range testing in real conditions. This article presents a key result, which allows the adaptive robust pole placement problem to be solved efficiently. Converge of the adaptive has also been established and numerical studies show excellent performance.

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Received: 27.11.2006.

# Verovatnoća uništenja oklopnih ciljeva pešadijskim protivoklopnim naoružanjem

**Teorijska ocena efikasnosti je veoma važna za samu pripremu i izvršenje poligonskih ispitivanja protivoklopnog naoružanja u svim fazama njegovog razvoja i modernizacije. U radu je izložena teorijska metoda za određivanje efikasnosti, odnosno, verovatnoće uništenja oklopnih ciljeva vođenim i nevođenim protivoklopnim projektilima sa kumulativnom bojnom glavom kada se gađanje izvodi iz pešadijskog protivoklopnog naoružanja. Izloženi su algoritam i matematičke osnove metode i dat je pregled signifikantnih parametara od kojih zavise verovatnoća pogađanja i uništenja cilja. Ovi parametri su svrstani u nekoliko osnovnih grupa koje obuhvataju: karakteristike lansirnog položaja, naoružanja, strelca, cilja, način pripreme i izvršenja gađanja i borbena situacija na terenu. Na bazi predloženog matematičkog modela razvijen je programski kod za proračun verovatnoće uništenja oklopnih ciljeva. Mogućnosti programskog koda ilustrovane su kroz nekoliko primera simulacije gađanja.**

*Ključne reči*: **protivoklopna borba, pešadijsko protivoklopno naoružanje, protivoklopna raketa, oklopno vozilo verovatnoće pogađanja, verovatnoća uništenja, probojnost, ocena efikasnosti, metoda proračuna.**

# Вероятность поражения бронированных целей пехотным противотанковым вооружением

Теоретическая оценка эффективности является очень важной для самой подготовки и выполнения испытаний на полигоне противотанкового вооружения во всех фазах его развития и модернизации. В настоящей работе растолкован теоретический метод для определения эффективности, т.е. вероятности поражения бронированных целей управляемыми и неуправляемыми противотанковыми снарядами с пробивной боевой головкой когда стрельба происходит из пехотного противотанкового вооружения. Здесь приведены алгорифм и математические основные методы и дан перечень значащих параметров, от которых прямо зависят вероятность попадания и поражения целей. Эти параметры классифицированы во несколько основных групп, которые охватывают : характеристики пускового местоположения, вооружения, воздушного стрелка, цели, способа подготовки и выполнения стрельбы, а в том числе и боевой ситуации на лётном поле. На основе предложенной математической модели разработана закодированная программа для расчёта вероятности поражения бронированных целей. Возможности закодированной программы представлены в несколько примерах имитационного моделирования стрельбы.

*Ключевые слова*: противотанковая борьба, пехотное противотанковое вооружение, противотанковая ракета, бронированная машина, вероятность поражения, вероятность попадания, исследование проникновения, пехотное вооружение, проницаемость, оценка эффективности, расчётный метод.

# La probabilité de destruction des objectifs blindés par les missiles antichars guidés

**L'évaluation théorique de l'efficacité est très importante pour la préparation même et la réalisation des essais sur le polygone de l'armement antichar dans chaque phase de son développement et de sa modernisation. Dans ce papier on a exposé une méthode théorique pour déterminer l'efficacité ou la probabilité de destruction des objectifs blindés par les missiles antichars guidés ou non guidés à l'ogive cumulative quand le tir est effectué par l'armement antichar d'infanterie. On a présenté les algorithmes et les méthodes mathématiques de base et on a donné un tableau des paramètres signifiants dont la probabilité de l'atteinte et la destruction de l'objectifs sont dépendantes. Ces paramètres sont classés en plusieurs groupes basiques comprenant caractéristiques du site de lancement, armement, tireurs, objectif, façon de préparation et exécution du tir ainsi que la situation de combat sur le terrain. A la base du modèle mathématique proposé, on a développé le code de programme pour évaluer la probabilité de destruction des objectifs antichar. Les possibilités du code de programme sont illustrées par des exemples de la simulation de tir.**

*Mots clés*: **combat antichar, armement, missile antichar, véhicule blindé, probabilité d'atteinte, probabilité de destruction, pénétrabilité, évaluation d'efficacité, méthode de computation.**