Computer analysis of explosive sensitivity to projectile impact

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Abstract: The use of different ERA reactive cassettes is shown. Functioning rules of reactive one- (ERAwa-1) and two-layered (ERAwa-2) reactive cassettes are presented. Different kinds of tests with ERAWAr armours are shown. There are some examples of the simulation of impact of different types AP and HEAT ammunition. Simulation was based on “free points” and AUTODYN2D &3D computer programs.

1. Characteristics of reactive armours

In continuous “competition” between armour and projectile, especially, shaped charge projectiles, during the last years essential progress has been noted. These projectiles [1] of \(d = 70\pm155\) mm calibre usually have copper liner, and angle of liner \(\varphi = 40\pm60^\circ\). (Table 1)

Projectiles or mines, for example, explosively formed projectiles EFP of \(d = 50\pm200\) mm calibre and with large mass of explosive material are the greate threat for tanks [3] (Table 1).

Table 1. Parameters of shaped charge and explosively formed projectiles

<table>
<thead>
<tr>
<th>Kind of projectile / energy of penetrator (E)</th>
<th>Mass of jet (m_j) / mass of cluster, ((m_j))</th>
<th>Length of jet / length of cluster, (l_j ) / (l_z)</th>
<th>Diameter of jet / diameter of cluster (d_j ) / (d_z)</th>
<th>Speed of jet / speed of cluster (V_j ) / (V_z)</th>
<th>Distance between projectile and RHA, (l)</th>
<th>Diameters of entry / mouth crater (d_1 ) / (d_2)</th>
<th>Depth of penetration of RHA (DP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[MJ]</td>
<td>(m_j) [m]</td>
<td>(m_z) [m]</td>
<td>[mm]</td>
<td>[mm]</td>
<td>[m s(^{-1})]</td>
<td>[mm]</td>
<td>[mm]</td>
</tr>
<tr>
<td>HEAT / (1,5 \times 9)</td>
<td>0.2</td>
<td>0.8</td>
<td>(&lt;1500) / (&lt;200)</td>
<td>(\leq0.2) d / (0.2) d (5 \times 30) / (\leq30)</td>
<td>(\leq8500) / (1500 + 2000)</td>
<td>2 (\div 10) d / (0.14 \div 1.5)</td>
<td>(\leq0.3) d / (0.1d) (50 \div 10)</td>
</tr>
<tr>
<td>EFP / (3 \div 10)</td>
<td>0.8</td>
<td>0.2</td>
<td>(0.1) d / (d)</td>
<td>(0.1) d / (0.5) d (50 \div 100)</td>
<td>(\leq1000) / (\leq2500)</td>
<td>10 (\div 1000) d / (1 \div 200)</td>
<td>0.5 d / (0.49) d (50 \div 100) / (49 \div 90)</td>
</tr>
</tbody>
</table>

ERA reactive armour (Fig. 1, 2) is even more efficient way of tank protection. It consists of cassettes in cuboid form, made of metal and filled with explosive material. These cassettes, placed at some distance of frontal plate and tank turret, are the screen in front of main armour. After perforation of cassette casing, shaped charge jet hits explosive material, causing its detonation. As a result there is a strong dispersion of part of shaped charge jet, which perforation ability decreases considerably after penetrating this cassette. In majority of hits it is sufficient to efficiently protect main armour of tank, which will not be penetrated then.

In Military Institute of Armament Technology in Zielonka three generations of reactive cassettes for tank PT-91 “Hard” [2-6] - ERAwa-1 and ERAwa-2 with module and block way of assembly were designed and next they were implemented in” Bumar-Łabędź” Plant and one of the examples of the third generation is presented in Figure 3.

In some foreign solutions distances between cassettes are very large \((40 \div 50)\) mm (Fig. 1, 2), what ensures protection of \((60 \div 70)\%\) flat surface. ERAwa cassettes can contact each other, and due to that flat surface is covered in 95%.
Fig. 1. American tanks in Persian Gulf with reactive cassettes

Fig. 2. Ukrainian tank T-84 with reactive cassettes

Fig. 3. Polish tank PT-91 Hard with quickly assembled blocks of ERAWA-1 and ERAWA-2 reactive cassettes (III generation)

Now a way of test of reactive armours will be shown on example of test of ERAWA-1 and ERAWA-2 cassettes, taking into account part of general requirements for such armours. Very close placed above neighbouring cassettes require the use of explosive (in these cassettes) as:

a) very sensitive to react during impact of:
   - shaped charge jet (Fig. 4, 5),
   - APFSDS projectile (Fig. 6, Tab. 2),
   - EFP projectile (Fig. 7, 8);

b) insensitive to react:
   - during impact of:
     - AP small calibre ammunition (Fig. 9, 10, Tab. 2),
     - fragments from exploded projectiles (Fig. 11, 12),
     - of neighbouring cassettes during the explosion of impacted cassette (Fig. 5),
   - during burning of:
     - petrol (Fig. 13, 14),
     - napalm (Fig. 15, 16),
     - thermite (Fig. 17, 18).
**Fig. 4.** Scheme of test of protective ability non-transferring detonation among ERAWA-2 block cassettes ($\alpha = 60^\circ$) with the use of 9M114M warhead (Malutka)

**Fig. 5.** Detonated ERAWA-1 cassette and destroyed neighbouring cassettes of block of nine cassettes, with 125 mm projectile BK-14M (HEAT, $\alpha = 60^\circ$). Penetration of RHA armour $h_n = 30$ mm, protective ability of cassette $CP = 94\%$

**Fig. 6.** Crater in plate of RHA armour after firing ERAWA-2 cassette from tank, with 125 mm projectile BM-15 (APFSDS-T, $h = 300$ mm, $\alpha = 60^\circ$). Penetration of RHA armour $h_n = 130$ mm, protective ability of cassette $CP = 57\%$

**Fig. 7.** Scheme of test of protective ability of ERAWA-2 cassette (2) by firing with the use of EFP warhead (1) ($d = 100$ mm, $h = 85$ mm), ($\alpha = 60^\circ$)

**Fig. 8.** Traces on RHA armour after penetration of ERAWA-2 cassette with warhead EFP; 1 - trace of detonation of ERAWA-2 cassette, 2 - trace of destroyed EFP projectile (EFP – $h = 85$ mm), $h_n = 5$ mm, protective ability of cassette $CP = 94\%$, ($\alpha = 60^\circ$)
Fig. 9. ERAWA-1 cassette after firing with six 7.62 mm armour-piercing projectiles B-32 ($\alpha = 60^\circ$)

Fig. 10. ERAWA-1 cassette after firing with 12.7 mm armour-piercing projectiles B-32 ($\alpha = 0^\circ$)

Fig. 11. Scheme of resistance test of ERAWA-1 cassettes to detonation and destruction with explosion of 82 mm mortar grenade

Fig. 12. ERAWA-1 cassettes after explosion of 82 mm mortar grenade

Fig. 13. Scheme of resistance test of ERAWA-1 cassette to detonation and destruction during burning of petrol around it

Fig. 14. ERAWA-1 cassette after combustion of petrol around it

Fig. 15. Scheme of resistance test of ERAWA-1 cassette to detonation and destruction during burning of napalm on it and around it

Fig. 16. ERAWA-1 cassette after combustion of napalm on it and around it
Table 1. Parameters of Polish KE projectiles

<table>
<thead>
<tr>
<th>No</th>
<th>Calibre of projectile (d) [mm]</th>
<th>Kind of projectile</th>
<th>Mass of projectile (m_p) ((m_p, m_n)) [g]</th>
<th>Speed of projectile (V_p), (V_{p(n)}) [m s(^{-1})]</th>
<th>Average kinetic energy of projectile (E_p), [J]</th>
<th>Thickness of RHA plate and penetration depth (h)/distance (I)/angle (\phi)</th>
<th>Comments, probability of penetration (p_p) and inflammation (p_n), [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.62</td>
<td>B-32</td>
<td>9.95</td>
<td>840 (\pm) 855 (847.5)</td>
<td>3573</td>
<td>10 200 0</td>
<td>inflammation of container with petrol behind target at distance of (L = 0.1\pm0.4) m, (80), {---}</td>
</tr>
<tr>
<td>2</td>
<td>12.7</td>
<td>B-32</td>
<td>47.4 (\div) 49 (48.2)</td>
<td>810 (\pm) 825 (817.5)</td>
<td>16106</td>
<td>20 200 0</td>
<td>(90), inflammation of container with petrol behind target (\pm)15, (L = 70) m, {75}</td>
</tr>
<tr>
<td>3</td>
<td>14.5</td>
<td>BZT</td>
<td>59.3 (\div) 61.3 (60.3)</td>
<td>995 (\div) 1015 (1005)</td>
<td>30452</td>
<td>20 100 20</td>
<td>(80), inflammation of container with petrol behind target (\pm)20, (L = 100) m, {80}</td>
</tr>
<tr>
<td>4</td>
<td>14.5</td>
<td>B-32</td>
<td>63 (\div) 64.8 (63.9)</td>
<td>980 (\div) 995 (987.5)</td>
<td>31156</td>
<td>20 100 20</td>
<td>(80), inflammation of container with petrol behind target (\pm)20, (L = 100) m, {80}</td>
</tr>
<tr>
<td>5</td>
<td>125</td>
<td>APFS DS</td>
<td>4100</td>
<td>1650</td>
<td>5.58</td>
<td>550 100 0</td>
<td>---</td>
</tr>
</tbody>
</table>

2. Model of detonation process of phlegmatized hexogen

The propagation of the detonative wave in the explosive has been described with the use of the approximation of so-called “the detonative optics”, in which the front of the detonative wave is a surface of the strong discontinuity, of the well-known shape (for the punctual initiation – the front is spherical), and the parameters of the medium on this surface are defined by the Chapman-Jouguet’s point. Propagation of the detonation products and their influence on the liner of the RPG-7M projectile are described with the use of equations of the hydrodynamics for the cylindrical symmetry:

- Conservation law of hydrodynamic detonation theory in cylindrical geometry:

- Mass conservation law:
\[
\frac{dp}{dt} + \rho \cdot \text{div} \psi = 0, \quad (1)
\]

- Momentum conservation law:
\[
\rho \frac{du}{dt} = -\frac{\partial p}{\partial x}, \quad (2)
\]
\[
\rho \frac{dv}{dt} = -\frac{\partial p}{\partial z}, \quad (3)
\]

- Energy conservation law:
\[
\rho \frac{dE}{dt} = -p \cdot \text{div} \psi + \rho Q \frac{d\alpha}{dt}, \quad (4)
\]
\[
\frac{d\alpha}{dt} = K \cdot \alpha^\gamma (1 - \alpha)^{1-\gamma} P \cdot E, \quad (5)
\]

where: \( \alpha \) – burn-up factor (\( \alpha = 0 \) – non reacted material; \( \alpha = 1 \) - totally reacted material);
\[
Q = Q_n (1 - B), \quad (6)
\]

B - mass fraction of phlegmatized hexogen; \( Q_n \) – heat of reaction (\( Q_n = 5.5265 \times 10^{10} \text{ [erg g}^{-1}] \)). \( K \) and \( \gamma \) are coefficients:
\[
K = 0.48 \times 10^{-14} \left( 1 + \frac{0.08}{1.75 - \rho_0} \right), \quad (7)
\]
\[
\gamma = 0.13 \left( 1 + \frac{0.2}{1.75 - \rho_0} \right), \quad (8)
\]

where: \( \rho_0 \) - initial density of phlegmatized hexogen [g cm\(^{-3}\)].

- Total pressure:
\[
p = \alpha \cdot p_{RD} + (1 - \alpha) p_{MW}, \quad (9)
\]

where: \( p_{RD} \) - pressure of detonation products; \( p_{MW} \) – pressure in non reacted material;
\[
p_{RD} = \Lambda e^{\frac{a}{T}} \left( 1 - \rho S_1 \right) + S_1 \rho^2 + \gamma_{RD} \rho E, \quad (10)
\]

where: \( \Lambda = 8.9616 \times 10^{12} \text{ [dyn cm}^{-2}\text{]}; a = 10.106 \text{ [g cm}^{-3}\text{]}; \gamma_{RD} = 0.3; S_1 = 2.9685 \times 10^2 \text{ [cm}^3\text{g}^{-1}\text{]; S}_2 = 2.786 \times 10^{10} \text{ [dyn cm}^4\text{g}^{-2}\text{]}; and:
\[
p_{MW} = C \left( 1 - x^3 \right) + S \left( x^2 - 1 \right) x^2 + \Gamma p E, \quad (11)
\]

where: \( x = \rho / \rho_0; \rho_0 = 1.72 \text{ [g cm}^{-3}\text{]; } \Gamma = 2.4, C = 7.12 \times 10^{10} \text{ [dyn cm}^{-2}\text{]; S} = 41.18 \times 10^{10} \text{ [dyn cm}^{-2}\text{].}

- A. *Equation of state of detonation products in the form of JWL*

The system of equations was supplemented with the equation of state of detonation products in the form of JWL:
\[ p_{pr} = A \left(1 - \frac{\delta}{R_1 V}\right)^{-R_1 V} + B \left(1 - \frac{\delta}{R_2 V}\right)^{-R_2 V} + \delta \rho \varepsilon, \]  
\text{(12)}

where: \( V = \rho_0 / \rho; A, B, R_1, R_2, \delta - \) empirical constants.

In case of lack of the knowledge of the shape of detonative wave front, more complicated model is used, in which the shape of the front results from the solution of equations of the motion of detonation products and of equations of chemical macrokinetics. The equation of conservation of energy has the form of [30]:

\[ \rho \frac{dE}{dt} = -p \cdot \text{div} \ w - Q \frac{d\alpha}{dt}, \]  
\text{(13)}

where: \( \alpha - \) the coefficient of the burning; \( Q - \) heat of combustion of the explosive unit.

The equation of macrokinetics of chemical reactions was accepted in the form of the Arhenius’s equation:

\[ \frac{d\alpha}{dt} = -\nu \alpha \cdot \exp \left( -\frac{E_a}{RT}\right), \]  
\text{(14)}

where: \( \nu - \) the collision coefficient; \( E_a - \) the activation energy; \( R - \) the gas constant; or the Forest Fire’s equation:

\[ \frac{d\alpha}{dt} = -\alpha \cdot \exp \left( A + Bp + Cp^2 + \cdots + Xp^s \right). \]  
\text{(15)}

Basic data can be found in very many sources, but there is little and often incomplete information concerning information such details as gap creation, the influence of gaps on strength properties, sticky effects, coefficients of the Forest Fire’s equation.

- B. The jet of RPG-7 projectile + the reactive cassette (steel/ TNT / steel - 5/5/5/ mm)

**Table 3.** Coefficients in the JWL equation for explosives of RPG-7M projectile

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Phlegmatized octogen</th>
<th>Phlegmatized hexogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \rho_0 ) [g cm(^{-3})]</td>
<td>1.783</td>
<td>1.777</td>
</tr>
<tr>
<td>( D_0 ) [m s(^{-1})]</td>
<td>8730</td>
<td>8500</td>
</tr>
<tr>
<td>( \rho_e ) [dyn cm(^{-2})]</td>
<td>(3.35 \cdot 10^{11})</td>
<td>(3.4 \cdot 10^{11})</td>
</tr>
<tr>
<td>( A ) [dyn cm(^{-2})]</td>
<td>(9.433 \cdot 10^{12})</td>
<td>(6.347 \cdot 10^{12})</td>
</tr>
<tr>
<td>( B ) [dyn cm(^{-2})]</td>
<td>(8.805 \cdot 10^{10})</td>
<td>(0.8 \cdot 10^{11})</td>
</tr>
<tr>
<td>( R_1 )</td>
<td>4.70</td>
<td>4.20</td>
</tr>
<tr>
<td>( R_2 )</td>
<td>0.90</td>
<td>1.0</td>
</tr>
<tr>
<td>( \delta )</td>
<td>0.35</td>
<td>0.3</td>
</tr>
<tr>
<td>( \rho_0 \delta_0 ) [dyn cm(^{-2})]</td>
<td>(1.02 \cdot 10^{11})</td>
<td>(8.9 \cdot 10^{10})</td>
</tr>
</tbody>
</table>
Table 4. Data of the copper RPG-7M liner - physical model - elastic-plastic body

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>( \rho_s ) [g cm(^{-3})]</td>
<td>8.93</td>
</tr>
<tr>
<td>5</td>
<td>( \gamma_0 )</td>
<td>1.99</td>
</tr>
<tr>
<td>6</td>
<td>( k_1 ) ( \times 10^{12} ) [dyn cm(^{-2})]</td>
<td>1.386</td>
</tr>
<tr>
<td>7</td>
<td>( k_2 ) ( \times 10^{12} ) [dyn cm(^{-2})]</td>
<td>2.749</td>
</tr>
<tr>
<td>8</td>
<td>( \rho_0 ) ( \times 10^6 ) [g cm(^{-3})]</td>
<td>5.113</td>
</tr>
<tr>
<td>9</td>
<td>( E_{010} ) ( \times 10^6 ) [erg g(^{-1})]</td>
<td>-1.178</td>
</tr>
<tr>
<td>10</td>
<td>( E_{01} ) ( \times 10^6 ) [erg g(^{-1})]</td>
<td>-2.344</td>
</tr>
<tr>
<td>11</td>
<td>( E_{02} ) ( \times 10^6 ) [erg g(^{-1})]</td>
<td>7.529</td>
</tr>
</tbody>
</table>

Table 5. The explosive of the reactive cassette

<table>
<thead>
<tr>
<th>Physical model</th>
<th>TNT material</th>
<th>Diameter</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model „of detonative optics”</td>
<td>300 mm</td>
<td>5 mm</td>
<td></td>
</tr>
</tbody>
</table>

Table 6. The model of the detonative optics (TNT)

<table>
<thead>
<tr>
<th>Parameters in the point C - J</th>
<th>Coefficients of the JWL equation of state</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \rho_0 ) ( \times 10^{12} ) [dyn cm(^{-3})]</td>
<td>( \rho_0 ) ( \times 10^{12} ) [g cm(^{-3})]</td>
</tr>
<tr>
<td>0.21</td>
<td>6.93</td>
</tr>
</tbody>
</table>

Table 7. Data of steel reactive cassette for: 1 - Diameter of armour (\( d_s \)) = 300 [mm]; 2 - Thickness of armour (\( L_t \)) = 5 [mm]; Velocity of armour - , - physical model - elastic-plastic body

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>( \rho_0 ) [g cm(^{-3})]</td>
<td>7.9</td>
</tr>
<tr>
<td>5</td>
<td>( \gamma_0 )</td>
<td>2.17</td>
</tr>
<tr>
<td>6</td>
<td>( k_1 ) ( \times 10^{12} ) [dyn cm(^{-2})]</td>
<td>1.6481</td>
</tr>
<tr>
<td>7</td>
<td>( k_2 ) ( \times 10^{12} ) [dyn cm(^{-2})]</td>
<td>3.124</td>
</tr>
<tr>
<td>8</td>
<td>( k_3 ) ( \times 10^{12} ) [dyn cm(^{-2})]</td>
<td>5.6491</td>
</tr>
<tr>
<td>9</td>
<td>( E_{010} ) ( \times 10^6 ) [erg g(^{-1})]</td>
<td>-1.34</td>
</tr>
<tr>
<td>10</td>
<td>( E_{01} ) ( \times 10^6 ) [erg g(^{-1})]</td>
<td>-2.908</td>
</tr>
<tr>
<td>11</td>
<td>( E_{02} ) ( \times 10^6 ) [erg g(^{-1})]</td>
<td>1.012</td>
</tr>
</tbody>
</table>

3. The results of simulation

The results of simulation process of impact AP ammunition of 7.62 mm, 12.7 mm 14.5 mm, and 125 mm calibre the type of APFSDS are presented in Figures 19+22. In these figures the change of following parameters on the Z axis: density \( p \), thickness \( L \), collapsing velocity \( V \) and pressure \( P \) during penetration of ERA in function \( t \), are presented.
Fig. 19. Parameters of explosive while impact of 7.62 mm AP on ERA with velocity of \( v = 855 \) [m s\(^{-1}\)]:
- a) scheme of experimental stand- 1 rod; 2 – coat; 3, 5 – steel; 4 – explosive; \( t = 0 \) [ms]; b) – for \( t = 0.032 \) [ms]

Fig. 20. Parameters of explosive while impact of 12.7 mm AP on ERA with velocity \( v = 820 \) m/s; a) - for \( t = 0 \) [ms]; b) – for \( t = 0.032 \) [ms]
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Fig. 21. Parameters of PBX 9404 explosive while impact of 14.5 mm AP on ERA with velocity $v = 995 \text{ [m s}^{-1}]$: a) - for $t = 0 \text{ [ms]}$; b) – for $t = 0.023 \text{ [ms]}$, 1 - non reacted explosive ($F=0$), 2 - detonation products ($F=1$)

Fig. 22. Parameters of explosive while impact of 125 mm APFSDS on ERA with velocity $v=1800 \text{ m/s}$: a) - for $t = 0 \text{ [\mu s]}$; b) – for $t = 4 \text{ [\mu s]}$
The next step to test the sensitivity of different types of ERA cassettes, containing different explosive layers placed on target, is the observation of their reaction to impact of KE (kinetic energy) ammunition. Explosive contains different percentages of phlegmatizing agent. The examples of reaction of two-layered explosive of different thickness (3–15) mm with different contents of phlegmatizing agent (70–97.4)%, are illustrated in Figures 23–31.

**Fig. 23.** Reaction of ERA cassette (of 10 mm thickness of explosive layer, containing 70% phlegmatizing agent) to impact of KE projectile with the speed of \( V_{Ap} = 800 \) [m s\(^{-1}\)]

**Fig. 24.** Reaction of ERA cassette (of 10 mm thickness of explosive layer, containing 77.5% phlegmatizing agent) to impact of KE projectile with the speed of \( V_{Ap} = 800 \) [m s\(^{-1}\)]
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Fig. 25. Reaction of ERA cassette (of 10 mm thickness explosive layer, containing 77.5% phlegmatizing agent) to impact of KE projectile with the speed of $V_{AP} = 1600$ [m s$^{-1}$]

Fig. 26. Reaction of ERA cassette (of 10 mm thickness explosive layer, containing 90% phlegmatizing agent) to impact of KE projectile with the speed of $V_{AP} = 800$ [m s$^{-1}$]

Fig. 27. Reaction of ERA cassette: a) of 10 mm thickness explosive layer, containing 80% phlegmatizing agent; b) 3 mm thickness interlayer and internal radius 20 mm, to impact of KE projectile with the speed of $V_{AP} = 1600$ [m s$^{-1}$]
Fig. 28. Reaction of ERA cassette: a) of 10 mm thickness explosive layer, containing 80% phlegmatizing agent; b) 15 mm thickness interlayer and internal radius 20 mm - 100% phlegmatizing agent, to impact of KE projectile with the speed of $V_{ap} = 1600$ [m s$^{-1}$]

Fig. 29. Reaction of ERA cassette: a) of 10 mm thickness explosive layer, containing 90% phlegmatizing agent; b) 10 mm thickness interlayer and internal radius 20 mm - 100% phlegmatizing agent, to impact of KE projectile with the speed of $V_{ap} = 1600$ [m s$^{-1}$]

Fig. 30. Reaction of ERA cassette: a) of 4 mm thickness explosive layer, containing 97.5% phlegmatizing agent; b) 6 mm thickness interlayer and internal radius 20 mm - 93% phlegmatizing agent, to impact of KE projectile with the speed of $V_{ap} = 1600$ [m s$^{-1}$]
4. Conclusions

4.1 In Military Institute of Armament Technology in Zielonka three generations of reactive cassettes for tank PT-91 “Hard” - ERAWA-1 and ERAWA-2 with module and block way of assembly were designed and next they were implemented in” Bumar-Lądek” Plant and one of the examples of the third generation is presented. It can be stated that:

4.2. Cassettes are insensitive (it means that they do not detonate) after firing from small-calibre weapon, after hitting with hand grenades and mortar fragments, in result of burning petrol, napalm, incendiary agents, producing temperatures about 3000 °C on them.

4.3. Computer analysis of parameters’ changes on the projectile penetration axis into ERA cassette, i.e. of density, thickness, pressure, impact velocity for different thicknesses of layers of this cassette as well as the projectile type and velocity, enables to know the initiation conditions of this cassette’s explosive.

4.4. The use of computer simulation enables to know the influence of quantity of phlegmatizing agent on the sensitivity of different thicknesses explosive of one-layered and two-layered reactive cassettes.

4.5. These cassettes can be used on the other kinds of tanks and armour vehicles.

References