MATEC Web of Conferences **373**, 00031 (2022) https://doi.org/10.1051/matecconf/202237300031
UNIVERSITARIA SIMPRO 2022

Technical-scientific considerations regarding the reduction of the explosion effects generated by the explosive materials on persons and industrial and civil objectives

Gabriel-Dragoş Vasilescu[1*], *Cristian* Rădeanu[1], *Ciprian-Ilie* Jitea[1], *Bogdan* Garaliu-Bușoi[1], and *Doru* Anghelache[2]

[1]National Institute for Research and Development in Mine Safety and Protection to Explosion INSEMEX Petrosani, 32-34 G-ral. Vasile Milea Street, Petroșani, 332047, Romania
[2]Nitro Nobel Group, 020011, Bucharest - Romania

Abstract. The attenuation is a function of a structural strength and mass of the PES structure. Relatively light or weak structures (or open PES facilities) are assumed to not attenuate any of the pressure or impulse load. These not-attenuating facilities include: Pre-engineered metal building, Hollow clay tile building, Trailer (drop or stand-alone), Tractor-trailer and Bulk/tank truck/Van truck. If there is a barricade present between the PES and the ES and this barricade meets certain criteria, the user can direct the model to reduce the pressure and impulse arriving at the ES because of the presence of the barricade. The fractional damage of the PES structure remaining intact after an explosive event is a function of the equivalent NEW (Net Explosive Weight) and the PES building type. The fractional damage (a value between 0 and 1) of each PES component (roof, front wall, side walls, and rear wall) is determined by comparing the NEW to lower-bound and upper-bound damage limits for the PES types. So, if the NEW is below the lower-bound damage limit value, then the PES structure is assumed to remain totally intact; if the NEW is greater than upper-bound damage limit value, then the PES structure is assumed to be completely destroyed; if the NEW value is between the lower-bound damage limit and upper-bound damage limit, the PES structure is partially or fractionally damaged. If the equivalent NEW is between the two values, an algorithm is used to determine how fast the PES structure transitions from zero damage to full damage as the NEW increases between the lower-bound damage limit and upper-bound damage limit values. This algorithm and all associated parameters are described in the following.

* Corresponding author: dragos.vasilescu@insemex.ro

1 Introduction

The probability of fatality given the event occurs and a person present is determined by considering the potentially fatal results at the Exposed Site (ES) due to multiple hazard mechanisms [1-3]. These potential fatality mechanisms should be analysed in parallel and can be grouped into four branches of sequential steps: Pressure & Impulse (the explosion produces a blast wave described by both the pressure and the impulse); Structural Response (two consequences are assessed here: building collapse and broken windows – flying glass); Debris (the debris branch combines hazardous debris from three sources into a single table of debris density as a function of Kinetic Energy (KE). These three components are primary debris from de explosive articles, secondary debris from the PES, and ejecta from the crater); Thermal (the thermal branch is only use for Hazard Division (HD) 1.3 explosive – mass fire). The effects and consequences of each hazard mechanism or branch are considered in sequence as the hazard is (1) generated at the PES, (2) affected by the PES structure if applicable, (3) affected by the distance between the PES and ES, and (4) affected by the presence of the ES structure applicable, before finally reaching the exposed person(s). Values for pressure and impulse are based on simplified Kingery-Bulmash hemispherical TNT equations. Pressure and impulse values for explosives articles that are classified as “Packaging with small fragments”, “Intermediate Bulk Container (IBC)”, or “No primary fragments” are based on the effective yield, which is equal to the yield of the event. Pressure and impulse values for explosives articles that are classified as “Metal-cased explosives articles” or ”Metal container” are based on the effective yield, W_1, and the hazard factor, Z. This hazard factor, or scaled range, is used to calculate the unmodified pressure and impulse values. These values are labelled as unmodified because they represent the baseline pressure and impulse value from an open-air detonation. They do not account for the presence of a PES or ES structure [4-7].

2 Technical aspects to calculate the blast shielding effects generated by the open-air pressure and impulse

The effective yield of an explosive article accounts for amplification or attenuation based on the material type and effects of the casing. This adjustment is made by calculating an equivalent hemispherical charge weight referred to as the Effective Yield, Y. This adjustment is made only if the casing or packaging of the explosive article has an effect on the explosive behavior. The following explosive article types have no adjustment due to negligible effects from the casing or packaging: No primary fragments; Packaging with small fragments; Intermediate Bulk Containers (IBC) [8, 9].

The remaining explosive article types (metal containers and metal-cased explosives articles) receive an adjustment to the specified explosive weight. The adjustment is sensitive to the scaled range, Z. Within a minimum scaled range (0.768 $m/kg^{1/3}$), a scaled range of 0.768 is assumed. A ceiling value specific to each explosive article type is also specified. Beyond this ceiling value, the ceiling scaled range value is assumed. Between these bounding values (for the vast majority of scenarios), an adjustment algorithm is used.

First, the scaled range from the PES to the ES being considered is determined. This is shown as Equation 1, where Z is the scaled range, d is the range to the ES and W_1 is the effective explosives weight. Equation 2 calculates the natural log of the scaled range, referred to simply as X.

$$Z = \frac{d}{(W_1)^{1/3}} \quad (1)$$

$$X = ln(Z) \tag{2}$$

Equation 2 presents the form of the effective yield adjustment and Table 1 presents the coefficients used as well as the scaled range values that use this form of adjustment. In this equation, X_w is the explosive weight of a single item.

$$Y_{i=\overline{1,2}}=\left(\frac{W_1}{X_{W1i=\overline{1,2}}}\right) e^{\left(a_{1i=\overline{1,2}}+a_{2i=\overline{1,2}}x+a_{3i=\overline{1,2}}x^2+a_{4i=\overline{1,2}}x^3+a_{5i=\overline{1,2}}x^4+a_{6i=\overline{1,2}}x^5\right)} \tag{3}$$

$$Y_{i=\overline{1,2}}=\left(\frac{W_1}{X_{W1i=\overline{1,2}}}\right)\cdot e^{\left[\begin{pmatrix}4.43036\\-2.980723\end{pmatrix}+\begin{pmatrix}-0.838135\\1.944348\end{pmatrix}x+\begin{pmatrix}0.544216\\-0.293102\end{pmatrix}x^2+\begin{pmatrix}-0.184942\\-0.173221\end{pmatrix}x^3+\begin{pmatrix}0.01943\\0.049327\end{pmatrix}x^4+\begin{pmatrix}-0.000231\\-0.0035675\end{pmatrix}x^5\right]} \tag{3'}$$

where: 1-Metal Container and 2-Metal-Cased Explosives Articles, Z and X_W are according to Table 1.

Table 1. Coefficients used and scaled range values

Explosive article type i=1,2	Scaled range, Z ($m/kg^{1/3}$)	X_W
Metal Container (for i=1)	0.768÷224.0	15.876
Metal-Cased Explosives Articles, (for i=2)	0.768÷166.4	0.091

Once the *Effective Yield* (*Y*) is calculated, the *Effective Scaled Range* (Z_0) and *Effective Natural Log* (X_0) can be calculated as shown in Equations 4 and 5.

$$Z_0=\frac{d}{(Y_0)^{1/3}} \tag{4}$$

$$X_0 = \ln(Z_0) \tag{5}$$

The *Unmodified Pressure* (P_1) and *Unmodified Impulse* (I_1) represent the open-air pressure and impulse experienced at the ES at its specified range from the PES as if there were no PES structure. The values are calculated as shown in Equations 6 and 7 according to scaled range provided in Table 2 and Table 3.

$$P_{1i=\overline{1,3}}=e^{\left(b_{1i=\overline{1,3}}+b_{2i=\overline{1,3}}x_0+b_{3i=\overline{1,3}}x_0^2+b_{4i=\overline{1,3}}x_0^3+b_{5i=\overline{1,3}}x_0^4\right)} \tag{6}$$

$$P_{1i=\overline{1,3}}=e^{\left[\begin{pmatrix}6.1937\\8.8035\\5.4233\end{pmatrix}+\begin{pmatrix}-1.4398\\-3.7001\\-1.4066\end{pmatrix}x_0+\begin{pmatrix}-0.2815\\0.2709\\0\end{pmatrix}x_0^2+\begin{pmatrix}-0.1416\\0.0733\\0\end{pmatrix}x_0^3+\begin{pmatrix}-0.0685\\-0.0127\\0\end{pmatrix}x_0^4\right]} \tag{6'}$$

where: i represent the numerical domain of the scaled range Z ($m/kg^{1/3}$): 0.32÷4.64 (for i=1), 4.64÷38.4 (for i=2) and 38.4÷320.0 (for i=3):

$$I_{1i=\overline{1,4}}=e^{\left(c_{1i=\overline{1,4}}+c_{2i=\overline{1,4}}x_0+c_{3i=\overline{1,4}}x_0^2+c_{4i=\overline{1,4}}x_0^3+c_{5i=\overline{1,4}}x_0^4\right)}\cdot Y^{1/3} \tag{7}$$

$$I_{1i=\overline{1,4}}=e^{\left[\begin{pmatrix}2.975\\0.911\\3.2484\\4.7702\end{pmatrix}+\begin{pmatrix}-0.466\\7.26\\0.1633\\-1.062\end{pmatrix}x_0+\begin{pmatrix}0.963\\-7.459\\-0.4416\\0\end{pmatrix}x_0^2+\begin{pmatrix}0.03\\2.960\\0.0793\\0\end{pmatrix}x_0^3+\begin{pmatrix}-0.087\\-0.432\\-0.00554\\0\end{pmatrix}x_0^4\right]}\cdot Y^{1/3} \tag{7'}$$

where: i represent the numerical domain of the scaled range Z ($m/kg^{1/3}$): 0.32÷1.543 (for i=1), 1.543÷3.84 (for i=2), 3.84÷54.4 (for i=3) and 54.4÷256.0 (for i=4).

3 Results and discussions

3.1 Attenuation

This step accounts for the presence of the PES structure and its potential to attenuate some of the blast load. Not all PES types attenuate blast loads [10, 11]. The main document lists those PES types that do not attenuate the blast loads. This section will present the methodology for attenuation used by those robust PES types that affect the blast loads.The *Adjusted Pressure* (P_2) and the *Adjusted Impulse* (I_2) represent the pressure at the ES considering the potential effects of the PES. If no attenuation is provided by PES structure, the adjusted pressure and impulse values (P_2 and I_2) are equal to the unmodified pressure and impulse values (P_1 and I_1) calculated above step. Similar to the methodology used to account for amplification or attenuation effects of explosives article casing or packaging, the potential attenuation of the PES structure is accounted for by modifying the explosives weight considered. In this step, the modified weight value is referred to as the *Adjusted Weight* (W_a). The equation for W_a is presented as Equation 8. The coefficients used in this equation are presented in Table 2.

$$W_{ai=\overline{\ ,9}} = W_1 e^{\left(d_{1i=\overline{1,9}}+d_{2i=\overline{1,9}}x_0+d_{3i=\overline{1,9}}x_0^2+d_{4i=\overline{1,9}}x_0^3+d_{5i=\overline{1,9}}x_0^4+d_{6i=\overline{1,9}}x_0^5+d_{7i=\overline{1,9}}x_0^6\right)} \quad (8)$$

$$W_{ai=\overline{1,9}}=W_1 e^{\left[\begin{pmatrix}-0.438640\\-1.283200\\0.7206800\\5.8111980\\-5.568345\\-8.572503\\-7.345585\\-4.186940\\-11.81948\end{pmatrix}+\begin{pmatrix}-8.416500\\-3.611100\\-8.851100\\-13.94288\\2.6646080\\1.2822870\\5.9060400\\2.2894100\\16.423350\end{pmatrix}x_0+\begin{pmatrix}16.706000\\5.4064000\\10.700000\\11.122640\\-0.6710276\\0.1804460\\-3.846292\\-0.1624718\\-8.9913860\end{pmatrix}x_0^2+\begin{pmatrix}-12.74900\\-3.158200\\-6.089100\\-4.566028\\0.4365081\\-0.226038\\1.7876420\\-0.071019\\2.2772750\end{pmatrix}x_0^3++\begin{pmatrix}4.7554000\\1.0194000\\1.8914000\\1.0500350\\-0.146579\\0.0394751\\-0.408498\\-0.000446\\-0.268759\end{pmatrix}x_0^4+\begin{pmatrix}-0.866790\\-0.177380\\-0.308110\\-0.129367\\0.0149590\\0.0149590\\0.0317336\\0.0018659\\0.0123688\end{pmatrix}x_0^5+\begin{pmatrix}0.0615260\\0.0124970\\0.0202990\\0.0067025\\0\\0\\0\\0\\0\end{pmatrix}x_0^6\right]} \quad (8')$$

where: i=1,9 for scaled range and adjusted weight, according to Table 2.

Table 2. The coefficients used in equation 8

		Scaled range, Z (m/kg$^{1/3}$)	**Adjusted weight, W_a (kg)**
For i=1	**E**arth-**C**overed **M**agazine (ECM)-front (all sizes/types)	> 38.4	0.1587 W_1
		0.96÷38.4	Eq. (5)/ Eq. (5′)
		< 0.96	0.0453 W_1
For i=2	**E**arth-**C**overed **M**agazine (ECM)-side (all sizes/types)	> 38.4	0.1587 W_1
		1.28÷38.4	Eq. (5)/ Eq. (5′)
		< 1.28	0.0589 W_1
For i=3	**E**arth-**C**overed **M**agazine (ECM)-rear (all sizes/types)	> 38.4	0.0907 W_1
		1.6÷38.4	Eq. (5)/ Eq. (5′)
		< 1.6	0.0635 W_1
For i=4	**H**ardened **A**ircraft **S**helter (HAS)-front	> 40.32	0.3084 W_1
		2.24÷40.32	Eq. (5)/ Eq. (5′)
		< 2.24	0.1723 W_1
For i=5	**H**ardened **A**ircraft **S**helter HAS-side (W>113.399 kg)	> 64	0.5443 W_1
		1.6÷64	Eq. (5)/ Eq. (5′)
		< 1.6	0.0136 W_1
For i=6	**H**ardened **A**ircraft **S**helter HAS-side (W≤113.399 kg)	> 64	0.5443 W_1
		1.6÷64	Eq. (5)/ Eq. (5′)
		< 1.6	0.0136 W_1

For i=7	**H**ardened **A**ircraft **S**helter HAS-rear	> 32	0.0317 W_1
		1.7÷32	Eq. (5)/ Eq. (5′)
		< 1.7	0.0317 W_1
For i=7	(AGBS), Operating Building, Unreinforced Concrete, Masonry and Shed	> 89.6	0.385 W_1
		0.73÷89.6	Eq. (5)/ Eq. (5′)
		< 0.73	0.009 W_1
For i=9	Ship (all sizes) and 3/8″ Steel Bin	> 64	0.6032 W_1
		4.99÷64	Eq. (5)/ Eq. (5′)
		< 4.99	0.2267 W_1
	ISO Containers, Steel Magazines, Vehicles/Trailers 1/4″ Steel Bin	> 64	0.4535 W_1

Once the *Adjusted Weight* (W_a) is calculated, the *Adjusted Scaled Range* (Z_a) and Adjusted *Natural Log* (X_a) can be calculated as shown in Equations 9 and 10.

$$Z_a = \frac{d}{(W_a)^{1/3}} \tag{9}$$

$$X_a = \ln(Z_a) \tag{10}$$

The *Adjusted Pressure* (P_2) and the *Adjusted Impulse* (I_2) are calculated as shown in Equations 8 and 9 with the required coefficients are the same as those previously provided in Equations 6/6' and 7/7'.

3.2 Overpressure Shielding Routine

This section discusses the mathematics involved in determining blast overpressure shielding [12, 13]. If distance L_1 is the length from the PES to the barricade and H is the height ofthe barricade,

$$L_H = L_1/H \tag{11}$$

If $L_H < 0.3048$ m (1 ft), the algorithm is not considered applicable and therefore no blast shielding is provided to the ES.

If $R/H \geq 6.096$ m (20 ft), where R is the distance between the barricade and the ES, no blast shielding is provided to the ES.

The barricade pressure reduction and the barricade impulse reduction factors can be seen in Figure 1 and Figure 2 respectively.

The pressure at the ES = $(F_P).(P_2)$ and, the impulse at the ES = $(F_I).(I_2)$ where, F_P is the pressure reduction factor and F_I is the impulse reduction factor, calculated by the following Equations (for NEW in kg - SI units):

$$F_P = 0.36\left(\frac{L_H}{6}\right)^{0.83}\left(\frac{R}{H}\right)^{0.21}\left(\frac{NEW}{2429.5}\right)^{-0.06} \tag{12}$$

$$F_I = 0.55\left(\frac{L_H}{6}\right)^{0.52}\left(\frac{R}{H}\right)^{0.22}\left(\frac{NEW}{2429.5}\right)^{-0.08} \tag{13}$$

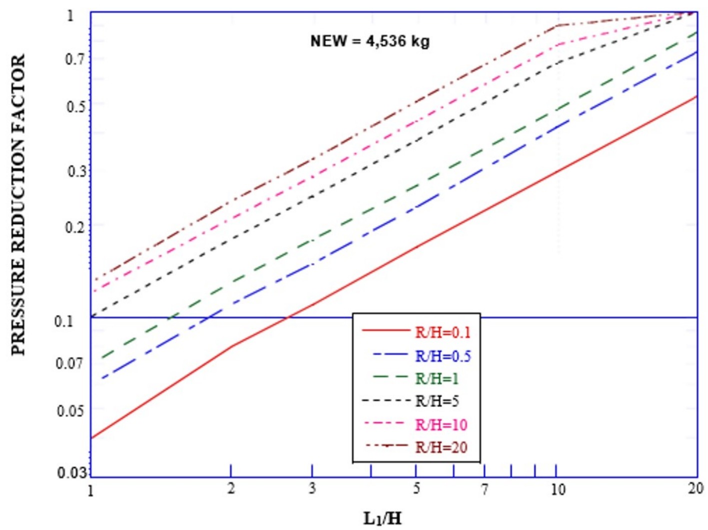

Fig. 1 Pressure Reduction Factor F_p.

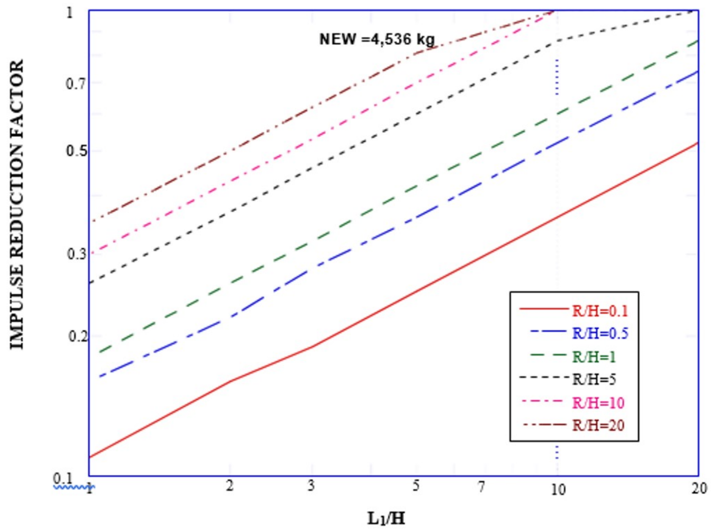

Fig. 2 Impulse Reduction Factor F_I.

As an illustration of the resultant shadow effect or barricade blast shielding is shown in Figure 3 and Figure 4. This scenario is an Open PES vs Open ES with 4,536 kg NEW and a qualifying 6.096 m (20 ft) high barricade. The adjusted pressure and impulse are plotted, but since the PES is open there is no attenuation from the PES. The x-axis is the distance between the ES and PES and the barricade is fixed at 152.4 m (500 ft).

 https://doi.org/10.1051/matecconf/202237300031

The ES is clearly not shielded until it gets beyond the barricade. Just beyond 152.4 m (500 ft), at about 155.4 m (510 ft), the graph shows a rapid decrease in impulse and pressure indicating the position where the ES experiences the maximum protection from the air blast effects. As the ES distance increase from the barricade and from the PES, the plot of the barricade's blast shielding effect decays rapidly until it has no effect on pressure and impulse at 161.5 m (530 ft) in this scenario.

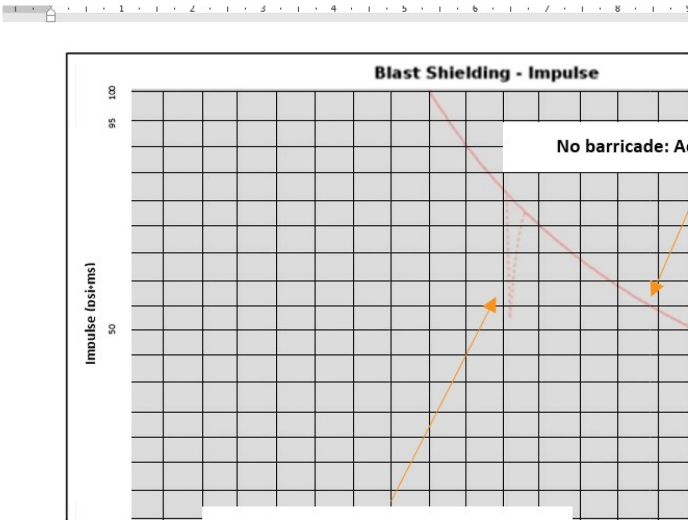

Fig. 3 Blast Shielding – Impulse.

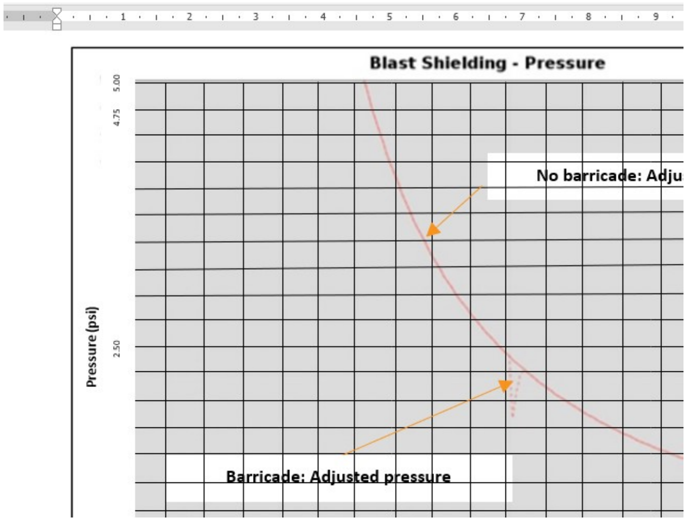

Fig. 4 Blast Shielding – Pressure.

3.3 Determining the PES Damage

The fractional damage (a value between 0 and 1) of each PES component (roof, front wall, side walls, and rear wall) is determined by comparing the NEW (W_2) in SI units (kg), to lower- bound (Y_0) and upper-bound (Y_{100}) damage limits for the PES types [14, 15]. These values are presented for all PES types in Equation 14 and Table 3.

$$PES_{damage\ i=\overline{1,10}}=\left[\frac{1}{\left(Y^{j=\overline{1,4}}_{100i=\overline{1,10}}-Y^{j=\overline{1,4}}_{0i=\overline{1,10}}\right)^{b^{j=\overline{1,4}}_{i=\overline{1,10}}}}\right]\left(W_2-Y^{j=\overline{1,4}}_{0i=\overline{1,10}}\right)^{b^{j=\overline{1,4}}_{i=\overline{1,10}}} \tag{14}$$

Table 3. The fractional damage of each PES component.

PES Name$_{i=1,10}$	Roof (j=1)			Front wall (j=2)			Side walls (j=3)			Rear wall (j=4)		
	Y_0	Y_{100}	b	Y_0	Y_{100}	b	Y_0	Y_{100}	b	Y_0	Y_{100}	b
Open, (i=1)	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Hollow clay tile, (i=2)	0.453	3.628	0.3	0.453	3.628	0.3	0.453	3.628	0.3	0.453	3.628	0.3
HAS, (i=3)	453.6	907.2	0.9	18.143	907.2	0.9	453.6	907.2	0.9	907.2	4,536	0.9
ECM (all sizes/types),(**i**=4)	6.803	113.399	1.0	0.453	4.535	0.6	907.2	4,536	0.9	907.2	4,536	0.9
AGBS (all sizes), (i=5)	0.453	7.257	0.5	0.453	3.628	0.3	0.453	3.628	0.3	0.453	3.628	0.3
Concrete operating building(all sizes), Small and Medium unreinforcedconcrete magazines and Double-Wythebrick building, (i=6)	0.453	7.257	0.5	1.360	45.359	0.4	1.360	45.359	0.4	1.360	45.359	0.4
Shed, (i=7)	1.360	18.143	0.4	0.453	3.628	0.3	0.453	3.628	0.3	0.453	3.628	0.3
Type 3 Day Box steel magazine, (i=8)	0.453	0.907	0.4	0.453	0.907	0.4	0.453	0.907	0.4	0.453	0.907	0.4
Steel magazines (all typesand sizes), ISO containers, Pre-engineeredmetal building(PEMB), Vehicles, Trailers and Bins, (i=9)	1.360	18.143	0.4	1.360	18.143	0.4	0.453	18.143	0.4	0.453	18.143	0.4
Ship (allsizes), (i=10)	45.359	2,268	1.1	45.359	2,268	1.1	45.359	2,268	1.1	45.359	3,402	1.1

If W_2 is less than Y_0, then the PES is undamaged.
If W_2 is equal to or greater than Y_{100}, the PES is completely destroyed.
If W_2 is between Y_0 and Y_{100}, the fractional damage is calculated according to Equation 14.

4 Conclusions

The pressure and impulse values are modified to account for the presence of the PES structure (if applicable) and determine the damage to the PES structure. The blast shielding effects of a barricade between the PES and ES are detailed in the specialised sections of the paper.

If a PES structure is present, this structure may attenuate or dampen a portion of the pressure and impulse loads generated within the facility. This attenuation is a function of the structural strength and mass of the PES structure.

If attenuation is applicable, the effective yield, W_1, is reduced according to the PES structure type and then the pressure and impulse equations are repeated to calculate the adjusted pressure, P_2, and adjusted impulse, I_2. The pressure and impulse calculated in this step represent the value at the ES location, accounting for the PES structure (if present) but not yet considering the shielding effects of the ES structure.

If there is a barricade present between the PES and the ES and this barricade meets certain criteria, the user can direct the model to reduce the pressure and impulse arriving at the ES because of the presence of the barricade.

According to the procedure which detailed in this paper, the fractional damage (a value between 0 and 1) of each PES component (roof, front wall, side walls, and rear wall) is determined by comparing the NEW (W_2) to lower-bound (Y_0) and upper-bound (Y_{100}) damage limits for the PES types.

This paper was developed within the NUCLEU - Programme, carried out with the support of ANCSI, Project no. PN-19 21 02 02.

References

1. J.C. Conte, E. Rubio, A.I. Garcia, F. Cano, Safety Sc, **49**, 306–314 (2011)
2. V.T. Covello, M.W. Merkhofer, *Risk assessment methods. Approaches for assessing health and environmental risks* (Berlin-Heidelberg-New pringer, Berlin-Heidelberg-New York, 1993)
3. M. Cruz, Operational risk modelling and analysis. Theory and practice (Risk Book, a Division of Incisive Financial Publishing Ltd, London, 2004)
4. A. Darabont, S. Pece, A. Dascalescu, Occupational Health and Safety Management, **I, II** (AGIR Publishing House, Romania, 2002)
5. J. Kotus, B. Kostek, Archives of Acoustics, **33** (4), 435-440 (2008)
6. M. Leba, A. Ionica, R. Dobra, V.M. Pasculescu, Env Eng and Manag J, **13** (6), 1365-1370 (2014)
7. H.S. Lee, H. Kim, M. Park, J of Comp in Civil Eng, **26** (3), 319-330 (2012)
8. M. Hardwick, J. Hall, J. Tatom, R. Baker, T. Ross, M. Swisdak, Approved Methods and Algorithms for DoD Risk-Based Explosive Siting, Technic document DDESB 14 Revision 4a (2016)
9. APT CDES-AL011-18-00100, *Probability of Event Study* (2018)
10. D. Nichols, J. Chrostowski, G. Nickell, J. Flores, B. Fulmer, Literature Review of Risk Methodologies Used in Industries and Disciplines other than DoD and How Those Methodologies May Be Applied to DoD Risk-Based Siting, APT CDES-AL011-17-00500, 10 (2017).
11. L. Santis, M. Hardwick, D. Leidel, J. Tatom, IMESAFR—A Tool for Managing Risk from Commercial Explosives Operations, Minutes of the 32nd DDESB Explosives Safety Seminar (2006)
12. J. Tatom,M. Hardwick, L. Santis, A Comparison of SAFER and IMESAFR Methods, Features, and Models, Minutes of the 32nd DDESB Explosives Safety Seminar (2006)
13. J. Tatom, L. Santis, A New Tool for Managing Risk with Commercial Explosive Operations, Minutes of PARARI 2007 (2007)
14. L. Santis, Managing Commercial Explosives Operations Using Quantitative Risk Assessment, *Proceedings of the 34th Annual Conference on Explosives and Blasting Techniques* (2008)
15. J. Tatom, L. Santis, D. Leidel, The Status of Risk Assessment in the Commercial Explosives Community, Minutes of the 33rd DDESB Explosives Safety Seminar (2008)