Safety Requirements for Service of Pistol and its Ammunition

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Abstract: Pistol and its ammunition life cycle are initiated by the process of setting needs and requirements. Pistol and its ammunition belong to dangerous products that exploit explosives for their functioning. The pistol shooting could result in pistol failures with serious consequences, such as shooter's injury or even shooter's killing. That is why we consider the safety requirements for pistol and its ammunition to be one of their most important characteristics. The requirements for pistol and its ammunition safety are divided by the author into two groups – requirements for design safety and requirements for safety risk level. Requirements for design safety mean the application of weapons and ammunition construction principles that have been proved and confirmed in practice. These requirements for safety risks level of small arms and their ammunition have neither been published nor elaborated on.

The method introduced by the author identifies in an original way both the area of acceptable safety risk for pistol and the area of acceptable safety risk for ammunition. A shooting experiment with the purpose to verify the fulfilling of the pistol safety risk requirements was conducted. Its goal was to achieve dangerous pistol failures, i.e. such failure categories which threaten shooter's health. The results of the experiment were used to determine maximal guaranteed lifetime of the given pistol of calibre 9.00 mm Luger.

Key-Words: Categories of Pistol Failures, Categories of Ammunition Failures, Acceptable Pistol Safety Risk, Acceptable Ammunition Safety Risk, Pistol Lifetime

1 Introduction

Each pistol and its ammunition (see Fig.1) have their own life cycle. Life cycle means the whole period of the existence of pistol and its ammunition, as a result of processes in the development, production, sales and while it is used by a user (for example in a sport competition or in the armed forces).

Although individual type of pistol and its ammunition vary broadly in their life cycles, there is definitely a model sequence of all characteristic phases that can be traced in any weapon and its ammunition life cycle [6]:

- I. Concept of a new pistol and its ammunition
- II. Development of pistol and ammunition
- III. Utilisation (service) of pistol and ammunition
- IV. Disposal of pistol and ammunition

Each phase of life cycle represents a relatively independent time period that is characterised by its specific purpose. Each phase has to be managed bearing in mind overall (general) plans of pistol and its ammunition life cycle.



Fig. 1. Pistol and its ammunition (http://www.czub.cz/)

This article brings a contribution to the first phase (concept of a new pistol and its ammunition) whose main purpose is to formulate requirements for a new pistol and its ammunition. The requirements present formulation of the needs of the user (for example sports shooters, police forces, armed forces etc). In author's view, the best method is based on the formulation of all requirements in logical groups – e.g. Legal Requirements, Requirements for Dimensional and Weight Parameters, Accuracy Requirements, Safety Requirements, Reliability Requirements, etc.

An unambiguous and understandable specification of the requirements is considered to be a basis for mutual understanding between a producer and a user. Completely and meaningfully described qualitative features of the required pistol and its ammunition are a basic prerequisite for the satisfaction of both user and the producer. To sum up, to achieve this goal, the requirements of the user have to be unambiguous, assessable, not contradictory, and observable.

Pistol and its ammunition belong to dangerous products that contain explosives. Fig.2 shows a damaged combat pistol with ruptured barrel which has caused shooter's severe injury.



Fig.2. Damaged pistol

That is why we consider the safety of a new pistol and its ammunition to be their most important characteristics [7].

2 Safety Requirements

We require the pistol and its ammunition to resist a wide range of effects of external environment without getting dangerous or useless for real user. The safety precautions must be kept during common manipulation, transportation, storing and also during operation (shooting) when pistol and its ammunition must fulfil all required functions. Furthermore, the ammunition must stay safe not only in the period of use, but also in the period of disposal when it is either irreversibly adjusted or physically liquidated [8].

Pistol and its ammunition are considered to be reliable if only a minimum failure occurs during the

period of use. In a safe pistol and its ammunition, no hazard arises for a shooter, for the pistol and ammunition or to the ambient environment (other persons or objects in the vicinity). In other words, in a safe pistol and ammunition, there is no failure which could endanger health or even life of a user or which could damage asset or environment.

Pistol and ammunition quality, reliability and safety are integrated (interconnected) and they form a common whole. They create a common pyramid with quality as both a base and frame with safety on the peak (see Fig.3).



Fig.3. Pistol and ammunition quality, reliability and safety

According to Fig.3, pistol and ammunition safety is the characteristic which can be quantified as the probability that it will cause no hazard threat during all periods of its life cycle (development, production, use and retirement) and the risk level of damaging human health, assets and/or environment is very low (negligible).

As far as safety is concerned, we analyze the effects of the failures arising during pistol and ammunition life cycle on the possibility of damage or destruction of the pistol and its ammunition and on the possibility of damaging human health, assets or environment. What we mean by that is, for instance, improper (not required) operation of pistol and ammunition, macro-plastic deformations, cracks, or fractures of important functional parts and functional surfaces, defects of connections and seals, damage of internal arrangement, prohibited changes in chemical composition of the material from which the pistol and ammunition have been made, etc.

We should add that an absolute safety (100 %) can never be guaranteed. Safety assessment analyzes the consequences of failures (phenomena and events) that occur during the whole pistol and its ammunition lifetime and that can cause damage or destruction of the weapon or ammunition itself or impairment of persons, damage of assets or human environment [9].

3 Categories of Failures

The starting point in pistol and its ammunition safety analysis is the risk analysis. Pistols and their ammunition risks are characterized and categorized according to severity of the worst impact on persons, assets and human environment as a result of their failures which can occur not only during the operation (firing), but also at e.g. manipulation, transportation, storing, maintenance, or during their liquidation (disposal).

A serious pistol and ammunition risk can be defined as a risk which could result in a failure with serious consequences, such as killing the shooter, big material damage on assets or serious damage to human environment.

Pistol and ammunition failures (and risks) classification with respect to the severity of failures according to NATO standards STANAG 4297 [10] is shown in Table 1.

Table 1. Matrix of severity of pistol and ammunition failures [8], [9]

Failure	FAILURE MAGNITUDE FOR			
Category	PERSON ASSETS		ENVIRONMENT	
Category I	death	loss (total damage)	severe damage	
Category II	severe injury or illness	severe damage	major damage	
Category III	minor injury or illness	minor damage	minor damage	
Category IV	no effect	no effect	no effect	

According to Table 1, pistol and ammunition failures are divided into four categories with respect to their severity.

Failure category I means the highest seriousness. This category covers such failures that result in person's death, total damage of assets or serious damage of human environment.

Failure category II involves pistol and ammunition failures which cause severe injuries or illnesses of persons, serious damage of assets or serious damage of human environment. Severe injury or illness is generally defined as an actual bodily harm that disables a person for more than one day. Severe damage to assets means that it causes non-functionality and unserviceability of the assets to fulfil given tasks for longer than one day.

Category III represents kinds of pistol and ammunition failures which cause minor injuries of persons, minor damage to assets and only minor damage to human environment. Minor injury or illness disables a person maximally for one day. Minor damage to assets causes non-functionality or unserviceability of assets for one day maximum.

Failure category IV includes pistol and ammunition failures which do not cause any effects on persons, assets or human environment.

4 Ammunition and Pistol Safety Risk Indicators

All projects of the development of a new pistol and ammunition must contain the procedure of safety evaluation of the given pistol and ammunition in the safety programme. The content of safety programme is pistol and ammunition analysis and tests aimed at its safety, i.e. verification that the explosive components of the ammunition and pistol as a whole will fulfil the required functions by prescribed way and with acceptable (negligible) safety risk level during the whole life cycle.

To be able to effectively control individual risks in safety programme, i.e. to accept meaningful measures for decreasing unacceptable risk level, it is necessary to determine indicators for safety risks monitoring and measuring.

Ammunition fulfils its function only at a shot. The ammunition belongs to the group of so called one-shot weapon systems [12]. The lasting of a shot is very short – in order of several milliseconds. In practice, this time is neither measured nor recorded for the purposes of safety analysis. To derive ammunition safety risk indicators, we will use an ammunition safety model – see Fig.4.



Fig.4. Ammunition safety model

The ammunition safety model shown in Fig.4 is arranged in such a way that it consists of a set of N pieces of ammunition of the same type which are in service under identical operational conditions. Variable t is for ammunition expressed by using time to failure (e.g. to failure category I).

The using time limits total time phase in which the cartridge is in service. This time can contain the time of transport (from producer to seller, from seller to user), time of storing, but also the time when the ammunition is in the state of readiness for shooting and the time of shooting itself (see Fig.5).



Fig.5. Ammunition using time

According to Fig.5, the using time represents the time which is the sum of time of transport, time of storing, time of readiness for shooting and time of shot. We measure it in appropriate time units (month, year).

The state of readiness for shooting means such a situation when ammunition is in magazine (or the first cartridge has been inserted in cartridge chamber of the weapon). This time can be short and thus negligible. There are of course some cases when it is not possible to neglect it regarding its significant share in total time of using. For instance, metropolitan policemen will fill up the magazine by ammunition before going on duty and they insert it into the weapon which is carried during their whole duty. After finishing the duty, the ammunition is usually taken out from the magazine and put into safety box where it will stay by the time of the next duty. The total time of ammunition stay in the state of readiness is in such cases relatively long. The time of using is measured by calendar time (most frequently in months or years).

Individual abscissas $(t_1, t_2, ..., t_N)$ in Fig.4 represent the time of ammunition being used from the moment of the beginning of its use to the time of ammunition failure occurrence.

To sum up, we use a failure occurrence probability as an indicator for the ammunition safety risks.

To indicate the pistol safety risk, we most frequently use failure rate $\lambda(t)$ (failure rate represents again the probability of arms failure related to one shot).

4.1 Ammunition Safety risk Indicators

Let us specify failure occurrence probabilities for ammunition :

- $Q_I(t)$ probability of category I failure,
- $Q_{II}(t)$ probability of category II failure,
- $Q_{III}(t)$ probability of category III failure,
- $Q_{IV}(t)$ probability of category IV failure.

The quantification of measures of failure occurrence probability $Q_I(t) - Q_{II}(t)$ includes only those failures that belong to the given failure category. Statistical estimation of the probability of category I failure for ammunition is given by the relation:

$$\hat{Q}_I(t) = \frac{n_I(t)}{N},\tag{1}$$

where $n_I(t)$ is the number of category I failures, N is the total number of pieces of ammunition (cartridges), t is the period of use.

Statistical estimations of the probability of category II, III and IV failure are defined for the ammunition according to the following relations:

$$\hat{Q}_{II}(t) = \frac{n_I(t) + n_{II}(t)}{N},$$
(2)

$$\hat{Q}_{III}(t) = \frac{n_I(t) + n_{II}(t) + n_{III}(t)}{N}, \qquad (3)$$

$$\hat{Q}_{IV}(t) = \frac{n_I(t) + n_{II}(t) + n_{III}(t) + n_{IV}(t)}{N}, \qquad (4)$$

where $n_{II}(t)$ is the number of category II failures, $n_{III}(t)$ is the number of category III

- failures, $n_{IV}(t)$ is the number of category IV failures.
- *N* is the total number of pieces of ammunition.

4.2 Pistol Safety Risk Indicators

As an indicator of pistol safety risk, failure rate $\lambda(t)$ and its acceptable level for individual failure categories were designed according STANAG 4297 [10] in the paper [8] as follows:

 $\lambda_l(t)$ failure rate for failures of category I,

 $\lambda_{II}(t)$ failure rate for failures of category II,

- $\lambda_{III}(t)$ failure rate for failures of category III,
- $\lambda_{IV}(t)$ failure rate for failures of category IV.

Statistical estimation of the failure rate for individual failure categories can be calculated as follows:

$$\hat{\lambda}_{I}(t) = \frac{n_{I}(\Delta t)}{\Delta t.N(t)},$$
(5)

$$\hat{\lambda}_{II}(t) = \frac{n_I(\Delta t) + n_{II}(\Delta t)}{\Delta t . N(t)},$$
(6)

$$\hat{\lambda}_{III}(t) = \frac{n_I(\Delta t) + n_{II}(\Delta t) + n_{III}(\Delta t)}{\Delta t . N(t)},$$
(7)

$$\hat{\lambda}_{IV}(t) = \frac{n_I(\Delta t) + n_{II}(\Delta t) + n_{III}(\Delta t) + n_{IV}(\Delta t)}{\Delta t . N(t)}, (8)$$

- where $n_I(\Delta t)$ is the number of pistol failures of category I in the interval of $(t, t + \Delta t)$,
 - $n_{II}(\Delta t)$ is the number of pistol failures of category II in the interval of $(t, t + \Delta t)$,
 - $n_{III}(\Delta t)$ is the number of pistol failures of category III in the interval of $(t, t + \Delta t)$,
 - $n_{IV}(\Delta t)$ is the number of pistol failures of category IV in the interval of $(t, t + \Delta t)$,
 - N(t) is the number of pistols in working mode at the moment t – i.e. at the beginning of the interval $(t, t + \Delta t)$,
 - Δt is the length of the time interval of pistol operation (number of shots).

The relation (8) implies that the total number of failures n(t) is equal to the sum of failures of all categories – see also Fig.6 where failure numbers of individual categories and their possible ratio are graphically illustrated:

$$n(t) = n_I(t) + n_{II}(t) + n_{III}(t) + n_{IV}(t).$$
(9)



Fig.6. Schematic illustration of an example of the proportion of the number of failures of individual categories

5 Acceptable Pistol and Ammunition Safety Risk

The requirements for a new pistol and its ammunition present users' needs and expectations that should be met by the given type of weapon system. Response of users to the new type of weapon and ammunition will be more positive with better fulfilment of their requirements. In general, the pistol and its ammunition safety requirements can be classified in the following way:

1. Requirements for design safety of a new pistol and ammunition (what pistol and ammunition must fulfil from safety viewpoint),

2. Requirements for safety risk level (which level of safety risk is accepted for a particular pistol and its ammunition).

Requirements for design safety introduce the application of weapons and ammunition design principles which have been proved in practice. They formulate requirements which pistol and ammunition must meet from safety viewpoint. For example, all materials used for the production of pistol and ammunition must be mutually tolerant. For instance, the primer cannot be released from the cartridge case during handling, loading, and shooting. Unintentional fall of the pistol must not cause a shot or barrel must not crack during firing and so on. Further, unintentional fall of the cartridge, e.g. during handling, must not initiate the primer and the propellant charge, etc.

Requirements for weapons and ammunition design safety are sufficiently elaborated on and described in current professional literature [1], [2], [3], [5] and in standards.

On the other hand, the requirements for risks of safety failure of small arms and their ammunition have not been published and elaborated on yet. No absolute guarantee of safety can ever be given. Therefore it is necessary to determine an acceptable level of safety risk in requirements for both new weapon and new ammunition.

During a pistol lifetime, 10^4 cartridges are fired on the average. It means that at least 10^4 times more cartridges than pistols will be produced during the process of a new pistol production.

The level of ammunition reliability could be defined by the value of failure probability Q_{IV} . Nowadays, it is about $Q_{IV}(t = 5 \text{ years}) = 10^{-6}$ for pistol ammunition during the period of use (storing) of five years [8]. It includes only category IV failures that cause neither injuries nor damage to assets or environment (e.g. misfire shot).

The level of high-quality combat pistols reliability nowadays ranges in failure rate from

 $\lambda = 10^{-3}$ to 10^{-4} [shot⁻¹], i.e. Mean Rounds between Failures (MRBF) comes up to 10,000 shots and it includes once again only failures of category IV which do not cause injuries or damage to assets or environment (e.g. the breech block stop at the rear position was not activated after firing the last cartridge).

Fig.7 and Fig.8 show that the level of pistol and ammunition safety risk must be determined with a satisfactory provision above the level of their reliability.

The lower limit of safety risk is minimally three orders higher than the level of arms and ammunition reliability. The difference between the level of reliability and lower limit of safety risk level is the safety range.

The dimension of safety range represents safety provision of pistol and ammunition safety for unexpected dangerous behaviour of the users. Moreover, it is also a provision for worsened technical conditions of the ammunition, abnormal wear of pistol outside prescribed parameters of technical requirements etc. Safety range is also a provision for possible pistol and ammunition damage, breaking safety rules while using the pistol and ammunition by the user (most frequently while manipulating), as well as other unexpected situations that have not been identified as dangerous up to now.

Safety range should protect the user even in cases frequently happening in practice when a pistol is fired after its life-time stated by the producer has expired significantly long before.

5.1 Acceptable Pistol Safety Risk

Requirements for new pistol safety risks can be defined in the following way (see Fig.7):

Failure rate $\lambda_{IV}(t)$ for failures of category IV, i.e. such failures which do not cause any damage of health, assets or human environment, can be generally bigger than 1.10^{-7} per one shot.

Failure rate $\lambda_{III}(t)$ for failures of category III should be lower than 10^{-7} per one shot. This definition of requirement for pistol safety risk accepts weapon failure which will result in minor injury of the shooter no more than once per 10 million shots.

Failure rate $\lambda_{II}(t)$ for failures of category II should be lower than 10^{-8} per one shot. Also this value of failure rate ensures that the failures with serious consequences for shooter's health are highly improbable. The value of safety risk admits weapon failure with a consequence of serious injury of the shooter no more than once per 100 million shots.



Fig.7. Acceptable level of safety risk for pistol

Failure rate $\lambda_I(t)$ for failures of category I with the most serious consequences for persons, assets and human environment should be lower than 10⁻⁹ per one shot. This value of failure rate ensures that the failures with lethal consequences are practically impossible. The given level of safety risk admits the only weapon failure with lethal consequence (failure of category I) no more than once per 1 milliard of shots [8].

5.2 Acceptable Ammunition Safety Risk

Requirements for ammunition safety risks can be defined in the following way (see Fig.8):

Failures of category IV are without an impact on the safety, and so they can be probable on the level that is acceptable for the user. From the point of view of safety, the probability of failure occurrence Q_{IV} can be higher than 10^{-9} during the whole period of ammunition use and the period of its disposal.



Fig.8. Acceptable level of safety risk for ammunition

Failures of category III probability must be lower than 10^{-9} . This means that the probability of ammunition failure Q_{III} must be lower than 10^{-9} in all climatic (weather), mechanical and electrical environments, in all defined regimes of use (storing, transport, manipulation and shooting) as well as in the defined way of disposal (liquidation). This definition of the requirement for safety risk tolerates pistol ammunition failure resulting in minor injury of the user not more than once in a milliard of shots.

Failures of category II must also be extremely improbable, but the probability of failure occurrence is in one order lower than in the category III. That is why Q_{II} must be lower than 10^{-10} during the whole period of ammunition use or in the period of its disposal.

Failures of category I having the most serious consequences for persons, assets and environment must be extremely improbable. The probability of failure occurrence Q_I must be lower than 10^{-11} in all climatic (weather), mechanical and electrical environments, in all defined regimes of use (storing, transport, manipulation and shooting) as well as in the defined way of disposal (liquidation). This definition of the requirement for safety risk tolerates ammunition failure resulting in user's death not more than once in 100 milliard of shots.

6 Practical Verification of Requirements for Pistol Safety Risk

Practical verification of the requirements for pistol safety risks calls for lots of tests and expensive experiments. The article analyses an experiment conducted up to the time of crack formation on pistol barrel. The cracks were formed in the area of locking lugs of the barrel [1] – see Fig.9.



Fig.9. Pistol breech with marking cracks on barrel

Crack formation on pistol barrel represents a failure of category II in terms of Table 1 (it can cause a serious injury of shooter or other person in the vicinity).

Fig.10 shows a photo of a barrel crack which was formed behind the second locking lug.



Fig.10. Photo of a crack on pistol barrel behind the second locking lug

10.00x10⁻⁵ shot⁻¹

Fig.11 shows a photo with a crack barrel before the first locking lug.



Fig.11. Photo of a crack on pistol barrel in front of the first locking lug

During this experiment, failures which affect pistol safety were recorded. The results of the experiment enable to find out if the pistol complies with safety risks stated in part 5.1 of this article.

Table 2 shows the values of numbers of shots up to crack formation on pistol barrels.

Table	2.	Number	of	shots	up	to	crack	formation
		(failure o	f ca	ategory	II)			

Barrel number	Number of shots		
7	95,200		
5	97,500		
3	98,700		
4	100,200		
9	101,900		
1	104,100		
2	115,300		
6	118,800		
8	125,400		

For statistical estimation of category II failure rate, the relation (6) can be used.

Values of category II failure rate for the interval of 10,000 shots are given in Table 3 (in the given time no category I failure occurred, that is why $n_t(\Delta t) = 0$).

Interval of number of shots $\Delta t = 10^4$ shots	Number of failures in the interval $n_{II}(\Delta t)$	Estimation of failure rate $\hat{\lambda}_{II}(t)$
0-10,000	0	0
~	~	~
80,001-90,000	0	0
90,001-100,000	3	3.33x10 ⁻⁵ shot ⁻¹
100,001-110,000	3	$5.00 \times 10^{-5} \text{ shot}^{-1}$
110,001-120,000	2	6.66x10 ⁻⁵ shot ⁻¹

Table 3. Statistical estimation of failure rate for $\Delta t = 10,000$ shots

From the data in Table 3 it is apparent that the failure rate of category II pistol failure up to 90,000 shots has zero value.

1

120,001-130,000

After firing more than 90,000 shots from the pistol, the value of failure rate goes up over the permitted limit of safety risk (10^{-8} per one shot). Now we will estimate the number of shots from the pistol which will ensure that the formation of barrel cracks will not occur with the given probability (this refers to the category II failure).

Let us assume that the time of barrel crack formation has a normal distribution (on the basis of Kolmogorov – Smirnov goodness of fit test, this hypothesis has not been rejected). From the gathered empirical data, both the mean value and standard deviation of normal distribution were stated N(106,344; 10,734.7).

The task is to find such a value of number of shots up to category II failure occurrence whose failure rate equals 10^{-8} shot⁻¹ – see Table 4.

Number of shots (theoretical)	Theoretical failure rate $\lambda_{ij}(t)$		
31,201.87255	9.13472E x 10 ⁻¹²		
33,348.80317	3.63096E x 10 ⁻¹¹		
37,642.66443	5.08814 x 10 ⁻¹⁰		
41,936.52568	6.07588 x 10 ⁻⁰⁹		
42,833.94268	9.99848 x 10 ⁻⁰⁹		
42,834.26472	1.00003 x 10 ⁻⁰⁸		
44,083.45630	1.97732 x 10 ⁻⁰⁸		
46,230.38693	6.18262 x 10 ⁻⁰⁸		

Table 4. Theoretical failure rate for normal distribution N(106,344; 10,734.7)

Fig.12 illustrates the principle of solving the task graphically.





Table 4 and Fig.12 show that the number of shots in demand which guarantees the required level of safety risk for category II failures is $t_{\lambda=1x10^{-8}} = 42,834$ shots.

For practical conclusion, it logically ensues from the results that to ensure the required level of pistol safety risk it is necessary for pistol guaranteed lifetime not to exceed 42,834 shots.

A similar result can be obtained assuming that the time up to category II failure formation (barrel cracks) has Weibull two-parameter distribution [11]. This hypothesis was not rejected on the basis of the Kolmogorov – Smirnov goodness of fit test either. From the gathered empirical data, the value of shape and scale parameters of this distribution was estimated using program Statgraphics Centurion 15 - W(10.5344; 111,175). For Weibull distribution of these parameters the number of shots in demand which guarantees the required level of safety risk for category II failures is 42,553 shots – see Table 5 and Fig.13.

Table 5. Theoretical failure rate for Weibull	
distribution W(10.5344; 111,175)	

Number of shots	Theoretical failure rate $\lambda_{II}(t)$		
42,550	9.99384 x 10 ⁻⁰⁹		
42,551	9.99608 x 10 ⁻⁰⁹		
42,552	9.99832 x 10 ⁻⁰⁹		
42,553	1.00006 x 10 ⁻⁰⁸		





Table 5 and Fig.13 show that the number of shots in demand which guarantees the required level of safety risk for category II failures is $t_{\lambda=1x10^{-8}} = 42,553$ shots.

For a simplification and on marketing grounds it is possible to state the values of 42,000 or 40,000 shots.

7 Conclusion

The method of requirements definition of pistol and ammunition safety risks introduced in the paper enables to unambiguously identify the area of acceptable safety risk that could result in pistol or ammunition failure with serious consequences. The method enables in practice to measure, monitor and evaluate risks of the given type of pistol and ammunition. It also guarantees a clear and complete formulation of safety in tactical-technical specification for the development of a new kind of pistol and ammunition.

Requirements for safety risks determine minimum acceptable level of reliability for critical parts of the pistol and ammunition (elements that have decisive effect on pistol and ammunition safety).

Requirements for acceptable level of pistol and ammunition safety risk have to be adjusted in safety analysis of concrete pistol and ammunition types. They should also be critically evaluated with regard to:

- range and character of damage that might be caused by the given pistol or ammunition,
- expected period of using ammunition,

- expected number of shots during the period of pistols life cycle,
- expected number of produced pieces of pistols, ammunition, etc.

The procedure of using data analysis results about number of shots of pistol up to crack formation on the barrel (category II failures) enables to state pistol lifetime specified as the permitted number of shots from the given pistol type guaranteeing the required level of pistol safety risk.

On the basis of the described experiment it is possible to specify maximum pistol lifetime as 40,000 shots. This lifetime takes into consideration the requirements for failure rate:

- of category I to be lower than 10^{-9} per one shot,
- of category II to be lower than 10^{-8} per one shot,
- of category III to be lower than 10⁻⁷ per one shot.

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Acknowledgement

This article was written in the framework of Specific Research Project FVT - K201/2010 and Project of Defence Research "Cannon" founded by the Ministry of Defence of the Czech Republic.