PROBLEMY MECHATRONIKI
UZBROJENIE, LOTNICTWO, INŻYNIERIA BEZPIECZEŃSTWA

ISSN 2081-5891

9, 3 (33), 2018, 93-108

PROBLEMS OF MECHATRONICS
ARMAMENT, AVIATION, SAFETY ENGINEERING

Major Conditions of Shooting Range Operation in Poland

Józef GACEK*, Bronisław MARCINIAK, Ryszard WOŹNIAK

Military University of Technology, Faculty of Mechatronics and Aerospace
Institute of Armament Technology,
2 Urbanowicza Str., 00-908 Warsaw, Poland
**Corresponding author's e-mail address: jozef.gacek@wat.edu.pl*

Received by the editorial staff on 9 April 2018.
Reviewed and verified version received on 9 August 2018.

DOI 10.5604/01.3001.0012.2741

Abstract. Under the "Authorisations of the Minister of National Defence" (latest – No. 57/MON dated 22 December 2014), a Permanent Expert Team operates at the Institute of Armament Technology of the Faculty of Mechatronics and Aerospace of the Military University of Technology (Warsaw, Poland), performing test shootings for the purpose of verifying the fulfilment of technical requirements to be met by garrison shooting ranges and their locations. During almost 20 years of its activity, the Team has conducted research studies under more than 325 civil law contracts concluded with operators of shooting ranges, numerous expert analyses and prepared specialist opinions for courts and prosecutor's offices, and participated in the creation of normative acts and documents, concerning – among others – provision of safety of the operated field training facilities, mainly garrison and training ground shooting ranges. The results of the Team's work have been used, among others, by the Ministry of National Defence (with the active participation of the Team) to prepare regulations of the Minister of National Defence concerning the technical conditions to be met by garrison shooting ranges and their locations.

This work has been compiled from the paper presented during the 7th Science and Technology Conference on "Prospects for the development of Polish production of rocket, artillery and light arms ammunition", Kołobrzeg, Poland, May 2017

The first of these regulations was issued on 4 October 2001 (Polish Journal of Laws of 2001, no. 132, item 1479), and its latest revision on 15 December 2017 (Polish Journal of Laws of 2018, item 113).

The paper presents selected results of studies of the Permanent Expert Team related to, among others, ensuring the safety of users of garrison and training ground shooting ranges, which form a part of the field training facilities of the Armed Forces of the Republic of Poland, the Police, the Border Guard, the Customs Service, security companies, hunting and sports organisations. Of particular value are the conclusions and propositions of the Expert Team related to, for example: improvement of quality of the law created in Poland, concerning in particular training facilities; ensuring safety at shooting ranges during training with firearms of various types and calibres, utilising various types of ammunition; expert supervision over construction, acceptance and operation of shooting ranges; principles of safe operation of shooting ranges, ensuring longevity of the facilities, etc.

Keywords: construction and operation of machines, troop training, training facilities, shooting ranges

1. INTRODUCTION

The educational and scientific activities of the Military University of Technology (Warsaw, Poland), including the Faculty of Mechatronics and Aerospace [1], is focused primarily on technical preparation of command staff for direct command and direction at numerous levels of military organisation, as well as highly-qualified specialists for the operation of modern weapons systems and their effective use on the battlefield.

The growing complexity of construction and functioning of modern weapons and combat assets requires soldiers and operators to be comprehensively prepared, both theoretically and practically, to use them effectively. Education of soldiers and operators must therefore be conducted in an organised and comprehensive manner, during a relatively long period, with a particular focus on consolidating the habits developed during use of weapons, as well as associating the capabilities of weapons with methods of both independent and group-based actions under various threat conditions occurring during combat operations.

Basic training of soldiers, as well as further stages of advanced combat training require suitable training facilities. Currently, practical training of troops is conducted at various facilities where they are prepared for combat, taking into account predictable – typical for the given military specialisation – threat conditions.

In practice, particular attention is paid to soldier shooting training, focused on achieving as high shooting results with the use of both individual and team-based weapons.

The basic training facilities during this stage of training are shooting ranges, where soldiers gain the necessary skills in handling weapons according to their intended use.

Shooting ranges differ in their design and intended use, among other differences. They can be characterised by different lengths and widths of shooting zones, different designs and furnishing with safety elements, and many other properties.

A modern shooting range should be viewed as an integrated system with subsystem elements, i.e. terrain and infrastructure ensuring safety, communication, supply, etc. The basic and most important requirement imposed on shooting ranges is that they provide the right training process, while at the same time ensuring the safety of training participants and persons not directly involved in the training, but present in the vicinity of the shooting range outside its safety areas.

In practice, there are cases where training requirements resulting from the introduction of new weapon types and combat assets cannot be met, e.g. for safety reasons. It appears that one way to solve such problems is to impart a sufficient momentum on the adaptation of legislative processes related to construction solutions and equipment of shooting ranges.

2. SELECTED ISSUES RELATED TO CONSTRUCTION AND OPERATION OF GARRISON SHOOTING RANGES

In 1999, the Institute of Armament Technology of the Faculty of Armament and Aviation (currently the Faculty of Mechatronics and Aerospace) of the Military University of Technology, under the order of the Ministry of National Defence, commenced scientific research studies in the field of military shooting range construction, focused on safety of their operation. The primary aim was to design and construct a safe garrison shooting range and determine its safety areas, i.e. the hazard area and threat area. As a result, a model experimental garrison shooting rage with a shooting zone length of 300 m was built and equipped with additional elements, and expanding or integrating previously operated protections (Pictures 1-3).

The shooting range underwent (in the years 1999-2000) comprehensive ballistic tests which enabled formulating conclusions concerning the construction of basic protection elements and the type of construction and technology used for the basic equipment of the shooting range, as well as the shape and size of protection areas (a division of the protection area into a hazard zone and a threat zone has been adopted).

Tests have demonstrated that despite the number of additional vertical screens in the shooting zone, the utilisation of space between screens P1 and P2 (Fig. 1), and the installation of the main backstop, ricochets still occurred in the shooting zone.

The source of these ricochets were elements of technical infrastructure and the ground of the shooting range construction plane (bottom backstop in screen no. 1: targets made of hard material; shooting range construction plane; head of the backstop closest to the main backstop; head slope of the main backstop).

Picture 1. Bulletproof roof over screens P1 and P2 of the experimental shooting range

Picture 2. Additional vertical screens placed one after the other, intended to capture ricochets from technical elements and targets in the shooting zone

During one test, the bottom backstop at the 100 m target line was removed, as shown in Fig. 1. Changes in the direction of ricochet flight after penetrating the metal target resulted in secondary ricochets from the shooting zone plane ground.

Picture 3. Main backstop of the experimental shooting range, intended to capture ricochets occurring at the bottom backstop, before the main backstop, and on the head slope of the main backstop

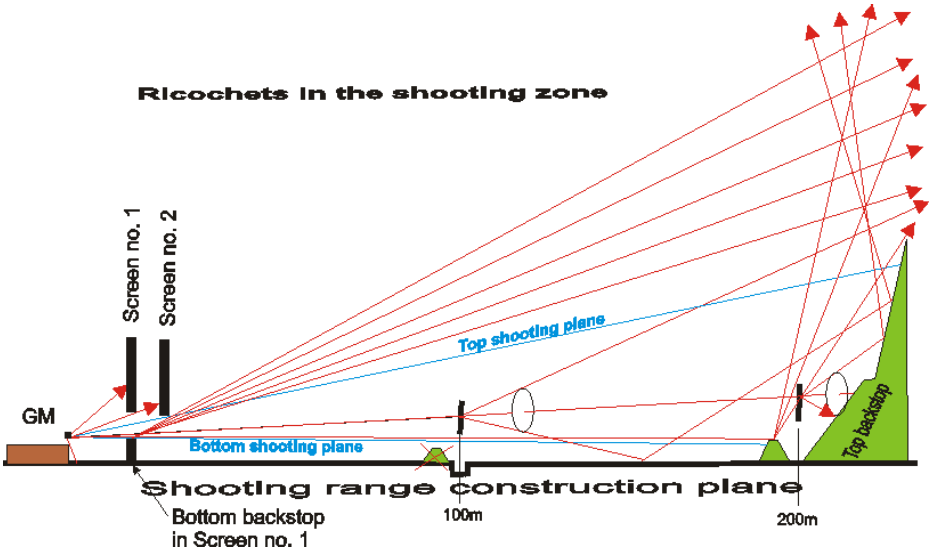

Fig. 1. Diagram of the vertical profile of ricochet trajectories occurring on infrastructure elements of the shooting zone of an example 200 m shooting range. The shooting zone, without additional protections, screens, other buildings or equipment limiting ricochet flight outside the shooting range. GM – gun muzzle

Selected effects of registered ricochets are shown in Pictures 4-8, and below, a description of these effects is presented:

– bullet ricochets off the bottom backstop head at the 200 m target line, then deflects its flight right, moving outside the shooting range and the hazard zone (Picture 4);

– two bullets ricocheted off the bottom backstop at the 100 m target line, further two – at the 150 m target line. Of the four ricochets, only one travelled outside the shooting range (the one most deflected to the right) (Picture 5);

Picture 4. Flight trajectory of a single T-45 bullet (7.62 × 39 mm intermediate cartridge) and its ricochet Shooting at targets 100 m away

Picture 5. A burst of 4 shots to a distance of 100 m. T-45 bullets (7.62 × 39 mm intermediate cartridge) fired from an AK carbine

– the first bullet ricochets off the bottom backstop head, deflects its trajectory up without leaving the shooting range. The second bullet hits the target, rebounds off the bottom backstop and travels low along the main backstop. After penetrating the target, the third bullet deflects its trajectory down, hitting the next bottom backstop and is stopped there (Picture 6).
– two bullets ricocheted off the bottom backstop head of the 150 m target line. The third bullet ricocheted off the bottom backstop head of the 200 m target line. The fourth bullet penetrated the target and was captured by the ground between screens 4 and 5 (Picture 7).

Picture 6. A burst of 3 shots to a distance of 100 m. T-45 bullets (7.62 × 39 mm intermediate cartridge) fired from an AK carbine

Picture 7. A burst of 4 shots to a distance of 100 m. T-45 bullets (7.62 × 39 mm intermediate cartridge) fired from an AK carbine

Picture 8. A burst of 4 shots to a distance of 100 m. T-45 bullets (7.62 × 39 mm intermediate cartridge) fired from an AK carbine

– two bullets ricocheted off the bottom backstop at the 100 m target line, further two – at the 150 m target line. Of the four ricochets, only one travelled outside the shooting range (the one most deflected to the right) (Picture 8).

Based on the analysis results of the recorded images of ricochet trajectories, it was found that many ricochets that travel high fall in the shooting zone or in the hazard zone of the shooting range. However, ricochets that travelled significant distance above and beyond the main backstop have been recorded as well. Radiolocation measurements demonstrated that their range was approximately 80% of maximum range.

An important conclusion formulated based on the test result analysis indicated the necessity for further expansion of shooting range protections against the consequences of exposure of personnel and equipment present at farther distances from the shooting range (in the defined threat zone). This was the basis for proposing the duty to designate a shooting rage safety zone, which was divided into two sections, arbitrarily called the hazard zone and threat zone.

Modifications in the construction of many protection elements were recommended, and some were removed (e.g. bottom backstops at individual target lines, leaving only the last backstop in front of the main backstop). Lifting equipment protection is implemented by embedding it in the ground of the shooting zone plane to a depth of approx. 200 mm above the top edge of the highest part of the lift.

The above test results were utilised to prepare an MND regulation [3]. It must be stressed that the regulation had previously been supplemented multiple times using the results of subsequent studies and the experience gained, as well as the running tactical and combat requirements of the Polish Armed Forces.

During more than 16 years since its introduction, the document has been verified with the experience gained during the construction of new garrison shooting ranges, or the modification or reconstruction of existing ones, intended for soldier training under garrison conditions.

However, the experience gained by our soldiers during international missions in subsequent years demonstrated that shooting ranges constructed in accordance with the requirements included in the regulation in question no longer provide the necessary training standards. Consequently, a need arose to prepare new, more modern shooting ranges, not only for basic training but for the training of special forces, preparing for further missions outside the borders of Poland. Modern shooting ranges must include the ability to simulate the battlefield, and to provide the ability to improve and maintain high shooting ability under conditions as close to the predicted area of combat operations as possible.

Very important requirements that determine the safety of operation of training facilities are the right linear and angular dimensions, which must be taken into account in construction designs of garrison shooting ranges. These values are shown in shown in Figs. 2-5.

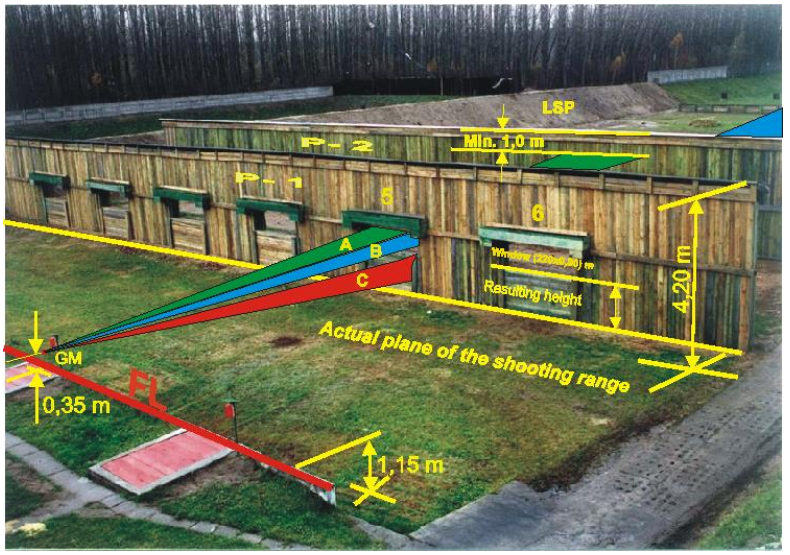

Fig. 2. Linear and angular relations and plane system in the 1st part of the shooting zone: LSP – left side protection, A – top shooting plane of the shooting range, B – top shooting plane of the shooting range, C – bottom shooting plane for screen P-2, GM – gun muzzle, FL – firing line, P-1 and P-2 – screens one and two

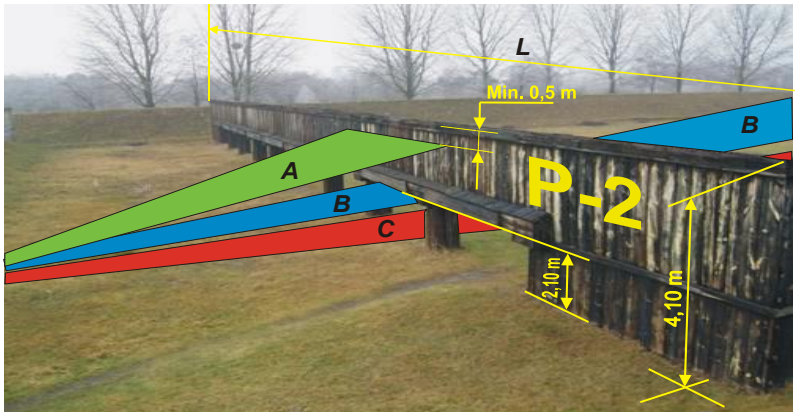

Fig. 3. Linear and angular relations and plane system in the 2nd part of the shooting zone: P-2 – screen two

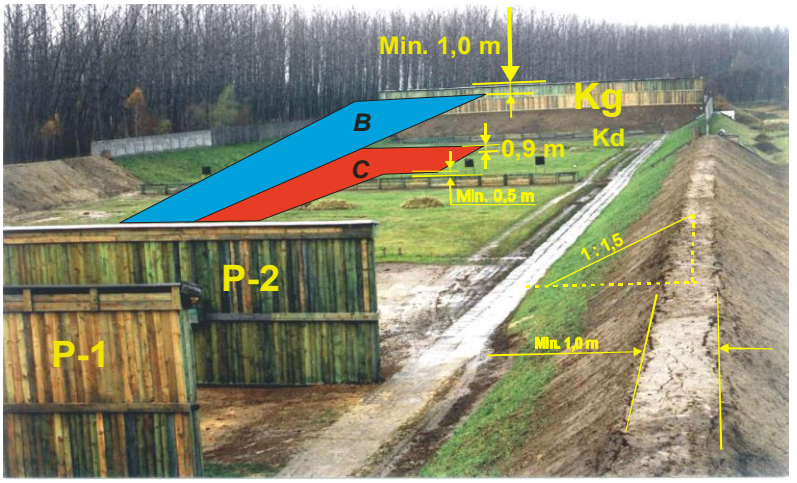

Fig. 4. Linear and angular relations and arrangement of planes in the 3rd part of the shooting zone; P-1 and P-2 – screens one and two, Kg – top backstop, Kd – bottom backstop

This resulted in amendments to the regulation, which caused a large number of garrison shooting ranges to be decommissioned, as they did not meet the safety requirements. This in turn forced ways to improve the quality of the closed down shooting ranges to be found, and a stopgap measure in this respect involved reconstructing, expanding or changing the intended use of "longer" shooting ranges for "shorter" ones, e.g. a 300 m shooting range was reclassified as a 200 m one, or at times even a pistol-grade range.

The insufficient numbers of garrison shooting ranges became noticeable, which provided an impulse to build new facilities and thoroughly upgrade the shooting ranges that had been decommissioned. This was made possible by the involvement of the Infrastructure Boards and Military Economy Units, with the acceptance of the leadership of the Ministry of National Defence. The upgrade process lasted many years, but currently it is found to be ineffective. The decommissioned and unused facilities have deteriorated greatly. Furthermore, these shooting ranges have "moved" dangerously close to residential areas of cities, which limits any potential safety zones and makes them a source of noise burden. Even changing the safety classifications of these facilities does not solve the problem of safe usage.

The issue of shooting training of soldiers in garrisons can be solved by building indoor shooting ranges. Due to the high costs of constructing such facilities, their number must be subjected to a thorough technical and economical analysis, taking into account location needs. Currently, indoor shooting ranges include types SK-100 m, SK-200 m and SK-300 m, as well as pistol ranges, constructed as ranges located both in separate buildings, and in adapted rooms, e.g. for pistol ranges.

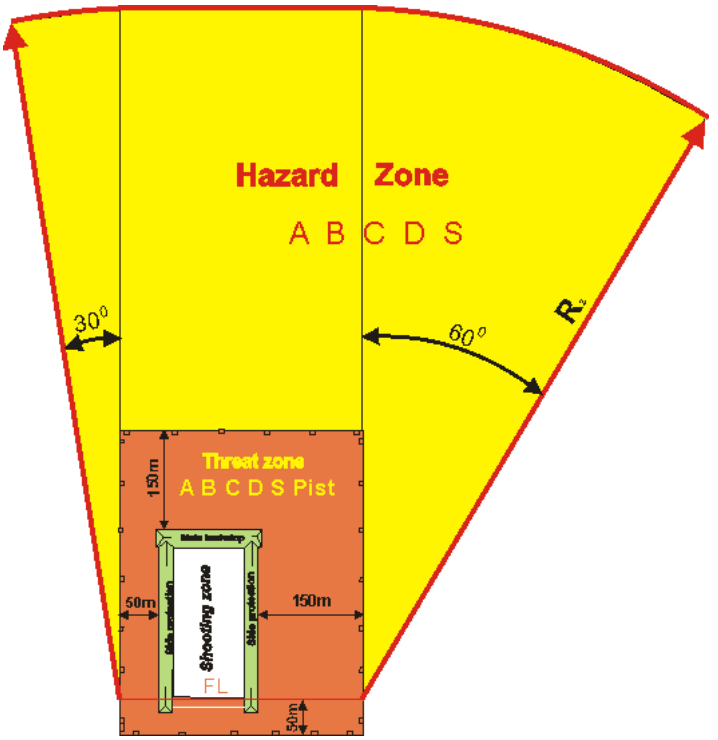

Fig. 5. Safety area of a garrison shooting range (hazard zone and threat zone; R_z – hazard zone radius depending on the grade, type and class of shooting range safety)

Indoor ranges have the benefit (compared to outdoor ranges) of being isolated from the effects of weather conditions, and the boundaries of its safety area are limited to the external outline of the building or room. Furthermore, indoor shooting ranges do not emit noise to the environment (they are obligatorily sound-proofed) or harmful agents released through the combustion of propellant charges (atmosphere is obligatorily filtered as part of shooting range ventilation).

3. SELECTED ISSUES RELATED TO TRAINING GROUND SHOOTING RANGES

Training ground shooting ranges share a story of construction, modification and upgrading similar to garrison ranges. Applicable normative acts and documents, in particular [5] (the basic act regulating the principles of training ground shooting range operation) aid in the process of modification and upgrading of training ground ranges as well, although in this case, the requirements of tactics and military art are always significantly ahead of novelties provided by shooting range design and equipment in this respect.

The cause of this situation is similar to garrison shooting ranges, i.e. lack of land with the required surface area to designate safety zones in accordance with the regulations.

Training ground ranges require a much greater area free of residential buildings or human activity, a more complex infrastructure, and additionally, significant limitations are introduced by regulations related to areas protected under the "NATURA 2000" project. Aside from that, the use of combat assets and armaments of various ranges and noise of the projectiles launched make these facilities burdensome for their surroundings.

4. PARTICIPATION OF THE INSTITUTE OF ARMAMENT TECHNOLOGY OF THE FACULTY OF MECHATRONICS AND AEROSPACE OF THE MILITARY UNIVERSITY OF TECHNOLOGY IN THE PROCESS OF ENSURING SAFE OPERATION OF GARRISON SHOOTING RANGES

Normative acts and documents, including [2], impose the necessity to verify constructed (modified) shooting ranges for the safety of their operation. This verification is conducted, among others, by the Permanent Expert Team from the Institute of Armament Technology of the Faculty of Mechatronics and Aerospace of the Military University of Technology, which was appointed to conduct test shootings for the purpose of verifying the fulfilment of technical requirements to be met by garrison shooting ranges and their locations (currently applicable "Authorisation no. 57/MON of the Minister of National Defence dated 22 December 2014").

During the period of its activity, the team conducted over 325 tests and reviews of construction and technology documentation of shooting ranges, prepared expert reviews and technical opinions of field training facilities, and analysis and expert reviews of ammunition stores and combat grenade throwing ranges, as well as expert reviews and opinions for courts and prosecutor's offices.

The team also offers running expert consultations to builders of new and modified shooting ranges, and prepares propositions of regulations and operating manuals of protection elements for shooting range operators.

Verification of the safety of shooting range operation is conducted in three main stages. During the first stage, design documentation is inspected; during the second stage, consistence of the constructed shooting range protection elements with the as-built design, while during the third stage, test shootings are conducted at the facility, enabling correctness of the execution of structural protection elements of the shooting range, effectiveness of target field control systems and systems ensuring controlled human traffic in the facility, as well as traffic of people entering the facility (for indoor ranges) to be inspected.

The same three-stage verification procedure is applied to all shooting ranges that had been built from scratch, modified, expanded or equipped with systems and devices other than designed.

Such inspections must also be conducted every 5 years of shooting range operation, or earlier in the event that shooting zone "geometry" of the shooting range is modified as a result of periodic technical inspections, during which whole protective elements are replaced (e.g. bottom backstop in screen one).

The end result of correctly executed shooting range protective elements is complete prevention of bullets and ricochets travelling outside the safety zone of an outdoor shooting range (shooting zone of an indoor range), ascertained during the test shooting. Positive results of all three stages of facility verification for safety of operation are confirmed by issuing a "Safe use decision", which constitutes an appendix to the application for permission to operate the facility.

5. SUMMARY AND FINAL CONCLUSIONS

Based on the many years of experience of the MUT Permanent Expert Team, it can be stated that:

1. perspectives for expansion of the Expert Team activities are highly optimistic, as modern and safe training facilities are needed both by "traditional" users and by the recently established Territorial Defence Forces, as well as the numerous enthusiasts of shooting in Poland. A growing interest in shooting sports in our country is observed;
2. the training ground shooting ranges currently under construction enable shooting exercises to be completed as scheduled [7]. The same applies to garrison shooting ranges, which ensure completion of shooting exercises listed in the programme [6], although the program does not include dynamic or situational shootings;
3. shooting range designers and builders have gained a sufficient master of the specific nature of shooting range protective elements, which are made of increasingly modern materials, including anti-ricochet, soundproofing, etc. materials. Furthermore, introduction of constantly improving target field control systems must be assessed positively, as it enables multi-variant arrangements and positively impacts the improvement of shooting skills, additionally providing a greater appeal and variety of the shooting tasks assigned;
4. many new construction and technical solutions that eliminate ricochets have been introduced in the training facilities, consequently contributing to improving the safety of shooting range operation. For example: bottom backstops at intermediate target lines have been removed; lifting equipment have been placed in niches below the actual shooting range plane; targets made of soft materials, equipped with hit sensors have been installed; steel

strip backstops have been introduced in indoor ranges; air exchange system in shooting halls has been changed from 10 to 20 times an hour, and additional ventilation of the main backstop chamber has been introduced; additional tactical elements have been installed at outdoor pistol ranges, and the target transport system used for shooting at different distances has been improved in indoor shooting ranges;

5. during the process of shooting range construction or modification, maintaining running contact of the construction work contractor with the scientific institution for the purpose of periodic inspections and subject matter consultations, mainly construction technologies, is preferred during construction of protection elements. This has great practical importance, as construction companies selected through bidding procedures frequently perform such tasks for the first time;
6. The three-stage subject matter expert supervision over initiated shooting range construction investments should be maintained, paying particular attention to the quality of the pre-design and design documentation prepared, including the use of construction and technical solutions and materials utilised (there can be no uncertainties or defects, which during the execution process could constitute obstacles for timely completion of the protection elements with the required quality);
7. a lack of many legal and normative regulations in the field in question is felt, e.g. there are no dedicated technical conditions for designing military indoor shooting ranges [8], or for constructing and operating outdoor shooting ranges for special forces, which would take into account the specific nature of their programmes and shooting methodology. Furthermore, there is no document that would regulate the terminology used in the field in question, as documents prepared in different departments and institutions utilise various terms with much flexibility. This leads at times to differences in interpretation, and may consequently result in serious errors. [9] should be supplemented with new terms and their use in technical literature should be strictly enforced, and correct translations of documents and specialist literature from foreign languages should be ensured;
8. principles of cooperation in terms of safe use of training grounds in Poland by foreign troops should be prepared. It is proposed that, following the example of NATO (USA) support units, plenipotentiaries for matters of combat training safety at their assigned training grounds be appointed at the District (Capital or Military) Infrastructure Boards or in units in training. Their duties should include close cooperation of Polish and foreign representatives for training safety during the entire period of training ground exercises.

REFERENCES

[1] Blimel Marcin. 2017. „Interdyscyplinarne kształcenie techniczne na Wydziale Mechatroniki i Lotnictwa Wojskowej Akademii Technicznej". *Nauka i Biznes* 1-2.

[2] Ustawa z dnia 7 lipca 1974 r., *Prawo budowlane* – tekst jednolity (Dz.U. z 2006 r., Nr 156, poz. 1118 z późn. zm.)

[3] Rozporządzenie Ministra Obrony Narodowej z dn. 4 października 2001 r. *w sprawie warunków technicznych, jakim powinny odpowiadać strzelnice garnizonowe oraz ich usytuowanie* (Dz.U. Nr 132, poz. 1479 z późn. zm.)

[4] *Ramowa instrukcja o eksploatacji i konserwacji garnizonowych strzelnic szkolnych*. Sygn. Kwat. Bud. 111/90.

[5] *Instrukcja działalności ośrodków szkolenia poligonowego*. Sygn. Dow. Gen. 2/2015.

[6] *Program strzelań z broni strzeleckiej*. Sygn. Szkol. 857/2012.

[7] *Program strzelań z wozów bojowych*. Sygn. Szkol. 856/2012.

[8] *Wytyczne Podsekretarza Stanu w Ministerstwie Obrony Narodowej do spraw uzbrojenia i modernizacji*. Sygn. Kwat. Bud. 130/2010.

[9] Polska Norma nr PN-V-01016 – *Broń strzelecka. Terminologia*, lipiec 2004.

[10] Gacek Józef, Bronisław Marciniak, Ryszard Woźniak. 2015. „Wybrane zagadnienia bezpieczeństwa konstrukcji i eksploatacji strzelnic garnizonowych". *Problemy Techniki Uzbrojenia* 133: 103-133.

[11] Gacek Józef, Bronisław Marciniak, Ryszard Woźniak. 2017. Aktualne uwarunkowania związane z eksploatacją strzelnic w Polsce. W *Materiały VII Konferencji Naukowo-Technicznej nt. „Perspektywy rozwoju krajowej produkcji napędów rakietowych oraz amunicji artyleryjskiej i strzeleckiej"*, Kołobrzeg: 7-22.

Najistotniejsze uwarunkowania związane z eksploatacją strzelnic w Polsce

Józef GACEK*, Bronisław MARCINIAK, Ryszard WOŹNIAK

Wojskowa Akademia Techniczna, Wydział Mechatroniki i Lotnictwa,
Instytut Techniki Uzbrojenia,,
ul. gen. Witolda Urbanowicza 2, 00-908 Warszawa

Streszczenie. W Instytucie Techniki Uzbrojenia Wydziału Mechatroniki i Lotnictwa Wojskowej Akademii Technicznej działa – na mocy „Upoważnień Ministra Obrony Narodowej" (najnowsze Nr 57/MON z dnia 22.12.2014 r.) – Stały Zespół Ekspercki do przeprowadzania strzelań sprawdzających, w zakresie warunków technicznych, jakim powinny odpowiadać strzelnice garnizonowe oraz ich usytuowanie. Przez prawie 20 lat działalności Zespół ten wykonał prace naukowo-badawcze w ramach przeszło 325 umów cywilnoprawnych zawartych z użytkownikami strzelnic, liczne ekspertyzy i opinie specjalistyczne dla sądów i prokuratur, a także uczestniczył w tworzeniu aktów i dokumentów normatywnych, dotyczące m.in. zapewnienia bezpieczeństwa użytkowania terenowych obiektów szkoleniowych, w tym głównie strzelnic garnizonowych i poligonowych. Wyniki prac Zespołu zostały wykorzystane m.in. podczas opracowywania przez Ministerstwo Obrony Narodowej (przy aktywnym udziale Zespołu), rozporządzeń ministra Obrony Narodowej w sprawie warunków technicznych, jakim powinny odpowiadać strzelnice garnizonowe oraz ich usytuowanie. Pierwsze z tych rozporządzeń wydano w dniu 4.10.2001 r. (Dz.U. z 2001 r. nr 132, poz. 1479), a ostatnią jego nowelizację – w dniu 15.12.2017 r. (Dz.U. z 2018 r., poz. 113).

W pracy przedstawiono niektóre wyniki prac Stałego Zespołu Eksperckiego w obszarze m.in. zapewnienia bezpieczeństwa użytkowania strzelnic garnizonowych i poligonowych, które wchodzą w skład terenowej bazy szkoleniowej Sił Zbrojnych RP, Policji, Straży Granicznej, Służby Celnej, służb ochroniarskich, organizacji myśliwskich i sportowych. Szczególnie cenne są wnioski i propozycje Zespołu eksperckiego w zakresie m.in.: poprawy jakości tworzonego prawa w Polsce, dotyczącego zwłaszcza obiektów szkoleniowych; zapewnienia bezpieczeństwa na strzelnicach podczas szkoleń z wykorzystaniem broni strzeleckiej różnych typów i kalibrów, strzelającej różną amunicją; nadzoru eksperckiego w procesie budowy, odbioru i eksploatacji strzelnic; zasad bezpiecznego użytkowania strzelnic, gwarantującego długowieczność obiektów, itp.

Słowa kluczowe: budowa i eksploatacja maszyn, szkolenie wojsk, obiekty szkoleniowe, strzelnice