

## SUMMARIES

of the scientific works of Inspector, PhD, Eng. Svilena Sevdalinova Arabadzhieva, submitted for review in a competition for appointment to the academic position of “Associate Professor” in the field of higher education

5. “Technical Sciences”, professional field 5.7. “Architecture, Civil Engineering and Geodesy”, academic disciplines “Hydraulics and Water Supply for Firefighting” and “Design of Fire Suppression Systems”,  
announced in the State Gazette (Issue No. 42/8 May 2026)

### 1. MONOGRAPHS

**1.1. “Water Supply for Internal Firefighting: Internal Fire Hydrants”, publisher:**  
*Academy of the Ministry of Interior, Sofia, ISBN 978-954-348-267-2*

The monograph examines water supply for internal firefighting through internal fire hydrants as an integrated technical, regulatory, operational and organisational system. Its principal objective is to develop a scientifically grounded applied framework for assessing and improving the reliability of internal fire hydrants (IFHs) by linking the building’s design coverage, product conformity, hydraulic characteristics, correct installation, technical maintenance, signage, user preparedness and operational use by fire and rescue crews. To achieve this objective, the study applies historical-regulatory and comparative analyses, hydraulic modelling, experimental measurements, questionnaire surveys and an analysis of recorded fires.

The results show that the formal presence and certification of an internal fire hydrant do not, in themselves, guarantee its actual firefighting capability. When equipment or individual components are replaced, not only their geometric and connection compatibility, but also their hydraulic compatibility must be demonstrated. Nozzles with the same nominal or equivalent diameter may differ substantially in flow rate, required operating pressure and water-jet range. Therefore, the product criterion for effective water application and the design requirement for reaching the critical point in the particular building should be treated as interrelated but independently verifiable indicators.

The study also identifies a substantial discrepancy between knowledge and visual recognition of IFHs, on the one hand, and practical readiness to use them, on the other. Correct signage and practice-oriented training are identified as important conditions for improving user preparedness. The analysis of actual incidents shows that IFHs are used predominantly by professional fire and rescue crews and constitute an important operational resource for the rapid delivery of an initial extinguishing or protective jet. On this basis, a comprehensive model for managing the reliability of IFHs throughout their life cycle is substantiated, aimed at

## 2. SCIENTIFIC PUBLICATIONS:

**2.1. – Г-8-1 – “On the Readiness of Passengers and Train Operating Staff to Undertake Fire Safety Actions on Passenger Trains”**, *Bulletin of the Faculty of Fire Safety and Civil Protection at the Academy of the Ministry of Interior, Issue 21, 2009, pp. 44–58*, publisher: Academy of the Ministry of Interior, Sofia, ISSN 2682-9576, co-authored by Boyko Georgiev Georgiev

A questionnaire survey was used to assess the readiness of passengers, conductors, locomotive drivers, assistant locomotive drivers and transport police officers to act in the event of a fire on a passenger train. Passengers were surveyed in 2007 and again in 2008 after the fire on the Sofia–Kardam train, making it possible to trace the impact of the serious incident on their behaviour and sense of security.

It was found that only about half of the passengers knew where the fire extinguishers were located, while a substantial proportion did not know how to use them. Following the fire, willingness to participate in firefighting decreased and the preference for immediately leaving the train increased. Only 8% of the passengers who stated that they would use the emergency brake took into account the possibility that the train might be in a tunnel or on a bridge. Among train operating staff, locomotive drivers and assistant drivers demonstrated the best preparedness, whereas significant deficiencies in the use of dry-powder fire extinguishers were identified among conductors and patrol police officers. The study concludes that systematic training, improved fire safety awareness, unobstructed access to fire extinguishers and resolution of the conflict between locking sleeping cars and ensuring safe evacuation are necessary.

**2.2. – Г-8-2 – “Analysis of the Criteria for Determining the Type and Frequency of Inspections at Sites Subject to State Fire Safety Control”**, *Current Issues in Population and Infrastructure Protection: Proceedings of a Scientific Conference, Vol. 3, 2012, pp. 177–186*, publisher: Publishing Complex of the Vasil Levski National Military University, Veliko Tarnovo, ISBN 978-954-753-104-8

The development of the regulatory requirements for state fire safety control during the period 1967–2012 was examined. Changes in the types of inspections, the criteria for identifying controlled sites, threshold values and inspection frequency were traced. It was established that until the early 1990s the degree of fire hazard was determined predominantly subjectively, whereas comprehensive, control and thematic inspections and quantitative criteria relating to area, number of occupants, height, purpose and location were subsequently introduced.

The comparison reveals substantial and inconsistent changes in the threshold values. For example, in educational establishments the criterion based on the number of occupants varied in

different periods from 1 to 500 persons, while different indicators for building footprint and gross floor area were used for industrial sites. At the same time, the interval between inspections gradually increased from one to four years. The study concludes that the tabular regulatory approach is easy to apply but insufficiently flexible and does not comprehensively reflect the actual fire hazard. The need for a method based on all material characteristics and the individual risk of the site is identified.

**2.3. – Г-8-3 – “Analysis of Railway Level-Crossing Accidents for the Period 01.01.2011–31.12.2015”**, *Yearbook of the Georgi Stoykov Rakovski Military Academy, Command and Staff Faculty*, 2/2016, 2016, pp. 239–242, publisher: G. S. Rakovski Military Academy, Sofia, ISSN 1312-2991, co-authored by Valentin Emilov Kehayov

A total of 124 railway level-crossing accidents were examined, with personnel and resources of the General Directorate Fire Safety and Civil Protection, Ministry of Interior (GDFSCP-MoI), participating in the response to 43 of them. All accidents involving fire and rescue crews were collisions between a rail vehicle and a road vehicle. Differences were identified in the way individual institutions classified the same events, as well as discrepancies in casualty data in 15 cases.

Passenger cars were involved in 73.81% of the accidents examined. The average time taken to notify GDFSCP-MoI of accidents involving casualties was 13 min, and the average response time was 8 min, meaning that intervention began, on average, about 21 min after the event. Fire crews extricated trapped persons in only 17% of the accidents involving casualties; in the remaining cases, the casualties had been removed before the crews arrived. The principal activities were clearing the crossing, maintaining a standby presence and removing vehicle parts. The study concludes that uniform reporting criteria, faster notification and a more precise definition of the role and resources of the rescue services are required.

**2.4. – Г-8-4 – “Study of the Flammability and Smoke-Producing Capacity of Polymeric Materials Used in Railway Rolling-Stock Furnishings”**, *Proceedings of the Annual University Scientific Conference of the Vasil Levski National Military University*, Vol. 3, 2017, pp. 117–125, publisher: Publishing Complex of the Vasil Levski National Military University, Veliko Tarnovo, ISSN 1314-1937

The study examined changes in the flammability and smoke-producing capacity of polyurethane foam from seats used in passenger railway cars for 8 and 12 years, comparing the results with those obtained for a newly manufactured seat. Flammability was determined by a standardised small-flame test, while smoke production was assessed by measuring the reduction in illuminance in a test chamber.

The new material exhibited an average burned length of 7.75 mm, an afterflame and afterglow duration of 2 s after removal of the flame, and produced no flaming particles. For the eight-year-old seat, the afterglow duration increased to 21.13 s and 62.5% of the specimens produced flaming droplets. For the twelve-year-old seat, the afterglow duration reached an average of 43.13 s, and flaming particles were produced by 75% of the specimens. At the fourth minute, illuminance decreased from 39.3 lx for the new seat to 27.7 lx after 8 years and 19.7 lx after 12 years, as a result of which the latter specimens failed to meet the requirements. It was demonstrated that service use leads to a substantial deterioration in fire-performance characteristics and that the materials must be tested periodically during their service life.

**2.5. – Г-8-5 – “Experimental Study on Hazardous Fire Factors in a Passenger Train Coupe”,** *Scientific Papers of the University of Ruse “Angel Kanchev”, Vol. 58, 2019, pp. 16–21, publisher: University of Ruse “Angel Kanchev”, Ruse, ISSN 2603-4123, co-authored by Todor Georgiev Toshev.*

A full-scale experiment was conducted in a life-size model of a passenger compartment fitted with authentic interior elements from an in-service railway car. The principal hazardous fire factors were examined: temperature, oxygen depletion, toxicity of the fire effluents and loss of visibility. Twenty-four thermocouples, a gas analyser and an experimental arrangement for assessing visibility were used. Owing to technical limitations, the data for hydrogen cyanide and nitrogen oxides were not processed; the gas analysis therefore focused on carbon monoxide, carbon dioxide and hydrogen sulphide.

According to the recorded results, toxic combustion products reached critical levels as early as approximately the first minute. A temperature of 70°C at a height of 1.7 m was reached between 1 min 45 s and 3 min 15 s, while critical loss of visibility occurred at approximately the third minute. Carbon monoxide exceeded the critical concentration many times over, whereas carbon dioxide did not, on its own, reach the adopted critical level during the experiment. It was concluded that safe evacuation from the compartment should be completed no later than approximately 45 s after ignition.

**2.6. – Г-7-1 – “On the Significance of Mathematical Methods for Assessing the Risk of Major Industrial Accidents”,** *Mathematics and Education in Mathematics: Proceedings of the Forty-Eighth Spring Conference of the Union of Bulgarian Mathematicians, 2019, pp. 99–106, publisher: Union of Bulgarian Mathematicians, Sofia, ISSN 1313-3330, co-authored by Stefan Iliev Parvanov*

The significance of mathematical methods in assessing the risk of major industrial accidents involving hazardous substances was examined. A distinction was made between the

concepts of “hazard” and “risk”, with risk represented by the probability of an undesirable event and the magnitude of its consequences. Deterministic and probabilistic methods were analysed, and the role of probabilistic analysis in assessing residual risk after the implementation of technical and organisational measures was highlighted.

The regulatory requirements for safety reports and the principal stages of quantitative assessment were presented: selection of installations; identification of loss-of-containment events; modelling of releases and dispersion; and modelling of exposure and damage. The risk-reduction measures considered include improving organisational safety, implementing a higher technological level of protection and establishing rapid emergency-response structures. The study concludes that mathematical methods should be applied both by operators of hazardous establishments and by expert supervisory authorities.

**2.7. – Г-8-6 – “Problems in Providing the Sites of the Ministry of Defence, the Structures Directly Subordinate to the Minister of Defence and the Bulgarian Armed Forces with Fire Blankets”,** *Proceedings of the Annual University Scientific Conference of the Vasil Levski National Military University, Vol. 6, 2019, pp. 58–62, publisher: Publishing Complex of the Vasil Levski National Military University, Veliko Tarnovo, ISSN 1314-1937*

The regulatory requirements and actual condition of fire blankets at sites of the Ministry of Defence and the Bulgarian Armed Forces were analysed. It was established that the required number of blankets is determined mainly according to the type of military formation or equipment, without sufficient consideration of the area and the specific fire hazard. A substantial proportion of the available blankets were manufactured between 1975 and 1989 and had exceeded the stated storage life of 5 to 10 years many times over.

Most of the older products contain asbestos. Ageing, tearing or opening packaging that has been stored for a long time may release hazardous asbestos dust, creating an additional health risk for users. These products must be withdrawn from service and replaced with modern fire blankets. The withdrawn items are classified as hazardous waste and must be collected, packaged, transported and treated by authorised persons. The study concludes that the principal problem is financial and includes both the purchase of new blankets and the costly disposal of the old asbestos-containing products.

**2.8. – Г-8-7 – “Use of Computer Simulations in the Training of Fire Safety and Civil Protection Personnel”,** *Innovative STEM Education, Vol. 1, 2019, pp. 14–22, publisher: Bulgarian Academy of Sciences, Institute of Mathematics and Informatics, Sofia, ISSN 2683-1333, co-authored by Stefan Iliev Parvanov and Stefan Toshkov Iliev*

The possibilities for using computer simulations, virtual reality and serious simulation games in the training of fire safety and civil protection personnel were examined. The limitations of traditional practical exercises were analysed: they require considerable resources, specialised training grounds and lengthy organisation, and do not always allow identical conditions to be reproduced for all trainees.

Computer simulations allow complex scenarios to be rehearsed repeatedly, training to be conducted under identical initial conditions, decisions to be analysed and subsequent debriefings to be conducted. The identified advantages include greater safety, improved motivation, the possibility of training for rare and high-risk events, and reduced environmental impact. The limitations highlighted include insufficient realism, the risk of learning incorrect approaches, dependence on the instructor's competence, licensing and adaptation costs, and the possibility of creating a false sense of safety. The study concludes that simulations should complement, rather than replace, practical training.

**2.9. – Г-8-8 – “Mathematical Methods in the Work of Engineers in the Field of Fire Safety and Civil Protection”**, *Innovative STEM Education*, Vol. 1, 2019, pp. 23–27, publisher: Bulgarian Academy of Sciences, Institute of Mathematics and Informatics, Sofia, ISSN 2683-1333, co-authored by Stefan Iliev Parvanov and Stefan Toshkov Iliev

The need for in-depth mathematical training of engineers in the field of fire safety and civil protection was substantiated. A comparative analysis was made of the proportion of mathematical courses in three related degree programmes: “Fire and Emergency Safety” at the Academy of the Ministry of Interior, “Fire Safety and Civil Protection” at Varna Free University, and “Population Protection in Disasters and Accidents” at the Technical University of Varna.

At the Academy of the Ministry of Interior, mathematical courses comprise 390 hours and account for approximately 6.19% of compulsory training. By comparison, their share is 7.96% at Varna Free University and approximately 2.88% at the Technical University of Varna. Typical activities requiring mathematical methods are presented: forecasting fire development, analysing accident scenarios, assessing risk, planning, allocating resources and evaluating fire safety through comparison, testing and computational models. It is concluded that the importance of mathematical methods in engineering practice will increase as technology develops.

**2.10. – Г-8-9 – “Hazards Identification, Risk Assessment and Preventive Measures at Specific Sites”**, *Innovative STEM Education*, Vol. 2, 2020, pp. 113–122, publisher: Bulgarian Academy of Sciences, Institute of Mathematics and Informatics, Sofia, ISSN 2683-1333, co-authored by Stefan Iliev Parvanov.

An integrated approach to hazard identification and risk assessment at specific and potentially hazardous sites was proposed, including critical infrastructure, strategic sites, sites of national importance, and lower-tier or upper-tier establishments. The requirements for describing accident scenarios, operational, external and natural causes, possible domino effects, impact zones and measures for safe operation were examined.

Qualitative, semi-quantitative and quantitative methods were systematised, including scenario analysis, fault tree analysis, event tree analysis, cause–consequence analysis, Bow-Tie analysis, Monte Carlo simulation, risk matrices and FN curves. The principal stages of quantitative assessment under CPR18E were presented: selection of installations; identification of loss-of-containment events; modelling of releases and dispersion; assessment of exposure and damage; determination of individual and societal risk; and selection of preventive measures. It was emphasised that measures should be determined after numerical risk assessment and should maintain risk below the recommended threshold.

**2.11. – Г-8-10 – “Provision of Ammunition and Explosives Storage Facilities with Initial Firefighting Equipment”**, *Logistics and Public Systems: Proceedings of a Scientific Conference, Veliko Tarnovo, 2021, pp. 226–235, publisher: Publishing Complex of the Vasil Levski National Military University, Veliko Tarnovo, ISSN 2738-8042, co-authored by Dimitar Goshev Kirilov*

The regulatory requirements for equipping ammunition and explosives storage facilities with initial firefighting equipment were analysed. Two approaches were distinguished: a traditional approach based on quantities prescribed by regulation according to the area, type or purpose of the site, and an individual quantitative approach in which the type and number of items are determined according to the assessed level of risk.

A comparison of different regulatory documents reveals unclear, incomplete and partly contradictory requirements. General fire safety regulations exclude the technical areas of explosives depots, while specialised military documents do not define the equipment of firefighting equipment depots with sufficient clarity. This necessitates the use of repealed rules and permits subjective increases or reductions in quantities without a uniform methodology. STANAG 4440 links equipment provision to hazard and risk analysis, but in Bulgaria it is applied with limitations, mainly to new infrastructure. The study concludes that the regulatory framework must be updated and a clear methodology introduced for determining the type, quantity and location of the equipment.

**2.12. – Г-8-11 – “Influence of the Geometric Parameters of Evacuation Routes on the Evacuation of People from Buildings and Facilities”,** *Innovative STEM Education, Vol. 3, 2021, pp. 72–82, publisher: Bulgarian Academy of Sciences, Institute of Mathematics and Informatics, Sofia, ISSN 2683-1333, co-authored by Stefan Iliev Parvanov*

The relationship between the geometric characteristics of evacuation routes and evacuation effectiveness was examined, and a comprehensive mathematical approach was developed for an open-air sports facility. The required evacuation time was considered as the sum of the time for fire detection, notification, decision-making, initiation of movement and actual egress. The widths of passageways, row lengths, crowd-flow density and speed, exit capacity, and the effects of constrictions and merging flows were analysed.

For an illustrative grandstand with 3,536 seats, the required widths of passageways, vomitories, gates and stairs were determined. The total provided width of the vomitories was 17.00 m, compared with a calculated requirement of 13.18 m; the width of the gates leading to the field was 14.00 m, compared with a requirement of 8.20 m; and the total stair width was 22.05 m, compared with a requirement of 16.80 m. It was established that at a density above approximately 5 persons/m<sup>2</sup>, movement speed decreases sharply and the risk of pulsation and stoppage of the flow increases. The study concludes that appropriate geometric solutions can substantially improve safety and should be assessed together with the behaviour and physical condition of the occupants.

**2.13. – Г-8-12 – “Control of Fire-Hydrant Flow Rates during Operation”,** *Proceedings of an International Scientific Conference, University of Structural Engineering and Architecture “Lyuben Karavelov”, Vol. II, 2021, pp. 375–386, publisher: University of Structural Engineering and Architecture “Lyuben Karavelov”, Sofia, ISSN 1314-071X*

The publication addresses the reliability of external firefighting water supply and, more specifically, the possibility of determining the actual flow rate of fire hydrants under real operating conditions.

The principal problem identified is that Bulgaria regulates the design, construction and maintenance of fire hydrants, but lacks a standardised methodology, suitable equipment and an established procedure for periodically determining their actual flow rate. The inspections normally performed verify signage, visible serviceability, the ability to open the hydrant and the presence of water, but do not demonstrate whether the hydrant supplies the design water flow and required pressure.

A comparative analysis was made of practices in the United States, the United Kingdom, Russia and Belarus. The following were examined:

- direct and indirect flow-rate measurement;

- the use of a Pitot tube, pressure gauges, flow-measuring nozzles and specialised attachments;
- measurement of static and residual pressure;
- testing a single hydrant and a group of hydrants operating simultaneously;
- formulae for determining flow rate and water-delivery capacity;
- classification and marking of hydrants according to the flow rate provided;
- test frequency, responsible institutions and documentation of the inspections.

The diagrams in the publication illustrate different configurations for group testing, the measuring equipment and the options for connection to the hydrant. The summary table compares institutional responsibility, scope and inspection frequency in the countries examined.

**2.14. – Г-8-13 – “Development of a Training Facility for Practical Instruction in the Correct Actions in the Event of a Kitchen Fire”, *Innovative STEM Education*, Vol. 4, 2022, pp. 113–120, publisher: Bulgarian Academy of Sciences, Institute of Mathematics and Informatics, Sofia, ISSN 2683-1333, co-authored by Tihomir Yavorov Abadzhiev**

The publication presents the design, construction and potential uses of a full-scale training facility for kitchen fires. The need for the facility is substantiated by kitchen-fire statistics and by a survey of school pupils, newly admitted cadets and members of the public. According to the results presented, only a small proportion of respondents knew the correct actions, while approximately 80% of persons under 25 years of age stated that they would use water to extinguish burning cooking oil.

The training facility was constructed at the training ground of the Faculty of Fire Safety and Civil Protection at the Academy of the Ministry of Interior. It is a single-storey structure with a building footprint of 4 m<sup>2</sup>, constructed of autoclaved aerated concrete with reaction-to-fire class A1. The room contains a kitchen worktop, a heating appliance, an extractor hood, a protected location for a gas cylinder, and various types of electrical distribution boards and switches.

A special technical solution is a pipe routed outside the structure, through which water can safely be introduced into a container of burning cooking oil. This allows a “grease explosion” to be demonstrated without the instructor entering the hazardous area.

The photographs and sequential images in the publication show the development of combustion in a container of cooking oil and the extensive flame spread following the addition of water. The training facility is used for:

- demonstrations for children and members of the public;
- training in the use of a fire blanket or lid;
- actions in the event of fires involving containers and propane–butane cylinders;
- disconnection of the electrical power supply;

- working with different fuses, switches and dielectric shears;
- full-scale experiments related to the development of kitchen fires.

**2.15. – Г-8-14 – “Study of the Relationship between the Factors and Parameters of Crisis Events Involving Animals”**, *Innovative STEM Education*, Vol. 4, 2022, pp. 162–168, publisher: Bulgarian Academy of Sciences, Institute of Mathematics and Informatics, Sofia, ISSN 2683-1333, co-authored by Stefan Iliev Parvanov

The relationship between the causes and circumstances giving rise to crisis events involving animals and the parameters of rescue operations carried out by GDFSCP-MoI was investigated. The analysis was based on data from the “Incidents” Automated Information System for the period 01.01.2011–31.12.2018. Statistical analysis and the “black-box” method were used, with events represented by input influences—the factors—and output responses—the parameters of the rescue intervention.

Incidents involving stray, domestic and wild animals, cats and dogs, insects and reptiles were systematised, together with their distribution by region and place of occurrence. The proposed model makes it possible to analyse how the type of animal, location and other characteristics affect the personnel, resources and rescue actions required. It is noted that, with more detailed data recording, relationships could be examined according to time of day, season, type of environment and specific rescue operation. The resulting correlations could support resource allocation, prevention and the decisions of the incident commander at the scene.

**2.16. – Г-8-15 – “Analysis of Kitchen Fires Extinguished by GDFSCP-MoI during the Period 01.01.2016–31.12.2020”**, *Proceedings of the Annual University Scientific Conference of the Vasil Levski National Military University*, Vol. 3, 2022, pp. 33–42, publisher: Publishing Complex of the Vasil Levski National Military University, Veliko Tarnovo, ISSN 1314-1937, co-authored by Tihomir Yavorov Abadzhiev

A total of 6,488 kitchen fires were analysed, of which 4,215 caused direct material damage. These incidents resulted in 458 injuries and 42 fatalities. The authors emphasise that the actual number is probably higher because some fires are extinguished by members of the public during their initial stage and are not recorded.

The principal results are as follows:

- 5,892 fires, or approximately 91%, occurred in residential buildings, and 596 in public buildings;
- the leading cause was the improper use of heating appliances—3,124 cases;
- this was followed by electrical short circuits—1,152 cases—and technical malfunction—995 cases;

- 925 of the cases classified as technical malfunction involved gas cylinders on fire;
- 790 fires involving cooking oils and fats were recorded, resulting in 62 injuries and two fatalities;
- for fires involving cooking oils and fats, the distribution between public and residential buildings was almost even—403 and 387 cases, respectively;
- the greatest number of cooking-oil fires began in cooking vessels—316, followed by deep fryers—237, extraction systems—140, and grills—87.

A particularly important finding is that “ignition of cooking oils and fats” is not a separate category in the nomenclature used. Such fires are recorded under different causes or only in the free-text field “Other Data”, which makes them difficult to identify and probably results in an underestimation of their actual number. The six graphs in the publication present the annual dynamics, building use, causes and distribution of cooking-oil fires.

**2.17. – Г-8-16 – “Burning Behaviour of Textiles Used for Passenger Railway-Car Seat Upholstery”**, *75 Years of Professional Education in Fire Safety and Civil Protection: Proceedings of the Tenth Scientific Conference with International Participation, 2022, pp. 203–208, publisher: Academy of the Ministry of Interior, Sofia, ISBN 978-954-348-236-8, co-authored by Hristiyan Antonio Dimitrov*

The scientific work investigates changes in the burning behaviour of eight types of textile used for seat upholstery in passenger railway cars after five years of service. The study was motivated by the absence of a maximum regulatory service life and periodic control of the fire characteristics of upholstery materials, despite their substantial importance for the fire load and fire spread within railway cars.

A total of 96 specimens oriented in the warp and weft directions were tested. They were exposed to a propane flame for 30 seconds, and the duration of burning, damaged area, flame spread and production of flaming particles or droplets were assessed. The results reveal substantial differences between the materials. Only two of the eight textile types—fabrics No. 4 and No. 7—retained acceptable burning behaviour after five years of service. The remaining materials exhibited complete burning, prolonged combustion, melting, the production of flaming sticky particles and intense smoke generation.

The difference between fabrics No. 3 and No. 7 is particularly indicative: according to the manufacturer, they should have identical characteristics and differ only in colour. After the service period, fabric No. 3 burned completely, whereas fabric No. 7 exhibited limited burning and met the highest applicable requirements. The authors conclude that the preserved physical integrity of upholstery does not guarantee preservation of its fire characteristics and therefore propose periodic testing of textile coverings at three-year intervals.

**2.18. – Г-8-17 – “Probabilistic Analysis of Passenger Safety when Using Rail Transport”**, *Innovative STEM Education*, Vol. 5, 2023, pp. 142–152, publisher: Bulgarian Academy of Sciences, Institute of Mathematics and Informatics, Sofia, ISSN 2683-1333, co-authored by Stefan Iliev Parvanov

An approach to probabilistic passenger-safety analysis was presented, based on logical structures, probability theory and the assessment of risk as the product of the probability of an event and the severity of its consequences. The logical operations “AND” and “OR”, as well as mutually exclusive events, were examined as a basis for constructing cause, hazard and event trees. The approach was applied to passenger distribution in compartment railway cars.

The questionnaire survey showed that compartment No. 2 was the most preferred, selected by 25.71% of participants, while compartment No. 8 was the least preferred. Window seats No. 7 and No. 8 were the most preferred, whereas middle seats No. 5 and No. 6 were the least preferred. A relationship was proposed according to which the probability of a passenger fatality at a particular seat is determined as the product of the probability of a fatal effect at that seat and the probability that the seat is occupied. Possible measures include structural strengthening, the use of seat belts and better organisation of passenger distribution. The method should be updated periodically to reflect changes in rolling stock, operating conditions and available statistical data.

**2.19. – Г-8-18 – “Concerning the Behavior of Passengers When Choosing a Seat in a Compartment Passenger Railway Car”**, *Innovative STEM Education*, Vol. 6, 2024, pp. 120–123, publisher: Bulgarian Academy of Sciences, Institute of Mathematics and Informatics, Sofia, ISSN 2683-1333

An empirical study was conducted of passenger behaviour when choosing a compartment and a specific seat in a second-class compartment railway car. Three sources of information were used: a questionnaire survey, analysis of advance reservations and direct observation of passengers on the Sofia–Gorna Oryahovitsa–Varna railway route. Constant factors were identified—preference for a window, the door and the direction of travel—as well as relative factors: compartment occupancy, the profile of the other passengers, the amount of luggage, journey duration and the condition of the interior.

It was confirmed that window seats are reserved and occupied most quickly. When one window seat is occupied, the other window seat is selected in 58% of cases and the diagonally opposite seat in 31%. When two persons travel together, the two window seats are reserved in 46% of cases; when three persons travel together, the two window seats and one adjacent seat are reserved in 86% of cases. Observation showed that seat No. 8 in compartment No. 2 had the

highest probability of remaining occupied for the entire route— $P = 0.72$ —while seat No. 4 in compartment No. 6 had the lowest— $P = 0.29$ . A discrepancy was identified between stated preferences and actual choices: the survey identified seats No. 5 and No. 6 as the least desirable, whereas direct observation identified seat No. 4 as the least frequently used.

**2.20. – Г-8-19 – “Possibilities for the Use of Rescue Dogs within GDFSCP-MoI”,** *Innovative STEM Education, Vol. 6, 2024, pp. 124–128, publisher: Bulgarian Academy of Sciences, Institute of Mathematics and Informatics, Sofia, ISSN 2683-1333, co-authored by Miroslav Lyubomirov Eftimov and Stefan Toshkov Iliev*

The role of rescue dogs in locating people trapped beneath collapsed buildings, the applicable regulatory framework and the possibilities for integrating them into the activities of GDFSCP-MoI were analysed. According to the situation examined in the paper, the Directorate did not have its own rescue dogs because the Ministry of Interior’s regulatory framework governed service animals primarily for guarding, crime prevention and border control. Existing national capacity was concentrated mainly in the Canine Rescue Group of the Mountain Rescue Service of the Bulgarian Red Cross and in newly established voluntary organisations.

Three principal approaches were proposed: expanding cooperation with the Mountain Rescue Service and voluntary associations; training and certifying, under IRO rules, employees who work with their own dogs; and establishing an independent GDFSCP-MoI capacity of service rescue dogs and handlers. At the time of the study, four employees were members of the voluntary association “Search and Rescue Dogs – Bulgaria”, and three were volunteers with the Mountain Rescue Service group; a total of ten privately owned dogs were undergoing training. Cooperation with voluntary organisations was assessed as the fastest and most economical approach, but one providing less institutional control. An in-house capacity is more expensive and difficult to establish, but more sustainable. Both approaches require regulatory amendments and clear rules for training, certification and participation in operations.

**2.21. – G-7-2 – “Numerical Study of the Hazardous Factors of a Fire in a Passenger Railway Car”,** *Mathematics and Education in Mathematics: Proceedings of the Fifty-Fourth Spring Conference of the Union of Bulgarian Mathematicians, 2025, pp. 91–100, publisher: Union of Bulgarian Mathematicians, Sofia, <https://doi.org/10.55630/mem.2025.54.091-100>, ISSN 1313-3330 (Print), 2815-4002 (Online), co-authored by Valentin Todorov Chochev*

A numerical study was conducted of the spread of smoke and toxic combustion products in a B84-type compartment passenger railway car under two scenarios: a fire with the compartment door open and a fire with the door closed. The modelling was performed with PyroSim/FDS using a digital model of the entire railway car. The computational domain

measured  $23 \times 10 \times 10$  m, and the mesh comprised 2,340,000 cells measuring 0.1 m. Sensors for temperature, oxygen, carbon monoxide, carbon dioxide and visibility were positioned in the compartment and corridor.

Approximately 87 s after ignition, with the door open, visibility in the corridor had already fallen below the critical level for normal movement and the carbon monoxide concentration was hazardous. With the door closed, conditions in the corridor remained favourable. After the glazing failed at approximately 89 s, smoke also began to enter the corridor in the closed-door scenario, and the local carbon monoxide concentration could be higher because of incomplete combustion under oxygen-deficient conditions. The principal conclusion is that closing the door of the burning compartment provides approximately 80 s of additional evacuation time with acceptable visibility and without hazardous concentrations throughout most of the corridor. The results may be used to develop instructions for train operating staff.

**2.22. – Г-8-20 – “Research on the Intensity of Fire Spray Nozzles with a Concentrated Jet”**, *Innovative STEM Education*, Vol. 7, ISSN 2683-1333, Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, pp. 254–259, DOI: <https://doi.org/10.55630/STEM.2025.0723>, ISSN 2683-1333, co-authored by Gabriela Tsvetanova Gigova

The throw and water-application intensity of hand-held AWG fire nozzles, types B, C and D, fitted with 75, 52 and 25 mm couplings, respectively, were investigated experimentally. The tests were conducted at the same flow rate of 130 L/min and pressure of 0.5 MPa. Twenty tests were carried out for each nozzle. Maximum and effective throw were determined on a standardised test rig, while water-application intensity was measured using forty collection vessels arranged in a 10 m line.

The maximum throw obtained was 24.5 m for the type B nozzle, 21.0 m for type C and 20.5 m for type D. The corresponding effective values were 22.1, 18.9 and 18.5 m. For nozzle B, the highest intensity was recorded in the 18–24 m zone; for C, the effective zone was approximately 15.5–19.5 m; and for D, the minimum required intensity of  $0.100 \text{ L}/(\text{s}\cdot\text{m}^2)$  was reached between 16 and 19 m. Nozzle D provided a shorter range but a finer and more uniform water curtain. For all types, the minimum required intensity was achieved in the dispersed portion of the jet, including beyond the effective throw defined by regulation. Errors were below 3%, confirming the repeatability of the results.

**2.23. – Г-8-21 – “Approaches to Adapting Religious Buildings—Cultural Monuments—to Safety Requirements”,** *Cultural and Historical Heritage: Preservation, Presentation, Digitalization, Vol. 11, Issue 2, 2025, pp. 101–114, DOI: <https://doi.org/10.55630/KINJ.2025.110208>, ISSN 2367-8038, co-authored by Stefan Iliev Parvanov*

The conflict between contemporary fire, structural and evacuation safety requirements and the principle of minimum intervention in the conservation of cultural heritage was examined. The study brings together the principles of the Venice Charter and ICOMOS, requirements and recommendations from NFPA 909 and NFPA 914, guidance from Historic England, and methodologies developed by UNESCO and ICCROM. European examples of the adaptive reuse of churches and monasteries were analysed, together with the fire at Hilandar Monastery, which demonstrates how the absence of compartmentation and fire protection systems can lead to the loss of a substantial proportion of authentic historic fabric.

For the engineering assessment, fire-load density, the EUROALARM index, the ASET–RSET criterion and the capabilities of HBIM/BIM for integrated modelling of geometry, materials, smoke, temperature, evacuation and seismic risk were applied. In the illustrative quantitative assessment, early detection reduced risk by 11.7%, compartmentation alone by 29.5%, and the combination of compartmentation, early detection, partial replacement with non-combustible materials, enhanced fire resistance and automatic suppression by 71.7%, reducing the index to a manageable level of 0.751.

An integrated model was proposed comprising an HBIM “safety passport”, concealed fire barriers, aspirating smoke detection, water mist or low-flow sprinklers, smoke control, evacuation plans for people and valuable objects, hot-work control, video surveillance, and a multi-hazard plan for fire, earthquake and flood. The study concludes that safety is not incompatible with conservation when interventions are minimal, distinguishable and, where possible, reversible.

**2.24. – Г-8-22 – “On the Readiness of the Population to Use Internal Fire Hydrants in the Event of a Fire”,** *Current Issues in Security: Proceedings of a Scientific Conference, Veliko Tarnovo, publisher: Vasil Levski National Military University, ISSN 2367-7465 (Print), 2367-7473 (Online), pp. 795–800, ISSN 2367-7465 (Print), 2367-7473 (Online), co-authored by Emilia Yuliyanova Staneva and Lyudmila Lyudmilova Kehayova*

A questionnaire survey of 720 adults was conducted between November 2025 and March 2026 to assess recognition of internal fire hydrants, knowledge of their regulatory signage and confidence in their practical use. The questionnaire contained ten questions and was administered both electronically and face to face. When asked whether they knew what an IFH was, 70.69% answered affirmatively, 20.83% were unsure and 8.47% stated that they did not know.

Despite the relatively high overall recognition rate, only 22.36% correctly identified the current regulatory sign. The largest proportion—44.31%—selected the old Bulgarian designation “ПК”, while 33.33% selected another graphic sign for a fire hose. Only 26.39% stated that they knew how to use an IFH and felt confident doing so. A further 37.5% believed that they knew the procedure in theory but did not believe they could perform it in practice. Employed respondents aged between 35 and 65 demonstrated the best preparedness, while students and persons not in employment demonstrated the lowest. The principal source of knowledge was workplace fire safety instruction.

The study concludes that there is a substantial difference between general awareness and actual readiness to act. It recommends introducing practical demonstrations in schools and universities, conducting regular workplace drills, and developing concise, publicly accessible video and written instructions.

**2.25. – Г-8-23 – “On School Pupils’ Knowledge of Internal Fire Hydrants”,** *Current Issues in Security: Proceedings of a Scientific Conference, Veliko Tarnovo, publisher: Vasil Levski National Military University, ISSN 2367-7465 (Print), 2367-7473 (Online), pp. 790–794, ISSN 2367-7465 (Print), 2367-7473 (Online), 2026, co-authored by Emilia Yuliyanova Staneva and Lyudmila Lyudmilova Kehayova*

The knowledge of 457 upper-secondary pupils from twenty schools in different regions and settlements was examined. Fifteen of the schools had an installed internal fire-hydrant system, while five did not. The questionnaire was administered electronically and face to face and covered recognition of IFHs, knowledge of the correct signage, self-assessment of practical skills and previous training.

Overall, 53.17% of the pupils stated that they knew what an IFH was, 27.79% were unsure and 19.04% did not know. The face-to-face surveys revealed a substantial discrepancy between self-assessment and actual knowledge: 21.80% of those who stated that they knew what an IFH was identified the wrong piece of equipment. The correct regulatory sign was recognised by 46.80% of all participants. In schools with available and correctly marked hydrants, correct answers reached 72%, whereas incorrect answers predominated where the equipment was absent or incorrectly marked.

Only 10.28% stated categorically that they knew how to use an IFH, while 11.60% had theoretical knowledge but did not believe they could use one in practice. In total, 78.11% either probably or definitely did not know how to operate the hydrants. Only 43 pupils had received training; all were from one school, and the training had been delivered by a representative of the fire service. The study concludes that pupils’ knowledge is directly related to the visibility, condition and correct marking of the equipment, as well as to the training provided. It is

emphasised that pupils should not be assigned responsibility for firefighting, but that developing fire safety awareness and knowledge of safe behaviour at an early age is essential to the population's future preparedness.

7 August 2026  
Sofia

Signature: /signed/  
(Inspector, PhD, Eng. Svilena Arabadzhieva)