CNBOP-PIB

Report on the 4th International Scientific Conference

Safety of New Technologies

Patronage:

CENTRUM NAUKOWO-BADAWCZE
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Table of contents

1. General information

Organizer: Centrum Naukowo-Badawcze Ochrony Przeciwpożarowej im. Józefa Tuliszkowskiego – Państwowy Instytut Badawczy (CNBOP-PIB) in Józefów.

Co-organizers:

- Akademia Pożarnicza
- WSB Academy in Dąbrowa Górnicza
- Institut für Feuerwehr- und Rettungstechnologie (IFR) der Feuerwehr Dortmund
- District Headquarters of the State Fire Service in Otwock
- City Headquarters of the State Fire Service in Krakow
- School of Aspirants of the State Fire Service in Poznan
- PZU LAB SA
- European Fire Safety Alliance
- National Association of Manufacturers of Fire Protection and Rescue Equipment
- Polish Association of New Mobility
- Polish Chamber of Energy Storage
- Association of Fire Service Engineers and Technicians
- Institute for Social Security of the "Social Observatory" Foundation

Honorary patronage:

- Chief Commander of the State Fire Service
- Marsh, "Gazeta Ubezpieczeniowa"
- "Safety & Fire Technology"

Date of the conference: 7 May 2025

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2. Purpose of the conference

The Fourth International Conference on the Safety of New Technologies and the Advancement of Rescue Technologies addressed topics related to the broadly understood fire safety of energy sources, electric batteries, energy storage systems, as well as new solutions in fire protection and rescue operations. The conference also covered the future and broader application of robotic solutions and artificial intelligence, not only in fire protection. The conference was aimed at manufacturers, designers and installers, uniformed and civilian staff of the State Fire Service, specialists and fire protection experts, property managers, users and owners of buildings, risk engineers, insurance brokers, specialists from various industries, and all individuals interested in the subject matter. Once again, the conference fulfilled its mission of serving as a platform for presenting and disseminating current research results, projects and implementations, as well as providing information about them. It also served as a review of knowledge and solutions and a forum for the exchange of views and experiences among various communities interested in the safety of rapidly developing new technologies.

The detailed scope of the conference included the following topics:

- Safety of new technologies;
- Robotics and artificial intelligence in fire protection;
- Identification and assessment of hazards posed by new technologies;
- Fire safety of energy storage systems, key factors affecting the safe use of energy storage;
- Fire protection measures, both physical and chemical, at the battery cell level;
- Battery management systems (e.g., BMS, TMS);
- Devices, electric vehicles, and renewable energy installations equipped with electric batteries as potential fire hazards;
- Fire protection requirements for buildings equipped with renewable energy installations that include electric energy storage and are intended for parking and charging electric vehicles;
- New solutions and technologies in fire protection;

- ❖ Conducting firefighting and rescue operations during incidents involving electric batteries, energy storage systems, hydrogen propulsion, and other new technologies.

3. Course of the conference

The scientific conference organized by CNBOP-PIB was divided into three sessions:

Session 1. Safety of New Technologies – safety of new technologies; robotics and artificial intelligence in fire protection; identification and assessment of hazards posed by new technologies.

Session 2. Fire Safety of Energy Storage Systems – fire safety of energy storage systems; key factors affecting the safe use of energy storage; fire protection measures, both physical and chemical, at the battery cell level; battery management systems (e.g., BMS, TMS); devices, electric vehicles, and renewable energy installations equipped with electric batteries as potential fire hazards; fire protection requirements for buildings equipped with renewable energy installations that include electric energy storage and are intended for parking and charging electric vehicles.

Session 3. Safety of New Technologies – knowledge, new solutions, products, systems, services, procedures, and education.

Additionally, as part of the first and second sessions, a discussion panel was held with the participation of both in-person attendees and online participants.

3.1. First session – Safety of New Technologies

During the first session, moderated by st. bryg. Jacek Zboina, D.Sc., Ph.D. Eng., the following topics were presented and discussed:

1) Development of a Robot Farm – Towards AI Agents – Ms. Agnieszka Wilczek, M.Sc.,
2) Modern Education and Communication in the Field of New Technology Safety – Mr. Krzysztof Kujawski and Mr. Paweł Mazurkiewicz,
3) Use of Artificial Intelligence in Civil Protection and Rescue Operations – Aleksandra Skrabacz, D.Sc., Ph.D., Prof. of the Military University of Technology, and Justyna Stochaj, Ph.D.,
4) Safety of New Technologies Based on the Institute's Own Research Experience – Tomasz Popielarczyk, Ph.D. Eng.,
5) Use of Artificial Intelligence and Other New Technologies to Support Rescue Operations, Command, and Information Access – Preliminary Research – Mr. Paweł Bujny, M.Sc. Eng.

3.1.1. Development of a Robot Farm – Towards AI Agents

Ms. Agnieszka Wilczek presented the activities of the National Revenue Administration (KAS) in the area of automation and robotization of administrative processes, with particular emphasis on the transformation toward

systems based on artificial intelligence. Currently, KAS operates 85 robots, which have performed over 2.5 million operations, resulting in the release of 470 full-time equivalents (FTEs).

A notable example of successful implementation is Robot R62, which automates the process of verifying notarial deeds submitted to KAS. It processes over 16,000 documents daily, freeing up more than 60 FTEs. Another robot, R64, has been deployed in 366 tax offices and responds to creditor inquiries from the UFG (Insurance Guarantee Fund), increasing the effectiveness of public debt collection and improving the fund's financial liquidity. Meanwhile, Robot R51 provides daily support for actions preventing the disposal of assets and optimizes enforcement activities.

The presentation also highlighted the use of AI tools in analytical processes – for example, in the KAS Analytical Department, where a system is being developed to identify CN codes based on invoice data, and in the Finance and Accounting Department, where automatic data extraction from contracts is carried out. AI enables both micro- and macro-scale data analysis, improves data quality, and enhances process efficiency.

Artificial intelligence is also used in the tax interpretation process, which involves over 25,000 rulings annually. AI supports application analysis, identification of similar cases, and facilitates decision-making. An innovative solution mentioned was the "OKO RENTGEN" system, which aids in detecting cigarette smuggling at border crossings. Over three years, it helped uncover the smuggling of 92 million cigarettes worth approximately PLN 121 million.

The Ministry of Finance also places a strong emphasis on developing the digital competencies of its staff. The "Academy of Robotization" program combines training with RPA solution pilots, developing new roles such as robot analysts and developers. All activities are supported by a hybrid Center of Excellence model, which ensures implementation consistency and the development of expertise. In conclusion, it was emphasized that AI systems are machines capable of autonomous operation, learning, adapting, and generating results based on input data – executing tasks in line with organizational goals.

3.1.2. Modern Education and Communication in the Field of New Technology Safety

The presentation "Humanverse" by Mr. Krzysztof Kujawski and Mr. Paweł Mazurkiewicz is a modern exploration of the potential of artificial intelligence in the field of creative technologies, with particular emphasis on education, communication, and marketing. The authors demonstrate how virtual entities – chatbots, avatars, and influencers – are no longer just technological curiosities, but are becoming real tools that influence users in the digital space. Humanverse is an ecosystem in which AI supports the generation of video, music, and images, as well as the creation of personalized voice and visual communication models tailored to the context and needs of the recipient.

The central figure discussed in the presentation is Meta_Queen – the first virtual influencer in Poland, who is actively engaged in social media, collaborates with brands (e.g., a campaign for Douglas), appears in traditional media, and participates in international marketing projects. Virtual influencers like Meta_Queen offer a response to the growing unpredictability and controversy surrounding their human counterparts – they are fully controlled by their creators, immune to image crises, and 100% owned by brands.

The creators of the presentation emphasize the potential of these technologies in preventive and crisis education. Virtual characters can explain safety rules, evacuation procedures, or first aid in an accessible and tailored way for specific audience groups (children, seniors, or people with language barriers). Their presence on social media during crises can prove more effective than traditional forms of government communication. Research cited in the presentation also indicates that users tend to trust such characters, which translates into the effectiveness of their messaging.

An important aspect discussed in the presentation is the role of avatars and chatbots as new interfaces to critical systems. Interactive conversational avatars can act as 24/7 assistants, supporting sales, education, and warehouse operations, as well as analysing user behaviour. Chatbots based on large language models (LLMs) can instantly respond to questions about safety procedures and translate messages into multiple languages, assisting foreigners in crisis situations. Their applications are virtually unlimited – from tourist information and customer service to communication during disasters.

However, the authors also caution that AI requires supervision and proper preparation – they reference examples of incorrect responses given by chatbots in real-world scenarios, which can have serious consequences. Therefore, they stress the importance of responsible system design and thorough testing in terms of usability and safety.

In conclusion, the presentation portrays chatbots, avatars, and virtual influencers as a new, forward-looking interface between humans and technology – tools that can revolutionize education, social communication, and brand promotion efforts, provided they are implemented consciously and responsibly.

3.1.3. Use of Artificial Intelligence in Civil Protection and Rescue Operations

The presentation provides an overview of the capabilities that modern artificial intelligence (AI) offers in the field of civil security and crisis management. Using the desk research method, the authors analyse available materials and case studies from around the world to highlight how AI can support preventive and emergency response actions in times of threat.

The main thesis of the study is to show the impact of artificial intelligence on enhancing public safety and increasing the efficiency of emergency response services. AI, which is becoming increasingly integrated into everyday life, has wide applications in both disaster prediction and prevention, as well as in real-time response to emergencies – from natural disasters to terrorist threats and cyberattacks.

In general terms, AI is understood as a branch of computer science focused on creating systems capable of self-learning, adapting to dynamic conditions, reasoning, and decision-making. For the purposes of civil protection, artificial intelligence can be applied in many areas.

Examples cited in the presentation include: intelligent irrigation systems, fire detection systems (e.g., ALERTCalifornia), weather forecasting, comprehensive crisis management systems (such as R100), terrorist

threat detection (APPRAISE project), border protection, rescue systems (Search and Rescue project), and solutions supporting disaster response (Rapid Analytics for Disaster Response – RADR).

In the area of transport and road infrastructure, the presentation emphasizes the importance of Intelligent Transportation Systems (ITS), which, thanks to AI, enable automated accident detection, reduced emergency response times, and support for vehicle diagnostics. These solutions combine information technology, measurement systems, automation, and telecommunications to improve safety and traffic flow.

Regarding the challenges and opportunities of AI implementation, the authors highlight aspects such as: the speed of analysing large datasets, the ability to monitor threats in real time, increased situational awareness, and the automation of decision-making processes. On the other hand, they do not ignore potential risks – ethical, technological, and social – including data security issues, the limited effectiveness of solutions in various local contexts, and the need to ensure transparency and control over algorithms.

In conclusion, artificial intelligence in civil protection is not just a future concept, but already today represents real support for preventive and operational activities of emergency services. Its responsible implementation can significantly increase society's resilience to various types of threats and improve crisis management. At the same time, it requires ongoing monitoring of its impacts and a thoughtful approach to ethical concerns, privacy, and the sustainable development of technology.

3.1.4. Safety of New Technologies Based on the Institute's Own Research Experience

The presentation prepared by Tomasz Popielarczyk, Ph.D. Eng., from CNBOP-PIB Laboratory of Fire Alarm Systems and Fire Automation – BA addresses the issue of the safety of new technologies, based on the Institute's own research experience. The author focuses on a practical and systemic approach to evaluating the safety of innovative solutions, emphasizing the responsibility not only of technology manufacturers and suppliers, but also of legislators, certification bodies, and end users.

The safety of new technologies is understood as ensuring that innovative solutions are safe for users, infrastructure, and the environment. The presentation showcases a wide range of research topics carried out at CNBOP-PIB, funded by the statutory support of the Ministry of Science and Higher Education, as well as the Institute's Internal Research Fund. These activities include, among others, research into the technical equipment of fire services, firefighter occupational safety, testing methods for fire vehicles and equipment, and the development of new technological solutions in the areas of fire and environmental protection.

Among the Institute's key research areas are: assessment of the explosiveness of flammable substances, effectiveness of water and water mist extinguishing systems, testing of components of fixed extinguishing systems, fire hazards related to electrical cables, and the safety of energy storage systems. The Institute also analyses the effectiveness of extinguishing agents, including their chemical composition and the emission of hazardous substances – factors that directly affect both user safety and environmental protection.

The presentation also highlights the development of research infrastructure and new laboratory stations, such as facilities for testing hydraulic tools, smoke ventilation system components, and linear smoke detectors. The ongoing research contributes to the development of guidelines, standards, and manuals – documents that are essential for designers, installers, and users of fire protection systems. Notable examples include guidelines for integrated fire protection systems, fire protection in garages for electric and plug-in hybrid vehicles, and voice alarm systems.

Through its own research, CNBOP-PIB also supports the State and Volunteer Fire Services by organizing training, conferences, and workshops that contribute to the development of professional competencies and strengthen the scientific and operational capacity of institutions involved in public safety. The overall aim of the Institute's efforts is to ensure that innovative technologies comply with safety requirements and are effectively integrated into existing protection systems. In this way, CNBOP-PIB actively contributes to building a modern, knowledge- and research-based culture of technical safety in Poland.

3.1.5. Use of Artificial Intelligence and Other New Technologies to Support Rescue Operations, Command, and Information Access

The presentation by Paweł Bujny, M.Sc. Eng., focuses on the potential of artificial intelligence (AI) to support the operations of fire services and emergency response units. The project presented, named Płomyczek, aims to create an innovative system that assists firefighters in real time – both during emergency response and in education and prevention.

At the core of the project is the development of a proprietary AI model, which allows for full control over data and information security – especially important in such a sensitive area as fire protection. This approach enables the system to be precisely tailored to the real needs of emergency services, while also avoiding dependence on commercial solutions that are often costly and inflexible. The main assumptions of the Płomyczek system include: processing large volumes of data in real time, generating recommendations for incident commanders and dispatchers, accessing operational data (e.g. hydrant locations, weather information, decision support system data), as well as conducting public education and preventive campaigns.

The project's development roadmap includes data analysis, feature engineering, model architecture selection, algorithm training, and integration with existing systems. The initiative is supported by an interdisciplinary team of CNBOP-PIB specialists – including IT professionals, information security auditors, and practitioners with experience in public administration and education. In future stages, the development of voice capabilities and the fine-tuning of a large language model (LLM) are planned, enabling the delivery of operational recommendations in real time through voice commands, without the need for visual interaction.

The ultimate goal of the project is to create an Intelligent Rescuer Assistant (IRA) – a tool designed to support firefighters directly in the field, helping them make better, faster, and more accurate decisions, while reducing mental and organizational burden. The presentation also emphasizes the importance of synergy between computer

engineering and fire protection practice, making Płomyczek a model example of a modern, interdisciplinary approach to public safety.

In conclusion, the proposed solution has real potential to transform the work of emergency services. By integrating advanced IT technologies with the operational expertise of rescue units, Płomyczek could become a cornerstone of future decision-support systems in crisis situations. The use of AI in firefighting may ultimately contribute to more effective rescue operations and enhanced safety for both responders and victims.

3.2. Second session – Fire Safety of Energy Storage Systems

During the second session, moderated by Jarosław Tępiński, Ph.D. Eng., the following topics were discussed:

1) Risks associated with the use of energy storage systems – Jarosław Tępiński, Ph.D. Eng.,
2) Fire safety research on energy storage systems: a preliminary report from the Institute's studies – Bryg. Wojciech Klapsa, M.Sc. Eng.,
3) Energy storage systems from the perspective of the insurance market – Mr. Marcin Zimowski

3.2.1. Risks associated with the use of energy storage systems

The presentation by Jarosław Tępiński, Ph.D. Eng., provides a comprehensive analysis of the risks associated with the operation of electrochemical energy storage systems and their impact on the safety of buildings and occupants.

In light of the growing share of renewable energy sources (RES) in the national energy system and the need to balance it, energy storage systems are becoming increasingly important as a stabilizing element for the power grid, helping to minimize transmission losses and protect against the effects of failures. At the same time, however, their use entails a range of significant hazards.

Electrochemical energy storage systems vary in scale (from residential to large-scale), installation location, and battery type. Regardless of their design, they typically consist of several key components: electrochemical batteries, a Battery Management System (BMS), power electronic converters, an Energy Management System (EMS), and electrical installations, cooling systems, and protective devices. Depending on the application, various types of batteries are used, such as lithium iron phosphate (LFP), lithium nickel manganese cobalt oxide (NMC), lithium titanate (LTO), sodium-ion (SIB), lead-acid (LAB), or vanadium redox flow batteries (VRFB).

The primary risk is battery cell failure. Factors such as mechanical damage, overcharging, short circuits, high temperatures, or manufacturing defects can lead to increased temperature and pressure inside the cell. This may result in electrolyte evaporation, smoke emission, sparking, and in extreme cases – fire or explosion. This process can escalate rapidly and be difficult to control, potentially leading to a "thermal runaway" event.

The risks associated with the operation of energy storage systems include, among others: fire hazards, electric shock, emission of toxic and corrosive chemicals, chemical burns, risk of gas explosions, and corrosion of nearby infrastructure components. Fires involving such systems are typically characterized by their rapid development, the

release of toxins, the generation of large volumes of smoke, and the potential for re-ignition even after firefighting operations have concluded.

An important aspect of preventive measures is the early recognition of failure symptoms, such as: battery deformation, temperature increase, the presence of gases or smoke, a burning smell, sparking, or unusual sounds coming from the device. Critical to the effectiveness of firefighting and rescue operations are early fire detection, efficient ventilation, interruption of the heating process, and containment of fire spread before emergency services arrive.

3.2.2. Fire safety research on energy storage systems: a preliminary report from the Institute's studies

The presentation by Brig. MSc Eng. Wojciech Klapsa from the Combustion and Explosiveness Processes Laboratory Team outlines the experimental framework and initial findings related to assessing the hazards posed by fires involving electrochemical energy storage systems. This research responds to the increasing importance of these systems in the energy supply infrastructure, coupled with the current lack of sufficient empirical data on their behavior under fire conditions.

The study was conducted in a specially prepared test room measuring 4 × 3.2 × 2.6 meters (volume: 33.3 m^3), simulating typical spatial conditions for residential or small industrial installations. The ventilation setup included an air inlet at floor level and an exhaust outlet at the ceiling. Inside the room, an energy storage unit was intentionally ignited under controlled conditions to observe the development of the fire and its impact on the surroundings.

Phenomena accompanying the fire were measured using a wide range of sensors and recording devices. Type K thermocouples (with a range up to 1100°C) were placed at 32 measurement points, and a thermal imaging camera was used to visualize the temperature distribution. Thermal radiation levels were monitored using four SB sensors with measurement ranges of 10, 50, and 100 kW/m^2, enabling precise evaluation of the hazard level in the immediate vicinity of the device. An important aspect of the study was also the analysis of light transmittance – conducted using a photocell and a laser – which allowed for the assessment of smoke density and its effect on visibility, critical for evacuation and firefighting operations.

A key component of the experiment involved examining the emission of toxic gases and the presence of harmful substances that settle on firefighters' protective clothing, which can pose secondary hazards after the firefighting operation. The presentation includes video footage recorded during the fire tests, documenting the fire's development and the conditions inside the room during ignition and combustion.

The ongoing research is part of a broader initiative by CNBOP-PIB to ensure the safe implementation of modern energy technologies – in both private and public sectors. The results of subsequent research stages will be crucial for the development of technical standards, firefighting practices, and evacuation procedures for facilities equipped with energy storage systems.

3.2.3. Energy storage systems from the perspective of the insurance market

The presentation prepared by Mr. Marcin Zimowski and Mr. Jacek Borowski outlines the current challenges and experiences of the insurance market related to Battery Energy Storage Systems (BESS). The presentation includes an analysis of loss events involving energy storage systems, identification of associated risks, and guidance on responsible risk management and insurance protection.

BESS – Battery Energy Storage Systems – are increasingly used for integrating renewable energy sources and stabilizing electrical power grids. However, due to their technological specifics and risks such as overheating, thermal runaway, and component degradation, they pose significant challenges for insurers. Notable past incidents – such as the Carnegie Road fire in Liverpool (2020), a fire during testing in Australia (2021), and a series of 23 incidents in South Korea between 2017 and 2019 – highlight the scale of the risk.

From the insurance industry's perspective, the most critical challenges include: fire risk, long lead times to replace key components (particularly transformers), exposure to natural disasters, unstable revenue from installations, performance degradation, and cyber risks. In cases of thermal runaway, a chain reaction occurs, rapidly spreading between battery modules and often resulting in the destruction of the entire installation. Recovery from such an event can take up to 24 months, significantly affecting revenue streams and leading to insurance capacity issues.

Preventive measures and technical safety standards are becoming increasingly important. These include cell separation, UL9540A-compliant testing, sprinkler systems, gas detectors, cooling systems, and collaboration with local fire departments. Infrared monitoring, spare parts management, and risk management systems are also gaining in importance.

A key element of the presentation is the set of insights drawn from advisory services provided by Marsh – from risk assessment prior to construction, through training, to support in selecting appropriate coverage and analysing loss scenarios (PML/EML). Insurers now inquire about a wide range of topics: battery technology and contractor experience, distances between components, geotechnical preparation, detection and ventilation systems, among others. Insurance conditions, as illustrated, vary depending on risk quality and market, with premiums reaching several basis points of the insured sum – depending on the level of protection and project history.

In summary, BESS are seen by the insurance market as innovative, yet burdened with significant technological, financial, and operational risks. Effective protection requires a comprehensive approach – from proper design and operation to detailed risk assessment and tailored insurance coverage. The presentation emphasizes that it is the integration of technology with risk management practices that will be decisive for the future of this sector.

3.2.4. Discussion panel

The discussion involved representatives from various institutions – scientific, industrial, and insurance sectors – who shared their experiences and insights on the safe operation of energy storage systems, with a focus on fire, technical, and regulatory risks.

Topics addressed:

1) **Complexity of energy storage systems**

   The panellists agreed that the development of energy storage technologies, particularly lithium-ion batteries, brings significant benefits to the power grid but also involves considerable risks. Particular attention was drawn to the phenomenon of *thermal runaway*, identified as one of the most unpredictable and difficult-to-control hazards.

2) **Gaps in regulations and standards**

   It was repeatedly emphasized that current legislation lags behind technological development, creating regulatory gaps in the design, installation, and operation of energy storage systems. There was a clear call for the development of guidelines and standards tailored to Polish conditions and risk levels.

3) **Need for research and knowledge sharing**

   It was noted that there is a lack of reliable experimental data on the behaviour of energy storage systems under emergency conditions (e.g. fire), which is essential for developing regulations, designing systems, and implementing effective protection. In this context, the work of CNBOP-PIB and other research institutions was highly appreciated, including scientific investigations and the first full-scale fire safety studies of energy storage systems. A preliminary report from these studies was presented during the conference. The lecture was complemented by a live stream from the research facility, where various scenarios will examine the impact of emergency states, thermal exposure, and mechanical damage to storage systems. These tests are part of CNBOP-PIB's unique research program on fire safety of energy storage systems, which is ongoing. The program includes a wide group of experts from different sectors and institutions. The final result will be the publication by CNBOP-PIB of full-scale test results on fire safety of energy storage systems, followed by *Fire Protection Guidelines* for such facilities.

4) **The role of insurers and market practices**

   Insurance sector representatives noted that due to the lack of historical claims data and the difficulty of risk assessment, energy storage systems are challenging to insure. They stressed that the availability of insurance coverage will depend on meeting strict technical standards and providing transparent design and operational data.

5) **Need for cross-sector collaboration**

All participants highlighted the importance of collaboration between designers, investors, emergency services, certifying bodies, and insurers. Joint safety efforts – from design and installation to operation – were identified as essential for the sustainable development of energy storage technology. Existing initiatives were acknowledged and further actions in this area were encouraged. Research results regarding fire development, temperature distribution, heat radiation, heat release, and combustion products are crucial for defining necessary fire protection requirements, including appropriate siting of energy storage systems and the specifications for fire safety devices used to protect them. As part of CNBOP-PIB's research program, additional studies are planned – beyond those already conducted – that will include monitoring of Battery Management System (BMS) parameters, fire detection system testing specifically dedicated to energy storage protection, and evaluation of the extinguishing effectiveness of dedicated fire suppression equipment and agents.

Key conclusions from the discussion:

1) **Technologies must be developed in parallel with safety standards.** Without this, responsible implementation of innovation is not possible.
2) **There is a need to build a Polish base of experimental knowledge** – through testing, fire trials, and hazard modelling – to develop effective procedures and standards.
3) **The operational safety of energy storage systems must be analysed systemically:** considering engineering, legal, operational, and financial aspects.
4) **Insurance can be a powerful tool in enforcing proper technical standards**, but coverage availability will depend on project quality and the investor's openness to audits.
5) **Education of designers, contractors, and users is essential** – both in terms of technical and organizational risks – to minimize the potential for human error.
6) **The industry needs a permanent forum for experience exchange**, such as conferences, collaborative networks, implementation projects, and standardization initiatives.

During the discussion, it was concluded that the safety of energy storage systems is a topic of key interest to many stakeholders and requires urgent, coordinated action to harness the potential of these technologies safely and in alignment with the public interest.

3.3. Safety of New Technologies – knowledge, new solutions, products, systems, services, procedures, and education

During the third session, moderated by Michał Chmiel, Ph.D. Eng., the following topics were discussed:

1) Requirements and testing of rescue robots – Mr. Norbert Pahlke, M.Sc. Eng.,
2) iSprink Home and iSprink – intelligent fire detection and suppression systems in the context of new technology safety – Mr. Dariusz Kot,

3) A hybrid method for evaluating the airflow parameters of rescue ventilation fans – Piotr Kaczmarzyk, Ph.D. Eng.,
4) Solutions dedicated to conducting rescue operations in garages during electric vehicle fires – Mr. Wacław Kozubal,
5) Fire protection for photovoltaic installations on flat roofs – Mr. Arkadiusz Waligóra, M.Sc. Eng.,
6) Artificial intelligence methods in the chemical risk assessment of advanced next-generation materials: opportunities and challenges – Ms. Alicja Mikołajczyk.

3.3.1. Requirements and testing of rescue robots

A presentation by Mr. Norbert Pahlke from Feuerwehr Dortmund offers insightful perspectives on the process of developing and implementing new technologies in rescue robotics. It incorporates practical experience, user needs, and the challenges faced by research institutions and industry. The presentation's key message is that effective innovations only emerge when end-users – in this case, firefighters – are involved in the research and development process from the very beginning.

Rescue robotics is evolving as a response to significant operational challenges, including natural disasters and infrastructure damage, which necessitate new approaches to internal logistics and adaptation to changing conditions. These technologies aim to fill gaps where conventional operational methods are insufficient or ineffective.

However, as the author notes, the success of a new technological solution depends on its simplicity, applicability in various situations, and integration with existing operational procedures. Devices that complicate rescuers' work or are too specialized are quickly abandoned. Therefore, a close partnership between users, research units, and manufacturers is essential. Joint testing, user interface (GUI) design, development of application profiles, and the integration of new solutions with real operational procedures are fundamental to successful implementation.

The lecture emphasizes the importance of integrating theory and practice in refining solutions for emergency services. It is crucial to jointly design, test, and implement systems that are not only modern but, above all, useful and acceptable to end-users. It is precisely this collaboration, understanding of operational realities, and openness to firefighters' experiences that allow technological concepts to be transformed into real, life-saving tools.

3.3.2. iSprink Home and iSprink – intelligent fire detection and suppression systems in the context of new technology safety

A presentation by Mr. Dariusz Kot offers a comprehensive overview of contemporary fire hazards associated with the development of electromobility and energy storage. It also introduces innovative technical solutions in the form of the i-Sprink system, designed for early detection and suppression of such fires.

In the first part of the presentation, the author discusses the rapid growth of the electric vehicle and energy storage market in Poland. According to the presented data, by the first quarter of 2025, the number of electric passenger cars had already exceeded 157,000. Additionally, there were nearly 25,000 electric two-wheelers and over 1,400 micro-vehicles. Along with this increase, there's a growing demand for energy and storage installations, both in the private (household storage) and commercial sectors. However, this phenomenon is accompanied by an increased risk of fire, as illustrated by the 2022 fire at the Senec energy storage facility in Germany. This incident led to an explosion, building destruction, and the re-ignition of a removed battery.

The lecture included a detailed analysis of the causes of lithium-ion battery ignition. These batteries have a high calorific value of 5.8 kWh/l (for comparison, gasoline has a value of 8.6 kWh/l). Overheating, mechanical damage, or failures in battery management systems (BMS) can lead to what is known as thermal runaway and the development of a fire. Household installations are particularly at risk, as users are often unaware of the dangers or forgo safety measures to reduce costs.

GRAS's answer to these threats is the i-Sprink system, which can be used in garages, technical rooms, and vehicle charging areas. In its i-Sprink Home version, the solution integrates an internal hydrant, a sprinkler system, smoke detectors, heat detectors, fire location indicators (FLI), and allows for management via a mobile application, as well as manual or automatic extinguishing activation. The system is designed to work with a classic hydrant network and does not require additional water installations or infrastructure expansion.

The latter part of the presentation showcased examples of deployments: in an underground garage in Warsaw (6 EV charging stations), an underground garage in Lublin (2 stations with expansion capability), a municipal waste room in Gdynia, and at an industrial plant – a sugar refinery in Bydgoszcz, where the sugar conveyor zone was secured. In all locations, FLI cameras, smoke, and heat detectors were used, ensuring early detection and immediate activation of firefighting operations.

In conclusion, with the development of electromobility and renewable energy sources, the importance of early response systems for fire hazards is increasing. The i-Sprink system is an example of a modern and practical tool that supports fire safety – in both public and private spaces – which can limit the risk of significant material losses and threats to life.

3.3.3. A hybrid method for evaluating the airflow parameters of rescue ventilation fans

A presentation by Piotr Kaczmarzyk, Ph.D. Eng., focuses on a novel approach to assessing the effectiveness of mobile fans used by fire protection units. In response to the lack of national standards regulating minimum requirements for these types of devices, the author presents a comprehensive methodology for evaluating flow parameters. This methodology, based on experimentation and numerical analysis, could form the basis for new regulations and technical standards.

The presentation highlighted that mobile fans, used for purposes such as positive pressure ventilation (PPV) and ventilating fire-affected buildings, are often put into service based solely on manufacturer-declared data, without reliable verification of their parameters. To address this, CNBOP-PIB (Scientific and Research Centre for Fire Protection – National Research Institute) has developed a set of technical and operational requirements along with a dedicated hybrid research method. This method encompasses both tests and Computational Fluid Dynamics (CFD) simulations.

The methodology consists of flow channel tests in accordance with PN-EN ISO 5801 (Method A), velocity profile tests in free flow conditions following National Institute of Standards and Technology (NIST) guidelines (Method B), tests in a real building structure – a multi-story building with a stairwell (Method C). These tests are complemented by CFD simulations, which allow for replicating actual airflow conditions and precisely predicting fan performance in various configurations.

This discussed method has wide practical applications. It enables fan manufacturers to verify their device parameters without the need for costly full-scale tests. Simultaneously, the State Fire Service gains a tool to assess equipment effectiveness, plan rescue and evacuation operations, and calculate smoke removal times in diverse spatial conditions.

In conclusion, further development of the methodology was announced, including expanding the research to include tunnel and field tests, as well as a comprehensive analysis of fan sets.

3.3.4. Solutions dedicated to conducting rescue operations in garages during electric vehicle fires

A presentation by Mr. Wacław Kozubal, M.Sc. Eng., focuses on the ineffectiveness of traditional firefighting methods for electric vehicles (EVs) in enclosed underground garages. He introduces an alternative solution: an Automatic Fire Blanket (AFB) as an integrated component of a fire safety system.

The presentation highlights that extinguishing an EV fire in a crowded, low-ceiling garage is practically impossible. Lithium-ion batteries burn with their own oxygen supply and are shielded by the car's body. The confined space also prevents the effective use of water and other firefighting equipment. Additional hazards include toxic smoke, which rapidly reduces visibility and endangers rescuers, as well as polluted runoff from firefighting operations.

The answer to these problems is the AFB – a specialized fire blanket designed for extinguishing electric vehicles. Traditional blankets, compliant with PN-EN 1869:2019-12, are too small. Therefore, large sheets made of high-temperature resistant materials have been developed to effectively suppress fires by cutting off the air supply. Exercises conducted with rescue services have confirmed that using such a blanket significantly limits fire spread and prepares the vehicle for safe removal.

The AFB can be activated automatically upon fire detection by a sensor, with a signal sent through the fire alarm control panel. It covers the vehicle, isolating the fire and limiting heat emission until the fire brigade arrives.

Subsequently, with the help of a small tow vehicle (either belonging to the State Fire Service or brought in from outside), the electric car can be towed out of the garage and placed in an evacuation container, from where it is transported to a safe location.

This system is based on a consistent evacuation and extinguishing procedure, divided into sequential stages: fire detection, AFB activation, fire brigade arrival, decision to remove the vehicle, its removal, and transport. The solution eliminates the need for hours-long firefighting operations in confined spaces, reduces the risk of secondary hazards, and allows for maintaining the facility's functionality, minimizing its downtime.

In summary, the presented solution offers a practical, inexpensive, and easy-to-implement method for enhancing safety in garages with EV charging infrastructure. This solution demonstrates that through proper facility preparation and the creation and practice of rescue action scenarios, the risk of electric car fires in enclosed spaces can be effectively mitigated.

3.3.5. Fire protection for photovoltaic installations on flat roofs

A presentation by Arkadiusz Waligóra focused on fire protection for photovoltaic (PV) systems installed on flat roofs. Key topics included the causes of fire hazards, the results of fire research and tests, and the potential for early detection using the LIST® linear heat detector.

The presentation began by outlining the main risk factors leading to PV system fires. These include both technological issues (e.g. incorrect installation, low-quality components, lack of maintenance) and environmental factors (e.g. hail, shading, surface contamination). Data from Clean Energy Associates indicated that the most common causes are grounding problems, mechanical damage, and incorrect polarity of connections.

The author cited results from comparative tests showing that roofs without PV installations exhibit negligible fire propagation, while roofs with panels facilitate the rapid spread of flames underneath the panels. This is due to heat accumulation and restricted ventilation. According to VdS S6190004 standard and observations from real fires, fire rarely extends beyond the area directly occupied by the PV installation. However, as demonstrated by the example of the ASKO warehouse roof fire in Norway, a critical risk is the penetration of fire into the building's interior, leading to immense losses and operational disruption.

In the section dedicated to prevention and detection, the presentation showcased the LIST® detector, which utilizes the SEC 15 sensor cable and the dLISTcontroller. This system enables rapid temperature detection, real-time monitoring of the installation's status, visualization of temperature distribution, precise localization of threats, and integration with fire alarm systems (FAS). Due to its design, the cable can be installed directly under PV panels, with the panel's width or length serving as the optimal spacing between measurement points.

An additional benefit of the LIST® system is its ability to increase PV installation efficiency by analysing temperature distribution. This allows for identifying malfunctioning or excessively heating components. The system also helps

reduce insurance premiums for facilities, as it significantly mitigates the risk of investment losses, production downtime, and system overheating.

In summary, the presentation identified the need for a systemic approach to fire safety for rooftop PV installations, from technical design to detection and monitoring. Solutions like the LIST® system can play a crucial role in protecting modern industrial and logistics facilities, providing effective prevention and minimizing the consequences of potential fires. The increased use of renewable energy sources must go hand in hand with investment in technical safety.

3.3.6. Artificial intelligence methods in the chemical risk assessment of advanced next-generation materials: opportunities and challenges

A presentation by Dr. Alicja Mikołajczyk introduced an innovative approach to assessing the safety of chemical substances and materials using digital tools, particularly artificial intelligence (AI).

The presentation emphasized that many novel substances are currently designed without full knowledge of their toxicity or environmental impact, creating hazards in emergency situations. The answer to these challenges is the SSbD (Safe and Sustainable by Design) concept, which integrates safety, efficiency, and sustainability requirements at every stage of a product's life cycle.

The presentation showcased specific digital tools and platforms. One such tool is the in silico Lab system, which enables the creation of AI-based predictive models for forecasting the toxicity of chemical compounds. Another significant tool is the nQTB platform, designed for assessing the safety of TiO_2, SiO_2, and ZnO nanoparticles. Both platforms help reduce research costs, eliminate the need for animal testing, and shorten the development time for safe chemical products, all while offering high prediction accuracy.

The integration of artificial intelligence, synthetic biology, and materials engineering opens new possibilities for the safe design of advanced materials. However, the success of such an approach depends on the availability of appropriate data, the quality of predictive models, and close collaboration among scientific, industrial, and regulatory communities.

3.4. Theses and conclusions

Based on the speakers' presentations, panel discussions, and case studies, key conclusions were formulated illustrating the current state of challenges and needs concerning the safety of selected new technologies. These elements form the foundation for further expert, legislative, and implementation work at both national and international levels. Below are the formulated statements:

1) Energy storage systems and battery technologies are becoming an indispensable part of the energy transformation; however, their implementation must account for the real risks associated with fire, technical, and operational safety.

2) The current legal and normative framework in Poland is not keeping pace with the development of new energy technologies, particularly regarding the safe design, operation, and protection of energy storage systems.

3) Phenomena such as thermal runaway in lithium-ion batteries, environmental hazards, toxic emissions during fires, and extended infrastructure reconstruction times are increasingly identified as key challenges for emergency services, designers, and insurers.

4) Detection systems, automatic extinguishing systems, and risk management techniques must be developed in parallel with energy technologies to ensure their safe operation in urban environments.

5) A modern approach to safety requires inter-industry cooperation – between science, industry, emergency services, experts, and the insurance market – and necessitates the creation of a platform for continuous dialogue, collaboration, actions, projects, implementations, and joint education.

6) It is crucial to create consistent and up-to-date national regulations pertaining to the design, installation, and operation of energy storage systems, taking into account fire, environmental, and technical aspects.

7) Experimental research on the behaviour of energy storage systems in emergency conditions must be continued and expanded, including fire tests, toxic gas emission tests, analyses of thermal radiation, and the effectiveness of extinguishing measures. This is an urgent need, crucial for assessing fire hazards and effectively counteracting them.

8) Systems like i-Sprink, AFBs (automatic fire blankets), linear heat detectors, and intelligent predictive platforms are already available fire prevention solutions that complement the existing range of fire protection measures.

9) The insurance market should be an active participant in the risk assessment process, offering individualized protection models for renewable energy and BESS (Battery Energy Storage System) projects, supported by audits and technical consulting.

10) Training and operational scenarios for the State Fire Service and fire protection designers must encompass newly identified hazards, which should be included in fire scenarios developed for garages with electric vehicle charging points.

11) Integrating digital tools with the material and energy installation design process enables their optimization in terms of safety and sustainable development.

3.5. Closing and conclusion of the conference

The “Safety of New Technologies” Conference, held in May 2025, reaffirmed the growing importance of interdisciplinary collaboration in developing and implementing innovative technologies while maintaining high safety standards. The event once again brought together a large group of representatives from academia, industry, fire

protection units, the expert community, public administration, and the insurance sector. This diverse participation allowed for a multifaceted examination of the discussed topics, encompassing technical, operational, regulatory, and user perspectives.

Throughout the plenary and thematic sessions, as well as expert debates, the challenges and risks associated with the implementation of energy storage systems, photovoltaic systems, and electromobility were thoroughly discussed. Particular emphasis was placed on the need to update technical and building regulations, standardize requirements for innovative solutions, and develop procedures and tools that support emergency services in hazardous situations.

The conference made it clear that the energy and digital transformation cannot proceed in isolation from safety concerns, both fire and environmental. Safety must be an integral part of the design and implementation process for new technologies. The presented solutions – including detection and extinguishing systems, risk assessment methods, predictive models, and digital platforms – demonstrate that the market possesses the potential to effectively respond to emerging threats, provided there is active cooperation among all stakeholders.

The conference organizers also highlighted the need for continued experimental and implementation research, systematic training for designers, and the development of permanent mechanisms for industry dialogue – at both national and European levels. Participants unanimously agreed that only joint actions – based on knowledge, responsibility, and openness – can ensure the safe functioning of new technologies in a changing social and economic reality.

In submitting this report, the conference organizer extends gratitude to its co-organizers and participants. They also wish to extend an invitation and express hope that future endeavours within the CNBOP-PIB initiatives titled “Safety of New Technologies” will be met with equally great interest, lively discussion, and constructive, practical conclusions as this year’s BNT IV conference. Video materials from the conference and educational materials will be made available on the CNBOP-PIB website: https://www.cnbop.pl/.

Chairman of the Scientific Committee of the Conference

st. bryg. Jacek Zboina, D.Sc., Ph.D. Eng.