

Vladyslav Ratushnyi, MSc

Lviv State University of Life Safety

e-mail: w.ratushnyi@ldubgd.edu.ua

ORCID: 0000-0002-5093-1984

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DETERMINANTS OF SAFE EVACUATION OF LARGE PRODUCTION FACTORIES

Abstract

In the realm of workplace safety, this article investigates the pivotal factors that underpin the safe evacuation of employees in large production factories. Addressing the complexities of industrial environments, the article explores the indispensable role of tailored emergency preparedness plans. It delves into the significance of employee training programs, emphasizing the need for continuous education to instill effective response protocols. The article also sheds light on the crucial aspect of clear and efficient communication systems, elucidating their role in disseminating timely instructions during emergencies. Furthermore, it examines the integration of cutting-edge technology, such as mobile applications and VR/AR mapping, in enhancing evacuation procedures. The strategic design of evacuation routes and the establishment of well-equipped safe zones are scrutinized as essential elements in ensuring a swift and secure evacuation process. Additionally, the collaborative efforts between factories and local emergency services are highlighted, showcasing the importance of coordinated responses. By reviewing these determinants, the article provides valuable insights into creating resilient and safe evacuation strategies, ultimately safeguarding the lives of employees and promoting a secure industrial work environment.

Key words

evacuation, production factories, emergency preparedness plans, safety measures.

Introduction

Ensuring the safety and well-being of employees in large production factories is a paramount concern for both employers and regulatory bodies. With the inherent risks associated with industrial environments, having robust and effective evacuation procedures in place is not just a legal requirement but also a moral obligation. The ability to swiftly and safely evacuate all personnel during emergencies, be it fires, chemical spills, or other hazardous incidents, is contingent upon a multifaceted approach that encompasses meticulous planning, continuous training, advanced technology integration, and seamless coordination with local emergency services.

In this context, this article delves into the intricate web of determinants that govern the safe evacuation of large production factories. Evacuation preparedness extends far beyond mere compliance; it is about instilling a culture of safety, fostering awareness, and equipping employees with the knowledge and tools necessary to respond effectively in high-pressure situations. Through a comprehensive exploration of key factors, this article seeks to shed light on the nuanced strategies and methodologies that factories can employ to ensure a swift, organized, and secure evacuation process.

Large production factories, often sprawling complexes with numerous departments and diverse operations, demand tailored emergency preparedness plans. These plans must be meticulously crafted, taking into account the specific risks associated with the materials used,

machinery employed, and the layout of the facility. Moreover, they should be dynamic documents, evolving in response to changes in the industrial landscape and advancements in technology. Such preparedness plans serve as the bedrock upon which a safe evacuation strategy is built, providing a structured framework for employees to follow during emergencies.

Beyond the written guidelines, the human element plays a pivotal role in the successful execution of evacuation procedures. Employee training and awareness programs are crucial components of any evacuation strategy. Regular drills and simulations not only familiarize employees with evacuation routes and assembly points but also cultivate a sense of preparedness and confidence. These initiatives instill in employees the understanding of their roles and responsibilities, ensuring a collective and organized response during emergencies. The article will delve into the importance of these training programs, emphasizing their role in enhancing overall safety awareness within the workforce.

Additionally, the advent of technology has ushered in a new era of possibilities in the realm of workplace safety. Integrating advanced technologies such as smart sensors and mobile applications can significantly enhance evacuation procedures. Real-time monitoring systems can detect anomalies, triggering automatic alerts and facilitating quicker response times. Mobile apps equipped with geolocation services can provide employees with personalized evacuation routes and real-time updates, empowering them with instant information at

their fingertips. The article will explore the innovative technologies reshaping the landscape of factory evacuations and highlight their practical applications.

Furthermore, the layout and design of evacuation routes and safe zones within factories are pivotal in ensuring a swift and orderly evacuation. Well-marked, obstruction-free evacuation routes, coupled with strategically positioned safe zones equipped with fire-fighting equipment and medical supplies, are indispensable elements of an effective evacuation plan. The article will underscore the importance of meticulous planning in this regard, outlining best practices and considerations for designing efficient evacuation pathways and safe zones within industrial complexes.

Collaboration with local emergency services forms another linchpin in the safe evacuation framework. Establishing clear communication channels and coordination protocols with fire departments, medical facilities, and other relevant authorities can significantly enhance the factory's emergency response capabilities. Joint drills and training exercises with these external agencies foster mutual understanding and seamless collaboration, ensuring a harmonized response effort during actual emergencies. The article will delve into the nuances of such collaborations, emphasizing their role in bolstering the overall resilience of large production factories.

In essence, this article serves as a short review, shedding light on the multifaceted determinants of safe evacuation in large production factories.

By dissecting the intricate interplay of preparedness plans, employee training, technology integration, efficient layout design, and collaborative efforts with local emergency services, this article aims to provide valuable insights for factory managers and safety professionals. As industrial landscapes continue to evolve, staying ahead of the curve in terms of evacuation strategies is not just a choice but a necessity—a commitment to the safety and well-being of the workforce that forms the backbone of the industrial world.

Defining evacuation. A strategic lifesaving endeavor in industrial contexts

In the intricate landscape of industrial safety, evacuation emerges as a pivotal and carefully orchestrated process, representing a lifeline during moments of crisis within large production factories. Evacuation, in its essence, embodies a systematic and strategic approach aimed at promptly and securely relocating individuals from potentially perilous environments to designated safe areas in the event of emergencies. It serves as a tangible manifestation of preparedness, representing the culmination of comprehensive planning, clear communication, and structured procedures meticulously designed to safeguard lives and minimize injuries amidst imminent danger. Evacuation procedures are not mere protocols; they are dynamic strategies rooted in the fundamental principle of protecting the workforce, ensuring their well-being, and mitigating

risks effectively. Polish laws governing workplace safety and evacuation procedures are primarily outlined in the Labor Code¹ and further specified in regulations². Compliance with these regulations is mandatory for all businesses, regardless of size or industry, and non-compliance can result in severe penalties and legal consequences.

Evacuation, in various contexts, refers to the organized process of relocating individuals from a potentially hazardous environment to a place of safety during emergencies. In the realm of workplace safety, it signifies the structured and systematic movement of employees away from danger, utilizing predetermined pathways and safe zones. From a military standpoint, evacuation involves the strategic withdrawal of forces from hostile territories to preserve manpower and resources³. In the context of natural disasters, it denotes the prompt removal of residents from areas prone to calamities, such as hurricanes or floods, mitigating the risk of harm⁴. Considering these definitions, evacuation can be universally defined as a carefully planned and coordinated effort to ensure the safety and well-being of individuals by guiding them away from imminent threats toward designated secure locations, emphasizing the importance of clear communication, well-marked routes, and mutual support among evacuees.

Evacuation, within the sphere of industrial safety, is not merely a procedural task; it embodies a strategic and lifesaving endeavor crucial for the well-being of employees during emergencies. The main determinants of ensuring a safe evacuation in large production factories are rooted in meticulous planning and proactive measures. Comprehensive emergency preparedness plans, tailored to the specific risks of each factory, form the bedrock of a successful evacuation strategy. Employee training and awareness programs play an equally vital role, fostering a culture of preparedness and confidence among the workforce. Clear communication channels are indispensable, guiding individuals with precision and timeliness. The integration of technology, such as smart sensors and mobile applications, enhances evacuation efficiency. Thoughtfully designing evacuation routes and safe zones ensures an organized and swift movement of individuals to secure areas. Collaboration with emergency services, marked by clear communication protocols and joint drills, cements a unified response effort. The synergy of these determinants orchestrates a comprehensive and effective approach, transforming evacuation from a set of procedures into a strategic and lifesaving initiative within the industrial landscape.

1 Act of 26 June 1974 *Labor Code* (Dz.U. //Journal of Laws/ of 2014, item 1465), Article 207.

2 Act of 24 August 1991 *on fire protection* (Dz.U. //Journal of Laws/ of 2022, item 2067).

3 Army Techniques Publication No. 4-02.13. Headquarters Department of the Army. Washington, DC, 30 June 2021, p. 12.

4 *Słownik terminów z zakresu bezpieczeństwa*, Warszawa 2008, p. 40.

Comprehensive Emergency Preparedness Plans. Safeguarding the heart of industrial safety

In the dynamic and high-stakes environment of large production factories, the foundation of a secure and efficient evacuation process rests upon the meticulous construction of Comprehensive Emergency Preparedness Plans. These plans are not mere documents, they are living, breathing roadmaps that navigate employees through the labyrinth of potential hazards during emergencies, be it a fire outbreak, chemical spill, or any other critical incident⁵. Standards like Environmental Management Systems (ISO 14001)⁶ and Occupational Health and Safety Management Systems (ISO 45001)⁷ is a useful tools for creating such plans.

The first step in crafting an effective emergency preparedness plan is a thorough risk assessment⁸. Factories are diverse entities, ranging from manufacturing plants dealing with volatile chemicals to assembly lines operating complex machinery. Understanding the specific risks associated with the materials used, machinery present, and the layout of the facility is paramount. A 'one-size-fits-all' approach simply won't suffice. Instead, plans must be tailored to the unique challenges posed by each factory, ensuring that responses are

finely tuned to the intricacies of the industrial processes.

Static plans are destined to fail in the face of ever-evolving industrial landscapes. Comprehensive Emergency Preparedness Plans need to be dynamic, constantly adapting to accommodate changes in technology, workforce, and regulations. Regular reviews and updates are essential to keep pace with advancements and to incorporate lessons learned from past drills and real-life incidents. This adaptive approach ensures that the plan is always relevant and effective, regardless of how the factory environment transforms over time.

While expertise from safety professionals is invaluable, the insights of the employees who navigate the factory floor daily are equally important. Employees often have unique perspectives on potential risks and challenges specific to their roles. Incorporating their input in the planning process not only enriches the plan but also fosters a sense of ownership and responsibility among the workforce. Employees who actively contribute to the creation of the plan are more likely to internalize its protocols, leading to a more effective response during emergencies.

Creating Comprehensive Emergency Preparedness Plans (CEPP) documentation is a critical step in ensuring the safety and resilience of large production factories. This documentation serves as a comprehensive guide outlining procedures, protocols, and strategies to be

5 R. Gates, *Be prepared for disasters*, "Occupational Health & Safety" 2015, p. 50-51.

6 PN-EN ISO 14001:2015-09 *Systemy zarządzania środowiskowego. Wymagania i wytyczne stosowania*.

7 PN-ISO 45001:2018-06 *Systemy zarządzania bezpieczeństwem i higieną pracy. Wymagania i wytyczne stosowania*.

8 M. Bienias, K. Czerniak, T. Ewertowski, *Preparation of an enterprise for emergency situations and their better communication*, "Informatyka Ekonomiczna" 2019, 3(53), p. 9-22.

implemented in the event of emergencies, ranging from natural disasters to industrial accidents. Below is a suggested structure for CEPP documentation:

1. Executive Summary:

- Overview of the purpose and importance of the Comprehensive Emergency Preparedness Plans.
- Brief summary of key components and objectives.

2. Introduction:

- Background information on the factory and its operations.
- Regulatory context and compliance requirements.
- Statement of commitment to safety and emergency preparedness.

3. Risk Assessment:

- Detailed analysis of potential hazards and risks associated with the factory's operations.
- Identification of vulnerabilities and potential consequences of emergencies.

4. Emergency Response Team:

- Formation and roles of the emergency response team.
- Contact information for key personnel.
- Chain of command and communication protocols.

5. Emergency Procedures:

- Specific procedures for various types of emergencies (e.g., fire, chemical spill, natural disaster).
- Evacuation procedures, including designated routes and assembly points.
- Shelter-in-place protocols.

6. Evacuation Plans:

- Evacuation maps with clearly marked exit routes and safe zones.

- Procedures for assisting individuals with disabilities during evacuation.

- Coordination with local authorities for large-scale evacuations.

7. Communication Protocols:

- Methods of communication during emergencies (e.g., alarms, intercom systems, mobile applications).
- Protocols for internal and external communication, including with emergency services.

8. Training and Drills:

- Schedule and details of regular training sessions for employees.
- Documentation of emergency drills, including scenarios and outcomes.
- Continuous improvement strategies based on drill evaluations.

9. Equipment and Resources:

- Inventory of emergency equipment (e.g., first aid kits, firefighting equipment).
- Procedures for maintenance and regular checks of emergency resources.

10. Community Engagement:

- Collaboration with local emergency services and community organizations.
- Information-sharing initiatives to enhance overall community preparedness.

11. Documentation Review and Updates:

- Schedule for periodic review and updates of the CEPP documentation.
- Process for incorporating lessons learned from drills and real emergencies.

Comprehensive Emergency Preparedness Plans stand as the bedrock of industrial safety. Tailored to the specific risks of each factory, embracing technological advancements, incorporating employee insights, and subjected to regular simulations, these plans are not just documents stored on shelves; they are dynamic tools that empower factories to safeguard their most valuable asset – their workforce. By investing in the creation and continuous improvement of these plans, factories pave the way for a safer, more secure future, where every employee can confidently navigate the challenges of emergencies, emerging unscathed and resilient.

Employee training and awareness. Fostering a culture of safety

The significance of employee training and awareness cannot be overstated. This multifaceted component forms the backbone of a resilient industrial safety framework, geared towards cultivating a vigilant and prepared workforce. The strategic design of training programs goes beyond routine procedural learning, delving into the intricacies of emergency preparedness, evacuation protocols, and the adept use of safety equipment. Regular drills and simulations, integral to these initiatives, serve as immersive experiences, enabling employees to not only comprehend theoretical concepts but also apply them in real-time scenarios. These practical exercises not only validate the effectiveness of emergency procedures but also instill a profound

sense of confidence among employees, empowering them to respond decisively and efficiently during actual crises.

Moreover, employee training and awareness extend far beyond the procedural domain. These initiatives incorporate comprehensive education on specific workplace hazards, offering a nuanced understanding of potential risks associated with the manufacturing processes. By arming employees with knowledge about the intricacies of their work environment, these programs contribute significantly to the creation of a safety-conscious culture. This heightened awareness transforms employees into proactive participants in their own safety, fostering a collective commitment to identifying, reporting, and mitigating risks.

Employee training and awareness programs are diverse and tailored to the specific needs and risks of the workplace. Here are several types of training and awareness initiatives commonly implemented in large production factories:

1. **Emergency Response Training.** Teaches employees how to respond effectively in various emergency situations, including fires, chemical spills, and natural disasters. Covers evacuation procedures, first aid techniques, and the use of emergency equipment.
2. **Evacuation Drills.** Conducts simulated evacuations to familiarize employees with evacuation routes, assembly points, and safe zones. Enhances the speed and efficiency of evacuation procedures during real emergencies.

3. **Fire Safety Training.** Focuses on preventing, detecting, and responding to fires. Includes training on the proper use of fire extinguishers, evacuation procedures, and techniques for minimizing fire hazards.
4. **Chemical Safety Training.** Informs employees about the safe handling, storage, and disposal of hazardous chemicals. Provides guidance on using personal protective equipment (PPE) and understanding chemical labels.
5. **First Aid and CPR Training.** Equips employees with basic first aid skills and cardiopulmonary resuscitation (CPR) techniques. Trains designated personnel as first aid responders to provide immediate assistance in medical emergencies.
6. **Health and Safety Orientation.** Introduces new employees to workplace health and safety policies, procedures, and expectations. Covers general safety rules, reporting mechanisms, and the location of emergency equipment.

Employee training and awareness emerge not merely as obligatory routines but as dynamic tools shaping a culture of safety within large production factories. By nurturing a workforce equipped not only with the know-how of emergency protocols but also with a profound understanding of workplace risks, these initiatives become instrumental in creating an environment where safety is not just a protocol but a shared responsibility, ensuring the well-being of every individual within the industrial landscape.

Clear communication channels. Pinnacle of safety infrastructure in large production factories

The diverse array of communication mediums, ranging from traditional intercom systems and alarms to modern digital messaging boards and cutting-edge mobile applications, embodies the complexity and sophistication required for effective communication in the modern industrial milieu. Each channel, uniquely tailored to its purpose, plays a pivotal role in transmitting crucial instructions, raising alarms, and providing guidance, particularly during evacuation procedures. The goal is clear – to ensure that every employee is not only made aware of the unfolding situation, but is also equipped with the knowledge and understanding needed to respond swiftly and effectively.

Precision in communication is non-negotiable, as the efficacy of evacuation efforts hinges on the clarity and immediacy of information dissemination. Alarms, with their blaring urgency, convey the need for immediate action, while digital interfaces provide nuanced instructions, creating a layered approach to communication. This precision is not just a matter of operational efficiency but serves as a testament to the commitment to the safety and well-being of the workforce.

Beyond their instrumental functionalities, these channels serve as more than conduits for transmitting information; they are the catalysts fostering the development of a robust

safety culture within the factory. They contribute to an environment where trust is built on the reliability of information, and employees feel empowered and confident in their ability to respond to unforeseen challenges. In the grand orchestration of emergency protocols, Clear communication channels transcend being operational tools; they become the pillars supporting a collective commitment to safety, ensuring that the workforce stands united, well-informed, and ready to navigate the complexities of emergency situations.

These communication channels are not just components of the safety infrastructure; they are the connective tissue binding together the various elements that safeguard the well-being of every individual within the vast expanse of the factory floor. As technology continues to advance, the evolution of communication channels will remain integral to the ongoing enhancement of safety measures, creating a resilient and adaptive safety infrastructure that mirrors the ever-evolving landscape of large production factories. The commitment to fostering a culture of safety through seamless communication is not just a regulatory requirement but an ethical responsibility, ensuring that the workforce is not only productive but, more importantly, secure in their work environment⁹.

Utilizing technology. Revolutionizing safety measures

The paradigm shift towards embracing cutting-edge technology is not just a trend but an imperative response to the evolving challenges of ensuring a secure work environment. From smart sensors to sophisticated monitoring systems, the utilization of technology has become synonymous with a proactive and adaptive approach to safety¹⁰.

One of the primary arenas where technology leaves an indelible mark is in the realm of evacuation procedures. The integration of advanced communication tools, such as mobile applications, allows for real-time alerts and personalized guidance during emergencies. These applications provide employees with dynamic information about evacuation routes, safe zones, and the unfolding situation, fostering a more informed and responsive workforce¹¹. Moreover, the advent of smart sensors enables the continuous monitoring of environmental conditions, identifying potential hazards and triggering automated alarms, facilitating swift and targeted responses.

The augmentation of technology extends beyond real-time communication to the strategic design of evacuation routes. Advanced mapping and simulation software allow for the creation of dynamic and optimized evacuation pathways. These pathways are not static but adapt in response to the specific

9 V. Q. Nguyen, H.T. Vu, V.H Nguyen. K. Kim, *A Smart Evacuation Guidance System for Large Buildings*, „Electronics” 2022, No 11.

10 C.I. Nwakanma, F.B. Islam, M.P. Maharani, J.M. Lee, D.S. Kim, *Detection and Classification of Human Activity for Emergency Response in Smart Factory Shop*, „Applied Sciences” 2021, No 11.

11 U. Atila, Y. Ortakci, K. Ozacar, E. Emrullah Demiral, I. R. Karas, *SmartEscape: A Mobile Smart Individual Fire Evacuation System Based on 3D Spatial Model*, „Isprs International Journal Of Geo-Information” 2018, vol.7, No.6.

nature of an emergency, guiding individuals away from danger with precision. Additionally, the incorporation of technology in designing evacuation routes includes features such as augmented reality, providing visual cues that enhance situational awareness, especially in low-visibility conditions.

Furthermore, technology plays a pivotal role in training initiatives. Virtual reality (VR) and augmented reality (AR) technologies offer immersive training experiences, allowing employees to simulate emergency scenarios in a controlled environment. These simulations not only enhance the retention of emergency procedures but also instill a level of confidence and preparedness that is invaluable during real crises. The gamification of training modules, enabled by technology, adds an element of engagement, making the learning process more interactive and enjoyable¹².

The utilization of technology in safety protocols is not without its challenges, ranging from initial implementation costs to concerns about data security. However, the long-term benefits far outweigh these challenges. Beyond immediate safety concerns, technology contributes to data-driven insights, allowing for the continuous improvement of safety protocols based on real-time information and historical trends.

The paradigm of utilizing technology in large production factories is not just about adopting the latest gadgets; it is a fundamental shift towards a more proactive, adaptive, and holistic

approach to industrial safety. The fusion of technology with safety measures is not an augmentation but a symbiosis, where the precision of sensors, the immediacy of communication tools, and the immersive nature of training technologies converge to create a resilient safety ecosystem. As technology continues to evolve, its role in industrial safety will remain pivotal, shaping a future where the workforce operates in an environment that is not only productive but, above all, secure and well-prepared for any unforeseen challenges.

Evacuation routes and safe zones. Blueprinting safety

The meticulous design of evacuation routes and safe zones emerges as an art and science that goes beyond mere physical infrastructure. These components form the backbone of a comprehensive safety strategy within large production factories, outlining a navigational roadmap for employees to swiftly and safely traverse in the face of emergencies. Evacuation routes are not mere paths; they are dynamic lifelines intricately woven into the layout of the factory, a choreography of exit points strategically positioned to guide individuals away from potential hazards with precision.

The design of these routes requires a keen understanding of the factory's layout, operational nuances, and potential risks. Advanced mapping and simulation technologies have revolutionized this process, allowing for the creation

12 R. Lovreglio, A Review of Augmented Reality Applications for Building Evacuation, *17th International Conference on Computing in Civil and Building Engineering*, Tampere 2018; J. Cavalcanti, V. Valls, M. Contero, D. Fonseca, *Gamification and Hazard Communication in Virtual Reality: A Qualitative Study*, „Sensors” 2021, 21(14).

of optimized evacuation pathways that adapt in real-time based on the nature of the emergency¹³. Augmented reality features further enhance situational awareness, providing visual cues that aid in navigation, particularly in conditions of low visibility.

Safe zones, strategically positioned along evacuation routes, serve as sanctuaries amid the chaos. These areas are equipped with essential resources, including firefighting equipment, first aid supplies, and communication devices. The design of safe zones considers not only their physical proximity to evacuation routes but also factors in their capacity, accessibility, and resilience. These zones are not just designated spaces; they are islands of safety designed to provide employees with a temporary haven to regroup, assess the situation, and await further instructions.

The significance of meticulous design extends beyond the physical realm. It encompasses clear and comprehensive signage, ensuring that evacuation routes and safe zones are easily identifiable even in high-stress situations. This visual communication is a critical component, especially when time is of the essence.

Designing evacuation routes and safe zones transcends being a blueprint for physical structures; it is a strategic endeavor that encapsulates the very essence of industrial safety. It requires a synthesis of technological innovation, architectural precision, and a deep understanding of human behavior in emergency situations. As large production

factories continue to evolve, so too must the design of evacuation pathways and safe zones, creating an environment where safety isn't just a concept but a tangible and dynamic reality, ensuring the well-being of every individual within the vast expanse of the factory floor.

Collaboration with emergency services. Forging Partnerships

Collaboration with emergency services stands as a linchpin, exemplifying a proactive and community-oriented approach to safeguarding lives and infrastructure. This collaborative endeavor extends beyond mere regulatory compliance; it represents a strategic partnership between the factory and local emergency services, a symbiosis designed to optimize response efforts in the face of unforeseen challenges.

At the heart of this collaboration lies the establishment of clear and efficient communication channels between the factory and emergency service providers. Joint planning sessions, regular meetings, and the development of standardized communication protocols ensure seamless coordination during emergencies. The aim is not just to inform emergency services of potential risks within the factory but to create a reciprocal understanding of each other's capabilities and limitations, fostering a relationship built on mutual trust and respect.

The collaboration extends to the staging of joint drills and exercises, where factory personnel and emergency service responders simulate various

13 A. Ramon, A. B. Rodriguez-Hidalgo, J. T. Navarro-Carri, B. Zaragoza, *A methodology for evacuation route planning inside buildings using geospatial technology*, "Data Management and Security" 2013, p. 155-166.

emergency scenarios. These simulations serve as invaluable training opportunities, allowing both parties to familiarize themselves with the factory layout, evacuation procedures, and potential hazards. The insights gained from these exercises contribute to the continuous improvement of emergency response plans, making them more robust and adaptive.

Collaboration with emergency services involves the development of contingency plans that outline specific roles and responsibilities for both the factory and emergency responders. This strategic alignment ensures that, in the event of a crisis, everyone is operating from the same playbook, minimizing confusion and optimizing the efficiency of response efforts.

Beyond the operational aspects, this collaboration also emphasizes community engagement. The factory becomes an active participant in local emergency planning initiatives, contributing resources, expertise, and support to broader community safety endeavors. This not only strengthens the factory's ties with the community but also enhances the overall resilience of the region to potential industrial incidents.

In instances where an emergency transcends the capabilities of the factory and local emergency services, collaboration with emergency services enables the establishment of a tiered response system that may involve regional or national resources. The ability to seamlessly integrate into larger emergency response frameworks ensures a comprehensive and adaptive approach to crisis management.

As technology advances, collaboration with emergency services also explores the integration of smart technologies, such as real-time monitoring systems and predictive analytics, to enhance the accuracy and speed of emergency response. The exchange of data between the factory and emergency services allows for a more informed and targeted deployment of resources, minimizing the impact of emergencies on both human lives and the surrounding environment.

The success of this collaboration hinges on transparent communication, joint training initiatives, and a shared commitment to fostering a resilient and secure environment. In a world where the unforeseen is inevitable, the strength of the collaboration between large production factories and emergency services becomes a beacon of preparedness, ensuring that, when the need arises, the response is swift, coordinated, and effective.

Summary

This article delves into the intricate web of safety measures within large production factories, specifically focusing on the pivotal aspects of evacuation and emergency preparedness. Titled „Determinants of Safe Evacuation in Large Production Factories,” the article navigates through various facets, encapsulating the essence of industrial safety in a world where potential hazards are ever-present. The article begins by highlighting the critical role of Comprehensive Emergency Preparedness Plans as the foundation of

a resilient safety strategy. These plans, tailored to the unique risks of each factory, go beyond procedural outlines, encompassing risk assessments, roles, and responsibilities, and regular training sessions.

The article then delves into the significance of employee training and awareness, emphasizing the cultivation of a safety-conscious culture through ongoing education and immersive drills. It underscores the vital role of clear communication channels as the lifeline during emergencies, detailing how various mediums, from alarms to mobile applications, contribute to the clarity and immediacy of information dissemination. The exploration of utilizing technology unveils the transformative impact of smart sensors, monitoring systems, and virtual reality in enhancing safety measures.

A substantial section is dedicated to the evacuation Routes and safe zones. It outlines the dynamic nature of evacuation routes, utilizing advanced mapping and simulation technologies to create optimized pathways. Safe zones are portrayed as not just physical spaces but as strategic sanctuaries equipped to provide temporary shelter amid chaos.

Collaboration with emergency services underscores the importance of forging partnerships beyond regulatory obligations. Clear communication, joint drills, and community engagement emerge as key components, ensuring a seamless integration of efforts between the factory and local emergency services.

In essence, this article paints a holistic portrait of safety excellence in large production factories, portraying

evacuation and emergency preparedness not as isolated components but as interwoven threads in the fabric of industrial safety. It advocates for a proactive and community-oriented approach, where collaboration, ongoing training, and the judicious use of technology converge to create an environment where safety is not just a protocol but a shared commitment. As the industrial landscape continues to evolve, this holistic approach becomes paramount in fostering resilience, adaptability, and, above all, the well-being of the workforce within the expansive confines of large production factories.

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About the Author

Vladyslav Ratushnyi, Graduate of the Wrocław University of Science and Technology, Faculty of Mechanical Engineering. Graduate of the Lviv State University of Life Safety, Faculty of Transport Technologies.