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PLANNING MEASURES OF PREVENTION, PREPAREDNESS AND RESPONSE TO AN INCIDENT SITUATION IN THE TRANSPORT OF DANGEROUS GOODS

Aleksandar Gošić[1, a], Siniša Sremac[2,b]

[1]Academy of Technical-Educational Vocational Studies Niš Department Vranje, Filipa Filipovića 20, Vranje, Republic of Serbia

[2]Faculty of Technical Sciences, University of Novi Sad, Trg Dositeja Obradovića 6, Novi Sad, Republic of Serbia

[a]aleksandar.gosic@akademijanis.edu.rs, [b]sremacs@uns.ac.rs

Abstract Risk implies the probability of occurrence of harmful outcomes resulting from the interaction between hazard, vulnerability of the community and the natural environment (the element exposed to risk). The term "incident situation" means an uncontrolled event that occurred during the process of production, transport or storage, in which certain quantities of chemical hazardous substances were released into the air, water or soil, at different territorial levels, which may result in the endangerment of life and human health, material goods and the consequences for the environment. Risk management represents the systematic application of policies, experiences and resources in the assessment and control of risks that threaten the health and safety of the population and have a negative impact on the environment. The management of the risk of occurrence of an incident situation in the transport of dangerous goods is a very complex process consisting of several sub-processes (phases) that are interdependent: Phase I - Analysis of the risk of occurrence of an incident situation: Hazard identification, Consequence analysis and Risk assessment; Phase II – Measures of prevention, preparedness and response to the incident: Prevention, Preparedness and Response to the incident; Phase III - Remediation: Development of a remediation plan and development of a report on the incident situation. After analyzing the risk of an incident situation, prevention, preparedness and incident response measures are implemented. This phase of incident risk management involves the engagement of a large number of entities and resources, from the dangerous goods transporters themselves to the competent services and state administration bodies. The importance of this phase of risk management is also reflected in the normative regulation of the area. The paper presents the methodology of risk management in the second phase, the basic normative documents in the field of prevention, preparedness and response to an incident and the obligations of the competent services in an incident situation.

Keywords: Sangerous goods; risk; prevention; incident situation.

1. INTRODUCTION

The term risk means the probability of occurrence of harmful outcomes resulting from the interaction between hazard, vulnerability of the community and the natural environment (the element exposed to risk). The term "incident situation" means an uncontrolled event that occurred during the process of production, transport or storage, in which certain quantities of chemical hazardous substances were released into the air, water or soil, and that at different territorial levels, which may result in the endangerment of life and human health, material goods and the consequences for the environment.

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The management of the risk of occurrence of an incident situation in the transport of dangerous goods is a very complex process consisting of several interdependent sub-processes (phases). The risk management methodology for the occurrence of an incident situation is applied when assessing the risk of operation and use of facilities, plants, devices, installations, equipment, means of transport and other means of work in which hazardous substances, that are produced, processed, transported, stored or otherwise used, can cause an incident situation, in order to protect people, natural and material goods and other objects in the vicinity of dangerous activities, that is, within the zone of influence of dangerous goods.

The management of the risk of an incident situation consists of the following stages [1]:

- Phase I - Analysis of the risk of an incident situation: Identification of the risk, Analysis of consequences and Risk assessment;

- Phase II – Measures of prevention, preparedness and response to the incident: Prevention, Preparedness and Response to the incident;

- Phase III - Remediation: Development of a remediation plan and development of a report on the incident situation.

The paper presents the methodology of risk management in the second phase, the basic normative documents in the field of prevention, preparedness and response to an incident and the obligations of the competent services in an incident situation.

2. PREVENTIVE MEASURES - PREVENTIVE

According to the Law on Environmental Protection [2], an accident is defined as a sudden and uncontrolled event caused by the release, spilling or scattering of hazardous substances, the performance of activities during production, use, processing, storage, disposal or long-term inadequate storage. The term that is also used in this law with the same meaning is chemical accident. According to the Rulebook on the content of the accident prevention policy and the content and methodology of the preparation of the Safety Report and the Accident Protection Plan [3], accident prevention is defined as a set of measures and procedures at the level of facilities, complexes and the wider community, which aim to prevent the occurrence of accidents, reduce probability of accidents and minimization of consequences. In accordance with the Law on Disaster Risk Reduction and Emergency Management [4], prevention includes a set of measures and activities for mitigating existing risks as well as reducing the risk of new consequences of a disaster.

According to Lavell [5], prevention is based on measures designed to prevent natural and social/political events and processes from turning into an accident accompanied by collapse, destruction and losses. With this definition, prevention is clearly used as a term that refers to the reduction of vulnerability, but does not include activities that modify or reduce the occurrence of hazardous events or modify the exposure of the population, production or infrastructure to them. Furthermore, the definition suggests that a disaster can exist in some cases without destruction and loss. This negates the idea of a disaster defined as a social disruption, unless we assume that when a disaster is mentioned, it is actually referring to the physical event that causes it.

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In addition to these two definitions of the concept of prevention, Wilches-Chaux [6] gave the simplest explanation of this activity, where he states that prevention is "saying no to hazards". According to him, prevention refers to activities or actions aimed at eliminating, reducing or changing hazards in a positive way for the community (society).

The interpretation of prevention by the World Health Organization, which divides prevention into primary and secondary, is very interesting. Primary prevention refers to activities that affect the reduction, avoidance or prevention of the risk of incident situations, by getting rid of hazards or vulnerabilities. Secondary prevention means quick recognition of a negative event and reduction of its effects.

Preventive measures and procedures are determined on the basis of data obtained by assessing the risk of an incident situation (the third step within Phase I - hazard analysis), and consist of [1]: adequate spatial planning and zoning of settlements (determination of protection zones, distances from dangerous activities from settlements, etc.); making an analysis of the danger of the incident situation and giving opinions and consent to them; the choice of those technologies that pollute the environment less and provide a higher degree of protection and those technologies that reduce the need to transport dangerous goods; timely elimination of all observed technical-technological deficiencies; maintenance of work-technological discipline at the required level; orderly maintenance of the passability of all roads and passages within dangerous installations; application of technical means and detection and protection equipment; control and supervision of monitoring and security systems; informing and involving the public in decision-making on all issues important for the safety of the population. Preventive measures and procedures include the development, monitoring and implementation of by-laws, norms and standards related to activities (transportation, storage, production, etc.) related to dangerous substances (goods).

Based on the above, it can be concluded that preventive measures and activities are undertaken at the very beginning of the construction of infrastructure facilities, but are applied throughout the entire life cycle of the facilities, with the application of a large number of subjects at all levels of management and the engagement of a large number of funds.

2.1. Hierarchy of Implementation of Management Measures

In order to properly understand any type of management measure, it is necessary to have a good knowledge of the nature and scale of hazardous activities, possible incidents and consequences that the management measure is supposed to manage, as well as the effects that the management measure has on these factors. With such an understanding, a basis is provided for defining performance indicators and standards for management measures, but also for defining those management measures that are critical for safe work. Management measures can be categorized according to the "management hierarchy". Operators can also benefit from classifying management measures into hardware management modes (technical systems) or software management modes (management systems, human resources or procedures).

It is important that the human resources component is sufficiently taken into account when designing and implementing management measures. Errors made in the design and implementation of controls,

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whether in technical safety devices, individual procedures and tasks, or in the overall safety management system, can result in controls that are unable to fulfill their intended purpose or achieve the level of performance required for full effectiveness. In addition, in this way, additional hazards can be caused that cause or contribute to the occurrence of major incidents. It is important that people who design and implement control measures look beyond the designed response to a detected problem and also consider whether it is possible to modify the problem at the source of the problem (e.g. by creating a less error-prone environment or activities that are less error-prone). Table 1 shows examples of the hierarchy of management measures, as well as their explanation [1].

Table 1. Example of the hierarchy of management measures.

Hierarchy	Explanation
Elimination	Management measures that completely remove, that is, eliminate the danger. Although it is clear that this is the most effective type of management measure, it is often not practical to eliminate hazards.
Substitution	The use of less dangerous substances that can satisfy the needs as well as dangerous substances with a higher degree of danger.
Prevention	A management measure that prevents or significantly reduces the likelihood of an incident scenario occurring.
Reduction	Management measures that reduce the severity of consequences, usually by detecting undesirable conditions and acting to stop the scenario from unfolding. They do not deal directly with the consequences of the incident situation.
Mitigation	Management measures that directly deal with the consequences of an incident situation by reducing their effect on people, objects and the environment. Although the least favorite type of control measure, well-designed mitigation controls are critical to safe operation, as they are the absolute last line of defense.

On the example of the risk assessment carried out in [7], management prevention measures could be applied for the transport of dangerous goods (by applying the prescribed measures in the transport of dangerous goods, training participants in the transport of dangerous goods, providing prescribed devices and equipment of vehicles for the transport of dangerous goods, etc.), reduction (using adequate equipment to reduce the severity of the consequences, devices for detecting malfunctions on vehicles, etc.) and mitigation (providing adequate means on the road infrastructure and facilities to neutralize the effect of hazardous substances, means for fire protection, etc.).

2.2. Examination of Alternative Management Measures

There are many reasons why it is necessary to use alternative management measures. One of the most convincing and direct reasons is the situation when the risk assessment has shown that the risk level exceeds some relevant criterion, that is, when the risk level exceeds the threshold value of the acceptable risk level. Other relatively straightforward reasons for examining alternative control measures for use are [1]: when it is apparent that an existing control measure is not doing the job as well as it should be, due to possible design flaws, performance degradation, or intentional incapacitation; when changes are proposed in the plant or in the execution of the transport service; when existing management measures should be replaced due to obsolescence; and when the operator becomes aware of more advanced technologies to manage possible risks. Somewhat less obvious reasons for examining alternative management measures for use are [1]: when operating conditions become more difficult without any changes in functioning; when the risk assessment has shown that as long as the level of risk does not exceed any relevant criteria, they are not negligible and therefore it is possible to reduce them further; and when there is a loss of knowledge about the basis for safe work, so no one remembers the reasons for which the existing measures were adopted.

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A number of factors influence the determination of a reasonable number of existing and alternative controls that an operator needs to perform a quality inspection. These factors include [1]: the nature of the risk profile for hazards that dominate the risk profile may require consideration of a number of alternatives; size and complexity of the plant (transportation process) – in larger and more complex plants there are usually more dangers lurking, so more control measures are needed, which also applies to the transport process; and the speed of development of new management measures – hazards for which new and improved management measures are being developed rapidly may require a more detailed review compared to areas where only a few improvements have been made.

Table 2 gives an example of the types of factors that are used when selecting or rejecting certain management measures [1].

Table 2. Factors used when selecting or rejecting certain management measures.

Factor	Questions
Existing management measures	Are the measures clearly linked to each hazard, or do some hazards have no defined (or insufficient) management measures? Does the number of management measures realistically reflect the magnitude of potential incident situations?
Effectiveness of alternatives	**Functionality** Is it enough to manage hazards in a defined way? Do existing management measures completely eliminate the hazard, prevent escalation, or simply mitigate the effects? **Reliability** Does the reliability of the alternative, as well as all the management measures combined, correspond to the level of risk associated with the hazard? Can functional testing detect failures, and can detected failures be quickly remedied? **Availability** Is the out-of-service control system available for testing, calibration, or maintenance for an unacceptable period of time? **Sustainability** Can the management measures function as intended during the incident situations they are intended to reduce or mitigate?
Hierarchy of management measures	Are management measures that eliminate hazards adopted first because they are practical, followed by substitution, intensification, prevention, reduction, and then mitigation measures?
Balancing management measures	Is there a balance of different types of controls (ie hardware and software controls) for each hazard? Are the management measures related to individual causes independent of each other or can some or all of them be disabled by the same mechanism?

After the implementation of prevention measures, that is, preventive measures, it is necessary to implement measures related to preparedness from the occurrence of an incident situation.

3. READINESS

Preparedness is a state that is achieved by preparing all competent subjects, equipment and techniques for the most adequate response to an incident situation with the least possible consequences, and is ensured by the adoption of Protection Plans. Protection plans are adopted for every place and every part of the territory of the Republic where there are dangerous activities that can cause an incident situation in the company - a protection plan at the place of the incident situation, in the municipality, that is, the city for the territory of the municipality, that is, the city, as well as the Republic as a whole. Protection plans are mutually coordinated and rely on each other (plans for protection against natural and other major disasters, protection in emergency and war conditions, etc.). The methodology for

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creating protection plans is prescribed by the Rulebook on the Content of Accident Prevention Policy and the Content and Methodology of Creating Safety Reports and Accident Protection Plans [3].

Within each Protection Plan, certain aspects of the response to the incident situation are elaborated, which refer to [1]: establishment of a system for alerting and informing persons participating in the response to the incident and citizens who need to be protected; establishment of care plans for the injured and intoxicated (first aid, triage, transport, further treatment, application of antidotes, drugs, etc.); establishment of population evacuation plans, basic movement directions, deployment areas, etc.; determination of means of personal and collective protection of the population, as well as the use of temporary means; establishing plans for the protection of domestic animals, food, fodder and drinking water; familiarization of the population with all potential dangers and anticipated measures of protection, exercises and education; and a program of evaluating, testing and innovating plans. The protection plans in the municipality, that is, the city, are coordinated with the incident response scheme that is applied in the state. Upon completion of the creation of the Protection Plan, the team appointed for its creation becomes the team for coordinating the response to the incident situation.

Within this phase of risk management, the monitoring of the safety situation, which is carried out through critical operating parameters, is extremely important. Critical operating parameters are process variables or other variables that can be measured almost instantaneously, as opposed to performance indicators that are typically monitored over a period of time. Critical operating parameters define a safe operating framework for a plant or vehicle, and moving outside of this framework is immediately displayed to the operator as exceeding the critical levels of one or more parameters [1].

Therefore, critical operating parameters have critical values that must not be exceeded. One critical operating parameter can have both an easier (soft) and a harder (hard) critical value. Soft values should define the normal framework of work. Exceeding the soft value provides a warning that one or more controls are failing to manage the work activities within that framework. Critical values are considered soft when there are additional control measures that can return the process to a safe state, even though the process is still safe, but in an emergency and undesirable operating zone. Hard critical values should be defined above the level of soft critical values, but must still be below the level of any unsafe or uncertain operating zone. Hard critical values should never be allowed to be exceeded, even when additional controls are in place to return the process to a safe state.

On the example of the risk assessment carried out in [7], for the transport of dangerous goods, operating parameters related to the vehicle and related to the dangerous substance being transported could be adopted: the speed of the vehicle, the values of the parameters of individual devices and systems on the vehicle (pressure, temperature…), pressure values in the space for storing hazardous materials, temperature of hazardous materials, voltage of electrical installation, etc.

4. RESPONSE TO THE INCIDENT SITUATION

The response to the incident situation begins the moment the first information about the incident situation is received, which contains data on: the place and time of the incident situation; the type of dangerous substances that are present; assess the course of the incident situation; assess risks and the

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environment; and other relevant data for responding to an incident situation. In the process of responding to an incident situation, in addition to the work arising from the Protection Plan, the following is also performed: assessment of the extent of the incident situation (threatened zones or zones of influence); assessment of the magnitude of consequences; establishment of continuous measurements and observations in the area where the incident occurred (fire, explosion, release of hazardous materials) and characteristic parameters (concentration of hazardous materials, movement of the contamination cloud, meteorological data: wind direction and speed, vertical air stability); informing about the incident situation and giving instructions on further action; making a decision on the possible evacuation of the population, the method of evacuation and the direction of movement, based on the size of the incident situation, the degree of threat to the population and the assessment of the duration of the danger, the available time for evacuation, etc.; coordination of the work of civil protection services, health organizations, fire services, technical assistance services; informing the relevant republican authorities and giving an assessment of the possibility of responding to the incident situation with one's own forces.

Subjects of the response to the incident situation on the basis of harmonized Protection Plans are: services of internal affairs bodies, services of means of communication, transport companies, communal services, fire services, information centers, specialized technical teams, rehabilitation teams, (eco) toxicological laboratories , analytical laboratories; hydrometeorological institutes and meteorological stations; emergency medical teams, institutes for health protection, institutes and institutes for occupational medicine, stationary health institutions with toxicology departments; organs, services, units, teams of the army, based on established cooperation and coordinated protection plans (specialized units for atomic-biological-chemical defense, technical services, etc.); headquarters and civil protection units, based on coordinated civil protection plans.

The response to an incident at dangerous installations takes place in accordance with the protection plan at the scene of the incident and in accordance with the current situation on the ground. The response to an incident of level I - the level of dangerous installations and the response to an incident of level II - the level of an industrial complex is realized in the company. Level I and II incident response is managed by the company's incident response coordination team. If it is estimated that due to the resulting incident situation, harmful consequences may occur to the wider environment, the protection plan of the municipality, that is, the city and the state, is activated.

Measures of prevention and safety of transportation of dangerous goods are undertaken in accordance with regulations on transportation of dangerous goods. In the transportation of dangerous goods, a protection plan is adopted and a response to an incident situation is carried out in accordance with the previously mentioned procedures.

5. DISASTER RISK REDUCTION AND EMERGENCY MANAGEMENT

The term disaster is defined according to the Law on Disaster Risk Reduction and Emergency Management [4] and represents a natural disaster or a technical-technological accident whose consequences threaten the safety, life and health of a large number of people, material and cultural goods or the environment on a larger scale, and the occurrence or consequences of which cannot be prevented or eliminated by the regular action of competent authorities and services.

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A technical-technological accident is a sudden and uncontrolled event or a series of events that got out of control during the management of certain means of work and during the handling of dangerous substances in production, use, transport, traffic, processing, storage and disposal, such as fire, explosion, accident, traffic accident in road, river, railway and air traffic, accident in mines and tunnels, stoppage of cable cars for transporting people, collapse of dams, accidents at power, oil and gas plants, accidents when handling radioactive and nuclear materials, severe soil pollution , water and air, the consequences of war destruction and terrorism, the consequences of which can threaten the safety, life and health of a large number of people, material and cultural goods or the environment on a larger scale.

A state of emergency is a situation that arises by declaration from the competent authority when the risks and threats or the resulting consequences for the population, the environment and material and cultural assets are of such scope and intensity that their occurrence or consequences cannot be prevented or removed by the regular action of the competent authorities and services, due to which for their mitigation and elimination it is necessary to use special measures, forces and means with an intensified work regime.

The law on disaster risk reduction and emergency management [4] also defines the rights and duties of the subjects of the disaster risk reduction and emergency management system. Subjects of the risk reduction and emergency management system are the Government of the RS, the Ministry of Internal Affairs, the Ministry of Defense, but also other ministries and bodies of state administration and local self-government. In addition to the obligations of state bodies, the rights and duties of business entities, associations and citizens themselves are defined. Based on the provisions of this law, it can be concluded that risk reduction is regulated at all levels and includes a large number of entities.

In order to monitor disaster risk reduction activities and coordinate and manage emergency situations, emergency staffs are formed at all levels of management, from the territory of the municipality to the territory of the Republic of Serbia. A special regulation [8] regulates the composition and way of working of the headquarters for emergency situations.

Civil protection is an organized system whose main activity is protection, rescue and removal of the consequences of natural disasters, technical-technological accidents and other major dangers that can threaten the population, material and cultural goods and the environment in peace and in a state of emergency and war. A special regulation [9] regulates the purpose, tasks and manner of use of civil protection units.

6. CONCLUSION

The management of the risk of occurrence of an incident situation in the transport of dangerous goods is a very complex process consisting of several interdependent sub-processes (phases). The risk management methodology for the occurrence of an incident situation is applied when assessing the risk of operation and use of facilities, plants, devices, installations, equipment, means of transport and other means of work in which hazardous substances are produced, processed, transported, stored or otherwise used can cause an incident situation, in order to protect people, natural and material goods and other objects in the vicinity of dangerous activities, that is, within the zone of influence of

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dangerous goods. The second phase of incident risk management, after the analysis of the risk of an incident, is the measures of prevention, preparedness and response to the incident.

This phase is governed and regulated by regulations on environmental protection, protection against ionizing radiation and nuclear safety, disaster risk reduction and emergency management, as well as regulations on the work of fire-rescue units. In the process of risk reduction, i.e. prevention, preparedness, incident response and emergency management, a large number of entities are involved with the engagement of all available resources.

In addition to administrative actions and procedures, a very important segment is the training of personnel involved in prevention, preparedness and incident response. Also, the segment of international cooperation, within which the exchange of experiences in this area would be carried out, must be highlighted.

The goal of taking measures and activities in the field of emergency management and general risk management is the safety and protection of human and animal health, fire protection and environmental protection from the negative effects of hazardous substances. In further research, it would be necessary to pay special attention to the training and development of personnel who are directly involved in the implementation of the measures defined by the protection and incident response plans.

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