PREVENTION OF UNDESIRABLE SITUATIONS IN CONNECTION WITH ILLEGAL HANDLING OF HAZARDOUS WASTE

Markéta Kubečková
Institute of Economy and Management, Faculty of Economics and Administration, University of Pardubice

Abstract: *Waste management is a rapidly developing area of the national economy. Developed countries have begun to address waste management intensively only in recent years. In the Czech Republic the first law on waste was made until 1991. Hazardous waste can harm human health or the environment, and therefore is needed to pay attention to it. The negative effects of hazardous waste can occur in the place of its origin, when transporting it or close to the place of the removal.*

Keywords: *Waste Management, Nalžovice, Hazardous Wastes, Environment.*

1. Introduction

Waste management is a relatively young but dynamically developing field of the national economy. Industrially and economically advanced countries started to intensively deal with the issue approximately 20-30 years ago, and the Czech Republic received its first legislation on waste management as recently as 1991. Prior to 1991 there were no legislative checks and controls in place concerning the handling of waste, and no integral regulations existed apart from the management of secondary raw materials.

In particular, handling hazardous waste is similar to handling highly toxic substances or chemical substances. Hazardous waste must possess at least one of the hazardous properties indicated in Annex 2 to Act No. 185/2001 Coll., on Wastes as amended (hereinafter the "act on wastes"). The hazardous properties of wastes include e.g. toxicity, carcinogeneity, mutageneity, infectiousness, ecotoxicity, etc. Quotable examples of hazardous wastes include the wastes of polychlorinated biphenyls (PCB), persistent organic pollutants (POPs), as well as infectious health care wastes or wastes containing mercury or wastes from production cycles using hazardous chemicals.

Hazardous wastes may be harmful to human health or the environment, and should be the object of increased attention. The negative impacts of hazardous wastes may occur in the course of their production, transport and disposal near the site of their origin. In 2006, several localities were identified where dangerous substances and hazardous wastes were incorrectly and illegally stored and handled. This paper will be focus on the above findings, on possible remedies to solve effects, and on eliminating these effects within the existing legal framework. Due to the complexity of our topic the paper will be focus on to the hazardous waste that seriously impacts public health and may impair the state of the environment.

The paper aims to point out the risks that may occur due to the nonobservance of the rules of processing, transportation and storage (handling) of dangerous wastes, and the nonobservance of applicable regulations pertinent to this issue.

2. The Current state of the problem

Waste is classified dangerous in accordance with Section 6 of the act on wastes, whereby a dangerous waste shall have been:

- included in the list of dangerous wastes in accordance with Regulation 381/2001 Coll., on the Catalogue of Wastes, List of Hazardous Wastes, and Lists of Wastes and States for the Purpose of Export, Import and Transit of Wastes, and Procedure of Granting Consent to the Export, Import and Transit of Wastes (Catalogue of Wastes),
- mixed or polluted with any of the wastes indicated in the List of Hazardous Wastes,
- mixed or polluted with any of the items indicated in the list of wastes that render waste hazardous in accordance with Annex 2 to the act on wastes,
- considered if the waste has one or more hazardous properties in accordance with Annex 2 to the act on wastes.

Every year the Czech Republic produces more than 1.5 million metric tons of hazardous waste. Although its production has been steadily declining, this type of waste, if improperly handled, is a certain risk to the environment and public health.

2.1 Definition of hazardous waste and relevant context

In accordance with the act on wastes, everything one disposes of or intends or is obliged to dispose of, and listed in one of the waste groups cited in Annex 1 thereto is waste. There are two basic categories of waste: Hazardous Wastes – NO and Other Wastes – OO.

A hazardous waste is cited among others in the List of Hazardous Wastes in accordance with Regulation 381/2001 Coll., on the Catalogue of Wastes.

At present, hazardous waste is waste with one or more of 14 decreed dangerous properties, namely: H1 explosiveness, H2 oxidation capacity, H3-A high flammability, H3-B flammability, H4 irritability, H5 harmful to health, H6 toxicity, H7 carcinogeneity, H8 causicity, H9 infectiousness, H10 teratogenicity, H11 mutageneity, H12 ability to release highly toxic and toxic gases in contact with water, air or acids, H13 ability to release hazardous substances to the environment during and after their elimination, H14 ecotoxicity

Input information for one to grasp the severity of the hazardous waste problem could come in the following three parts:

1. Wastes and the biosphere

2. Hazardous wastes and humanity

3. Harmful substances in hazardous wastes

Much hazardous waste comes from industrial waste (various chemicals, printing and metallurgical heavy metals, pharmaceutical refuse, sharp glass objects, miscellaneous food industry artifacts); agriculture (various pesticides, industrial fertilizer residues), civil engineering (some building materials contain asbestos, paints, varnishes, artificial resins and radioactive substances), transport (oil products, mineral oils, tires), trade (refrigeration equipment, food past its useful life, spoiled food), health care (unused medicines, sharp objects), and offices (spent electrical equipment, printer toners). All of the above fields produce countless other hazardous wastes and sometimes dangerous substances are the byproducts of decomposition of various materials.

The hazardous waste in the above cases originates from legal entities, companies, establishments, etc., or private businesses; these private persons and businesspeople are obliged to ensure proper waste management and waste disposal. Very strict regulations are in place regarding the handling of hazardous waste.

Only persons properly authorized in accordance with the act on wastes are permitted to handle hazardous wastes. An originator of hazardous wastes, i.e. a legal entity or a physical entity whose business activities generate wastes, may handle such wastes only with the consent of the applicable state administration body. Permits to handle hazardous wastes are granted by regional offices (in case of quantities over 100 tons per annum), and by the local authorities of municipalities with extended powers (in case of quantities below 100 tons per annum). Wastes may be handled only by establishments designed for the purpose and fully licensed to operate applicable equipment.

2.2 Waste in general

As long as man crafted his products exclusively from natural materials, i.e. wood, leather and plant and animal parts, all the recycled residues were gradually eliminated in such conversion cycles. They would decompose and materials obtained from minerals (metals and nonmetals) were deposited in earth, as evidenced by the unearthed foundations of ancient cities as well as artifacts created by people hundreds and thousands of centuries ago. In accordance with the natural relationships thus defined there was also an agriculture that provided food to the human society from its inception in the Neolithic revolution until the 19th century. But even in the 19th century, agricultural yields depended, alongside the natural conditions (land fertility and climatic conditions) solely on the amount of invested work of people and animals in field works, land reclamation, and returning organic matter to land in the form of farm estate manure.

During this developmental period, the waste problem became urgent only if a lot of organic refuse was collected in one place, its stench became overwhelming and there proliferated the organisms that feed on garbage and spread contagious diseases.

However, a different situation arises once alien (artificially produced) substances start cropping up in a natural environment which has no indigenous organisms to feed on and decompose them. The problem is further aggravated if these substances are toxic or otherwise dangerous to organisms and damage or disrupt the ecosystem relationships, and thereby endanger man.

2.3 Hazardous waste then and now

The first problems associated with hazardous waste began to appear in the period when people zeroed in on the cities where much refuse was gathering, especially excrements and food. That attracted many consumers (rodents and insects) that tended to spread infectious diseases. Polluted ground water and stinking air made people, still unaware of the true cause of contagion, want to call for sewage being somehow removed from cities and water wells. Time and tide, informed by the path of civilization, has helped promote the elimination and reduction of the impact of hazardous waste. Step by step, sanitary measures were introduced to prevent the accumulation of organic waste and to protect clean water.

But from the global point of view the human society worked in a rather differentiated and uneven way to forge a brand new approach to the environment. Thus, we keep exploiting natural resources we need to feed us and fashion things, but we are doing it on an

unprecedented level. The abundance of energy (mostly from fossil fuels), together with the advance in chemistry has helped us to produce chemical fertilizers and many substances, which never occur in nature and there are no organism ready to decompose them.

The cyclical character of relationship towards nature and original man-environment rapport has changed in favour of a one-way relationship.

The Industrial Revolution brought about major changes in the use of natural resources, in the way of life and also changed the nature of the waste very much. Entirely new types of waste appeared, particularly waste of dangerous chemical nature, in other words waste containing hazardous substances dangerous to the biosphere and human health. Hazardous substances, which accumulate in the environment, are not only pesticides. Various industrial wastes discharged into water or in the air, waste leached to land from badly designed based dumps or from old abandoned industrial plant, etc. can have similar influence on the environment.

3. Analysis procedure of the region and the measures taken in connection with illegal handling of hazardous waste

3.1 Description of actual emergency situations

In the course of 2006, three illegal chemical and hazardous waste dumps were discovered in three regions of the Czech Republic. Specific finds were made in the municipalities of Libčany (Hradec Králové Region), Chvaletice (Pardubice Region), and Nalžovice (Central Bohemian Region).

In the first case, Police of the Czech Republic discovered hazardous substances in Libčany (Hradec Králové Region). At an emergency session of the Regional Security Council and invited guests, the Governor of the Hradec Králové Region declared, on the request of the Lord Mayor of the Statutory City of Hradec Králové, a "state of emergency" in a limited part of the territory of the Libčany Municipality due to a "considerable threat to life, health and the environment in connection with the quantity of dangerous substances and preparations, deposited by unidentified entities and discovered on the property of the firm, SNOG HK, s.r.o., in the territory of Libčany, and due to possible threats that cannot be averted by routine action on the part of the administrative authorities".

In the second case stated above, the Police of the Czech Republic found dangerous substances in Chvaletice (Pardubice Region) in the course of investigating an industrial accident, involving one person and caused by an explosion when handling glass packaging material on the property of the firm, AVOT spol. s.r.o. (in liquidation). However, an emergency session of the Pardubice Region Security Council failed to find a legal justification of declaring a state of danger as proposed by Přelouč Municipality with Extended Powers.

The third above case relates to the Central Bohemian Region, where a local mayor indicated the presence of dangerous substances in Nalžovice. Analogically to above, an emergency meeting of the Central European Regional Security Council failed to find a legal justification of declaring a state of danger and consequently the Council did not recommend that the governor declare an emergency situation but proposed that the incident be solved by administrative bodies and IZS (Integrated Rescue System) components.

It is up to the authorized public administration bodies to evaluate situations and select policies and methods of solving situations. As a rule, public administration bodies rely on their advisory and operative segments, established on the basis of legislative provisions and

consisting of experts and specialists capable of recommending the adoption of adequate measures in cases of direct threat to life, health, property or the environment. The policies chosen and adopted by the Pardubice and Central Bohemian public administration bodies represent a suitable solution to the problem, inasmuch such solutions led to results identical to those achieved by the Hradec Králové Region, based on coordinated action by individual administrative bodies and the components of the Integrated Rescue System (hereinafter the "IZS"). Due to the fact that this was the first such incident reported in the Czech Republic, it was quite difficult to assess the legitimacy or justification of declaring such state as a purposeful and pragmatic move that could have pursued several goals at once, i.e. to quickly select a contractor, to provide funding, to coordinate action from a single command post, etc.

The approach taken by the Hradec Králové public administration bodies to the issue of illegal dump store, and their declaring a state of danger, was legitimate from the vantage point of legislative regulations. However, the imposition of a state of danger and the application of emergency measures should be resorted to only in boundary situations involving the immediate risk to the lives and health of the population, and to property and environmental conditions where such threat cannot be averted by routine action on the part of administrative bodies and ISZ components.

In the case of tackling emergencies in accordance with the provisions of Act No. 239/2000 Coll., on Integrated Rescue System and Amendments to Certain Acts (hereinafter the "IZS Act") involving the deployment of ISZ components, the command officer has sufficient powers to cause the solving of a situation to smoothly align with the elimination phase implemented by a specialized company. The command officer may for example ban or restrict persons from the site of action, order the exclusion of a person whose presence is not vital, order the evacuation of persons, and if needed also impose other temporary measures in order to protect lives, health, property and the environment. The command officer may also order the immediate execution or elimination of buildings and site modifications in order to mitigate or avert risks due to an emergency situation, and request that legal and physical entities provide personal or material assistance. It is essential, from this vantage point, that the administrator of coordination of preparation for emergency situations, i.e. the Ministry of the Interior or the General Directorate of the Fire Rescue Service of the Czech Republic (GŘ HZS ČR) include the experience based on the implementation of policies applied in tackling emergency situations in a system of professional training of crisis management bodies, and possibly also propose methodological solutions for decision-making purposes.

However, the main thrust for solving the above situations was limited to procedures within the framework of routine activities by administrative bodies and the funding of the measures adopted, whereby applicable legislation fails to provide sufficient instruments to achieve quick and effective solutions to the above-indicated illegal handling of chemicals and wastes on a large scale. The process of detecting the said illegal actions and the supervision of associated commitments to be met by originators of wastes or users of chemical substances is fragmented in terms of legislation (see legislation concerning the environment, small holdings and building contractors, criminal and crisis management legislation, protection of public health, fertilizers, veterinary practice, Labor Code, etc.), and it not easy for the above administrative bodies to find their bearings on various cases and make appropriate decisions.

The funding of adopted measures to eliminate the consequences and threats of the said illegal activities is generally entrusted by legal regulations to the bottom-level state administration bodies (municipalities with extended powers and possibly also regions), which

incurs additional outlays to their budgets and in the above cases, said bodies were unable to finance adopted measures to eliminate the consequences of illegal activities, and the efforts to seek compensation for their financial costs from perpetrators are usually counterproductive.

3.2 Case study Nalžovice

The article also focuses on specific safety assessment, risk assessment, process and addressing the removal of illegal storage of chemicals and waste in the municipality Nalžovice in the Central Bohemia Region. The chapter was also based on document "Safety and feasibility project" as prepared by DEKONTA of 16 January 2007 [3].

3.3 Input information

Having investigated a former pig farm near Nalžovice in the Sedlčany area, the Police of the Czech Republic discovered a quantity of unidentified chemical substances and duly summoned a Central Bohemian Fire Rescue Corps to the scene. According to the estimate of the team's experts, there were tens of thousands of materials stored on the site that was described as extremely hazardous waste. The chemicals were stored in miscellaneous containers without any classification whatsoever. Some of the materials could be combustible. At that moment, the relevant public administration bodies were materially adviced by the Central Bohemian Fire Rescue Service that there was **no imminent danger**. However, it was necessary to prevent the access of any third persons and possible manipulation of the dangerous materials. Having discussed the affair at an emergency session of the Central Bohemian Regional Security Council, the Governor decided to cope with the situation in coordination with administrative bodies and IZS components and not to declare a state of danger. The crucial measures adopted included around-the-clock police surveillance and protection of the site, a closer probe launched by the Central Bohemian Fire Rescue Service to rule out the presence of radioactive materials, and following essential negotiations with specialists concerning the presentation of a proposal for further action to identify and take stock of the hazardous substances and providing for their elimination, to propose further action with emphasis on safety.

The administrative bodies concerned faced the critical task of coping with the legal and ownership issues of the owner of the Nalžovice site and of the items (chemicals and wastes) deposited on this property. The chemicals were the product of the owner's business activities and most of them had been relocated here from a leased property the owner was supposed to vacate. The owner produced six business permits, some of them covering:

- production and import of chemical substances and chemical preparations classified as explosive, oxidizing, extremely flammable, highly flammable, highly toxic, toxic, carcinogenic, mutagenic, toxic in reproduction, and dangerous to the environment and the trading in chemical substances and chemical preparations classified as highly toxic and toxic;
- business activities in the field of handling wastes except for hazardous wastes; and
- business activities in the field of handling hazardous wastes.

The Region proceeded to order a safety and implementation project to identify, take stock of and eliminate dangerous chemical substances and wastes. The project was supplied by the firm, Dekonta a.s., which had previous experience with the elimination of illegal waste dumps in the two previously mentioned instances, i.e. in the Pardubice and Hradec Králové Regions. Their project specifically defined risk factors, planned activities, and safety measures.

In light of the importance of establishing risk factors in eliminating dangerous substance depots for the purposes of identification, inventory and substance removal, as well as setting relevant conditions for public tenders to select the remover of dangerous substance storage facilities and the identification of main sources of danger, I will devote myself in the further sections of my paper to set risk factors, the description of the main sources of danger, and the evaluation of safety aspects of storing hazardous waste and chemicals in Nalžovice.

3.3.1 Identification of risk factors from the angle of redevelopment works

Redevelopment crews face the following risk factors in the course of rehabilitation of a hazardous substance depot:

- highly toxic chemical substances and wastes (including explosive, radioactive, highly toxic, extremely combustible, oxidizing, caustic, and carcinogenic substances along with substances prone to violent chemical reactions when exposed to water and air)
- thermal load
- physical and mental load
- dust

Other factors are less significant and there is no need to further address them. In accordance with the qualitative and quantitative input data, obtained in the course of additional surveys, the work factors and risks will be further précised and continually updated for the entire field of occupational safety, health protection and occupational hygiene (based on continuous safety and hygiene monitoring). Prior to the commencement of works in the locality, working environment quality measurements are carried out in accordance with legislation concerning the protection of public health so as to materially propose the level of protection of intervening employees. The values thus obtained are compared with the permitted exposure limits. The methods of measurement and evaluation are guaranteed by the National Institute of Public Health. In accordance with the working environment characteristics ascertained, individual jobs may be assigned to individual categories. It is expected that most of the works thus performed are classed in the third to fifth category in accordance with Act No. 258/2000 Coll., on Public Health Protection as amended. For safety reasons it is necessary to minimize the number of jobs in handling hazardous wastes (no transloading) and immediately place them in shipment containers. In the event of a very dangerous substance or situation the works are considered an emergency task, inviting the need to use the highest level of personal protection (i.e. pressurized protective suits – OPCH 90 POV, and self-contained oxygen breathing apparatuses). If explosives or ammunition are found, the Police of the Czech Republic must be immediately alerted. In case of discovering substances listed by Decree No. 50/1997 Coll. (implementing the Act on Some Measures Concerning Chemical Weapons Prohibition) or nuclear materials it is necessary to immediately convey such information to the State Office for Nuclear Safety in accordance with Acts Nos. 18/1997 Coll. (“Atomic Act”) and 19/1997 Coll. (on certain measures concerning chemical weapons prohibition). In the event of an emergency situation the procedure is according to emergency regulations. Only nonsparking tools and aids will be used at work.

Stored dangerous chemical substances and wastes pose a grave source of danger. Their dangerous character is greatly enhanced by storing them without heed to elementary safety principles invited by occupational safety and fire prevention requirements. Generally, stores containing hazardous waste come in two categories – one with partly sorted contents and one corresponding to the original emergency. The duty to report the presence of hazardous

substances and their properties is derived from the two categories as stated above. The composition of sorted out and arranged materials is known either precisely or at least in a framework manner. During the exploratory works in the compound, large quantities of various chemicals with a wide spectrum of dangerous properties were found, including the following types in regard of potential accident:

- gaseous substances stored in pressure bottles, including toxic and combustible substances and those forming explosive mixtures when exposed to air (sulfur dioxide)
- radioactive substances, e.g. uranyl and thorium salts
- highly combustible substances releasing combustible vapors (when reacting with water or between themselves), potentially phyrophobic substances in contact with air or moisture (e.g. sodium and potassium metals)
- explosive substances and substances forming explosive mixtures (pyrotechnical materials)
- volatile substances containing toxic or caustic vapors (fluorhydric acid, hydrochloric acid, nitric acid, hydrous ammonia solution, etc.)
- substances prone to violent mutual reactions (e.g. mixtures of acids and hydroxides, or acids and peroxides, etc.)
- highly toxic and ecotoxic substances, persistent pollutants (e.g. heavy metal compounds)
- high oxidants (hydrogen and sodium peroxide, nitrates, etc.)

3.3.2 Identification of risks

To identify the risks, standard tools and methods, which are applied in similar situations in the chemical industry (eg HAZOP method "Hazard and operability of Study" and other similar methods, such as What-If, FMEA), were used. Especially HAZOP method is a powerful tool even in terms of identifying risk in the detection of illegal hazardous waste. The method was used for its universality and for the rich experience at home as well as in abroad. In addition to that, DEKONTA a.s., company which worked out a study to identify cases of…., also has the experience with this method.

The presence of the above-mentioned groups of hazardous substances helps us to identify substantial risks, the major of which were the following:

- An uncontrolled reaction of mutually incompatible chemical substances accompanied by an explosion of gases or vapors, explosion of flammable liquid vapors, or an explosion of unidentified pyrotechnical contraptions or ammunition threatening employees. Such accidents are dangerous to mainly the personnel in the storage facility and its nearest vicinity. In case of the very pessimistic scenario of the explosion of equivalent 100 kilograms of TNT in a semi-closed space, its effect within less than 200 metres (i.e. the closest buildings) will amounts to a few windows shattered but no direct threats to human lives.
- Breaking transport containers or an uncontrolled reaction of mutually incompatible chemical substances followed by leaks of toxic gases or fumes. The impact of such accident will be smaller than that described in point a) due to the use of small substance packages and reducing the development of toxicant by virtue of the speed of chemical reaction; consequently the danger again ensues mainly for workers in the compound and its close vicinity. There is the danger of contamination of the environment.
- Fire in the depot produces toxic combustion products and threatens site workers and neighboring citizens with environmental contamination. This scenario envisages

maximal risks to the broader neighborhood because the fire has released dangerous chemical substances, especially toxic metal compounds and heat-transformed compounds such as chlorohydrocarbons, pesticides etc., and their transportation by fire smoke and thermal uplift. In this case the area within about one kilometer of the accident will need to feel threatened. The fire itself is very dangerous to employees and IZS personnel due to its toxic effects and the possibility of chemicals exploding in the storehouse. Another major threat is the contamination of the environment by toxic smoke fallout and fire-extinguishing liquids escaping ground levels. It is not possible to rule out the presence of radioactive substances and their possible spread by means of combustion products.

Health risk to site workers due to possible presence of radioactive substances. Due to the heterogeneous nature of hazardous wastes stored in various situations it is necessary to expect the presence of a wide spectrum of miscellaneous dangerous substances in the working environment, with a wide range of dangerous properties (namely: H1 explosiveness; H2 oxidation capacity, H3-A high flammability, H3-B flammability, H4 irritability, H5 harmful to health, H6 toxicity, H7 carcinogeneity, H8 causicity, H9 infectiousness, H10 teratogenicity, H11 mutageneity, H12 ability to release highly toxic and toxic gases in contact with water, air or acids, H13 ability to release hazardous substances to the environment during and after their elimination, and H14 ecotoxicity). PEL is the permitted exposure limit time-weighted as the average concentration of gases, vapors and aerosols in working environment, to which, according to the present level of knowledge, workers could be exposed during an eight-hour working day without being threatened, even after lifelong working exposure, by health problems or reduced working ability and working performance. These limits are applicable to workloads with lung ventilation not exceeding 20 liters per minute. The PEL[1] is accordingly adjusted (decreased) if the workload is higher.

3.3.3 Assessment of safety aspects of the Nalžovice storage site for hazardous wastes and dangerous chemical substances and preparations

DEKONTA a.s., worked out a study concerning this issue Assessment of safety aspects of the Nalžovice storage site for hazardous wastes and dangerous chemical substances and preparations included a description of the site, definition of the source of danger, risk assessment, safety conclusions, and recommended measures to tackle this issue.

Hazardous chemical substances and preparations, found on the site along with stored combustible wastes and materials were singled out as the primary source of danger. They were all the more dangerous because they were stored regardless of the elementary safety principles applicable to work and fire prevention. Only basic information about the substances stored was available, together with a very rough estimate of their quantity at the time of the study. Even though a large part of the substances was preliminarily indentified by labels on bottles and packages, it would have been wrong to assume that the list is complete and the descriptions are reliable, and it was necessary to expect the influx of new information, in terms of both quality

*1 PEL is permissible exposure limit. It is time-weighted average concentrations of gases, vapours or aerosols in the workplace, to which the workers may, according to the present state of knowledge, be exposed during an eight-hour working time, without harming their health, jeopardizing their ability to work and performance, even if they have been in lifetime occupational exposure. The limits apply to the work load, **when the average** pulmonary ventilation does not exceed 20 l / min. If the workload of workers increases, the PEL values are adjusted in respect with that.*

and quantity, about the substances present, as it proved hardly possible to identify all the chemicals piled up.

The list of substances present, as well as the inspection of the site clearly revealed a considerable risk potential due to the toxicity, ecotoxicity, combustibility and oxidation ability of the substances as well as due to their reactivity and mutual incompatibility. When mixed, some of them release highly toxic gases (e.g. combinations of sulfites, thiosulfates, and acids), while others release toxic and corrosive gases upon spilling ((HF, HBr, HNO_3…), and reactions between them could lead to self-ignition (potassium and moisture, potassium and acids), and self-igniting yellow phosphorus was also present. There were many such dangerous combinations at Nalžovice.

Safety risk assessment

The storage facility in Nalžovice harbored a number of potential risks, the most serious of which have been identified in the scenarios quoted below:

a) Rupture of sealed containers (due to damage or spillage), release of toxic or ecotoxic fluids and fumes, intoxication of people and environmental contamination
b) Spontaneous reaction of incompatible chemical substances accompanied by the release of toxic gases or vapors and intoxication of personnel or population
c) Spontaneous reaction of incompatible chemical substances accompanied by explosion of gases or vapors, explosion of flammable liquid vapors, or explosion of undetected pyrotechnics or ammunition involving the risk of injury to personnel
d) Fire in the storage facility followed by environmental contamination

Rupture of sealed containers and release of toxic or ecotoxic liquids and vapors

There were various quantities of substances in the storage facility, which, when spilled, release toxic or caustic fumes, such as fluorhydric, hydrobromic, hydrochloric and nitric acids, hydrous ammonia solution, formaldehyde solution, etc. These substances were present in the order of liters to tens of liters; hence possible accidents would have endangered mainly warehouse workers but also citizens (employees and security personnel of an agricultural enterprise) in the nearest range of tens of meters. Fortunately, all these substances were easy to detect as they produce strong irritable smell, so the probability of exposure to them in the open, which would have led to serious health hazards, was small but not negligible. Hence such scenario of impact on the immediate environment could be rated a medium probability with rather average impacts, although the threat to intervening personnel would have been rather more serious. Therefore careful preparation and tight observance of safety rules were inevitable. A certain risk ensues from the possible escape of environmentally harmful or toxic fluids, inasmuch the storage facilities in question were inadequately protected against leaks, had no emergency tanks or other effective entrapment system, and any substance leak would freely contaminate the environment. The pig farm should have been designed so as to prevent leaks and escape of liquid manure; however, the actual technical condition of the long-disused building was not known to us. The leak and contamination scenario is quite problematic in the event of fire in the storage facility.

Spontaneous reaction followed by the release of toxic gases or vapors

This type of accident was very difficult to predict as wastes in small containers were deposited in packages (such as barrels, boxes or crates, etc.) in a chaotic way, without respecting even the elementary principles of handling dangerous chemical substances and

preparations; sometimes the containers were damaged. The fact that no undesirable chemical reaction or accident happened due to such careless handling procedures ought to be ascribed to sheer luck, rather than to safety-conscious management. The fact that the wastes were deposited in lightweight containers led, similarly as in the case discussed in the previous section, basically to endangering personnel and their immediate environment. The scenario thus described could be considered fairly probable and its consequences would have been similar to the previous case.

Reaction accompanied by explosion; explosion of combustible vapors; other explosions

There existed a certain probability of an explosion in the Nalžovice storage depot. Any explosions, including very small blasts, could and indeed would have triggered fire and the release of hazardous substances multiplying the impact of possible explosions.

- Undetected explosives, ammunition and pyrotechnical materials. Due to the unknown quantity and type of such materials, it is not possible to produce a quantitative estimate concerning this particular event. However, the risk would last until the wastes are sorted out and checked. It should be noted that residues of spent pyrotechnical contraptions were found near the storage depot.
- Reaction of incompatible chemicals directly leading to an explosion. This scenario was very improbable and would not have had major impacts as these combinations are limited and there exist relatively few substances reacting in this way. However, mixing oxidants with flammables would have been a serious problem as such mixes could have caused an explosion triggered by another chemical reaction. It was quite difficult to estimate the possibility of producing explosive organic peroxides by chemical reactions involving organic solvents and atmospheric oxygen, but many explosions have occurred in laboratory and industrial conditions (usually involving evaporation or distillation products), and substances such as unstable diethyl ether, prone to similar reactions and evaporation, were present in the storage depot.
- Mutually incompatible chemicals reacting to produce flammable gases, especially hydrogen. Here the probability was higher, because acids present in large quantities may react with various metals (contained e.g. in scrap metal mixed with waste acids) to produce hydrogen, whose explosive limits are very broad and whose explosions are known to have massive destructive effects. Also present were potassium and sodium boron hydride that release hydrogen when reacting with water. Moreover, hydrogen tends to accumulate in upward-closed “pockets”, for example at ceilings or in upturned vessels, and is easy to initiate.
- Explosive vapors of solvents and other flammable liquids spilled on the floor of storage rooms or leaking from poorly sealed containers. Such explosions can be quite powerful, may disrupt structural statics and are likely to cause massive fires. However, an explosion of this type requires the evaporation of a larger quantity of combustible substances, which may happen only in case of spilling a large quantity of flammable liquids. At the time of completion of this study there was no information available whether the electrical installations on the site were non-explosive or whether sufficient provision was made to prevent the risk of static electricity and other triggers. However, workers faced no small risk of explosion of empty containers with residual flammable liquids, and it was vital to observe strict safety rules.

Fire and its consequences

This scenario envisaged the worst effects but luckily it was the least probable. The above scenarios indicate many possibilities of starting fire also due to negligence, and we certainly

could ill afford to underestimate the risk of the depot being set on fire by a third person, whether through negligence or on purpose, such as in a effort to complicate investigations. A fire in the storage depot would cause massive environmental contamination leading to immediate and chronic threat to the health of the Nalžovice population.

The environment would be contaminated in two principal ways, i.e. noxious fumes and contaminated water used by firefighters. This scenario would lead to the contamination of ground and, in unfavorable circumstances, also of the influent stream (Musík Brook). The situation would probably be further aggravated by the use of firefighting substances that could increase the outflow of rinsed wastes. The mechanics of washing away toxic products of burning chemical storage facilities is well documented by many industrial accidents; the contaminated water used in extinguishing a fire in the Sandoz chemical factory in Basel in 1986 poisoned over 200 kilometers of the river Rhine. However, an even worse effect than earth contamination in the thalweg below the depot would be produced by noxious fumes generated by burning chemical substances including photo chemicals, especially toxic volatile compounds of metals such as arsenic, cadmium, mercury, lead etc. There were kilograms of such metals present in the storage depots; they would evaporate in fire and descend from smoke within a range of probably several hundred meters. Due to the prevailing western winds, the population of Nalžovice could be directly threatened during the fire and subsequently earth and vegetation would be contaminated by the metals, and decontamination would be necessary. The scope of toxic effects would be limited to the nearest environment which, however, hosts an institution for woman clients with limited freedom of movement, which would cause evacuation problems. The toxic effects of smoke from fires are double – acute (sulfur dioxide) and belated (toxic metals).

4. Conclusion

A comprehensive awareness-building program focusing on the environmental impacts of hazardous substances and wastes and on health protection would require considerable investments in the provision of special instruction aids and the training of key target groups to correctly and effectively convey information concerning hazardous wastes. On the other hand, however, it could be assumed that the provision of such information could exercise a much-needed effect from the vantage point of environmental awareness, economics (reducing immediate and prospective sickness rates) and social situation (increasing the quality of life) and become quite effective from the societal point of view. In addition, such comprehensive education could greatly improve the environmental awareness of citizens.

Regrettably, the hazardous waste storage facilities we have discussed are but the tip of the proverbial iceberg of various quantities of variously hazardous wastes and chemicals hidden in defunct industrial buildings, warehouses, residential blocs, etc. Such dumps pose a potential risk of immense proportions to the environment.

The abovementioned cases, together with illegal imports of hazardous waste from abroad and the ecological burden of defunct industrial installations have inspired our analysis and led to the adoption of many measures.

One of the measures that have come to fruition was the compilation of a list of problem sites in 2007. Most regions have each singled out more than three localities; however, the Pardubice, South Moravian and Vysočina regional offices failed to single out localities while some other regions cited completely unsuitable sites.

The Czech Environmental Inspectorate (ČIŽP) has checked 109 localities in a nationwide crash program. No hazardous wastes or chemicals were found in any of these buildings and compounds, which would be delivered there for the purposes of storage.

An analysis of the risk of storing hazardous wastes and chemicals in the former pig farm in Nalžovice showed the site as dangerous to the surrounding area, especially in the event of fire. Although it was possible to reduce the risk posed by this storage depot by taking stock of and sorting out hitherto unsorted wastes, this move alone did not eliminate the risk. That was possible to achieve only by eliminating the source of the danger, i.e. hazardous wastes and chemical substances, and their professional removal. Special attention was paid to the nearby institute of social care and instructing its employees on action in the event of fire and on ways of effective fire prevention, localization and elimination.

Importantly, individual public administration bodies possess sufficient powers to take action to prevent incidents of the type described above.

In order to prevent undesirable situations in connection with the illegal handling of chemical substances and hazardous wastes the Government of the Czech Republic passed Resolution 1076 on 27 August 2008, introducing system-based measures to be implemented by the end of 2009. Chief among them is an amendment to the act on wastes, unification of the methods of granting permission by regional offices to the operators of establishments handling hazardous wastes, and intensifying control activities through the adoption of an online information system monitoring the movement of dangerous substances and wastes, the introduction of a system of handling unused chemicals, and formulating a system of methodological guidance of and assistance to self-governing bodies in the field of waste and chemical waste management.

However, in spite of all the above measures, it is necessary to emphasize the role of prevention, because enforcement is always the last resort. Most of the cases described above can be prevented. One of the necessary conditions for this is the human factor, as evidenced by the list of various mistakes, for which public administration officials were chiefly responsible. No amount of well-coordinated legal regulations alone can guarantee the elimination of such incidents in the future.

Analysis of the abovementioned emergency situations also goes to show that not even the introduction of a specific type-plan for the elimination of such emergencies presents a solution, as incidents tend to differ in their key aspects and every case is quite unique. It is therefore necessary to consistently apply existing IZS policies and to effectively work with public administration bodies with an emphasis on consistent control and vigorous action in the event of detecting a potentially risky case.

References:

[1] Dokumentace pro jednání Bezpečnostní rady Kraje Středočeského kraje, Bezpečnostní rady státu a usnesení vlády ČR ze dne 27. srpna 2008 č. 1076

[2] Ministerstvo životního prostředí, Odbor odpadů, *Informační pomůcka k problematice nebezpečných odpadů, rok 2007*

[3] Společnost DEKONTA a.s., Bezpečnostní a realizační projekt: Identifikace, *inventarizace a odstranění nebezpečných chemických látek a odpadů v bývalém objektu vepřína v Nalžovicích, z 16.7.2007*

Contact address:

Ing. Markéta Kubečková
Ústav ekonomiky a management
Fakulta ekonomicko-správní
Univerzita Pardubice
Studentská 10
Pardubice
Email: Marketa_.Kubeckova@seznam.cz
Phone: 733 347 362