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1. Introduction

The contribution deals with the problems of prioritization and analysis of risks of small and medium-sized enterprises in association with emergency planning. The risk analysis is the basis of planning measures to secure the protection of population in case of accident. In the wording of law on major accident prevention, measures with operators of group B (upper tier establishments) are planned by means of external emergency plans. However, small sources of risks (water treatment plants, ice stadiums, food processing plants, technical gas storage facilities, and others) are significant sources of risks to their surroundings as well. The need to assess even risks of these smaller sources follows from many other factors, especially accidents that have occurred so far, stress laid on the reduction of risks of these technological facilities, the necessity of preventing accidents within the frame of land planning, i.e. the approval of location of new plants in relation to residential and protected areas, the necessity of improving emergency preparedness, planning the measures to secure the protection of population, etc. The performing of risk assessment and subsequent measures to reduce the risks can contribute to the prevention of accidents, the reduction of accident consequences on human lives, the environment and on asset and cultural values, or they can prevent the unsuitable location of a new plant in the vicinity of human settlements and/or protected areas from the point of view of environmental protection. The prioritization and the assessment of risks contribute to a better level of awareness of risk sources, accident consequences and endangered target groups. Prepared accident scenarios help improve emergency plans and preparedness for effective accident response.

In the Czech Republic, the area of emergency planning and risk analysis is laid down above all in the act on integrated emergency system, according to which regional emergency plans and external emergency plans are also prepared in the framework of preparation for extraordinary events. The external emergency plans are specific and deal with measures to secure the protection of population, the environment and property for so-called area of emergency planning zone, which is determined after the act on major accident prevention for large operators classed into the group B. The regional emergency plan concerns measures in relation to all identified extraordinary events in the region analysed (e.g. floods, releases of hazardous materials, traffic accidents, earthquakes). In the area of risk analysis, the regional emergency plan provides room for the prioritization of not only individual types of extraordinary events, but also for the prioritization of risks. Measures to secure the protection of population, the environment, asset values and critical infrastructure are dealt with either in the regional emergency plan or separately in the frame of operational plans and emergency cards (e.g. Operational plan for securing protection in case of special flood in the hydraulic structure, Emergency card for a release of ammonia under critical meteorological conditions in the ice stadium).

2. Regional Risk Prioritization and Analysis

For the purpose of risk prioritization, many methods exist. In the Moravian-Silesian Region (henceforth referred to as MSR), the prioritization of types of extraordinary events was done by scoring the individual types of extraordinary events, from which a need to make a more detailed analysis of selected types of extraordinary events followed (see Table 1). Measures for extraordinary events of the category of risk level IV are dealt with within the MSR Crisis Plan, measures for extraordinary events of the categories III and II in the MSR Emergency Plan. In the case of extraordinary events with the risk level I, they are expected to be responded by routine activities of units of Integrated Emergency System.

For the prioritization and the analysis of risk sources with hazardous materials, the IAEA-TECDOC-727 (IAEA, 1996) method is used most widely. This method does not make high demands on the persons involved in solving; however, it has its own limits and restrictions on uses. Principally, the method evaluates the level of risk in the region from the point of view of endangering human lives and health. Nevertheless, it does not consider a possibility of damaging the environmental compartments

and asset values in the area analysed. Furthermore, this method cannot be used to assess objectively the units of low-pressure storage of flammable gases occurring in the Moravian-Silesian Region in large numbers (gasholders with metallurgical gases).

For the above-mentioned reasons, the method REHRA (Rapid Environment and Health Risk Assessment) (REHRA, 2001) of World Health Organization (WHO) was used for the prioritization of stationary risks in the area of MSR. This is an indexing method that assesses separately the hazardousness of a locality, the vulnerability and a zone affected by the accident for the purpose of risk analysis. The hazardousness of the locality is given by the risk of occurrence of natural threats (floods, seismic activity, landslide), the quantity and hazardousness of the material and the hazardousness of the establishment. The hazardousness of the material is assessed on the basis of physical-chemical and toxicological characteristics of the material in combination with the quantity which may be released into the surroundings. The hazardousness of the establishment is a parameter indicating the technical level of the establishment and measures leading to the increase in safety. Total vulnerability is a combination of vulnerabilities of population, the environment and economic activities, see Figure 1. What is assessed is the presence of defined groups within the zone affected by lethal accident effects. To determine the zone affected by the accident, the method uses primarily the principles of IAEA-TECDOC-727. With reference to the above-described disadvantages of this method, the method was not used for this part of assessment and was replaced by other methodological approaches (e.g. modelling the lethal and wound concentrations by means of software Aloha 5.4. (ALOHA, 2006)).

When assessing the vulnerability of population, categories of so-called objects of importance, in which groups of people concentrate (e.g. educational facilities, hospitals, cultural amenities and sports fields), are assessed in addition to the categories of residents and temporary residents of the region. Environmental vulnerability is given by a possibility of contamination of surface water, soil environment and biotic compartment of the environment. Economic vulnerability takes into account the presence of structures of industry, trade and agriculture.

The resultant index is given by a combination of total vulnerability and hazardousness of a locality. Risks are assessed on three levels. In the area of MSR, 65 significant sources of risks in the categories of medium and high risks were identified (of total 260 analysed) (see Figure 2). Significant risk sources are mainly the structures where liquefied toxic gases and metallurgical gases are handled. For the significant risk sources in the area of MSR, measures for a case of accident occurrence are planned in a form of external emergency plan or in a form of so-called emergency cards of Integrated Emergency System. Results of assessment considering the proportions of specific risk sources in the analysed area are summarised in a graph in Figure 3.

3. A Proposal for Guidelines on Risk Assessment

From the above-mentioned information and acquired experience, the following proposal for the guidelines on the assessment of risks of all risk sources in the region was prepared. The proposal for the guidelines is based on the following three levels of risk assessment and management:

1. the preliminary assessment of risks to the surrounding population, the environment and asset values,
2. the detailed assessment of social, economic and environmental risks,
3. the management of accident risks and measures to reduce the risks.

For the first step of the guidelines – preliminary risk assessment, approaches used in various countries were compared at first. In the Czech Republic, basic threshold quantities of hazardous materials are laid down in the Act No. 59/2006 Coll., on major accident prevention. These threshold values adopted from the European Seveso II Directive, however, consider merely the largest sources of risks (about 150 industrial enterprises in the Czech Republic), and thus smaller establishments, which may under certain conditions represent significant risks of major accidents, are not included. For this reason, these thresholds were compared with the Dutch approach in the methodology Purple Book CPR 18E (TNO, 1999), with American thresholds determined by the organisation EPA for including into RMP (Risk Management Program) (EPA, 2002), further with thresholds given in the guidelines for integrated risk assessment IAEA-TECDOC-994 (IAEA, 1998), which were identical with the approach of the method REHRA (REHRA, 2001) and with thresholds stated in the European project ARAMIS (ARAMIS, 2004), in the framework of which a new harmonized methodology ARAMIS was prepared.

Results of the comparison for three selected materials occurring most frequently in the unclassified risk sources are shown in Table 2.

It follows from the table that the thresholds of Czech act on major accident prevention (and similarly the thresholds of European Seveso II Directive) are approximately 10 times higher than legal thresholds in the United States and several times higher than thresholds recommended by accepted international methodologies. From this difference it is evident that in the Czech Republic there is a real need for risk assessment for establishments with lesser quantities of hazardous materials than given in legislation concerning the area of major accident prevention.

Below a brief summary of the proposed guidelines is presented.

The 1st level – Identification and preliminary risk assessment

Installations are subject to risk assessment by this methodology if the quantities of hazardous materials present in them exceed the thresholds set. Of the approaches presented above, the approach of the methodology ARAMIS was taken for the proposed guidelines owing to its comprehensiveness and the division of materials also according to their states of matter. Specifically, these ARAMIS thresholds were determined in the Belgian method VADE MECUM (DGRNE, 2000) used for the selection of installations requiring risk analysis.

In this phase of assessment, the following steps are to be taken:

- To select major risk sources
    1. in the territory of administrative unit (by the method REHRA),
    2. on the premises of the establishment (by the selection method from Purple Book).
- To find the distances between the closest residential area and the risk sources.
- To find the distances between significant elements of the environment, such as watercourses, groundwater sources and elements of territorial system of ecological stability (ÚSES) – biocentres and biocorridors and the risk sources.

If:

a) a population occurs within 100 m from the risk sources and simultaneously these installations were assessed as major risk sources from the point of view of present hazardous material quantity, the detailed assessment of risk to the population and asset values must be done.

b) there is a potential possibility of damaging the environmental compartments (surface water, groundwater, soil, biotic components), the analysis of accident consequence on the environment must be carried out.

The 2nd level – Detailed risk assessment

The goal of detailed risk assessment is not only the individual assessment of accident affected zones but also the evaluation of existing safety measures and risk assessment.

a) For the detailed assessment of risks to the population, the new ARAMIS methodology is recommended or other methodologies, such as Purple Book, CPQRA, etc., which enable the determination of zones affected by the lethal and wound accident effects.

b) For the analysis of consequences of accidents on the environment, the H&V Index method (MZP, 2003) or other approaches to modelling the spread of contaminant in the environmental compartments can be recommended.

The 3rd level – Risk management

The evaluated risks that were analysed in detail must be further monitored and evaluated in the system of risk management, whose principal elements, in addition to preliminary examination, are as follows:

- Planning (determination of system policy, analysis of sources and needs, determination of goals and priorities)
- Realization (determination of responsibilities and competence, introduction of system of communication, training and education, procedures in the area of emergency planning)
- Check and audit (internal check of set goals, audit of various levels)
- System examination (presentation of results, effectiveness, system evaluation)

The whole recommended procedure for the assessment of risks of unclassified risk sources is clearly arranged in Figure 5.

4. Emergency Planning as a Tool for Taking Measures

In the area of major accident prevention, measures are planned by means of external emergency plans. The external emergency plans are prepared only for operators classed into the group B. By comparing the outputs of prioritization by the method REHRA with the act on major accident prevention, it can be stated that the wording of this act concerns with not all important sources of risks. Even unclassified operators may be significant risk sources and may endanger the surroundings in the case of accident. To secure the protection of population and the external environment, the Fire and Rescue Service of MSR proceeded to the processing of so-called emergency cards of Integrated Emergency System (henceforth referred to as IES).

The emergency cards of IES are processed for significant risk sources with the risk levels II and III. They are a tool for decision making in case of accident associated with a release of hazardous material. They define basic regulations concerning techniques of response units. From the practical point of view, they are processed in the A 4 format. With regard to the fact that in the majority of cases, toxic dispersion occurs and that in the Czech Republic generally a “deterministic” approach to risk analysis exists, the precondition of which is the evaluation of the worst possible scenario, and thus also dispersion under “critical” climatic conditions, the cards are processed for individual risk sources as variants for the neutral (stability class D (convection), ground wind velocity of 3 m/s, air temperature of 20°C) and the critical (stability class E (inversion), wind velocity less than 1 m/s) meteorological conditions (EPA, 2002; ALOHA, 2006). In addition, in industrial concentrations the inversion situation occurs in one third of days of the year.

The text part contains a brief description of hazard source, hazardous properties of material, the determination of zones affected by the accident (so-called lethal and wound zones), basic information, the organisation of response action and activity of units, the number of threatened persons, objects of importance, broadcast systems for population warning. Great emphasis is put on the graphic part created in the environment of geographic information systems (GIS). GISs are not only the visualisation of outputs; they are also a tool for the analysis of the region. This analysis enables the evaluation of covering the region by a signal of alarm, the evaluation of routes of access to the installation, the planning of closure of endangered area, the visualisation of action distance of accident effects and the visualisation of endangered objects of importance, and others (see Figure 4).

5. Conclusion

The road to securing the protection of population, the environment and property in the course of extraordinary events leads through the process of emergency planning, whose integral part is the risk analysis; because if we are not able to identify and analyse the risk, then we are not able to fight it effectively. The process of emergency and crisis planning reflects in itself not only the preparation of plans themselves, but also the determination of tasks and goals to secure safety, the examination of the set tasks, and further a drill in the determined procedures by exercising preparedness for accidents.

As the sources of risks unclassified under the legal effect of Seveso II Directive, e.g. food complexes (breweries, dairies, meat combines), sports facilities (ice-stadiums, swimming pools) and further water treatment plants, pressure cylinder storage areas, refuelling stations and LPG tanks were identified. Results acquired from risk assessment point to a necessity of managing the risks of even these unclassified sources of risks that may represent significant risks of major accidents.

The complete solution to the issue of major accident risk management requires an integrated approach based on the knowledge of engineering, natural and social sciences. The procedure of assessment of risks of unclassified risk sources recommends the operators of these establishments a suitable approach by means of several levels, when the depth of and demands for assessment increase gradually. The main aim in the framework of system of managing risks in the region was to contribute to the prevention of accidents to unclassified risk sources. The procedure of risk analysis is aimed at identifying the risk as well as at providing the operators of unclassified risk sources with help in voluntary risk assessment, when it recommends a suitable procedure of solving and offers available tools, and in connection with securing the protection of population, the environment and property to plan and take desirable measures in the frame of activity of units of the Integrated Emergency System.

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References

ALOHA, 2006, Software ALOHA 5.4. Areal Locations of Hazardous Atmospheres, US EPA, 2006, http://www.epa.gov/ceppo/cameo/aloha.htm

ARAMIS, 2004, Accidental Risk Assessment Methodology for IndustrieS in the framework of the SEVESO II directive, User Guide, contract number: EVG1–CT–2001–00036, http://aramis.jrc.it

DGRNE, 2000, Vade Mecum: Spécifications techniques relatives au contenu et à la présentation des études de sécurité, Cellule Risque d'Accidents Majeurs, Direction Générale des Ressources Naturelles et de l'Environnement, Walloon Region Ministry, Belgium,

EPA, 2002, RMP Program Overview, U.S. Environmental Protection Agency, Chemical Emergency Preparedness and Prevention, http://yosemite.epa.gov/oswer/ceppoweb.nsf/content/RMPoverview.htm

IAEA, 1996, IAEA-TECDOC–727, Manual for the classification and prioritisation of risks due to major accidents in process and related industries, International Atomic Energy Agency, Austria, 1996

IAEA, 1998, Guidelines for Integrated Risk Assessment and Management in Large Industrial Areas, IAEA-TECDOC-994, IAEA, Vienna, ISSN 1011-4289

MZP, 2003, Ministerstvo životního prostředí: Metodický pokyn odboru environmentálních rizik pro stanovení zranitelnosti životního prostředí metodou ENVITech03 a analýzu dopadů havárií s účastí nebezpečné látky na životní prostředí metodou H&V index, *Věstník MŽP* 3/03,

REHRA, 2001, WHO/Europe - REHRA methodology (Rapid Environment and Health Risk Assessment) [on-line]. c2001, [cit. 2004-12-10]. Available at: <http://www.euro.who.int/watsan/CountryActivities/20030729_11>.

TNO, 1999, Guidelines for Quantitative Risk Assessment, “Purple Book”, CPR 18E, The Hague

Table 1: Prioritization of types of extraordinary events on the level of Moravian-Silesian Region

Type of extraordinary event	Risk level
Flood, special flood, earthquake, epidemic, epizootic.	IV
Long-term heat and drought, methane release, **fire of solid, liquid and gaseous substances**, release of radioactive substances, **release of toxic substances**, **release of explosive gases and vapours, release of oil products**, accident in road, rail, air and pneumatic transport, failures in gas, electricity and heat supply, failures in technological processes, terrorism and diversion activities.	III
Gale, cyclone, rainstorm, landslide, earth void collapse, natural fires, **explosion of gases, vapours, dusts**, failures in water and/or fuel supply, failures in telecommunication networks, organized crime.	II
Hailstorm, glaze, ice, snow calamity, pest attack, temperature inversion, failures in raw material supply, immigration waves.	I

Note: Those events are accentuated that concern the releases of hazardous materials analysed further by the method REHRA.

Figure 1: Principle of assessment by the method REHRA

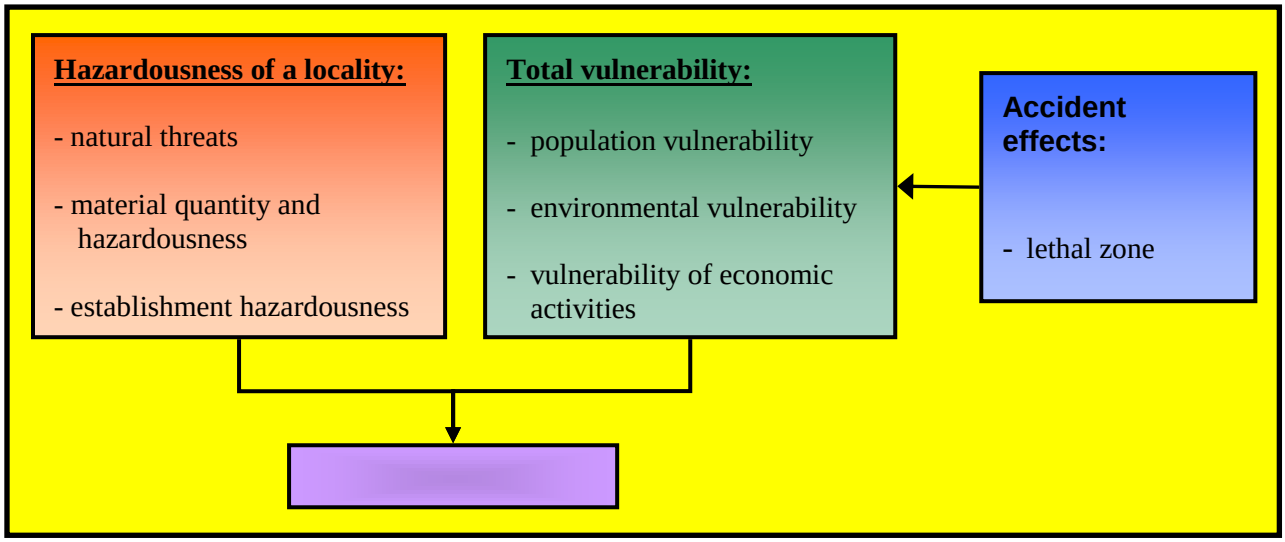

Figure 2: Proportions of risk levels in MSR

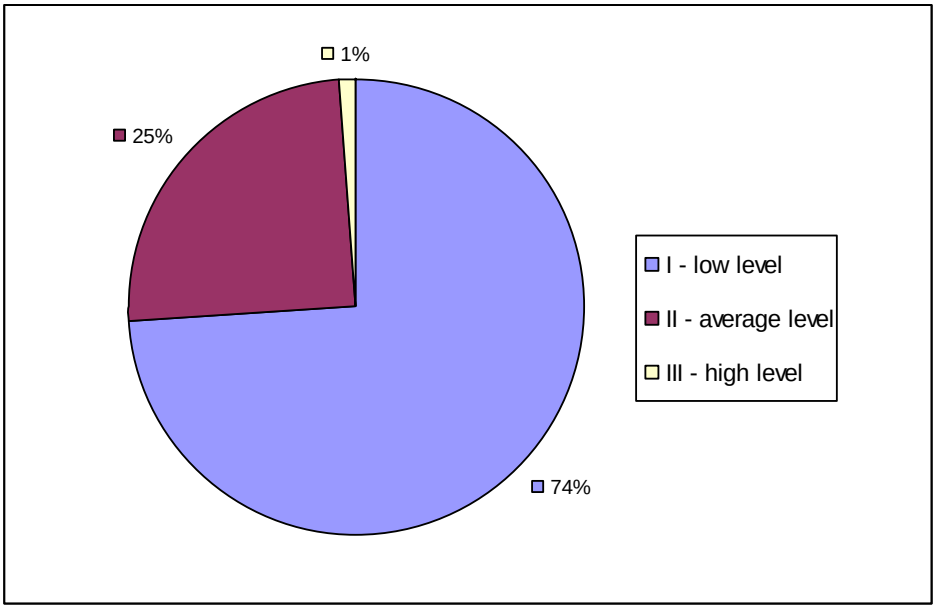

Figure 3: Risk level and proportion of individual risk sources in MSK

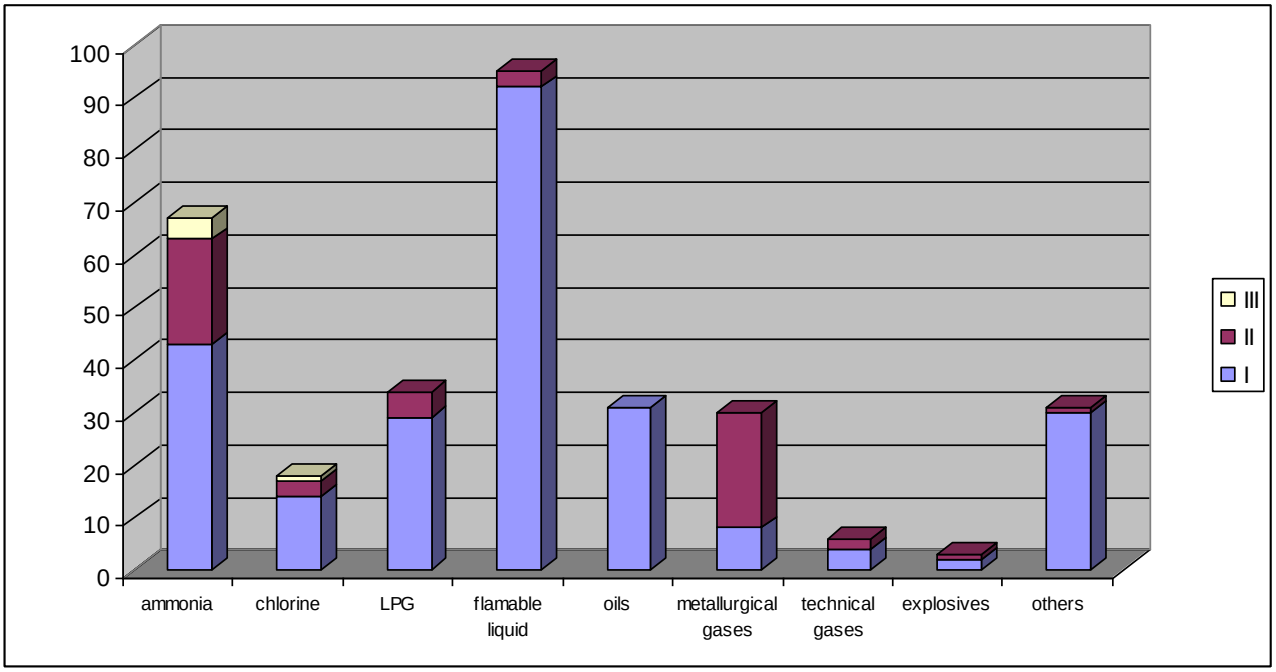

Table 2: Comparison of threshold quantities of hazardous materials (in tonnes)

Hazardous material	Seveso II	Purple Book	U.S. EPA	IAEA-994	ARAMIS
Ammonia	50	3	approx. 4.5	3	1
Chlorine	10	0.3	approx. 1.1	0.3	1
LPG	50	10	approx. 4.5	10	1

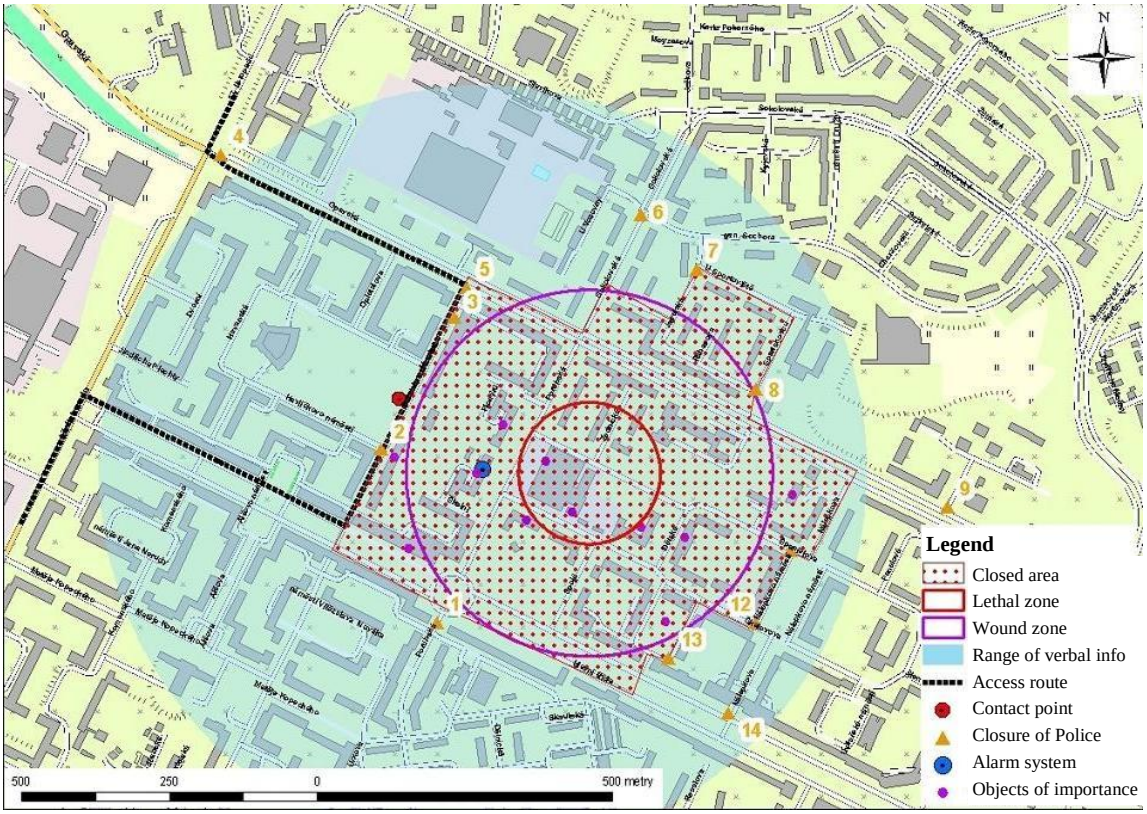

Figure 4: An example of graphic part of emergency card of Integrated Emergency System

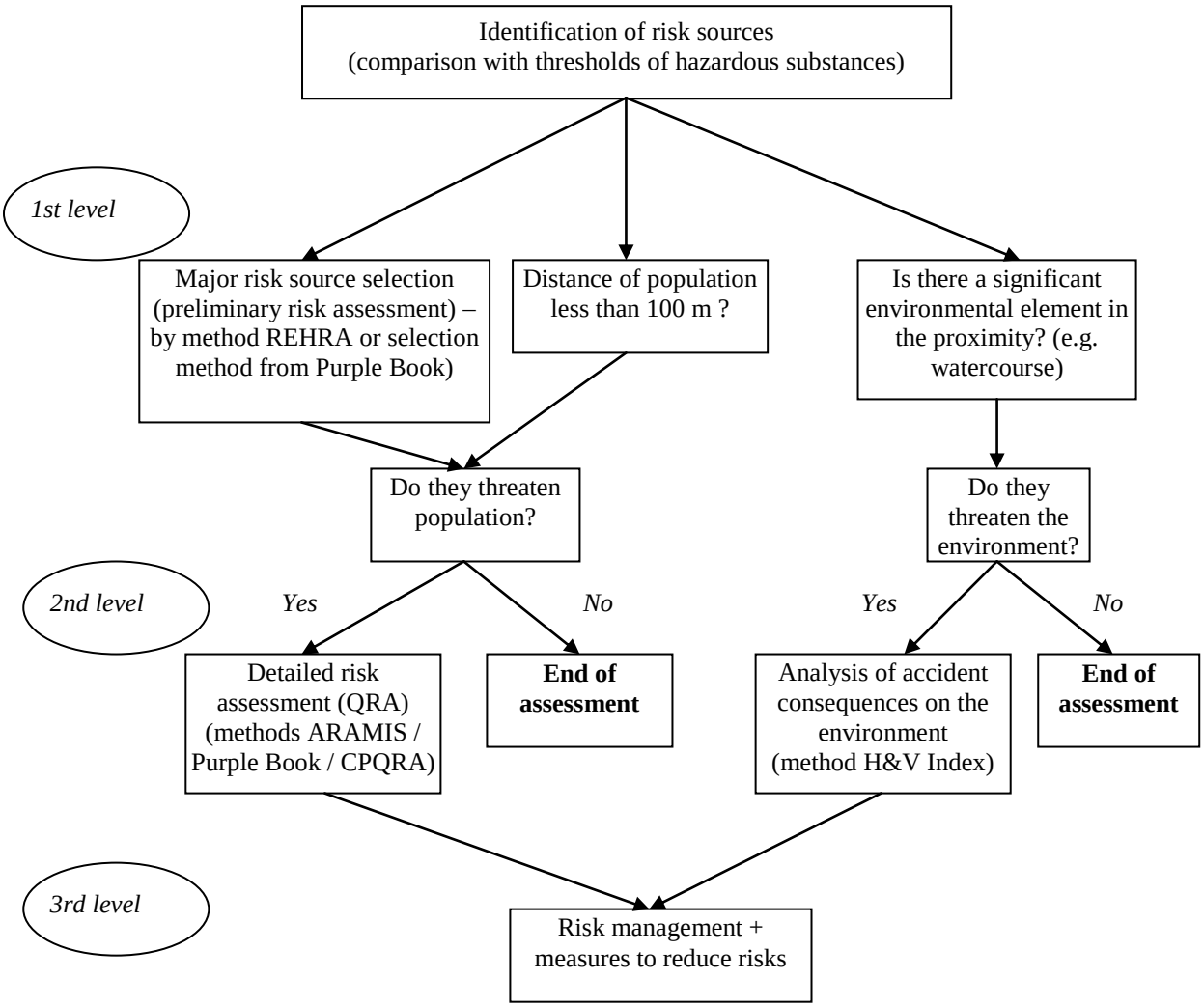

Figure 5: A recommended procedure for the assessment of risks of unclassified risk sources