

## TECHNICAL AND TECHNOLOGICAL EMERGENCIES AS A SEGMENT OF SECURITY THREATS – INDUSTRIAL EMERGENCIES

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### Abstract

The main topic of this scientific work are technical and technological emergencies as a segment of security threats with special emphasis on industrial emergencies. During the development of this work mainly methods those are used are explicative, descriptive and statistical analysis, and content analysis. There is described and explained classification of emergencies as well as technical and technological emergencies. Special emphasis is given to industrial emergencies. There were described and explained industrial production aspects. Especially, there were described industrial emergencies – emergencies related to hazardous materials and mining emergencies. Additionally, there are presented some diagrams and map related to technical and technological emergencies and industrial emergencies. The aim of this scientific work is to highlight the risk of industrial emergencies, as an important segment of security threats.

**Key words:** Emergency Management; Security; Emergencies; Technical and Technological Emergencies; Industrial Emergencies.

### INTRODUCTION

States of the modern world are faced with many forms of security threats, including the phenomena that lead to emergencies. Since the beginning of man

emergencies cause starvation and suffering of the population, country and society as a whole, contributing to the social disorder and reducing the economic capacity of the country. Various forms of emergencies have different implications on the state and society, but definitely the greatest consequences remain after wars, among which the most difficult conflict was the Second World War, and after natural disasters, which usually lead to great suffering of the civilian population. The Second World War is the biggest disaster that has befallen humanity, and resulted in a loss of 60 million lives. (Weinberg, 1994, p. 894). Also, Spanish fever was fatal and in the period 1918–1919 it killed about 50 million people (Taubenberger & M, 2006, p. 15). Taiping Rebellion (1850–1864), a conflict of imperial China under the Qin dynasty against supporters of converts to Christianity of Hong Xiuquan, the worst conflict in the history of China, has killed 50 million people (Lone, 2007, p. 24). The First World War had over 8 million victims (Howard, 2002, p. 122) while it is estimated that the Russian civil war had between 7 and 14 million dead (Bullock, 2008, p. 133).

Besides the wars, the highest death toll is related to natural disasters. Only in the last century and the beginning of this century, natural disasters have caused millions of victims: The earthquake in Haiti in January 2010 took the life of 230,000 people; The earthquake and tsunami in the area of Sumatra in December 2004 were murdered in South East Asia over 225 thousand people; During the floods in August 1971, which hit the area of Hanoi, in the former North Vietnam, it has been lost about 100 thousand lives; The eruption of the volcano Nevado del Ruiz in Colombia in November 1985 caused the death of at least 25 thousand people (The world's worst natural disasters: Calamities of the 20th and 21st centuries, 2010).

Apart from wars and natural disasters, many lives were carried away by different accidents of technological character. Fire in the Church of the Society of Jesus in the Chilean city of Santiago, in the middle of the nineteenth century, has killed about 2500 persons (Terrific Tragedy in Chili, 1864). Emergencies with a large number of victims are frequent in traffic: Aviation accident on the Spanish island of Tenerife in 1977 had resulted in 583 dead persons (Correction of the Report on the accident involving aircraft BOEING 747 PH-BUF of KLM and BOEING 747 N 736 PA of PANAM, 1978); Marine accident of the ferry *MV Doña Paz* in the Philippines in 1987 took the life of 4341 persons (Philippine ferry survivor found at sea, 2009); The train accident of the train *Queen of the Sea* in Sri Lanka, in 2004, killed more than 1,700 people (Steele, 2004).

Among the technical and technological emergencies may emphasize individual accidents which belong to the industrial emergencies and often put to death many lives. Thus, in the explosion of ammunition in the Canadian city of Halifax in 1917, died about 1600 persons (Halifax Explosion Remembrance Book; McAlpine's Halifax City Directory, 1918) and in an explosion in the Nigerian city of Lagos in 2002 killed more than 1,000 people (Toll in Blast at Nigerian Armory Exceeds 1,000, 2002). But the biggest disaster occurred in pesticide factory in the Indian city of Bhopal in 1984 where died 10 000 people (Abkowitz, 2008).

Different natural, technical and social disasters, including industrial accidents, are the cause of a number of victims and suffering of people but are also a source of suffering and weakening of the economy of countries' economic potential. A large number of victims is characteristic of poor countries, ie. the countries of so called Third World (Indochina, Insulindia, Indian Subcontinent etc.).

Technical and technological advances will have the dual affect on industrial emergencies' threats. On the one hand, better safety standards will reduce the number of industrial accidents but in poor countries, with old plants, the risk of industrial accidents will grow due to aging machinery and equipment. On the other hand, new technologies will provide new forms of threats and "enrich" the diversity of industrial emergencies.

## DEFINITION OF AN EMERGENCY

Definition of emergency can be viewed from two main aspects – linguistic and scientific. The scientific aspect means defining the notion of emergency, while the linguistic aspect relates to the different terms of an emergency in various languages. Because of the danger which may in certain circumstances to escalate into emergencies with different consequences, it is very difficult to formulate a single, comprehensive and precise definition of an emergency, which would include all its characteristics and specificities (Štrbac, 2008, pp. 15-16).

In Serbian, for an *emergency* it is used a term *emergency situation*. According to Katarina Štrbac emergencies are extraordinary, disturbed, unwanted and harmful society condition which is caused by the activity of the human factor, the natural forces and other large scale harmful events, causing great losses to people, flora and fauna,

environment, enormous material destruction and paralyzing the functioning of constitutional order (Štrbac, 2008, p. 16). In the Serbian *Emergency Act (Zakon o vanrednim situacijama*, Article 8, Paragraph 1) emergency is defined as "a condition in which the risks and threats or the consequences of disasters, emergencies and other dangers for the population, the environment and property are of such scope and intensity that their formation or the consequences can not be prevented or eliminated by regular actions of competent bodies and services, so for its mitigation and removal is necessary to use special measures, forces and resources with the enhanced mode" (Zakon o vanrednim situacijama, p. 3).

In Cambridge International Dictionary of English for emergency it is said that this is something dangerous or serious, which happens suddenly or unexpectedly, and needs immediate action, in order to avoid harmful results (Cambridge International Dictionary of English, 1995, p. 450). In Oxford Advanced Learner's Dictionary it is said that emergency is a sudden serious and dangerous event or situation which needs immediate action to deal with it (Hornby, 2005, p. 409). Webster's Revised Unabridged Dictionary says that emergency is sudden or unexpected appearance; an unforeseen occurrence or combination of circumstances which calls for immediate action or remedy (Webster's Revised Unabridged Dictionary, 1913, p. 484).

According to the Canadian *Emergencies Act* emergency is "an urgent and critical situation of a temporary nature that: a) seriously endangers the lives, health or safety of Canadians and is of such proportions or nature as to exceed the capacity or authority of a province to deal with it; or b) seriously threatens the ability of the Government of Canada to preserve the sovereignty, security and territorial integrity of Canada" (Emergencies Act (1985, c. 22 (4th Supp.)), 2010, p. 2). The United Kingdom Government defines emergency as: an event or situation which threatens serious damage to human welfare in a place in the UK; an event or situation which threatens serious damage to the environment of a place in the UK; or war, or terrorism, which threatens serious damage to the security of the UK (Emergency Response and Recovery, 2009, p. 9). In American *Dictionary of Homeland Security and Defense* emergency is: 1) Any incident, human caused or natural, which requires responsive action to protect life or property; 2) Any occasion or instance for which, in the determination of the President, federal assistance is needed to supplement state or local efforts and capabilities to save lives and to protect property and public health and safety, or to lessen or avert the threat of a disaster or catastrophe in the United States;

3) An event that may be managed locally without the need of added response measures or changes to procedure; 4) A sudden occurrence demanding immediate action (O'Leary, 2005, p. 155).

The notion of emergency is not precisely defined in other languages too. In Russian it is used a term *чрезвычайная ситуация* (*chrezvychaynaya situatsiya*) (Bošković, 2007, pp. 693, 816). According to Rezchikov and Tkachenko, emergency is an event in a particular territory (aquatorium, object), originated as a result of accidents, hazardous natural phenomena, catastrophe, natural or other disasters, which can cause human casualties, damage to human health or the environment, material damage and disruption of daily life (Резчиков & Ткаченко, 2006, p. 254). A similar definition is given by the Russian federal law on protection from emergencies (Федеральный закон от 21.12.1994 N 68-ФЗ (ред. от 30.12.2008) "О защите населения и территорий от чрезвычайных ситуаций природного и техногенного характера" (принят ГД ФС РФ 11.11.1994, с изменениями на 19 мая 2010 года)). In German state of emergency is called *Notstand* (Zečević, 2010, p. 316). A term *Notfall*, with the term *Notfallsituation*, is used to denote an emergency (Schenk, Für den Notfall vorgesorgt, 2009, pp. 4-47). In French emergency is called *situation d'urgence* (Nikolić, Francusko-srpski srpsko-francuski rečnik, 2005, pp. 341, 382) (Guide ORSEC départemental – Méthode générale, 2006, pp. 13-45), and similar case is in other Romance languages. In Italian *stato di emergenza* is a state of emergency. The term for an emergency is *situazioni di emergenza* (Pavlović, 2006, p. 95) (Schenk, Previdanza per le situazioni di emergenza, 2009, pp. 4-47). In Spanish, emergency is denoted by the term *emergencias* (Nikolić, Špansko-srpski srpsko-španski rečnik, 2006, p. 229) (Schenk, Preparados para las emergencias, 2009, pp. 4-47). The situation is similar in other languages.

Thus, we arrive to the definition that *emergency is an event in a certain area, which is a result of natural, social or technical and technological accidents, which has resulted in human casualties, damage to human health, harm to the environment, material damage or disruption of the normal way of life, and that requires a quick response by appropriate or available resources, in accordance with existing standards and procedures* (Ćulibrk, Upravljanje vanrednim situacijama, 2015, str. 30).

## CLASSIFICATION OF EMERGENCIES

When emergencies are defined it is easier to make their classification, although at this point there is no uniformity of views, as a result of a different definition of a risk. There are various aspects on which it would be possible to classify emergencies.

With regard to the possibility of overcoming the resulting consequences, emergencies can happen with: repairable partially repairable and irreparable consequences (Mijalković & Keserović, 2010, pp. 109-110). According to the duration of emergencies we have short-term and long-term emergencies, and by the certainty of occurrence emergencies can be certain emergencies and possible emergencies. According to the distribution, emergencies can be divided into: local emergencies, regional emergencies, state or national emergencies, interstate emergencies and international emergencies.

According to the classification of British author Bridget Byrne and Sally Baden (Byrne & Baden, 1995), emergencies are divided into six basic categories: natural (fast-growing), technological (fast-growing), slowly evolving (eg. drought), complex (political emergencies), ongoing emergencies (eg, poverty) and mass migration. This classification is based on the mode and speed of manifestation of emergencies and partly on the consequences of an economic character. The disadvantage of this classification is that war and contemporary risks are almost not mentioned (Štrbac, 2008, p. 17).

However, the classification of emergencies usually starts with the process of the occurrence of an emergency. One of these classifications was given by Serbian authors Šimon Đarmati and Vladimir Jakovljević. They divided emergencies into: 1) Natural emergencies , 2) Technical and technological emergencies and 3) War emergencies (Đarmati & Jakovljević, 1996, p. 49). Katarina Štrbac makes a similar classification (Štrbac, 2008, pp. 18-21), so to the three kinds of emergencies above added two more – ecological emergencies and complex emergencies. While Đarmati and Jakovljević, among man-made emergencies, mention only the war, Katarina Štrbac, although alleges other emergencies, does not unite them, but expands the classification.

In order to reach optimal classification, it is necessary to link the classification to the sources of threats and security risks and threats. Usually, the sources of threats are the natural system, the technical and technological system and the social system.

Following this typology and in accordance with the aforementioned classifications emergency would be classified as:

- 1) Natural emergencies;
- 2) Tehnical and technological emergencies; and
- 3) Social emergencies.

In addition to these groups, as a fourth group can be singled out combined emergencies, which are essentially a mutual combination of natural emergencies, technical and technological emergencies and social emergencies (Figure 1).

Emergencies			
Natural Emergencies	Technical and Technological Emergencies	Social Emergencies	(Combined Emergencies)

**Figure 1 Emergencies Classification** (Source: Author)

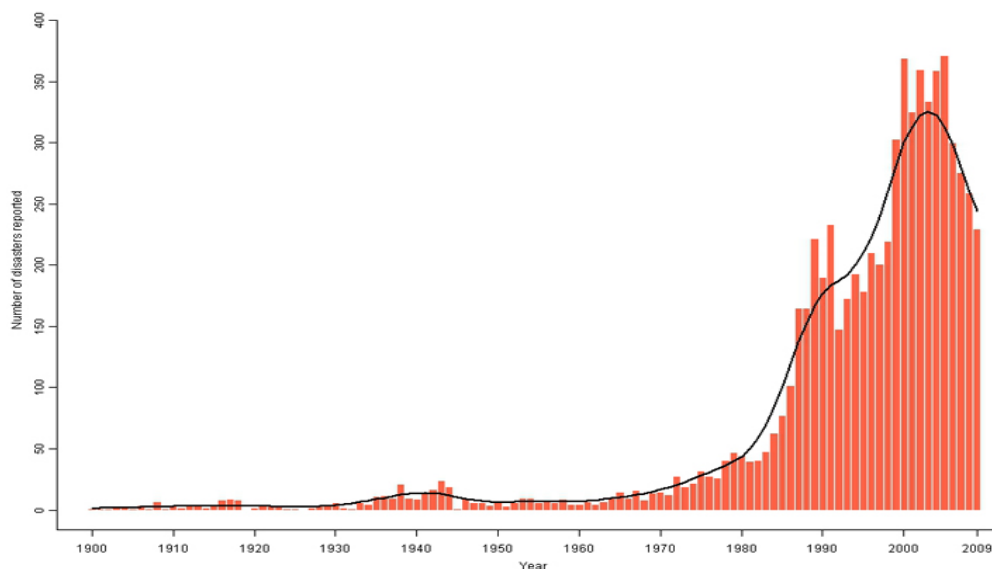
### TECHNICAL AND TECHNOLOGICAL EMERGENCIES

The life of most of modern humanity is almost unthinkable without the technical and technological achievements, which are in the function economic prosperity and quality of life. But for them, as well as fire and water, apply the maxim that they are "good servant, but evil lords" (Mijalković & Keserović, 2010, p. 135). Technological achievements bring both benefits and risks. Construction of a dam on the river can bring benefits such as electricity and water supply, but carries a risk of flooding if the dam is damaged or collapses. The balance between risks and benefits is rarely very clear. When internal combustion engine is presented, no one could have predicted our current dependence on the car or the fact that the number of casualties in road traffic will be about 250 000 people every year (Sinha, 1998, стр. 1).

Technical and technological emergencies are the result of incidents and accidents in industry, mining, transport. They are formed by unintentional human activities or due to disturbances of technical resources, and may be deliberately caused

by sabotage<sup>171</sup> or war actions. They are formed suddenly, but to some extent they are identifiable and can be controlled, whereby the human factor plays a decisive role (Štrbac, 2008, p. 19). The causes, in addition to human mistakes and technology defects, can be natural factors (eg, storms, earthquakes, etc.).

Technical and technological emergencies are the product of technical and technological achievements and their number and diversity is increasing in line with the advancement of technology, and to a large extent threaten lives, property and the environment (Figures 2, 3).<sup>172</sup> These emergencies include accidents from the spills of chemicals to the fires, and accidents from the collapse of the computer system to the traffic accidents. They are most commonly associated with industrial or traffic accidents, or structural collapses.



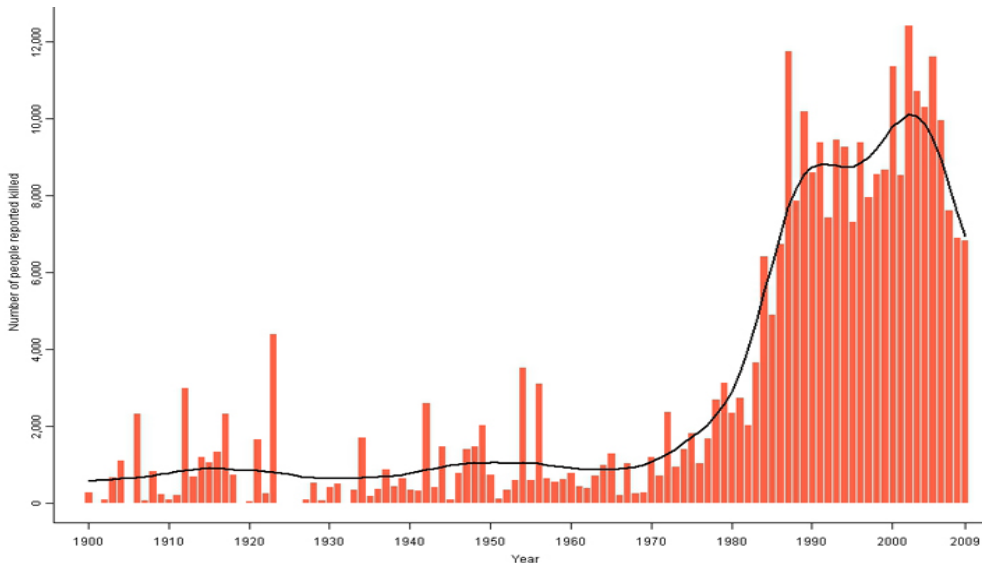
**Figure 2 The Number of Technological Disasters 1900–2009**

(Source: The EM-DAT International Disaster Database)

<sup>171</sup> Sabotage is deliberately and covertly causing of material damage to the economy and labor organizations, through attacks on economic good by individuals or groups who work on the buildings in which it seems the damage (Mijalković & Keserović, 2010, p. 175).

<sup>172</sup> Since 1980 the number of recorded technical and technological accidents is dizzying increased, and this increase follows the increase in the number of victims of these accidents.





**Figure 3 The Number of People Killed by Technological Disasters 1900–2009**

(Source: The EM-DAT International Disaster Database)

There is no unified position on the classification of technical and technological emergencies. The authors from the University of Eastern Kentucky provide the classification, according to which the most important technological disasters stand out fires in houses, hazardous materials, terrorism and accidents in nuclear power plants (Schneid & Collins, 2001, p. Foreword). The authors of the New Zealand University of Canterbury accidents classified as accidents caused by malfunctions and accidents whose cause is human error (Cowan, Fauchart, Foray, & Gunby, 2000, str. 4-8). According to the Emergency Response Plan of the Rhode island Department of environmental management (Horwitz & Mulhare, 2004) technical and technological emergency situations can be classified as structural collapses (dam/levee, building, bridge, tunnel), fires and explosions (building, industrial, residential, health care, arson, bomb and explosion), energy and utility incidents (fuel shortage , power outage, water shortage, communication problems), transportation incidents, hazardous material (HAZMAT and oil spills, chemical, asbestos), biological accidents, radiological accidents, weapons of mass destruction, terrorism, information collapses.

According to Charles Perrow (Perrow, 1984) we classify technical and technological emergencies according to causes (human error, mechanical failure,

environment, system design, implementation procedures). But this emergencies will be classified on the basis of manifestations, so we classify this emergencies to transportation emergencies, industrial emergencies, infrastructural emergencies and construction emergencies (Figure 4).

Technical and Technological Emergencies			
Transportation Emergencies	Industrial Emergencies	Infrastructural Emergencies	Construction Emergencies

**Figure 4 Technical and Technological Emergencies** (Source: Author)

## INDUSTRIAL EMERGENCIES

Throughout its history, a man has become habituated to natural disasters and their consequences. Along with the technical and technological developments have occurred technical and technological emergencies. As part of this development an important place belongs to industrial development, and along with the industrial development there comes emergence of industrial emergencies, which are emergencies which cause related to industrial production.

Aspects of industrial production that can lead to loss of life and material damage can be considered in two categories (Banerjee, 2003, p. 1). The first category of the fast-developing situation, leading to "acute" problems, mainly in industrial plants. Second category includes "chronic" problems (wastewater spills, exposure to hazardous agents) and significantly influence the occurrence of ecological emergencies. More attention starts to be devoted to industrial emergencies 1970s, after an explosion in Flixborough in 1974.<sup>173</sup> and after the expiration of toxic substances in Seveso in 1976,<sup>174</sup>

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<sup>173</sup> The explosion at the cyclohexane plant in the English countryside Flixborough, on June 1 1974, killed 28 and injured 89 people, and bring an extensive damage (Prevention of industrial disasters, 1992, p. 3).

<sup>174</sup> In the Italian village Seveso, near Milan on 10 July 1976 occurred the defect in the installation of the chemical industry, which has resulted in the spread of dioxins at Seveso and surrounding

and especially after the disasters of 1984 - auto-gas explosion in Mexico and the disaster in Bhopal.

Industrial emergencies can be divided to emergencies related to hazardous materials and mining emergencies. As a special subcategory under these emergencies can be singled out industrial fires and accidents at work. Industrial fires occur in all segments of the industry. The causes of industrial fires can be natural (earthquakes, storms), human (lack of commitment, negligence, diversion, sabotage), or technical (bad installation, defects in an industrial plant, etc.). Manifestations and consequences of industrial fire depends on the type of industrial plant in which it occurs. Accidents at work occur in a variety of industrial plants, at mines, etc. The most common causes are inattention, faulty devices, incorrect installation etc..

On the basis of existing definitions (What Is Hazardous Material?, 2010) (Hazardous Materials, 2010) (De Lisi, 2006, p. 7) (Schnepp, 2009, p. 5), we can give a definition that hazardous substances are solids, liquids and gases of radiological, biological, chemical or physical origin, which, due to the wrong transporting, producing, packaging, storage or handling can harm the life and health of people, to make the damage on property, endanger wildlife and environment. A large part of industrial production is based on the use of hazardous substances. With the loss of control over these substances people, property and the environment are put at risk.

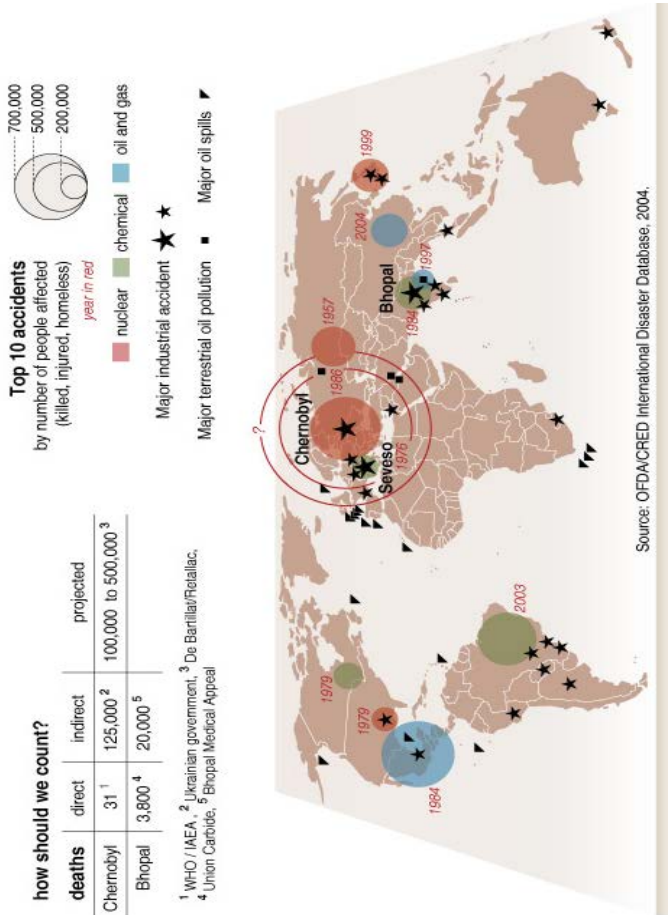
Most emergencies involving hazardous materials occurs during the transport of hazardous materials (tanks in roads, railways and air traffic, and tankers in water transportation - oil spills),<sup>175</sup> while the smaller part relates to industrial plants (chemical industry, nuclear plants - disaster in Chernobyl),<sup>176</sup> civilian and military warehouses, etc. (Figure 5).

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areas. In this accident there was no dead, but about 250 people succumbed to the effects of chlorine on the skin, while 450 people suffered burns of sodium hydroxide (ie, caustic soda). Infected is about 17 km<sup>2</sup> soil, a 4 km<sup>2</sup> of land has become uninhabitable (Kletz, 2001, p. 103).

<sup>175</sup> Accidents related to the transport of dangerous goods, depending on the scope and intensity, can be labeled as a traffic emergencies or environmental emergencies of acute character, which indicates that there is no simple division of emergencies but they are intertwined.

<sup>176</sup> The Chernobyl disaster (explosion of a nuclear reactor, which led to the release of radioactive material) resulted in a 31 direct victims and 32, 000 indirect victims (Low, 1999, p. 70).



**Figure 5 Industrial Disasters (Source: Coppola, 2007)**

Improper handling of hazardous materials may cause a fire, an explosion or some form of radiation, and it is important that persons who manage or work with hazardous materials take account of the characteristics of each hazardous material (flammability, solubility, toxicity) in order to avoid accidents.

Mining, along with an agriculture, is the oldest and most significant human activity (Sinha, 1998, str. 84). This is confirmed by the names of historic periods – stone age, iron age and bronze age. Mining emergencies are related to accidents in the mining industry, and the most common causes are poisoning with toxic gases, methane explosions, collapse of mines, fires. Emergencies in underground mines are often followed by a massive victims. Mining emergencies carry more lives than the rest of the

industry (Coppola, 2007, p. 95), and more than 80% of accidents in coal mines happen in China (Xiaohui & Xueli, 2004).

## CONCLUSION

We have seen that there are different types of technical and technological emergencies, as well as various types of industrial emergencies. Each of the processed emergencies carries its own risk and should be not neglected any of them. We saw that some parts of the world prone to certain industrial disasters, depending on the development of the industry and the level of safety at work in an area where they are placed.

We have also seen that technological advances accompanied by a great number of different accidents. Further progress of science and the development of new technologies certainly will increase the risk of technological and social emergencies, but will have a big impact on the frequency of natural emergencies, since technological development can often have a negative impact on the environment.

Fully understanding the causes of various emergencies and awareness that there is a risk of their manifesting is the first step in their suppression.

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