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TRANSCOM 2015, 22-24 June 2015
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Safety at Railway Crossings and Procedures for Intervention Units Fire and Rescue Service in Accidents

[*]Michal Ballay
[*] University of Žilina, Faculty of Security Engineering, Department of Fire Engineering, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Michal.Ballay}@fbi.uniza.sk

Abstract. The article is focused on safety at level crossings. It describes the basic rules to ensure safety at level crossings and points to the number of accidents and the consequences of these road accidents. It further describes the roles and procedures of the Fire and Rescue Service for rescue operations in the event of an adverse event on a level crossing.

Keywords: Safety, railroad crossing, rescue, Fire and Rescue.

1. Introduction

The issue of traffic accident is a serious social problem in all spheres of human activity, and therefore requires a comprehensive and rational approach. In terms of safety on the railway line is the most dangerous place railway crossing. Traffic accidents at level crossings are not among the most commonly due to accidents in road transport, but the consequences are more severe, and the number of killed and seriously injured. In the event that a negative event at a level crossing, it requires the cooperation of the components of the integrated rescue system.

2. Safety at railway crossings in Slovak Republic

The railway crosses the level crossing of the railway line and road. In recent years, the safety level crossing received little attention. Traffic accidents in general are a serious social concern. It requires a comprehensive and effective solution, will exhibit signs of a deliberate process of all stakeholders and institutions with a broad public support. In terms of road crossings happen in a fraction of accidents that cannot be completely overlooked in terms of the consequences of accidents on the road. Basic rules for ensuring safety at level crossings are the relevant laws:

- Law no. 193/1997, which was declared full text no. 135/1961 Collection of Laws on roads (Road Act), as shown by the changes of Law No.27 / 1984 Collection of Laws., Law of the Slovak National Council No.160 / 1996 of the Laws and Law No.58 / 1997 of the Laws
- Law no. 8/2009 Collection of Laws. road transport and amending certain acts
- Law no. 513/2009 of the Laws on railways and amending certain laws
- Ministry of Interior of the Slovak Republic. 9/2009 Collection of Laws implementing the Road Traffic Act and amending certain laws [1,2,3]

The total number of crossings in the Slovak Republic is 2,160, of which 1,088 secured and unsecured 1,072. In terms of road crossings happen in a fraction of accidents that cannot be completely overlooked in terms of the consequences of accidents on the road. The railway accident statistics, however, accounted for a significant proportion of level crossings. [1, 2]

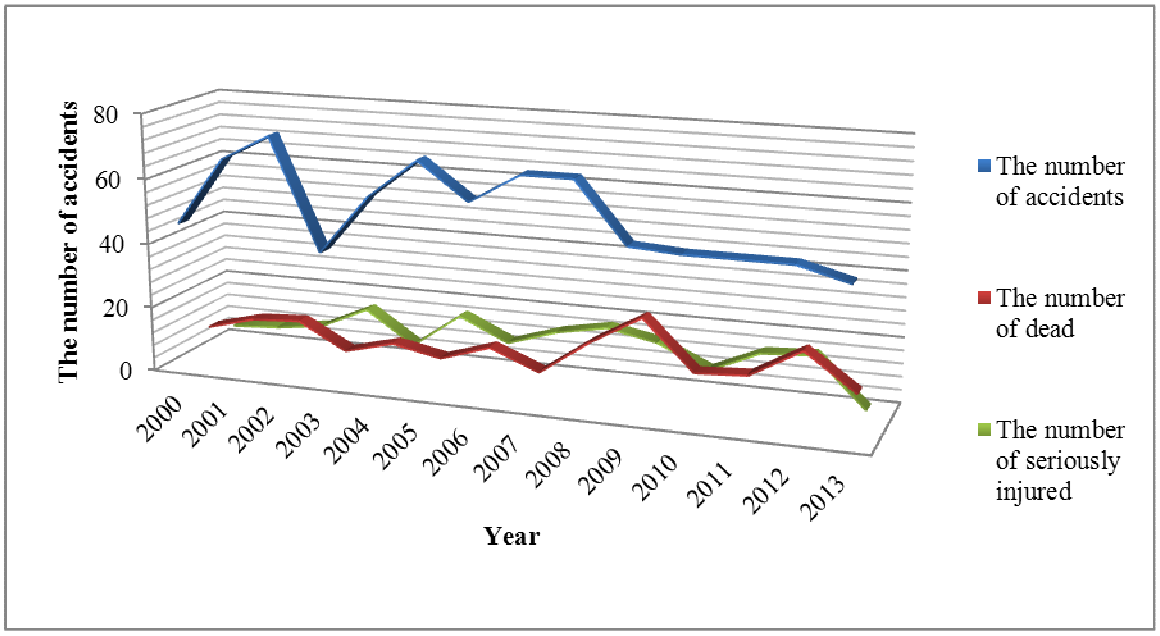

Fig. 1 The number of accidents and the consequences of such accidents at level crossing [1,2]

The main causes of accidents on level crossings are:

a) failure to comply with traffic rules, the recklessness of its participants;
b) lack of technical measures, especially in front of a dangerous band of level crossings;
c) a violent injury level crossing safety installations, in particular:
   - Broken or damaged spars,
   - Violent damage to the stand level crossing security equipment,
   - Theft of cables for checking the status of level crossing security equipment,
   - Broken lights Indicator (Slovak Railways), [1,2]

The number of accidents at level crossings, which are equipped with gates is significantly below (the case of no), as the number of accidents at crossings without gates. This is mainly due to the fact that, in general, barriers are physical barriers to road user observes rather than light signaling. Table 1 shows the consequences of accidents by type of level crossing safety device in 2013. [1]

Type crossing / result	The number of accidents on the railway crossings	The number killed in accidents	The number of seriously injured in accidents
Unsecured "K"	16	6	2
Light without barriers"CPL"	**24**	**9**	**12**
Light with barriers "CPL-Z"	10	6	1
Mechanical with barriers "CSM"	0	0	0
Together	50	21	15

Tab. 1 Comparison of the effects of accidents by type of level crossing safety device in 2013 [1]

Safety at railway crossings depends not only on the security level crossing safety systems, but in the first row from the disciplines road drivers, respectively, all users of roads. [2]

3. Tactical - methodology of implementation interventions Fire and Rescue Service for accidents at level crossing

Railroad Crossing is the only place of direct physical contact between the otherwise relatively insulated transport modes. An accident at a level crossing can be characterized as an event in which

there is a death or personal injury or property damage. One of the most important things that you need to remember is that when catastrophe such as a collision with a train, bus system work rescue team is different than standard intervention. Firstly, it is a large number of injured persons and persons trapped in the wrecked vehicles. Given the nature of the situation is great emphasis placed on the technical means necessary for this type of intervention. This is particularly the hydraulic extrication equipment, stabilizing elements and other means. Furthermore, it is necessary to develop a system that allows for quick sorting wounded, simple treatment and evacuation to health facilities. [4,5,8]

The tasks and procedures of the Fire and Rescue Service for rescue lie primarily in marking the danger zone because of the potential for explosion. Outside the marked area may move medics. Members of the Fire and Rescue Service (the Fire and Rescue Service) check that vehicles cannot move and that leaking fuel. A typical element in these events is chaos, it is important to avoid further danger to life and health and to a material damage. Members of the Fire and Rescue Service must ensure the vehicle and gradually postpone injured. At the same time when these events require interaction with other components of the integrated rescue system and physically competent authorities. [6,7].

Fig. 2 Interventions by Fire and Rescue Service in an accident at a level crossing [5]

The danger in these types of accidents is critical intervention units Fire and Rescue Service is very high. It can be characterized by the following complications:

- sharp objects on the scene of an accident,
- glass fragments,
- dangerous movement of people who are not involved in an accident, but moving it lay close,
- opacity sites of action and inaccessible terrain,
- inaccessibility disconnecting the battery more pieces of batteries,
- large number of injured, difficult communication with injuries
- unpredictable behavior of disabled persons due to the eye, alcohol, drugs, and the remaining aggressiveness
- leak large amounts of fuel and fluids,
- insufficient resources to carry out rescue work, [7,8,9]

4. Conclusion

The numbers of accidents at level crossings are still relatively high. Given the social hazard level crossings should be subject to a thorough analysis of these objects. In view of the Fire and Rescue procedure is never identical in emergencies. Accidents at railway crossings are characterized by very extensive work must therefore Commander Fire and Rescue choose an

intervention in order to cope with the situation on the ground and avoid the fact that interventions lead to any secondary injuries or condition deteriorated.

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Research Bases of Fire Risks

[*]Vladimír Benedik, [*] Jana Adamíková, [**] Helena Ondrúšková
[*] University of Žilina, Faculty of Security Engineering, Department of Crisis Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Vladimir.Benedik, Jana Adamikova}@fbi.uniza.sk
[**] University of Žilina, Faculty of Security Engineering, Department of Crisis Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Helena.Ondruskova}@fbi.uniza.sk

Abstract. The authors describe the factors that affect the origin of the fire risks in terms of the cause, with regard to three conditions of the onset of fire, i.e. the oxidant, fuel and initiator. The paper is aimed to identify any risk of fire in terms of source of risk. The source of risk is mainly the human factor and other environment factors. The article proposes measures to reduce the identified risks.

Keywords: Fire risk, quantification, risk analysis.

1. Introduction

Fires occur in a particular environment (area), but the environment itself does not always cause the fire. The human factor is an important factor which causes fire. Therefore, the authors have decided to identify the risks.

2. The factors influencing the risk of fire

In everyday life people face multiple risks. The occurrence of risk in a particular environment is usually associated with negative impact on human, property or the environment. The fire risk is no exception. If it occurs with a certain probability in an environment (forest, enclosed space – house, office), then it has a negative impact (injuries or death, damage of property or environment).

In order to identify the fire risks, the risk factors affecting the actual fire must be determined. After studying the topic the authors agreed on two factors which have major impact on fire risks – human (anthropogenic) and environment (non anthropogenic) factor (see Fig. 1.) [13, 14, 15, 16]. Human factor can cause fire ignition or fail to prevent fire ignition and fire growth. For this reason, there are cases of fire ignition even in places where they would probably never occur if there were no human factor. The environment factor consists of set of characteristics such as the availability of the fuel (material), initiator, oxidant [8]. Also the mutual interaction of factors is the determinant of fire risk [9]. Thus the fire ignition is affected primarily by the human factor and secondarily by the environmental factor.

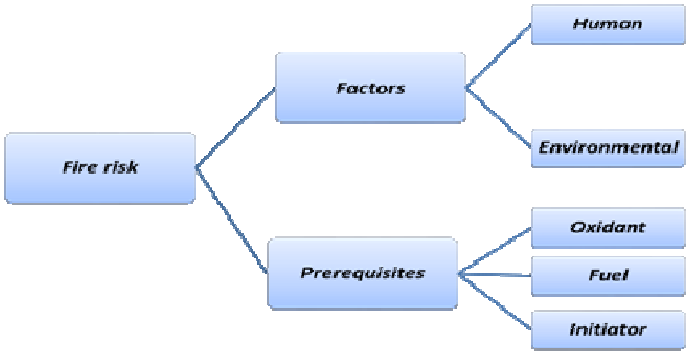

Fig. 1 Factors affecting fire risk

Human factor affects the fire initiation deliberately and also unintentionally [3]. Unintentional fires are caused by [13, 14, 15, 16]:

- negligence – failing to keep matches out of children's reach, neglecting regulations for electrical or gas wiring and equipment installation etc.,
- carelessness – incorrectly handling the open fire, burning dry vegetation, setting up fireplaces in the woods and close to them, violations of safety in industrial sites, carelessness in the use of electrical devices, placement of heating devices on combustible materials, improper storage of flammable substances especially in households near chimneys or heaters, smoking or other careless human behaviour,
- ignorance – inconsistent training of employees, employers, low public (citizens) awareness, lack of interest and others.

The environmental factor can significantly increase the fire risk, in particular with the parameters of the environment which may be affected by climatic changes – sharp rise in temperatures, periods of droughts, rainfall absence, airflow and others [10]. Of course the landform features and relief, the type and potential of the environment for fire risk can have significant impact on fire risk [3].

The initiation of fire is often influenced by the combination of the human and environmental factor. Of these two factors it is complicated to distinguish the one critical for the initiation of fire.

3. Identification of risks

Everyone's activity can cause a negative event. To prevent negative events, the identification of risks is necessary. In this case the risks will be identified from several points of view. The first division in terms of causes of fire risks is divided into two groups – human and environment. The authors will further subdivide the human causes of risks into the risks caused by natural persons and risks caused by juristic persons [20, 21].

Risks caused by natural persons include citizens and also employees. The identified risks within this group are [13, 14, 15, 16]:

- ignoring the laws of the Slovak Republic (unprofessionally set up electrical wiring and gas pipelines, burning garden waste, dry grassland etc.),
- infringement of the general principles of handling an open fire (in time, during the activity and in places of elevated fire ignition risk – leaving burning fuel (fireplace) unattended etc.,
- improper handling of hazardous substances (flammable, combustion-promoting substances or substances capable of initializing the fire),
- invasion of foreign substances into the natural environment (creation of landfill sites, increase of the range of possible initiators and other),
- inability to recognize the illegality of one's behavior (leaving the initiator in the reach of children, persons with special educational needs etc.),
- mishandling of combustible substances and combustion-promoting substances (prone to spontaneous combustion – biological, chemical, mechanical).

Risks can be caused also by juristic persons (municipalities and enterprises) [13, 14, 15, 16]:

- insufficient fire protection of premises [7],
- failure to ensure the qualification of employees in management of hazardous substances and while using personal protective equipment,
- neglect of duty in the municipal documentation concerning fire protection,
- lack of examination of the medical fitness and especially the mental ability of employees to execute specific activities (activities with increased fire risk),
- ignoring the verbal or written warnings of employees.

In order to identify the risks in terms of impact on the environment, the very concept of environment must be characterized. The authors of this paper will distinguish the natural and man-

made environment. Subsequently the identification of risks in terms of the influence of environment can be carried out, whereby the following will be included [3]:

- sudden change of environmental parameters (long periods of drought, sudden temperature changes, lack of rainfall, electrostatic discharge etc.) [11, 18],
- the nature of the environment as the availability and specificity of the properties of the fuel, oxidant, initiator (excessive concentration of fuel in a small area, ignition point of the fuel, excessive concentration of the oxidant, permanent availability of the initiator) [1],
- low ability of the environment to resist fire ignition (constructions made of flammable materials, monoculture in forests and others) [2].

4. Measures aimed to reduce the fire risk

Fire hazard is a problem not only in Slovak Republic, but also all around the world. The previous chapters identified the fire risks and discussed the factors affecting them. Identifying the fire risks is essential in order to propose and adopt measures aimed to reduce these risks. The quantification of the reduction of the probability of fire development by means of specific actions in Slovak republic is missing. The actual measures do not have the same effect in different situations and their effects on the decrease of the fire risk interact. Measures concerning the identified risks in terms of natural persons (citizens and employees) are [20, 21]:

- filing a complaint to municipal authorities about the violation of regulations in the field of fire protection,
- proposing the removal of the deficiencies in the field of fire protection on the premises belonging to juristic person,
- fulfilling the obligation of the natural person to report every occurrence of fire in the facilities belonging to juristic person or elsewhere,
- giving impetus to the rights protection authorities (police forces of Slovak Republic, judicatures etc.).

Fire risks can be decreased by taking the following measures within the municipalities. These measures are proposed within the scope of the risks identified in terms of the juristic persons (municipalities and enterprises) [6, 20, 21]:

- removing (reducing, limiting) one of the three factors which affect the formation of the fire risk itself,
- organizing, executing and evaluating the controls in the field of fire-control on the part of the municipalities, juristic persons (natural persons – entrepreneurs) and state-level fire surveillance,
- ensuring regular training of the enforcement officers and the employees of juristic person, mainly the members of fire patrol of the juristic person and natural person – entrepreneur, the fire patrol of the workplace and the assisting fire patrols,
- developing and updating the documentation of fire-control in the municipality and in the office,
- establishing and regularly training a voluntary fire brigade in the municipality.

Measures aimed to identify the risk in terms of the environment:

- predicting and monitoring sudden changes of the parameters of the environment,
- enhancing the ability of the environment to resist fire ignition (i. e. constructing the buildings of fire-resistant materials, improving the resilience of the forst stand by planting mixed forest stand) [4, 9],
- reducing the concentration of fuel and changing the type of fuel in the given area (adjusting the surface of the terrain, creating fire protection zones and others) [5],
- changing the parameters of the environment (installing fixed firefighting systems, decreasing the concentration of flammable gases and others) [6, 12, 19].

5. Conclusion

With the increasing numbers of the intervention of the human factor to the natural and also man-made environment there is a rise in the probability of fire ignition. Šimák also includes the fires caused by human factor to the most problematic category [17]. The presented paper concludes that there is a need to tackle this issue in more detail – in terms of municipalities, enterprises and also in terms of the citizens themselves.

The authorities, which supervise the compliance with obligations which ensue from the public statutes of the Slovak Republic, should focus mainly on controlling the execution of these responsibilities.

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Biogas and Scenarios of its Major-accidents

[*]Katerina Derychova, [*]Ales Bernatik
[*]VSB - Technical University of Ostrava, Faculty of Safety Engineering, Lumirova 13/630, 700 30 Ostrava-Vyskovice, Czech Republic, katerina.derychova@vsb.cz

Abstract. Biogas represents an alternative energy source. Biogas produced in anaerobic digestion are consist mainly of methane and carbon dioxide. The energy utilization of biogas is multifaceted. This article summarizes information about the production and properties of biogas and its use depending on the its cleaning, possibilities for storage and transport. The article also include determining the major-accident scenarios and supplemented with event tree analysis.

Keywords: Biogas, Biomethane, Propertie of Biogas, Scenarios.

1. Introduction

Fossil fuels have limited capacity, therefore we should be interested in their replacement. Alternative sources of energy are a suitable substitution of fossil fuels. Alternative energy sources are the sources that are naturally regenerated during their use. Among renewable sources belong solar energy, wind energy, hydropower energy, biomass, biogas, and more. [20]

Nowadays the trend is still construction of biogas plants where biogas is an alternative source of energy and fuel. Biogas is nothing new, its history dates back to the late 19th century. However, its production in the past and nowadays is significantly different. Therefore, it can be alleged that anaerobic fermentation is a new developing and perspective technology. Biogas is basically a mixture of gases, among major components belong methane and carbon dioxide and minor components is formed by: hydrogen sulfide, water, hydrogen, nitrogen, ammonia, oxygen and optionally another substances. Representation of individual components in the mixture and its amount varies depending on the raw materials and technological process.

The aim of this article is to summarize available information of biogas and determine possible scenarios of major accidents of biogas.

2. Biofuels

Biofuels are fuels that are directly obtained from plants or indirectly from industrial, municipal, forestry or agricultural waste. Biofuels can be divided according to the state of aggregation to liquid, gaseous and solid biofuels. Further biofuels can be divided into the first generation, the second generation and the third generation.

2.1. Distribution of biofuels

According to the state of aggregation can be biofuels divided to:

- Solid biofuels - firewood, wood chips, sawdust, straw, pellets, briquettes.
- Liquid biofuels - bioethanol, biobutanol, methanol, biodiesel.
- Gaseous biofuels – biogas, wood gas, hydrogen. [2]

A disadvantage of solid biofuels is that it is possible to burn only in a grate or a fluidised fireplaces with a low conversion efficiency to electricity. Among the advantages of liquid and gaseous biofuels belongs a cleaner composition (pollutants and inert components are removed

during production), then easier transportation and using as a fuel for internal combustion engines (gasoline and diesel) and gas turbines. [4]

Biofuels can be dividend also into generations: [3]

- I. generation: from polysaccharides and oilseed - biodiesel, bioalcohol, bioethanol,
- II. generation: from lignocellulosic residues - bioethanol, methanol, biobutanol,
- III. generation: from an algae and microorganisms direct production of fuels H_2, CH_4 and C_xH_y.

Biomass is the starting feedstock used in the production of the first generation biofuels. The advantage of the second generation biofuels is using "non-food" biomass. In the case of production of the third generation biofuels, which is still in development, are the feedstock algae or cyanobacteria. Algae compared to biomass growing much faster, it can be grown without the need for field plots and can be harvested continuously, as compared to biomass have a higher oil content and low water consumption. [3],[5]

2.2. Gaseous biofuel

Gaseous biofuels are biofuels which are during storage and transport in the gaseous state. Among gaseous biofuels belong biogas, wood gas and hydrogen. [1]

3. Biogas

In Act no. 165/2012 Coll., As amended, biogas is defined as gaseous biomass fuels used to produce electricity, heat or for the production of biomethane. The purified biogas which contains ≥ 95% methane is called biomethane.

Biogas plants can be divided according to a raw feedstock on an agricultural biogas plants, landfill plants, sewage treatment plants, municipal and industrial plants. The composition and yield of biogas depends on the type of biogas plants, on the technological process of production and on the feedstock. [12]

3.1. Production

The case of production of biogas is a biological process when organic matter is decomposed in absence of oxygen by various cultures of microorganisms in four phases hydrolysis, acidogenesis, acetogenesis and methanogenesis. [6], [11][13] Process of anaerobic fermentation take a place in a certain operating temperature (according to the type of bacteria - psychrophilic, mesophilic, thermophilic) at pH from 6.5 to 7.5 and for a specific time (according to the type of bacteria 10 - 120 days). [15] The outcome of this process is mixture of gases (biogas) and digestate, which is a quality fertilizer. [12]

3.2. Composition

The composition of the biogas depends on the raw materials delivered to the process, but mostly it is composed of methane and carbon dioxide. [2] Approximate composition of the biogas is presented in Table No.1.

Component	Chemical formula	Content in %
Methane	CH_4	50 - 70
Carbon dioxide	CO_2	25 - 50
Nitrogen	N_2	0 - 10
Hydrogen sulfide	H_2S	0 - 3
Hydrogen	H_2	0 - 1
Oxygen	O_2	0 - 1
Ammonia	NH_4	0 - 1

Tab. 1. Approximate composition of biogas [6],[11]

The major components of biogas are carbon dioxide and methane. Methane is extremely flammable and non-toxic gas which is lighter than air. The methane‘s explosive limits are very large, from 5 to 15 vol. % and autoignition temperature is 595 ° C. Carbon dioxide is non-flammable and unbreathable gas, it does not support combustion and is heavier than air. CO_2 sticks to the ground, for example in silage or sanitation, cellars and wells, which can cause asphyxiation. [10],[12]

The minor components of biogas represents hydrogen, its danger is in extreme flammability and its ability to form explosive mixtures with air. Nitrogen is an inert gas is not toxic or dangerous. [12] This does not apply in the case of hydrogen sulfide and ammonia, both of these compounds are highly toxic and have a serious impact on human health even at low concentrations. Hydrogen sulfide is also extremely flammable gas. Together with the ammonia are dangerous for the environment. [12],[16] It is worth to mention that the hydrogen sulphide produced in the anaerobic digestion has a value between 30 ppm and 160 ppm. [17]

3.3. Properties of Biogas

Biogas is unbreathable gas with a density of approximately 1.2 kg/m^3. It is slightly lighter than air, which has a density of 1.29 kg/m^3, this means that biogas will grow rapidly mixed with air. [11], [14] The mixture of air and biogas can explode, in cases where the proportion of the biogas in the mixture with air is 6-12 % and the temperature of the ignition source is higher than 650 ° C. If the proportion of the biogas with air in the mixture is higher than 12 % there is a risk of fire. [13] The ignition temperature of biogas is 650 - 700 ° C and the critical pressure is in the range from 7.5 to 8.9 MPa and the critical temperature is - 82.5 ° C. Biogas has a very slow diffusion combustion, the maximum advancement speed of the flame in air is 0.25 m/s, because of causes CO_2. [11]

The bad property of biogas is its ability to separate into its compounds. Carbon dioxide is heavier than air (1.53 kg/m^3), that's why is falling and holding to the ground, meanwhile methane is lighter than air (0.55 kg/m^3) and rises into the atmosphere. [11],[14]

Gases contained in the biogas have their characteristic physicochemical properties. It is appropriate and necessary to know the properties of the individual components of biogas.

From 2012 is in Norway (AGA A Member of The Linde Group) available material safety data sheet (MSDS) for biogas with a methane content of 97 % in the mixture. The purpose of using the gas is as fuel and as a gas for heating. Even USA (Airgas) has MSDS for biogas since 2009, but in this case it is 100 % methane, it is no longer mixture of gas. Compressed methane is extremely flammable gas that could lead into a Flash fire.

3.4. Cleaning

The upgrading is necessary for efficient use of biogas. Treatment technology of biogas can be divided into adsorption, absorption, permeation technology and cryogenic rectification. At first are from biogas removed impurities (hydrogen sulfide, water, nitrogen, ammonia, siloxanes, small particles and oxygen), and in a second step carbon dioxide is removed while increasing the proportion of methane to > 95%. Modified biomethane is again adjusted to precisely the required composition and calorific value. Prior to compression it has be odored and after that is injected into the natural gas grid. [11],[18] In Germany is over the 100 biogas treatment devices This devices are occurring and also using in Sweden, Switzerland and Austria. [11]

3.5. Utilization

Energy utilization of biogas is multifaceted. It is necessary to modify biogas before its use. Biogas can be used to produce electricity, heat, electricity and heat, also used in transport as a fuel and it is possible to supply biogas into the gas grid or to producers of heat. Act no. 165/2012 Coll., As amended, supports the production of electricity from renewable sources. In 2014, according to the CEZ Group reached salling price of electricity from biogas from 3.04 to 4.12 CZK/kWh.

According to the conditions of the energy market is biogas most often used for combined heat and power generation (CHP). [12]

Biogas plants utilize about 20 - 40% of produced heat to heat the digesters (process heat) and the other 60 - 80% of heat is called "waste heat", it is farther used for additional electricity production. [11] An approximately 7 - 10% of produced electricity is used in the actual process of biogas production. [7]

3.6. Storage

Biogas can be stored for long periods of time and then can be used without the loss. Biogas is stored in sealed tanks that are technologically designed as low pressure, medium pressure and high pressure reservoirs (tank). The characteristics of these reservoirs are shown in Table No. 2. [11],[13] Other types and methods of storing are mentioned in the publication [9], there are reservoirs divided according to the time of storage on short term and long term.

Pressure Level	Operating pressure	Bulk	Storage Facilities
Low pressure	20 - 50 mbar	50 - 200 m^3	Gas tank with water seal
	0,05 - 0,5 mbar	10 - 2000 m^3	Gas tank with foil cover
Medium pressure	5 - 20 bar	1 - 100 m^3	Steel storage tank
High pressure	200 - 300 bar	0,1 - 0,5 m^3	Steel cylinder

Tab. 2. Design of biogas tanks [13]

3.7. Transport

In biogas plants is biogas most often converted directly in cogeneration units into electricity or heat. Electricity from biogas can be delivered to the electric power grid. Biogas/biomethane can be distributed through a pipelines as a heat or gas, or can be transported down the road too.

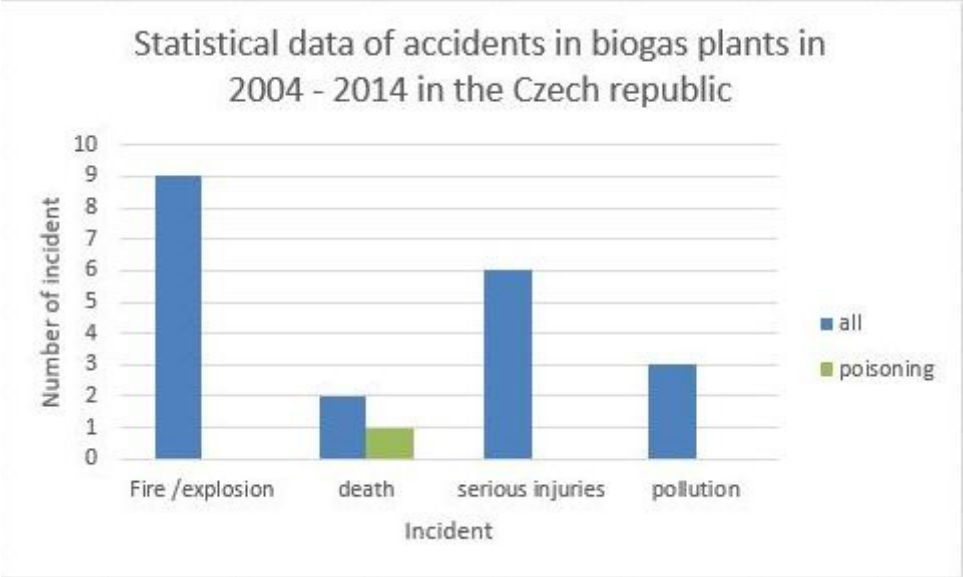
The one of possibility is to transport biogas via gas distribution grid. Gas pipelines are a convenient way to transport large quantities of gas with low operating costs. High-pressure pipelines is usually made of steel, while the low-pressure pipelines are usually made of polyethylene. Injecting biogas into the natural gas grid requires, that quality of biogas has to be adjusted as is set to the network parameters. It is assumed the upgrading of biogas to fuel quality. [8] Publication [9] proposes to build a dedicated pipeline, but with advantage only to a distance of <1 mile (1609 meters).

In Germany, France, Switzerland, Austria, the Netherlands and Sweden have formulated standards of upgraded biogas for injection into the natural gas grid or for its use as a fuel for transportation. [18] The Czech Republic has no project purifying of biogas to biomethane and its use as a fuel for transportation yet. [19] Injection biomethane into the natural gas grid is regulated in the Czech Republic by Act no. 459/2012 Coll., As amended. Publication [11] introduce how could be efficiently transported biogas by gas pipelines to so-called satellite CHP units, which are nearby by consumers, e.g. it works in Trebon. However, the legal conditions for a biogas pipelines are not clear and there is no classification of biogas pipeline.

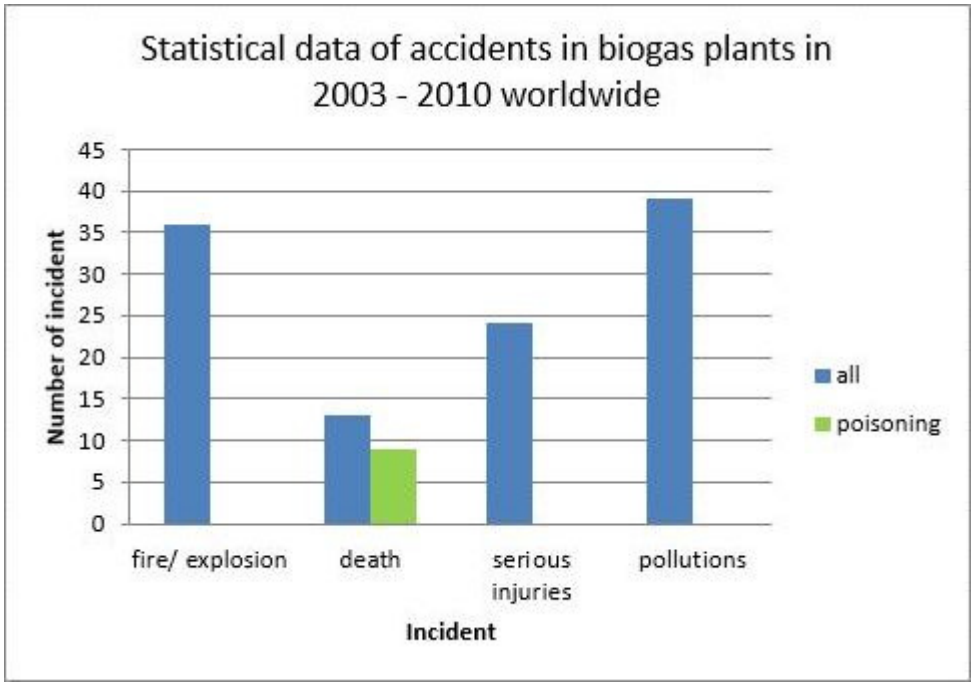
In the case of that no network of natural gas is nearby to biogas plant, biogas can be transported down the road. Biogas / biomethane can be transported in containers or tank trucks. Gas is compressed and feeded into vessels in the form of CBG (Compressed Biomethane Gas) or it can be liquefied at LBG (Liquefied Biomethane Gas). Efficiency of road transport depends on the suitable choice of vessel or tanks and on the quantity transported compressed or liquefied gas. [8],[9] In Sweden and Switzerland, there is a good infrastructure for using CBG in transport, including the network of filling stations. In many countries are more frequent filling stations with a mixture of CNG / CBG. [11]

4. Emergency of the release of biogas

The occurrence of the events which had happened recently, show that biogas presents a certain danger. In January 2013 occurred a massive explosion with detonation inside the biogas plant in Chotetov, the station was still under the construction and it was not put into operation. In November 2013 in Chric was found employee in the shaft, most likely was intoxicated by methane. Statistics data of incidents in biogas plants in the Czech Republic is shown in Graph No. 1. [23] Even abroad, there are accidents which have its casualties. In Germany in 2009 exploded biogas plants, one worker was killed and two others were injured. Data from ZEBEC project report are transferred in Graph No. 2, which show the numbers of incidents in biogas plants worldwide. [22]



Graph 1. Statistics of incidents in biogas plants in the Czech Republic



Graph 2. Statistics of incidents in biogas plants worldwide

In the following diagram (Fig. No. 1) are shown possible scenarios for accidents caused by biogas.

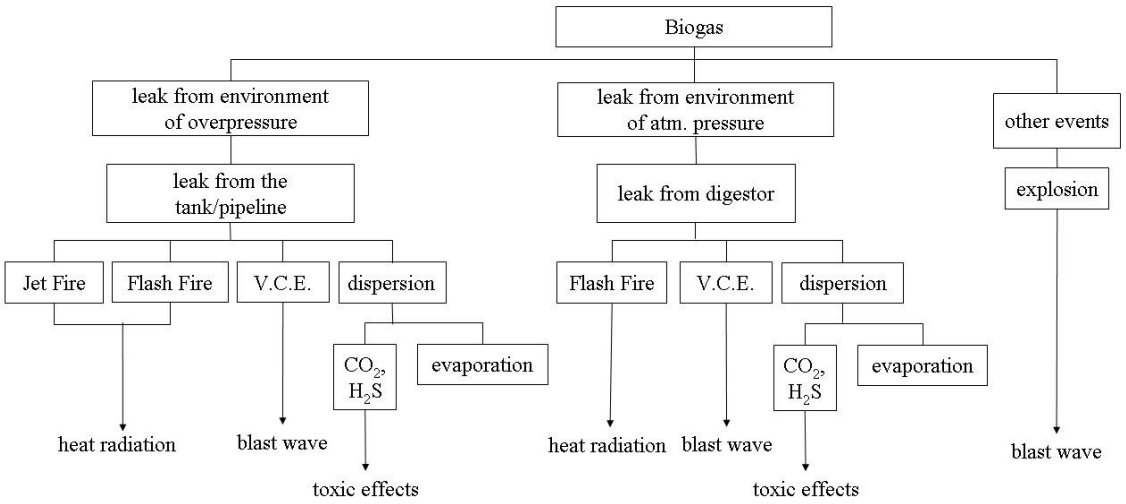


Fig. 1. Scheme of scenarios for accidents caused by biogas

Among the possible consequences of the accidents caused by biogas are the heat radiation in case of fire, blast wave with any flying fragments in case of explosion and toxic effects of gases scatter into the atmosphere.

Event tree was assembled for scenario of biogas leakage from the tank. Graphically is event tree shown in the following Fig. No.2.

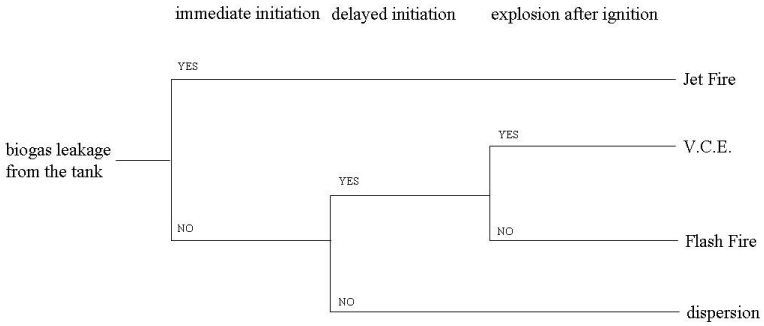


Fig. 2. Event tree of biogas leakage from the tank

The resulting emergency conditions presents a fires as Jet Fire, Flash Fire, explosion type VCE and gas dispersion into the atmosphere. Jet Fire occurs when the compressed flammable gas leaks from a pipe or container. The phenomenon of Flash Fire occurs sudden and intense fire caused by ignition of a mixture of air and a dispersed flammable gas. In the case of the phenomenon VCE is a vapor cloud explosion. [21]

5. Conclusion

Biogas production is a cheap energy from residues and wastes. By-product digestate is used as a fertilizer. The benefit of biogas is reducing the burden for an environment. The advantage of biogas is its versatility of using, depending on its purification (cleaning).

The Czech Republic has not properly legislatively captured production, storage, transport and distribution of biogas. Our legal environment does not distinguish crude or purified biogas. Still missing MSDS for biogas and concentration limits for its use in transportation. Czech legislation (Act no. 459/2012 Coll, as amended) already indicate the qualitative parameters for biomethane (≥ 95 % mol.) as "replacement" of natural gas and its injection into the natural gas grid.

In condition of the Czech Republic has not created MSDS for biogas yet. To determine the risk is therefore based on the properties of individual components of biogas and their percentage representation. In biogas has the largest representation of methane and carbon dioxide. Methane is a danger in extreme flammability. A carbon dioxide has an effect on human health. Minority gases in

the biogas mixture represent a risk and it is important to deal with them. Hydrogen sulfide is extremely flammable, highly toxic even in a very small amounts and it is dangerous for the environment. Creating MSDS is probably impossible because of a variable composition of biogas. [12]

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Minimal Criteria for Biometric Recognition by Video-surveillance Systems

[*]Martin Ďurovec, [**]Marián Magdolen
[*] University of Žilina, Faculty of Security Engineering, Department of Security Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Martin.Durovec}@fbi.uniza.sk
[**] University of Žilina, Faculty of Security Engineering, Department of Security Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Marian.Magdolen}@fbi.uniza.sk

Abstract. Video-surveillance is the most used type of surveillance systems. With development in information technologies requirements for more effective, reliable and faster systems arise. Application of biometric recognition ability to such systems become more often and used not only in state operated systems but in private and commerce application as well. Operators should be aware of the minimal criteria for biometric recognition for flawless implementation of to the existing systems or for installations of new systems. These article should provide a basic instructions and manual what to expect or how to determine the optimal video-surveillance system settings to achieve desired purpose of biometric recognition in demanded recognition rate.

Keywords: Biometrics, biometrics recognition, biometric identification, biometric video-surveillance system.

1. Introduction

Biometric recognition represents nowadays a common functionality for identification or verification of individuals not only in commercial but in private applications as well. Examination of biometric characteristics and features is not anymore exclusive for application in scientific, criminalistics or medical research, but become due to sufficient computing capacity and relative affordability implemented to many surveillance systems, where the speed, effectivity and reliability of person`s identification or verification is essential.

For appropriate biometric surveillance system deployment is inevitable to have detailed knowledge of hardware, software and environment requirements for such system to achieve required effectivity and comparison reliability.

In this article we are trying to specify minimal pixel density and object distance from the camera in biometric video-surveillance system for person recognition through the experiment performed with the aim to determine this values.

1.1. Vocabulary

For better understanding it is necessary to explain some basic terms used in this article to specify its meanings and to avoid possible misinterpretation. Due to biometric functionality in systems of question, some terms have different meaning as from regular video-surveillance system. Terms and definitions are used mainly as defined in ISO/IEC 2382-37:2012 Information technology – Vocabulary – Part 37: Biometrics, EN 50132-7:2012 Alarm systems. CCTV surveillance systems for use in security applications. Part 7: Application guidelines and in other influential scholar textbooks.

Recognition, identification and inspection – according the EN 50132-7:2012 to perform recognition, identification or inspection by means of video-surveillance, the recording or the picture

should be at quality and number of details[1] to allow such activity. [1] In case of biometric systems such terms are not commonly used and the verification of individual`s identity is called biometric recognition.

Biometric recognition – process of "establishing the identity of a person based on the physical (e.g., fingerprints, face, hand geometry, and iris) or behavioral (e.g., gait, signature, and keyboard dynamics) attributes associated with an individual. A typical biometric system uses appropriately designed sensors to capture the biometric trait of a person and compares this against the information stored in a database to establish identity." [2] As difference to regular video-surveillance systems "biometric recognition is synonym for biometric authentication, meaning verification or identification in biometrics." [3]

Video-surveillance system – "system consisting of camera equipment, storage equipment, monitoring equipment and related facilities for the purpose of image transmission and control." [4]

Biometric (video-surveillance) system – "biometric system is system for biometric recognition of individuals based on their biometric characteristics". [5] To specify such system for our experiment we used biometric capture device (video-surveillance system[2]) to acquire specific biometric characteristics and their conversion to biometric template.

Biometric characteristic – "biological and behavioral characteristic of an individual that can be detected and from which distinguishing, repeatable biometric features can be extracted for the purpose of automated recognition of individuals." [6] "Biological and behavioral characteristics are physical properties of body parts, physiological and behavioral processes created by the body and combinations of any of these." [7]

Biometric feature – "biometric features are the information extracted from biometric samples which can be used for comparison with a biometric reference." [8] "For example, characteristic measures extracted from a face photograph such as eye distance or nose size etc. The aim of the extraction of biometric features from a biometric sample is to remove superfluous information which does not contribute to biometric recognition. This enables a fast comparison and an improved biometric performance, and may have privacy advantages." [9]

2. Experiment

In international standards some parameters for individual's identification are established. In case of video-surveillance systems according EN 50132-7:2012 a pixel density of 4mm/pixel[3] is required. In case of biometric systems ISO/IEC 19794-5:2005 requires at least 180 pixels for head width (or 90 pixels between the eyes). [10] For example AXIS, one of leading company in development of video-surveillance system states that "following suggested operational requirements from SKL, the Swedish National Laboratory of Forensic Science and supported by our own test results at Axis Communications, we have chosen to use 80 pixels (for horizontal dimension of the face - author`s note) as the requirement for facial identification for challenging conditions[4]." [11]

To sort and challenge these various values established by different interdisciplinary standards we decided to perform an experiment to determine the minimal pixel density of the picture and the

[1] For **recognition**: at least 50% of screen height (PAL), with person`s height 1.7m, to determine with high degree of certainty that person on the screen is the same person as before (and/or 8mm/pixel). For **identification**: at least 100% of screen height (PAL), with person`s height 1.7m, to identification of individual without any doubts (and/or 4mm/pixel). For **inspection**: at least 400% of screen height (PAL), with person`s height 1.7m, to perform court inspection (and/or 1mm/pixel).

[2] Video-surveillance system consist from camera, camera lens, digital recorder and surveillance software and all necessary equipment to operate such system.

[3] For 160mm width face (according AXIS statement – see reference [11]) it should be 40 pixels for face width.

[4] Challenging conditions according AXIS are "situations with very varying or weak lightning. People, objects and vehicles are seen from an angle where details are in shade, or facing away from the camera. " [11] In contrary in case of good conditions AXIS recommends only 40pixels as an operational requirement for person`s identification.

optimal distance of the object from the camera and their correlation to set up this values for optimal performance of biometric recognition function.

2.1. Experiment goal

When preparing the experiment we established our hypothesis and desired values for determination to be able to prepare and perform appropriate experiment which would allow us to achieve wanted outcomes.

The goal was to find out how the distance of object from the camera change the rate (score) of biometric recognition and determine the optimal zone where the subject has to be situated in order to reliably perform biometric recognition. This information can help the biometric systems operators to determine the camera settings and area selection that is required for efficient system operation. Because the distance is not the only value relevant for such recognition, we calculated the pixel density of the camera recording that is necessary for such recognition and to be able to use this values universally, we transformed this value to the pixel density for face width (as used in international standards).

2.2. Experiment settings

In our experiment we used readymade, standard video surveillance system set with none hardware or software changes to simulate consumer's conditions, which consist of:

- 1,3 mpx video surveillance camera Panasonic WV-SP305 with 1/3" (MOS sensor)
- lens TAMRON M13VG288IR – type CS with auto iris F/1,2 (Field of view - horizontal 35,8° – 100,1°/ vertical 26,8° – 72,9°)
- network video recorder Panasonic WJ-NV200K with online face detection and recognition function

System was set up to record color image with resolution 1280 x 960, frame rate 5 fps and compression H264. Focal length of the lens was 8 mm with depth of field sufficient to focus on the object for the whole distance range of the experiment. Camera installation height was 1.7m in order to achieve zero or maximum 10% angles from test objects heads (according the test object height). Test objects were uniformly illuminated from the front side so the faces contained no shadows during recognition.

As test objects we used real persons - volunteers from students and our colleagues. As we wanted to create conditions as ideal as possible for recognition purposes the test objects should maintain during experiment neutral face expressions and head movements should not exceed more than 10% from frontal view in any direction. For the same reason any possible disguises were not allowed (hats, both sun and prescribed glasses, etc.), because it could affect experiment results.

2.3. Equations

To determine pixel density we used equation (1) that allowed us to calculate image resolution for 1 meter of recorded area (pixel density) from known values and camera settings:

$$image\_resolution(px/m) = \frac{focal\_length(mm) * number\_of\_pixels_{horizontal}}{camera\_distance(m) * sensor\_width} \quad (1)$$

2.4. Experiment procedure

Before experiment we loaded face pictures of test objects to the video-surveillance system by the means of network video recorder included software. To create a bigger dataset for possible recognition, we selected double quantity of pre-set faces as real test objects. For experiment 20 persons were used and dataset contained 40 faces. Minimal resolution of each recorded face was

200x200 pixels (in significant area of the face). Each face sample was recorded by the same settings, illumination and position from camera.

First part of experiment was performed in order to determine the specific area, where the system is able to perform biometric recognition. Changing distance of object from the camera simulated different image resolution (or the face pixel width). We asked test objects to move towards the camera in preselected 1 meter steps, from 6 m to 1 m distance from the camera (1 meter marks were marked on the floor). If the system was able to recognize face of test object the outcome of such recognition was logged. Illumination in testing area ranged from 800 - 2200 lux. 20 measurements was performed.

According the outcome of first part of experiment we narrowed the distance and continued with the experiment only at specific distances from camera. We selected the area from 4 m to 2 m[5] where the used video-surveillance system was able to perform biometric recognition (correct match was not necessary). In second part of experiment we repeated the test as in the first part, but now the test objects moved only with 0.1 m steps towards the camera. Illumination in testing area ranged from 300 - 500 lux. 40 measurements was performed. During the test each outcome of recognition was logged in order to calculate recognition (successful) rate in each selected distance. The recognition rate is calculated from the total set of matching and non-matching results of each measured distance.

3. Findings based on Experiment

Based on the outcomes from the first step we determined that used biometric video-surveillance system was able to detect object face from distance approximately 4 meters.

Illumination (lux)	2250	1830	1550	1300	1200	875
Distance (m)	1	2	3	4	5	6
Pixel density (pix/m)	2133	1067	711	533	427	356
Recognition rate (%)	**94,44**	**100,00**	**72,22**	**33,33**	**0,00**	**0,00**

Tab. 1. Recognition rate according the distance of test object from camera (distance from 1m to 6m, steps 1m)

During the second part of the experiment we determined detailed recognition rates for 0.1m steps and by using simple line graph visualized the correlation between pixel density and the distance of object from the camera.

Illumination (lux)	451	448	403	356	376	370	361	348	348	352	381
Distance (m)	2,0	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3,0
Pixel density (pix/m)	1067	1016	970	928	889	853	821	790	762	736	711
Face width (pix)	140	134	127	121	118	113	110	105	101	97	95
Recognition rate (%)	**97,50**	**97,50**	**97,50**	**95,00**	**92,50**	**95,00**	**95,00**	**100,00**	**92,50**	**92,50**	**95,00**

Tab. 2. Recognition rate according the distance of test object from camera (distance from 2m to 3m, steps 0.1m)

Illumination (lux)	346	360	362	360	360	388	405	350	400	380
Distance (m)	3,1	3,2	3,3	3,4	3,5	3,6	3,7	3,8	3,9	4,0
Pixel density (pix/m)	688	667	646	627	610	593	577	561	547	533
Face width (pix)	92	89	87	85	82	80	77	76	74	73
Recognition rate (%)	**82,50**	**85,00**	**77,50**	**57,50**	**62,50**	**57,50**	**40,00**	**52,50**	**45,00**	**37,50**

Tab. 3. Recognition rate according the distance of test object from camera (distance from 3.1m to 4m, steps 0.1m)

[5] As we wanted to determine the minimal value for pixel density, it was not necessary to perform the test for distances lower than 2 meter, with assumption that in such distances the rate of biometric recognition is very high.

Values from second part of experiment provides us with an example how the success rate of biometric recognition changes proportional with decreasing pixel density and object`s distance from camera. In order to be able to apply our findings to any settings of video-surveillance systems where the settings can and probably will be different from our experiment, we calculated and measured the pixel density of recognized face. Values from Tab. 2. and Tab. 3. are shown in graphs below.

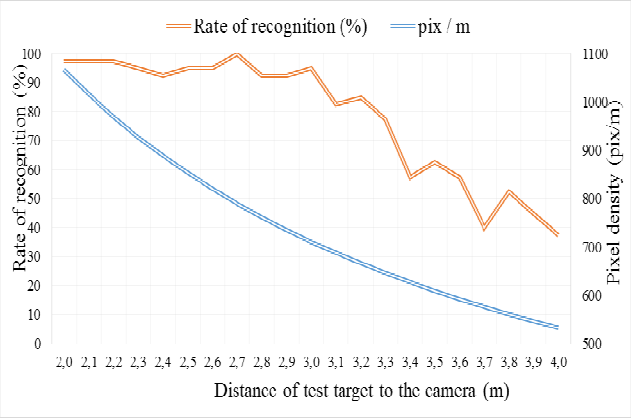

Fig. 1. Recognition rate and pixel density based on outcome from experiment (distance from 2m to 4m, steps 0.1m)

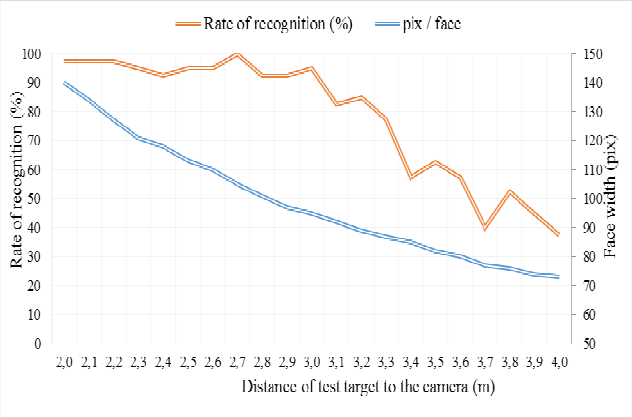

Fig. 2. Recognition rate and face width based on outcome from experiment (distance from 2m to 4m, steps 0.1m)

4. Conclusion

The experiment shows the dependency of recognition rate to the distance of the object from the camera and resolution of the recording. When we compare the requirements from different international standards or video-surveillance producers we can see big difference among these requirements. We can see that in real application of biometric recognition the required pixel density of EN 50132-7:2012 standard for identification – 4 mm/pixel is not nearly enough for biometric identification and on the other hand the requirement of 180 pixels for head width established by ISO/IEC 19794-5:2005 standard is too restrictive for everyday use, and with such high pixel density the recognition rate should be almost 100%. These requirements suppose different use and different applications (and/or meaning) of identification process and therefore each operator of video-surveillance system should be aware of his minimal requirements for recognition rate (for his intended or specific purpose of the system). According our experiment and experience we should recommend minimum requirement of 90 pixels for head width for video surveillance systems in standard security applications. However for autonomous identification systems the minimum requirement should be at least 140 pixels for head width to ensure maximum reliability of the system.

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Comparison of Natural Risk Assessment Methods through Multi-criteria Decision-making at the National Level of the Slovak Republic

[*]Ján Dvorský, [*]Tomáš Pavlenko, [**]Jan Kopřiva
[*]University of Žilina, Faculty of Security Engineering, Department of Crisis Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Jan.Dvorsky, Tomas.Pavlenko}@fbi.uniza.sk
[**]Czech Technical University in Prague, Faculty of Transportation Sciences, Department of Security Technologies and Engineering, Konviktská 20, Prague 1, 110 00, Czech Republic, {jan.kopriva}@fd.cvut.cz

Abstract. As a result of globalization as a whole and the dynamic changes in society connected to it the pressure to prevent risks that can have a negative influence on the sustainability of urban areas is increasing. Using quantitative methods of operational analysis, the article compares several identified methods that have been implemented in the legal norms of highly developed countries for the assessment of natural risks. Result of the comparison is a selection of the most appropriate method for natural risk assessment at the intrastate level of Slovak Republic using methods of multi-criteria decision-making – the Forced Decision Matrix Method (FDMM) and the Analytic Hierarchy Process (AHP). To evaluate the outcomes of the multi-criteria decision process the Matlab software was used. The article outcomes will enable the development of a theoretical scientific platform for sector integration of the influence of environmental risks safety management.

Keywords: Assessment, comparison, AHP method, natural hazards.

1. Introduction

All activities which are carried out in life whether consciously or unconsciously are the result of a decision-making process. If this is conscious decision-making then there is always an effort to obtain the most information possible about the issue and to arrive at the best conclusion on that basis. If a problem is considered in which there are several contradictory viewpoints then it is not possible to decide which of the alternatives would be the most beneficial. A simple and at the same time complex solution which enables splitting the problem into a transparent structure and always working with as few elements as possible simultaneously is necessary [1]. Methods of multi-criteria decision-making enable the division of the entire problem into hierarchies possible as well as the subsequent comparison of two elements by which weights of the criteria and partial evaluation of the alternatives are obtained. With a simple synthesis an overall assessment is achieved.

At present HRVA methods (Hazard, Risk and Vulnerability Analysis) are used in developed countries for assessment of natural risks on a given territory [2]. By using the multi-criteria decision-making approach it is possible to analyze selected methods of natural risk assessment with the aim of choosing a method which – with respect to stipulated criteria – could be implemented on an intrastate level in the Slovak Republic.

2. Methods of multi-criteria decision-making

Methods of multi-criteria decision-making belong among the exact heuristic methods of operational analysis. They are utilized during various decision-making processes, where more than one criterion is important. The advantage of multi-criteria decision-making methods lies particularly in their simplicity and their speed of use. However, the main disadvantage of multi-criteria decision-making methods – the possible inaccuracy of their results – also arises from this simplicity [3]. Expert estimates of qualitative criteria are used in the methods; therefore, it is possible to

consider them semi-qualitative methods. Semi-qualitative methods are those in which monitored attributes are expressed as numerical values. The following methods of multi-criteria decision-making are arranged in order from the simplest up through the most complex method [4]:

1. Decision Matrix Method (DMM) – method without differentiation of the weights of individual criteria, i.e., all criteria are equally important.
2. Forced Decision Matrix Method (FDMM) – method based on comparison of two criteria which assigns values of 0 and 1 to them according to which is more important.
3. Analytic Hierarchy Process (AHP) – method during which each criterion has its own weight in comparison with others, expressed as a value from 1 to 9 or 1/9 to 9/9.

In the following section selected methods of risk assessment which are currently used in developed countries will be compared using the most exact methods of multi-criteria decision-making, i.e. the Forced Decision Matrix Method and the Analytic Hierarchy Process [5].

3. Analysis of selected methods of risk assessment

In Tab. 1 provides the following methods for the assessment of natural hazards, which are used in developed countries. Names of methods are derived from the names of organizations that have been developed.

Method	Organization name
FEMA	Federal Emergency Management Agency
SMUG	Australia – Emergency Measures
EPC	Canada – Emergency Preparedness Canada
CVCA	Climate Vulnerability Capacity Assessment
NOAA	National Oceanic and Atmospheric Administration
APPEL	Sweden –Swedish Rescue Services
UNDRO	UN-UN Disaster Relief Organization
HIRV	Hazard, Impact, Risk and Vulnerability

Tab. 1. Methods of assessment of natural risks and vulnerability of a territory at the intrastate level

A method which would with high probability be the best to implement at the intrastate level of the Slovak Republic will be selected according to set criteria. The criteria of multi-criteria decision-making do not have to be only quantitative but can be qualitative as well. The criteria are determined by a partial goal, which is high quality of the outputs. The quality of the outputs is influenced by the degree of objectivity and measurability of the results. A no less important factor is the complexity of application from which cost of the used model derives. The time for application of the method and the necessary worker expertise connected with the used model require increased expenditures.

The following criteria were stipulated after consultations with employees of the Ministry of the Interior based on the above mentioned reasons and the basic characteristics of the selected methods which are available in the crisis management section of the Ministry of the Interior of the Slovak Republic:

- K_1 – measurable outputs (quantitative, semi-qualitative, qualitative);
- K_2 – degree of objectivity (to what measure is the method influenced by the subjectivity of the user);
- K_3 – time demand (time required for preparation, application and assessment of method);
- K_4 – expert demand (number of experts needed for method utilization).

Paired comparison methods for assessment of selected risks during multi-criteria decision-making are done under expert supervision of a competent worker from the crisis management

section of the Ministry of the Interior of the Slovak Republic given its wide practical experiences with their application. However, even despite the expertise of workers from the Ministry of the Interior of the Slovak Republic, a larger number of assessors of the selected methods was necessary; these were in particular foreign experts in the given field.

3.1. A comparison of the selected methods of risk assessment using FDMM

Using a modified method of a decision-making matrix – FDMM – first the selected criteria and later the methods of assessment of natural risks themselves are compared in pairs. We assign the value of "1" to the more important criteria or method in the paired comparisons and to the less important criteria or method in the paired comparison we assign the value of "0". Individual steps of the FDMM calculation process are described in foreign and domestic scientific literature [6].

Kritériá	Váha	Hodnotenie metód							
		FEMA	SMUG	EPC	CVCA	NOAA	APPEL	UNDRO	HIRV
K1	**0,476**	0,143	0,179	0,071	0,143	0,071	0,179	0,071	0,143
K2	**0,081**	0,172	0,138	0,172	0,172	0,069	0,103	0,103	0,069
K3	**0,155**	0,138	0,138	0,103	0,103	0,172	0,138	0,069	0,138
K4	**0,288**	0,133	0,100	0,133	0,133	0,167	0,067	0,133	0,133
Vážený súčet		**0,142**	**0,146**	**0,102**	**0,136**	**0,114**	**0,134**	**0,091**	**0,133**
Percentuálne vyjadrenie (%)		**14,2**	**14,6**	**10,2**	**13,6**	**11,4**	**13,4**	**9,1**	**13,3**
Poradie		**2.**	**1.**	**7.**	**3.**	**6.**	**4.**	**8.**	**5.**

Tab. 2. Results of a comparison of the methods used for assessment of natural risks using FDMM

The result of the modified method of a decision-making matrix – FDMM – on the basis of the selected criteria is determining the order and the most suitable method of natural risk assessment on an intrastate level. The most suitable in this case is the SMUG method. However, other examined methods such as e.g. FEMA, CVCA, APPEL, HIRV and NOAA had a comparable percentage value with SMUG using this method of multi-criteria decision-making.

3.2. Comparison of the selected risk assessment methods using AHP

AHP is based on paired comparisons of the degree of significance of individual criteria and determination of how the evaluated variants satisfy these criteria. AHP is considered to be the most reliable method from the viewpoint of precision of outputs. The assessment scale is, however, notably more complex. Assessments are made on the basis of a scale (equal – weak – medium – strong – very strong) and the corresponding numerical scale (1 – 3 – 5 – 7 – 9) [7]. These scales consider the measure (influence) of the relationship between two criteria or variants. Numerical calculations are made with the aid of the Matlab software and the individual steps are identical with the steps in expert and domestic literature.

The result of the analytical hierarchical approach (AHP) method based on the selected criteria determines the most appropriate method of natural risks assessment at the intrastate level as well as the order of all the examined methods. The most appropriate method in this case is APPEL. However, other monitored methods such as SMUG, FEMA, NOAA and CVCA also had percentage value comparable with that of APPEL using this method of multi-criteria decision-making

Criteria	Weight	Assessment of methods							
		FEMA	**SMUG**	**EPC**	**CVCA**	**NOAA**	**APPEL**	**UNDRO**	**HIRV**
K1	**0.476**	0.131	0.175	0.056	0.147	0.089	0.220	0.073	0.108
K2	**0.081**	0.151	0.115	0.182	0.163	0.104	0.091	0.095	0.099
K3	**0.155**	0.126	0.136	0.091	0.092	0.222	0.130	0.076	0.127
K4	**0.288**	0.164	0.103	0.106	0.106	0.174	0.080	0.154	0.114
Weighted sum		**0.142**	**0.143**	**0.086**	**0.128**	**0.135**	**0.155**	**0.099**	**0.112**
Percentage (%)		**14.2**	**14.3**	**8.6**	**12.8**	**13.5**	**15.5**	**9.9**	**11.2**
Order		**3.**	**2.**	**8.**	**5.**	**4.**	**1.**	**7.**	**6.**

Tab. 3. Results of a comparison of the methods used for assessment of natural risks using AHP

4. Conclusion

The results acquired with the FDMM method are more exact than those with the DMM method because the weights of the criteria are set more exactly. On the other hand, the FDMM method has – in comparison with the AHP method – a disadvantage in that we get considerable differences in the values of the individual methods even when they differ only slightly. Verification is done by comparing the results acquired by using the FDMM and AHP methods of multi-criteria decision-making. The results of the FDMM method determined the SMUG, FEMA and HIRV methods as being the most suitable natural risk assessment methods. By utilization of the AHP method the most suitable methods for natural risk assessment were determined to be APPEL, SMUG and FEMA. By comparing the acquired results the FEMA and SMUG methods were determined to be the most suitable of the natural risk assessment methods.

The disadvantage of use of the AHP method is the great measure of subjectivity, mainly with qualitative criteria [8]. It is necessary to reduce the measure of subjectivity. One solution is for decision-making to be based on professional estimates of teams of expert who would discuss their opinions on assessment and subsequently agree on the selection, weights and evaluation criteria. Another solution for reducing subjectivity of the assessments is increasing the number of assessors; however, the selection of criteria, weights and their paired values would be done individually. In this way, the influencing of individual assessors by professional teams would be prevented.

In the Slovak Republic, with respect to territorial vulnerability and natural risks occurring on its land, it is possible to come to the conclusion that all of the selected methods have their strengths and weaknesses. Through synthesis of findings about usability of selected methods for risk assessment it is – while utilizing current mathematical and technical possibilities, tools of information analysis and with the help of personnel of crisis management authorities in Slovakia – possible to improve the method of risk assessment at the intrastate level.

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The Reaction to Fire Testing of Combustible Product

[*] Adelaida Fanfarová, [**] Esko Mikkola
[*] University of Žilina, Faculty of Security Engineering, Department of Fire Engineering, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Adelaida.Fanfarova}@fbi.uniza.sk
[**] KK-Palokonsultti Oy, KK-Fire Consult s. r. o., Piispantilankuja 4, 022 40 Espoo, Finland, {esko.mikkola}@kk-palokonsultti.com

Abstract. Fireproofing of combustible materials is a specific area of fire protection. The fire retardants are ones of efficient means to ensure the safety of people, animals, property and environment. Due to growing interest in environmental issues in the construction industry, natural building materials of plant origin (e.g. wood, straw, cellulose, hemp) are becoming increasingly popular. These materials have high flammability. For scientific research as well as for real-life practice, not only their structural and physical properties, but also fire-technical characteristics are really important. The present researchers mostly focus on fire-retardant treatment of wood, that is why the authors of this paper focused on a different combustible material. This paper presents an experiment focused on reaction to fire tests in laboratory conditions. The purpose of the experiment is testing the thermal insulation of hemp fiber that was impregnated by the selected fire retardant.

Keywords: Testing, reaction to fire, thermal insulation, fire retardant, experiment.

1. Introduction

The most suitable tests for testing flammable products and materials are those ones that are able to simulate conditions of a burning process, i.e. real fire in the most natural way. It is inevitable to properly design, test and evaluate the evaluation criteria for tests, selection and size of specimens, testing conditions, testing devices, testing procedures, methods of evaluation and processing of the test results. In that case it is possible to objectively interpret the behaviour of the tested material or product during fire [1]. The reaction to fire is not a term related only to construction materials and substances but also construction products. The reaction to fire tests are fire tests that further specify the specific methodological and testing procedures to determine the behavior of a respective subject of testing in case of fire. The objective of these tests is to define the reaction to fire of a tested material or a product. The testing experiment of reaction to fire of a combustible product was realized using the methodology for testing fire retardants and fire-retardant treatments of materials - reaction to fire tests - test for limited flame spread [2]. This method was developed in the Fire-chemical laboratory of the Department of Fire Engineering, Faculty of Security Engineering, University of Zilina as an internal document within the institutional grant project. The methodology specifies the fire test focused on evaluation of the specimen combustion behaviour when exposed to a direct mid-height flame for a longer time period. It describes and specifies the fire test for testing retardant treatments of combustible materials exposed to a mid-height flame, with the surface exposure angle of 45° to the vertical axis. This angle is the angle of the product used in real-life practice. The subject of testing was the building material of plant origin named Canabest Basic - natural thermal and sound insulation made of hemp fiber. It is normally used as a filler in roof construction, between the rafters or beamed ceilings. Hemp fiber insulation can be characterized by specific properties such as: high moisture resistance, ability to dry quickly, insulation stability in extreme conditions and creation of natural microclimate. Due to the natural content of bitter substances, it does not support fungal growth and has a certain resistance against rodents [3]. Manipulation with this material is without health risks, such as skin damage, eye and airways irritation. It is also important to point out that hemp as a pure natural material is environmentally

friendly, with no adverse health effects, recyclable and renewable. There was applied the fire retardant Ohnostop special - a colourless watery substance of inorganic salts, 100% ecological, naturally recyclable, environmental and health friendly. It is hygroscopic - it is able to bind water molecules and absorb moisture from the air or water vapour from the surrounding environment. This retardant was invented to decrease the combustibility and to improve the fire resistance of building products in interior spaces. It works on the principle of releasing non-combustible gases in the heat interval when the combustible gases are generated by thermal decomposition of the combustible material. This leads to dilution and decompression of concentration of flammable gases and, in this way, their ignition is impeded. In case of long-time exposure to direct flame it significantly impedes the spread of fire. We can apply it by soaking, coating, spray application or by the vacuum - pressure method [4].

2. The test specimens

The test specimens for the experiment comprised 18 specimens which were cut from a piece of thermal hemp insulation product Canabest Basic (see Fig. 1). Each specimen had dimensions of 200 x 100 x 30 mm (± 1 mm). All the specimens were divided into three sets. The first set of the tested specimens (marked X1 » X6) was not impregnated or modified in any way. The second set of the tested specimens (marked 1 » 6) was impregnated by soaking in the fire retardant Ohnostop special. The third set of the tested specimens (marked 1B » 6B) was similarly impregnated by soaking in the fire retardant Ohnostop special but with addition of another effective chemical element in order to increase its fire protection.

Fig. 1. The test specimens of thermal insulation product Canabest Basic

3. The testing device

The testing device used for the fire test is a complex device, constructed according to the scheme adopted from an older standard (STN 73 0862 - supplement b). It is formed by a structure of materials resistant to the adverse effects of heat and combustion products released during the test. This device (see Fig. 2) consists of the following parts [2]: a test specimen holder of non-combustible material, gas burner, flow meter with fuel flow regulation and the fuel source - technical propane butane mixture cylinder. The fuel source is a pressure cylinder with a technical propane-butane mixture with purity of at least 95 %.

Fig. 2. The testing device for fire tests constructed and located in the Fire-chemical laboratory of the Department of Fire Engineering, Faculty of Security Engineering, University of Zilina

The testing device also includes laboratory scales Mettler Toledo - model MS1602S (see Fig. 3). They are specifically designed to be used in laboratories. They are protected against dust and water, resistant to most chemicals including acetone, have a protective cover to protect them against stains and scratches, the maximum weighing capacity of 1 620 g and readability of 0.01 mg. The fast and error-free data transfer is provided via the USB computer connection. These analytical and calibrated scales combine a lot of weighing alternatives that can be adjusted with the help of properly set software. It is also possible to set the measurement in various time intervals - as little as 1 second.

Fig. 3. The laboratory scales Mettler Toledo - model MS-S located in the Fire-chemical laboratory of the Department of Fire Engineering, Faculty of Security Engineering, University of Zilina

The preparation for both reactions to fire tests included several activities. The first step was mixing the Ohnostop special fire retardant solutions in compliance with the producer's instructions. The specimens of hemp insulation were impregnated by soaking for 5 minutes, whereas 350 ml of fire retardant solution was used for each two specimens. Subsequently, the specimens were weighed in regular intervals until completely dry, which meant complete evaporation of water bound during the retardation process. When the weight of all test specimens became stable (with 1g deviation), the test devices were prepared and the required laboratory conditions arranged.

The testing procedure according to the methodology for testing the fire retardants [2], necessary for determination of fire-technical characteristics of combustible materials, consisted of the following steps: before the test was conducted each specimen was weighed and the weight was recorded; then each test specimen was placed in the test device holder under the angle of 45° and

was exposed to the effects of an open mid-height flame for 5 minutes. The flame height was set according to the methodology to 100 mm (± 1 mm). During the exposure of the specimen to the effects of flame the weight loss of the specimen was recorded using the laboratory scales in the set time interval of 10 seconds. During this experiment there were recorded further evaluation criteria that reflected the behaviour of the tested specimen (time of ignition, time of spontaneous combustion, time of smouldering, burning process etc.). This data is necessary for evaluation of the fire protection efficacy of the tested product. Each specimen test adhered to the unified test methodology and fire safety measures for laboratory work.

4. The results of testing

The main evaluation criterion in this experiment was the weight loss of the tested specimens. This value represents the difference between the weight loss before the testing, the weight change during the testing (10-second interval), and the weight after the testing. All the weight values were measured using the laboratory scales Mettler Toledo. The results of the reaction to fire tests - weight losses- according to the sets of the tested specimens are as follows:

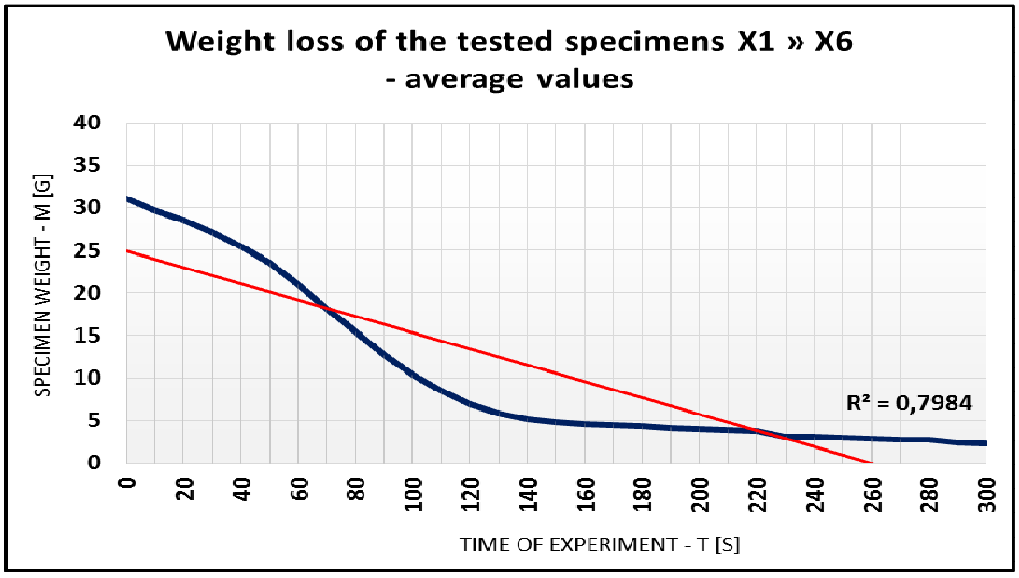

Fig. 4. Weight loss of the tested specimens X1 » X6 (not impregnated)

- The first graph (see Fig. 4) presents the continuous weight loss of the first set of the tested specimens (marked X1 » X6), that were not modified or impregnated with a fire retardant. The curve presents the average values of the total weight loss of each specimen in the set. All the tested specimens behaved in a similar way, they participated in the process of combustion, ignited, there was spontaneous combustion, considerable smouldering and smoking. Some specimens were dripping flaming particles. Each specimen reacted to the flame exposure and in 2 minutes it lost more than 2/3 of its original weight. The average weight loss calculated with regard to the original weight (the weight before the experiment) in this set was more than 90%. One specimen even burnt completely in the 4th minute and did not withstand the given time of the fire exposure. We can thus conclude that this set of specimens achieved the worst results in our experiment.

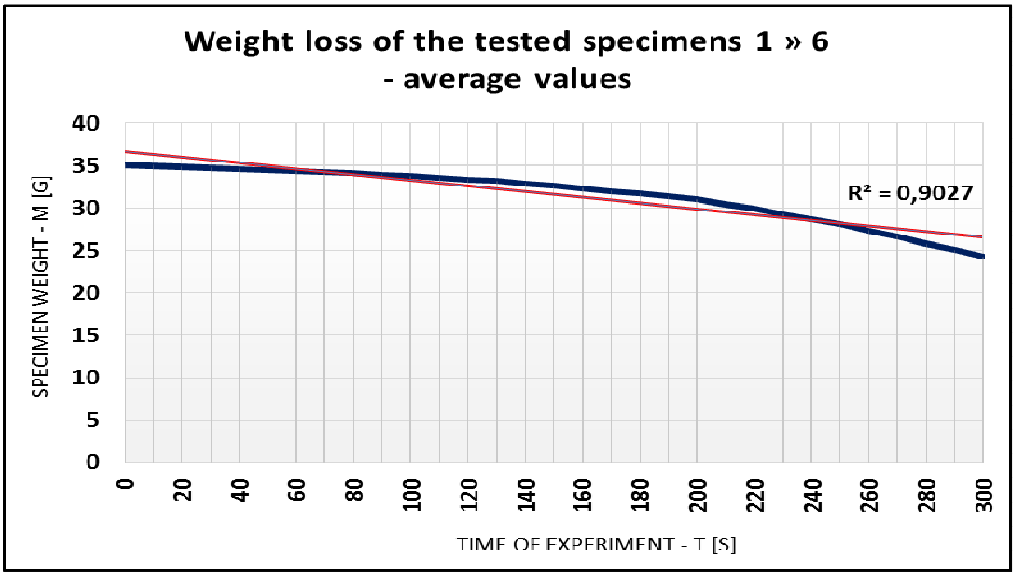

Fig. 5. Weight loss of the tested specimens 1 » 6 (impregnated with the fire retardant Ohnostop special)

- The second graph (see Fig. 5) presents the average weight loss values of the second set of the tested specimens (marked 1 » 6). These specimens were impregnated with the fire retardant Ohnostop special and due to this impregnation their results were better compared to the first set of the tested specimens. Even after the given time of the experiment expired (5 minutes), all the tested specimens were able to retain more than 1/2 of their original weight. The average weight loss in this set of specimens was approximately 30%, which is 2/3 less than the first set of specimens. The behaviour of the impregnated specimens during the testing procedure: they resisted the effects of flame better, they did not ignite, there was no spontaneous combustion or smouldering, the specimens emitted smoke only.

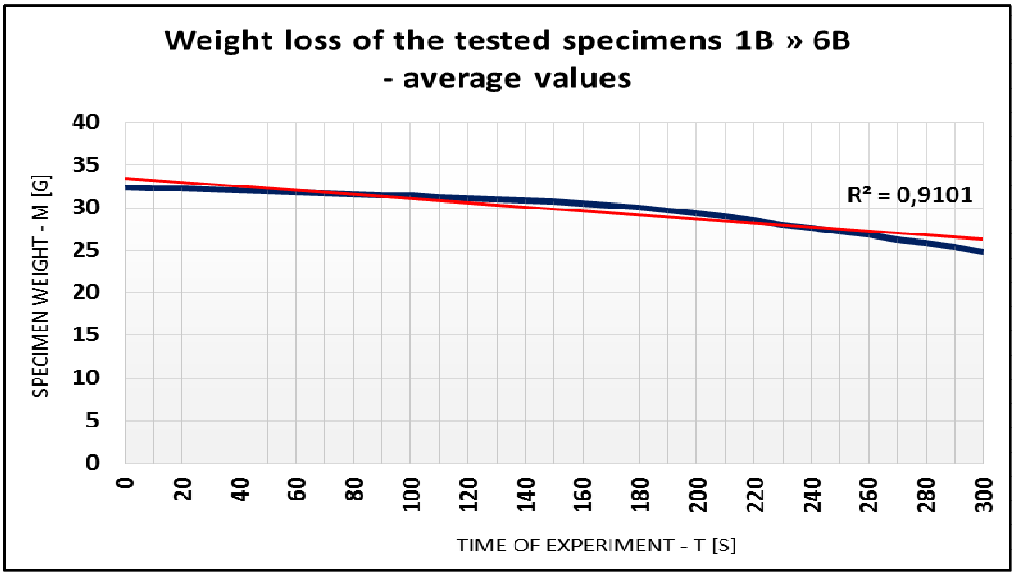

Fig. 6. Weight loss of the tested specimens 1B » 6B (impregnated by the fire retardant Ohnostop special with a chemical additive)

- The third graph (see Fig. 6) shows the curve of the average weight loss values of the third set of the tested specimens (marked 1B » 6B). Similarly as with the second set of specimens, these specimens were impregnated with the fire retardant Ohnostop special, but there was also a new chemical element added to the fire retardant solution. The aim of this modification was the improvement of fire-technical properties of the tested combustible product. We were able to meet this goal as this set of the tested specimens showed the lowest weight loss as well as the best behaviour during all the experiment. The average weight loss in this set is 25%.

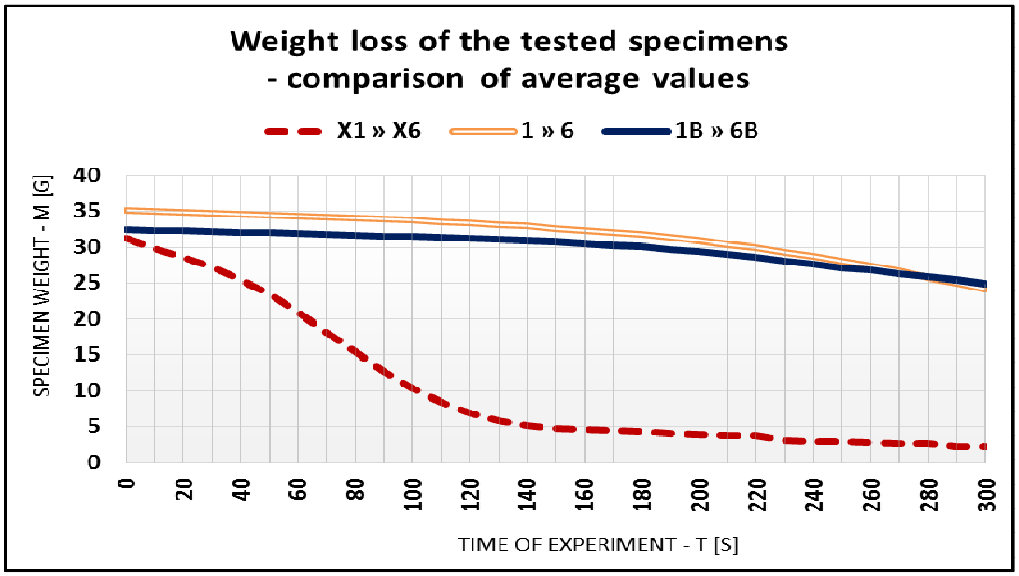

Fig. 7. Comparison of average weight loss values of the tested specimens according to the specimen sets

The final graph (see Fig.7) presents the comparison of average weight loss values of all the tested specimens as divided into sets. It also interprets the behaviour of all three sets of the tested specimens during the laboratory experiment focused on the testing of reaction to fire.

5. Conclusion

The experiment results confirmed that the impregnation of the tested combustible product with the fire retardant improved positively its reaction to fire. The applied fire retardant Ohnostop special was able to improve the fire-technical characteristics of the thermal insulation product, especially its combustibility. From the point of view of weight loss, when the effective chemical element was added the improvement was more than 65%, compared to the unimpregnated material. The linear trend line with the level of confidence R2 was added to the individual graphs (Figures 4 – 6). This value of the coefficient of determination states that more than 90% of the weight loss of specimens impregnated with the fire retardant depends on the time of flame exposure. This particular piece of information can be found helpful by improving the quality of fire protection and safety. The experiment was conducted with maximum effort to approximate the laboratory conditions to real-life environment.

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Local Level Rescue System Integration – the Bottom-up Approach

[*]Pawel Gromek
[*]The Main School of Fire Service, Faculty of Civil Safety Engineering, Department of Safety Engineering, Slowackiego 52/54 Street, 01629 Warsaw, Poland, pgromek@sgsp.edu.pl

Abstract. The article presents a manner of the local level rescue system integration with the use of the bottom-up approach. The nature of the Polish Firefighting Rescue System (FRS) is described. The competency gaps and improvement areas are identified. They are presented as reference points to implement the approach. The bottom-up character of the approach bases on local accidents and common risk data. Author describes their information potential. Relevant possibilities and usability aspects are highlighted. One points that local rescue systems ought to reflect local safety and security determinants, filling identified gaps and taking the improvement chances. It needs to conform to the National Security System of the Republic of Poland as well.

Keywords: Rescue system, integration, bottom-up approach, national security.

1. Introduction

The security engineering can play a crucial role in actual rescue integration processes in Poland. The results of the last strategic review of the national security (2011-2013) emphasized that the integration is necessary not only in case of the rescue system, but also in many others, national security aspects [1]. The security engineering tools can be useful at this point of view as they are generally coherent to the cybernetic approach commonly introduced in all national security subsystems design processes in Poland [2].

1.1. Firefighting Rescue System – the integration foundation

FRS is an integral element of the state internal security organization directed to protection of people life, health, possessions and environment. It is comprised by fire protection units (mostly the state fire services and the voluntary ones), as well as other services, inspections guards and institutions cooperating in the face of fires, natural disasters and local accidents. The system organization assures proper threats forecasting and fighting with [3].

Taking into account actual law assumptions, the system units pursue rescue operations in following areas [4]:

- ecological rescue,
- chemical rescue,
- technical rescue,
- medical rescue.

Besides these, Polish rescue trade experiences show additional areas of the operations. There are fire rescue (the operations conducting simultaneously to firefighting actions) and water rescue (the operations dealt with as activities generally supported by FRS units).

As an opposite point of view, a catalogue of all rescue kinds in Poland should be presented [4], [5]:

- ecological rescue,
- chemical rescue,
- technical rescue,
- medical rescue,
- fire rescue,

- water rescue,
- mining rescue,
- mountain rescue,
- railway rescue,
- radiation rescue,
- aviation rescue,
- flood rescue.

Comparing the law rescue kinds with the actual ones allows to make a conclusion, that FRS does not fill the whole rescue domain. The gaps are noticeable. Furthermore, the gaps are complemented by results of analysis regarding the chosen aspects of the rescue system in Poland. Exemplifying, there are no detailed guidelines dedicated to leading the mining, railway, mountain, aviation, water and flood rescue actions in law documents. Content of internal instructions and procedures does not cover all possible (and even general) action types.

However, as far as FRS is concerned, there are no more appropriate rescue body to be a reference point in rescue system integration proceeding. FRS contains most of rescue units in the country. The units are being permanently equipped and trained. It makes a possibility to show FRS in the light of foundation to make the whole rescue system integrated and coherent.

1.2. Rescue system integration processes

There are two main ideas regarding to current rescue system integration processes in Poland. First of them bases on actual strategic documents [1], [6], [7]. The need of integration is highlighted but only an one manner is described there. It consists in gradual uniting FRS and Medical Rescue System (MRS). The integration medium is a common rescue notifying system dealt with as a subsystem of both FRS and MRS. Figure 1 shows it graphically.

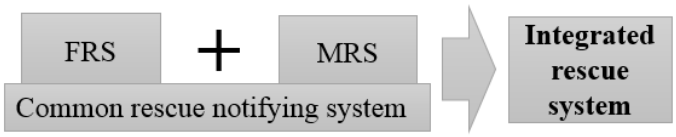

Fig. 1. Integrated rescue system in Poland – the actual integration idea.

The second integration way is to implement all rescue kinds into one integrated system. It forces a necessity to use universal system, gathering all possible rescue actions and the common security aspects. The proper one is the crisis management system (CMS) [8]. Its origin is from organizational and security engineering theories. Figure 2 presents graphically the CMS rescue system integration situation.

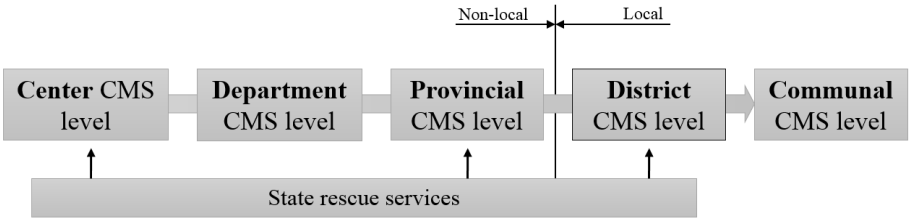

Fig. 2. Integrated rescue system in Poland – the CMS integration idea.

CMS is comprised by decision makers as well as their decision support bodies (crisis management teams) and administration bodies (crisis management centers) in four structural levels: center, department, provincial, district and communal. As the event of emergency forcing the necessity of crisis management is considered, all rescue subjects to the CMS decision makers are subordinated. The level of subordination depends on crisis management level. However, the basic and related to the state services (e.g. State Fire Service) is the district one. Possibility of rescue system integration at the local level is constituted precisely because of this fact.

2. The bottom-up approach

The bottom-up approach is closely connected with security engineering tools using for data gathering and analyzing in the optics of risk management. As far as the risk is concerned, the generally threats are taken into consideration. Thus, accordingly to the security realm, risk is understood in the negative meaning only.

The approach refers mainly to accidents and risk data sources. Information stemming from the object analysis could be introduced in such areas of practical usage as security system rationalization, security cost optimization, equipping of rescue units, security strategies harmonization, security educational programs creation and common exercises organization. The main aim is to use them as decision support means in the enumerated elements.

2.1. Accidents and risk data sources – possibilities

Particular accidents and risk data sources by different determinants are characterized. Tabel 1 shows the most important ones with their illustrative content.

No	Data source name	Illustrative data sources' content
1	The State Fire Service registers	Number of injured and/or killed, kinds of actions taken on site, equipment used by rescuers, resources involved in the actions (fire service, police, ambulances, etc.), probable cause of the event, coordinates and address.
2	Public data base of traffic accidents from the Pomeranian Province	Number of accidents and collisions, car accidents, total number of victims, injured and dead included in the division of particular years, administration units, areas, types of roads, weather conditions, types of perpetrators, accident circumstances and causes.
3	The Police Headquarters reports	Number of accidents and collisions, car accidents, total number of victims (injured and dead included) in the division to particular years, months and administration areas (provinces). Statistics regarding to drownings number in particular months and days in years 1999-2014.
4	The Polish Traffic Safety Observatory	Number of accidents with cars and other vehicles and as well as victims in division to such problematic aspects as youths on the roads, alcohol, children, speed, cyclists, motorcyclists, pedestrians and elderly traffic users.
5	Reports of the General Directorate of National Roads and Motorways	Traffic accidents on national roads in relation with accident month, death/injury, road category, weather conditions, category of victims (adults, children, pedestrians), conditions of road surface, lighting conditions, road infrastructural conditions, accident place, accident direct cause, kind of vehicle, driver behavior, pedestrian behavior and province.
6	The Central Statistical Office OSH-related reports	Number of work accidents and absence days dedicated to administration area, trade type, public or private sector, accident place, type of external cause (technical, organizational and human) as well as type of injury.
7	Reports of the National Labour Inspectorate	Number of work accidents related to accidental type, work position, injury, place and cause (additionally divided into organizational, human and technical groups).
8	Insurance institutions' data bases	Detailed data related with events divided into insurance interest-related groups (fires, road accidents, drownings, work accidents, etc.).
9	Reports of the Agricultural Social Insurance Office	Number of the accidents in agricultural environment, their reasons and causes (health and economic).
10	The State Fire Service yearly bulletins	Rescue and firefighting operations (fires and local threats), preventive operations, descriptions of characteristic actions in particular months (e.g. burned area, number of firefighters and fire engines engaged, hour of fire notification).
11	The Water Volunteer Rescue Service statistics	Number of drownings in particular years (1998-2012), special reports related with drowning rate (1 victim per 100 000 inhabitants) in years 1962-2012, number of drowned people in relation with gender and sobriety.
12	The National Institute of Public Health yearly reports	Poisonings and infectious diseases in relation with mordibity, number and percent of hospitalized people in particular provinces, gender, age and environment, number of infected people in relation with gender, age and environment, mordibity in relation with gender, age and environment, percentage of infected people in relation with gender, age and environment, number of infected people and mordibity in relation with environment and number of people in towns.

Tab. 1. Accidents and risk data sources – possibilities.

2.2. Accidents and risk data sources – usability aspect

Particular accidents and risk data by different usability are characterized. Tabel 2 shows the most important ones with their illustrative usability description.

No.	Data sources' name	Illustrative data sources' usability
1	The State Fire Service registers	Data in The State Fire Service registers for general public is partly accessible. Data is also provided for local authorities and for other interested organizations on request only. This information could be relevant for local accident prevention if made more available. The lack of detailed information regarding to type and scale of injury may be a problem.
2	Public data base of traffic accidents from the Pomeranian Province	The data base of traffic accidents is an open access information source. The source is: http://www.baza.fril.org.pl. The base could be very useful in preventive operations design and optimization as it includes diversified, accident determinants.
3	The Police Headquarters reports	The reports are available for the general public and can be downloaded from the internet sites: http://statystyka.policja.pl and http://statystyka.policja.pl. This information could be relevant for local accident prevention. The data for the particular months do not include the victims who died during hospitalization after accidents. The yearly reports include also people who died within 30 days after the accident. The reports are the most useful data source when it comes to road accidents. The reports also mention the time of the day and the locations which are especially prone to accidents
4	The Polish Traffic Safety Observatory	The Observatory is public-available on the internet site: http://www.obserwatoriumbrd.pl. Involved information could be relevant for both local and national level of preventive activities. It is free of charge and completely accessible for all registered users – representatives of all organizations making research in the area of traffic safety. It could be very useful information source taking into consideration traffic threats and risk factors. Economic factors are described as well.
5	Reports of the General Directorate of National Roads and Motorways	The General Directorate of National Roads and Motorways yearly reports are public available in: https://www.gddkia.gov.pl. They are worth-to-mention information sources in complex traffic safety analysis.
6	The Central Statistical Office OSH-related reports	The reports include number of accidents and absence days dedicated to administration area, trade type, public or private sector, accident place, type of external cause (technical, organizational and human) as well as type of injury. Nevertheless, the data concern only employees contracted for work. There is no references to civil-contracted workers.
7	Reports of the National Labour Inspectorate	The National Labour Inspectorate (NLI) is the most important, operational and preventive, Polish institution dedicated to occupational accidents problematic aspects. It generates periodical reports with information referring to accidents' number depended to accidental type, work position, injury, place as well as cause. One needs to mention that the causes are divided into organizational, human and technical groups. NLI reports take into consideration all investigated accidents. Because of this fact they mostly include all injured employees, not only those contracted for work.
8	Insurance institutions' data bases	Insurance institutions made their own reports concerning detailed data related with events divided into insurance interest-related groups (fires, road accidents, drownings, work accidents, etc.). Information is mostly much more detailed and complex than in case of public information sources. Unfortunately, the information is generally inaccessible or very expensive for external users.
9	Reports of the Agricultural Social Insurance Office	The Agricultural Social Insurance Office (KRUS) is a public body responsible for investigations and compensations' payments for farm workers in Poland. It publishes periodical reports containing information related with accidents in agricultural environment. The information is generally published in: www.krus.gov.pl.
10	The State Fire Service yearly bulletins	Covers only events with FRS units' presence. Consists information relevant only firefighting-rescue activities. The bulletins are public available in: http://straz.gov.pl.
11	The Water Volunteer Rescue Service statistics	Data base is public-available in: http://www.wopr.pl. Statistics have forms of tables and graphs. They are useful in creating a basic point of view on water safety in Poland.

No.	Data sources' name	Illustrative data sources' usability
12	The National Institute of Public Health yearly reports	National Institute of Public Health – National Institute of Hygiene reports are public available in: http://www.pzh.gov.pl. Data is detailed and comprehensive, very useful during safety analysis in Poland.

Tab. 2. Accidents and risk data sources – possibilities.

3. The bottom-up integration idea

The bottom-up approach IRS integration idea is described by following assumptions:

1. The approach ought to correspond with the district CMS level as a foundation for designing the integrated rescue system (IRS) in Poland. Regarding to the law, relevant CMS bodies have in their disposal most of rescue units in district area with their data sources.
2. IRS structure should be built on the base of division into three main subsystems: the decision one (decision makers, crisis management centers, crisis management teams), the relation one (law and other normative documents) and the executive one (all rescue subjects). The law determines a hierarchical structure of the decision subsystem and the net structure for the executive subsystem (see Figure 3).

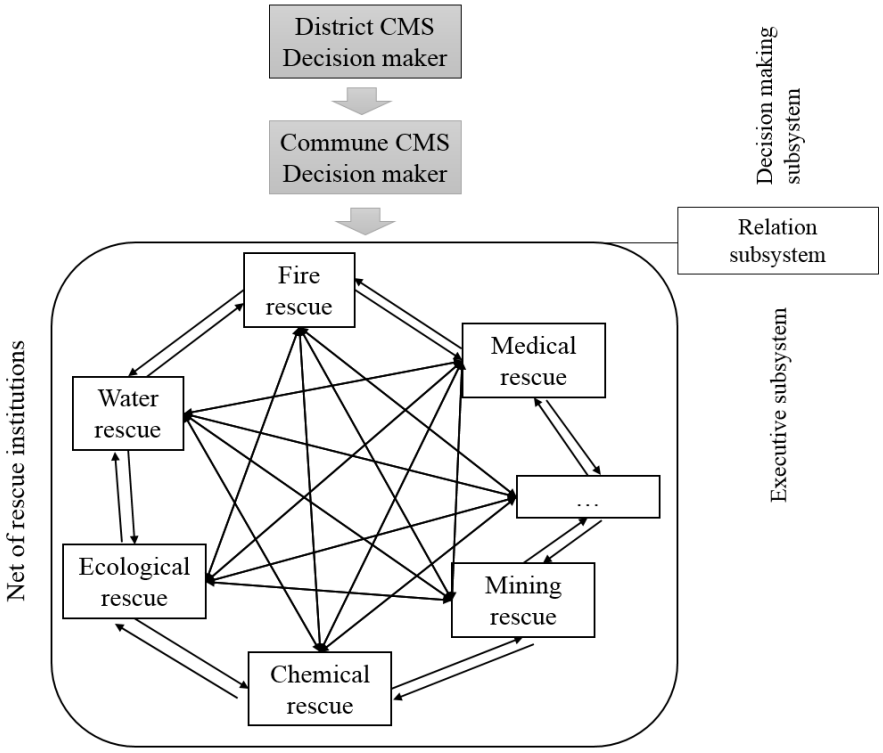

Fig. 3. The IRS suggested structure.

3. As communication is a crucial IRS integrator, the actual integration idea should be implemented. However, there is a need to expand the idea by such communication subjects as CMS bodies and other rescue areas' representatives (e.g. water voluntary rescue service, mountain voluntary rescue service, mining rescue services). The communication should be dealt with as a IRS nervous subsystem.
4. As the three first assumptions force the law changes need and the legislation processes consume much time, a more dynamic integration manner are necessarily desired. Accident and risk data sources ought to be used for the object need then.
5. Accidents and risk data sources need to be used in the all possible areas of practical usage.
6. The integration aspects should be coherent and directed to synergy effect maximization.

Multidimensional character of the integration is very important from a practical point of view. The accidents and risk data sources usage is crucial for meet especially local security environment requirements and determinants.

4. Conclusion

FRS is the fundamental element of national security, especially in relation with common security aspects. It plays role of basic IRS integration component.

The bottom-up approach consists in the fact, that local security determinants can impact on IRS integration processes. The determination can be in relation with the two main, actual ones. First of them finds expression in gradual uniting FRS and MRS. The second one uses CMS to integrate all subordinated rescue services under one command in case of crisis situation or crisis.

The approach core is usage of information concerning the local security environmental factors (accidents, risk) for the integration needs. The information sources are public and non-public available statistics, registers, reports and data bases. Most of information is gathered by public institutions. The most detailed is reserved generally for insurance companies.

Nevertheless, awareness of local security environmental factors can determine decisions regarding to security system rationalization, security cost optimization, equipping of rescue units, security strategies harmonization, security educational programs creation and common exercises organization. It has substantial impact for the local security systems, IRS involved. The determination can be associated with the rescue integration processes, creating the chance to meet IRS to local security state.

Acknowledgement

The author would like to thank all members of BaltPrevResilience project (*The Baltic everyday accidents, disaster Prevention and Resilience*, www.msb.se/baltprevresilience) he also participates in. The project is still a great inspiration for scientific work. Information concerning accidents and risk data sources was gathering simultaneously and thanks to the project work.

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Financing a Development of Road Transport Critical Infrastructure in Žilina, Slovak Republic

* Alexander Kelíšek
* University of Žilina, Faculty of Security Engineering, Department of Crisis Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Alexander.Kelisek}@fbi.uniza.sk

Abstract. Road transport in Slovak Republic is quickly developing and this process brings new problems of increasing urban traffic. There are three highways in a country. The most important and longest is highway D1 which is a part of a branch A trans-European multimodal corridor No. V. Increasing urban traffic is solved mostly through using bypasses around the cities and areas with higher population density. Paper deals with an example of bypassing city of Žilina through three main projects developing road transport with using elements of critical infrastructures.

Keywords: Road Transport, Critical Infrastructure, Highroad Network in Slovak Republic, Highroad Tunnel, Critical Infrastructure Risks.

1. Introduction

Slovak Republic is due to its geographical position in the heart of Europe well placed to become a significant European transport hub. Prevails especially road and rail transport and importance of Slovakia as a road transport transit country towards neighbouring countries (CZ, PL, UA, HU, AT) is rapidly rising. We can observe the current state and planned development of highway network in the Slovak Republic at the next figure

Fig.1. Constructed and planned highway network in Slovak Republic (as it was on July, 2014)

Building a quality road transport infrastructure in the Slovak Republic is very challenging because the geomorphologic conditions of country do not permit construction of the highway

network without the need of building a number of bridges and tunnels as elements to overcome the uneven terrain.

It is worth noting especially the amount of planned tunnels in the north of Slovakia, because of mountainous nature of the terrain. Most of these tunnels are currently either under construction or in the approval phase of the project documentation. There are not precisely defined elements of critical infrastructure in the legislative of Slovak Republic. The Act No. 45/2011 on critical infrastructure defines only the cross-sectional criteria for determining the elements of critical infrastructure, specifically in § 7, as follows:

a) By the number of vulnerable people, including killed and injured persons,
b) According to the economic impact, which is the range of:
   1. Economic loss,
   2. Decrease of goods quality,
   3. Decrease of public services,
   4. Negative impact on the environment,
c) According to the impact on the population, to the quality of citizens life in terms of:
   1. Severity power supply and the time of renewal,
   2. Severity of failure of the public service and its recovery time,
   3. Availability of goods substitutes supplies,
   4. Availability of public services substitutes.

In the context of the Act on critical infrastructure will be as an element of critical infrastructure considered, "engineering construction, public service and information system in the sector of critical infrastructure whose disruption or destruction would according to sector and cross-section criteria are significant negative impact on the economic and social functions of the state, and thereby the quality of life from the point of life protection, health, safety, property and the environment". (Act No. 45/2011). According to the National Programme for the Protection and Defence of Critical Infrastructure would be considered as a components of critical infrastructure highways and expressways, which includes major road objects such as tunnels, bridges and information cables within the boundaries of cities with significant density of population (massive psychological effect on the population in case of a terrorist attack).

2. Increasing traffic in city of Žilina

Regional capital northernmost region of Slovakia is Žilina with about 100,000 inhabitants. The city is due to its location the most important railway and road transport hub in Slovakia. Also, there is based University of Žilina with history more than 60 years, whose main educational and research profile is oriented to the area of transport, posts and telecommunications. Although, operating efficiency of road network for urban and suburban transport is sufficient, in terms of transit traffic is absolutely insufficient. This problem escalates in recent years for several reasons.

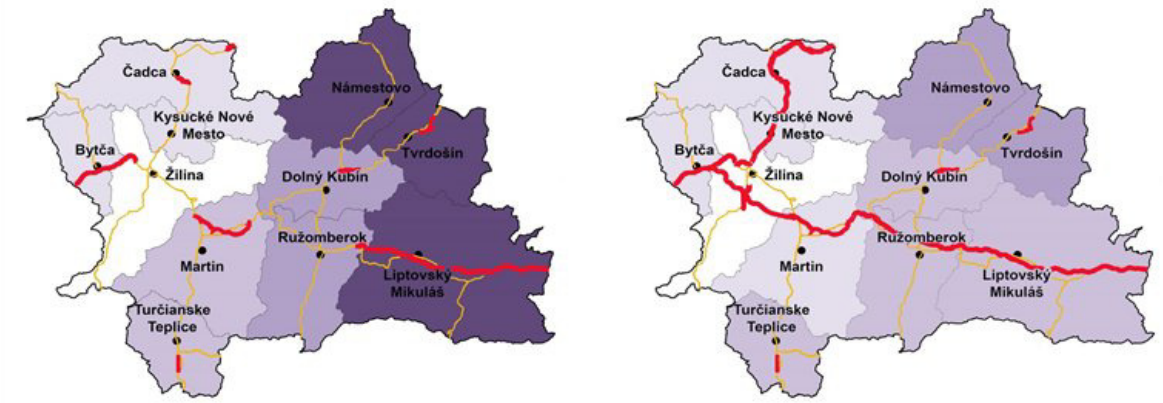

Fig.2. Road transportation network of Žilina self-Governing Region in Slovak Republic

The intensity of transit traffic in the city of Žilina has increased after the Slovak Republic joined the Schengen Area of free trade. In 2006 started a production in KIA automotive plant, which also contributed significantly to the growth of traffic in Žilina.

Because of the mountainous terrain in northern Slovakia and the on-going process of building a highway network there are not any continuous highway sections around Žilina. All these facts contributed to the traffic increase in Žilina to intolerable proportions. 24-hour road traffic intensity in Žilina can be seen in figure 3.

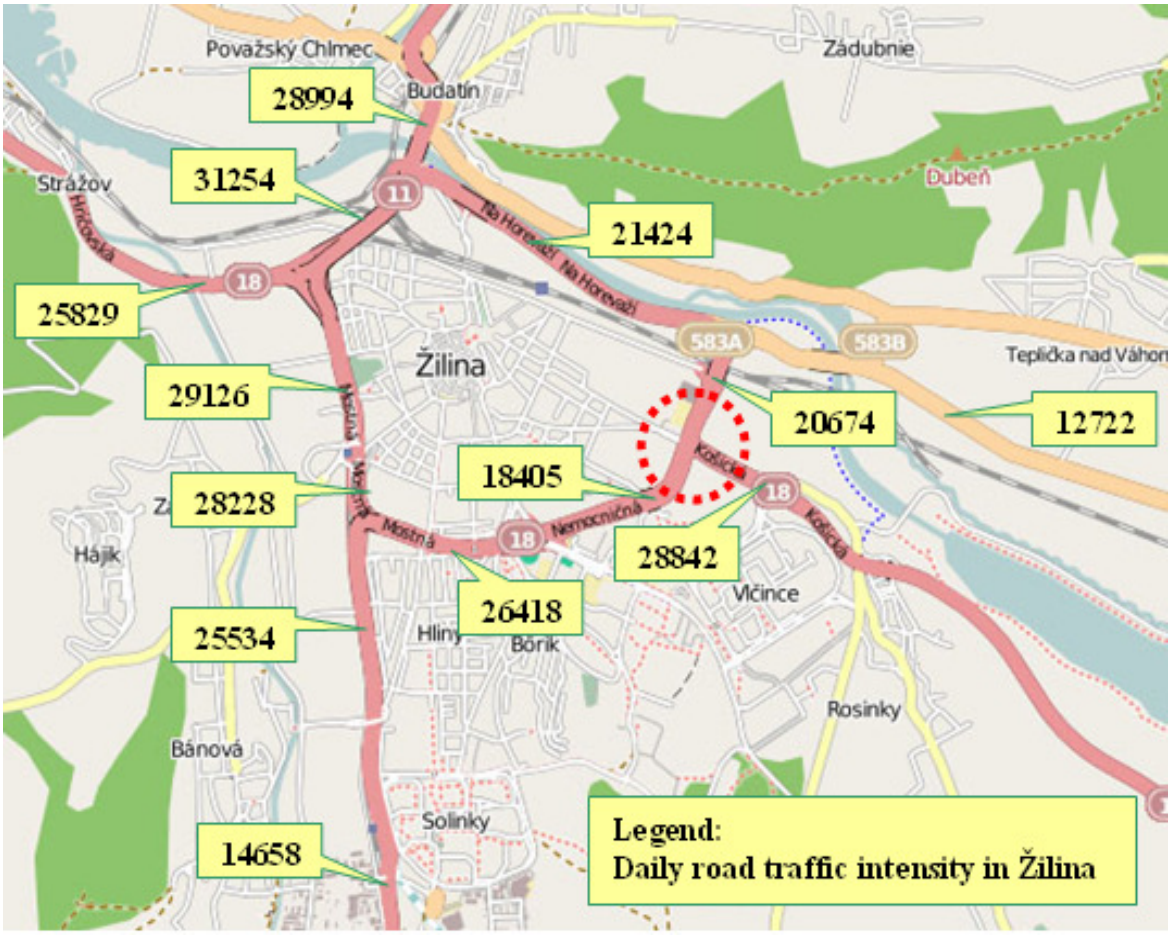

Fig.3. 24-hour road traffic intensity in Žilina

3. Long-term solutions for reducing traffic intensity in Žilina

Proposed solutions of reducing traffic intensity in Žilina through highway bypasses can be seen in figure 4. By red colour in the figure are marked the most burdened road communications inside the city of Žilina. Planned sections of the highway network with elements of critical infrastructure, which represents road traffic long-term solution in the city of Žilina, are marked green in figure 4.

Based on upper mentioned criteria can be stated that proposed measures to reduce road traffic intensity in Žilina may be included to the area of critical infrastructure.

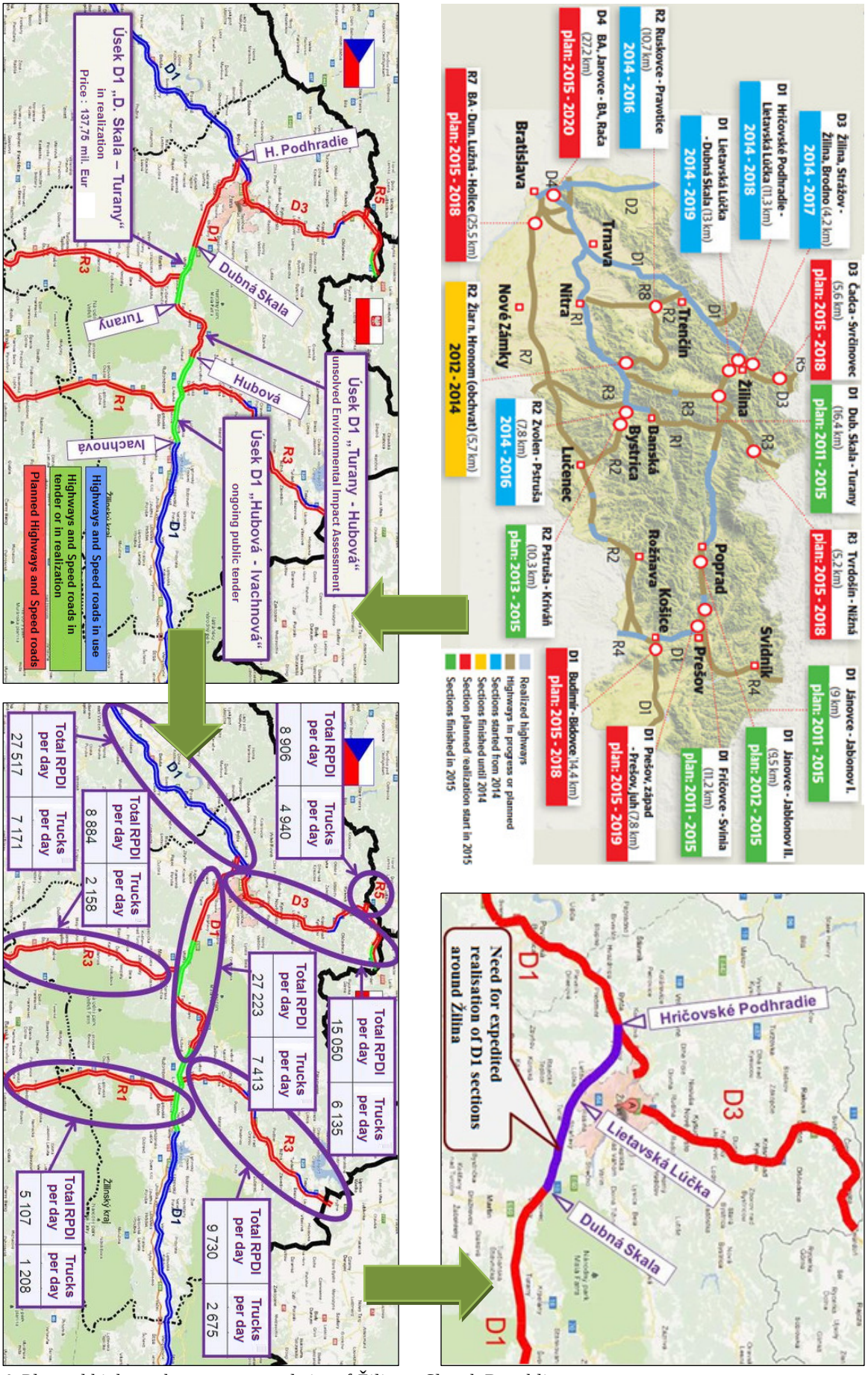

Fig.4. Planned highway bypasses around city of Žilina – Slovak Republic

These designed highway bypass sections can be divided according to its position into 3 parts:

Highway D3 Žilina (Strážov) – Žilina (Brodno) is a connection to the existing highway D1, which currently ends a few kilometres before the town of Žilina in the direction to Bratislava - the capital of Slovakia. A critical infrastructure element on this bypass should be a highway bridge over the river Váh near the village of Považský Chlmec.

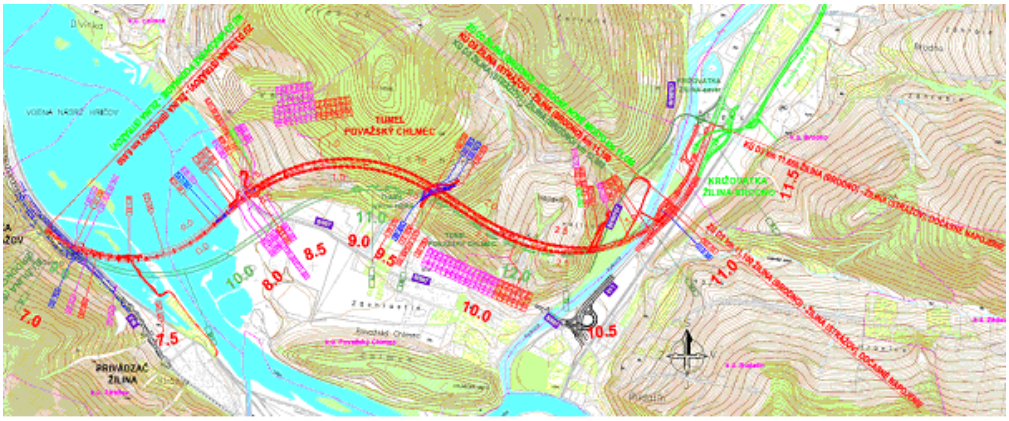

Fig.5. Planned highway D3 Žilina (Strážov) – Žilina (Brodno)

Road I/18 Žilina (southeast) bypassing the city from the east side, where the bridge through Žilina dam will ensure connection to the eastern arterial road to Martin.

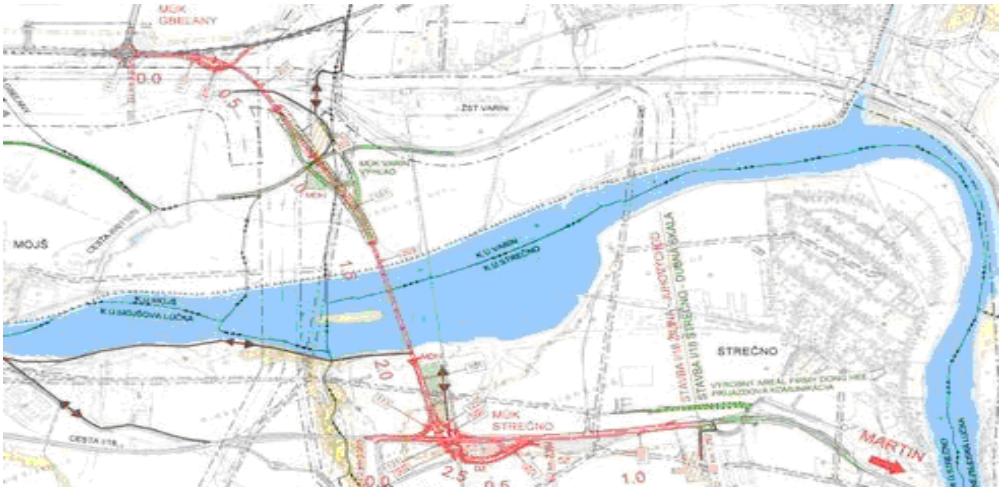

Fig.6. Planned connection of Road I/18 Žilina (southeast)

Highway D1 Hričovské Podhradie – Dubná Skala is part of D1 highway from Bratislava to the border with Ukraine, which is also a part of an international corridor E-50 (Paris - Nuremberg - Prague - Brno - Trenton - Žilina - Košice - Uzhgorod) to continue through Ukraine and Romania through further south, or through Russia further east. In national terms this highway is belonging to the basic communication skeletons of Slovakia. Mentioned southern bypass of Žilina is planned in 3 separate sections:

Highway D1 Hričovské Podhradie - Lietavská Lúčka will be connected to the construction of the highway D1 which currently ends in Hričovské Podhradie. At this place will be located junction of highways D1 and D3. Route leads through the mountain by tunnel “Ovčiarsko” and continues along the slopes of the stream valley Bitarová. By next tunnel “Žilina”, planned on D1, highway enters the valley of village Lietavská Lúčka. There is planned elevated highway over the village and trail ends at the intersection with feeder to Žilina.

Fig.7. Visualisation of highway D1 Hričovské Podhradie - Lietavská Lúčka

Highway category	**D 26.5/80**
Tunnels category	T 8.0
Length of the section	12 350 m
Tunnel Ovčiarsko	2 609 m
Tunnel Žilina	655 m
Bridges - 9 pcs	4 773 m
Retaining walls	305 m
Noise barriers	1 110 m
Riverbed changes	3 734 m
Rainwater sewer	8 142 m

Tab.1. Parameters of highway D1 Hričovské Podhradie - Lietavská Lúčka

Highway D1 Lietavská Lúčka – Višňové connecting previous section is in close contact with the area of mountain chain Malá Fatra. The route begins at the intersection Lietavská Lúčka and ends in the start of section highway D1 Višňové - Dubná Skala.

Fig.8. Visualisation of highway D1 Lietavská Lúčka – Višňové

Part of the construction is resting place Turie with fuel station, parking sites and small architectural objects (benches, tables, drinking fountain). At the beginning of the section in Lietavská Lúčka is placed the Centre of highway management and maintenance. The entire route from start to finish highway section D1 Lietavská Lúčka - Višňové is led rising to the portal of tunnel “Višňové”.

Highway category	**D 26.5/100**
Length of the section	5 400 m
Bridges - 5 pcs	2 373 m
Retaining walls - 9 pcs	2 337 m
Rainwater sewer	2 131 m

Tab.2. Parameters of highway D1Lietavská Lúčka – Višňové

Highway D1 Višňové - Dubná Skala section consists of a tunnel “Višňové”, which is the longest tunnel on the upcoming Slovak highway network and end junction connecting the road I/18 in Dubná Skala. There is planned ventilation shaft in 1/3 of the tunnel length. There are also

proposed safety measures and structural modifications according to the latest requirements of domestic and foreign standards.

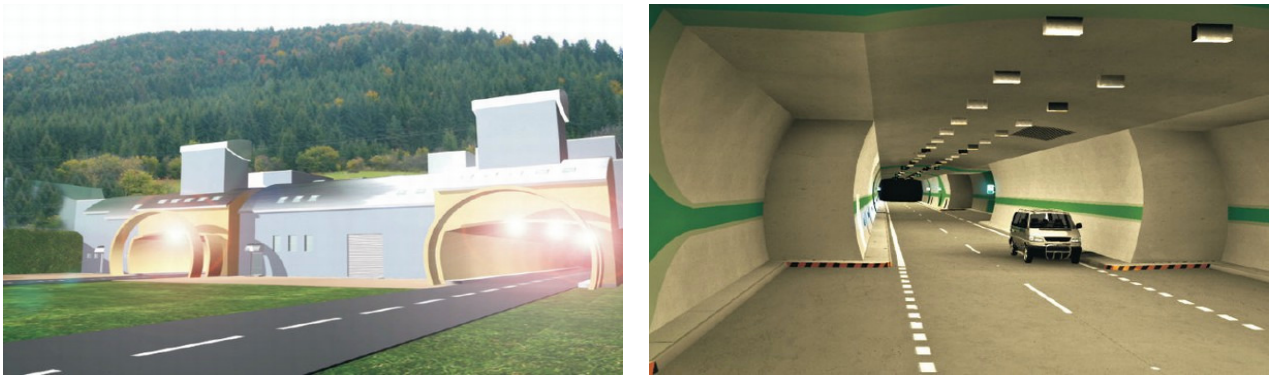

Fig.9. Visualisation of highway D1 tunnel Višňové - Dubná Skala

Solution of highway horizontal alignment is adapted to the expected geological conditions along the tunnel route. From the western portal are limestone and dolomites in the length of about 1.3km then continues granites. There are a lot of blocks deformations with cracks and intensive circulation of groundwater through entire length of planned tunnel Višňové.

Highway category	**D 26.5/80**
Tunnel category	T 7.5
Length of the section	8 110 m
- thereof tunnel	2 x 7 500 m
Bridges - 1 pcs	201 m
Walls - 2 pcs	487 m
Junction	1 242 m
Rainwater sewer	1 162 m

Tab.3. Parameters of highway D1Višňové - Dubná Skala

4. Conclusion

The most important element of critical infrastructures in the planned road network trace bypasses around Žilina is a highway tunnel in Višňové with total length of 7.5 km. It is the longest tunnel in Slovakia (from existing and planned tunnels), therefore in the Slovak Republic isn't a lot of options for comparison with existing elements of critical infrastructure. The only similarly long highway tunnel is a tunnel Branisko almost five kilometers in length. Branisko tunnel is located in eastern Slovakia between cities Prešov and Levoča. It is part of the D1 highway section, namely Beharovce-Fričovce. Tunnel Branisko replaced the difficult transition road I/18 through the mountain pass Branisko, located at level of 751m above sea and thus facilitate motorists crossing the challenging hill.

Highway section	**D1 Beharovce - Branisko**
Construction period	1997 – 2003
Tunnel length	4975 m
Number of tubes	1
Designer	Banské projekty s.r.o., Terraprojekt a.s. Bratislava

Tab.4. Construction characteristics of tunnel Branisko

Construction of highway section D1 Beharovce - Branisko, including Branisko tunnel was originally estimated at 187.5 million €. However, the costs been rising constantly and has increased the percentage of 37%. The reasoning, according to the official statement of the Slovak An increase of the cost for constructions by government, will serve to increase security already during the actual construction of the tunnel. Overall costs for building this part of highway was over 255.6 million €. The actual installation of technology climbed of the original amount of 22.5 million. € up

to 55 million. €, which indicates the percentage increase of 159%. Most of the funds were invested in the construction itself and also in its technological equipment. In general, there can be stated that the cost of construction of tunnels is around 33 million € per 1km of twin-tube tunnel. However, it is necessary to have to add approximate 20% increase of funds because of coverage its technological equipment. Height of the financial cost will be about 60% or more of this sum, if we consider only the construction of one tube. We can find that not building the tunnel itself, but its technological part was very costly, if we compare these numbers with the cost for construction of tunnel Branisko.

Investment target	**Financial costs (mil. €)**
Construction section (1. and II. stage)	145.00 million €
Highway and bridges	38.03 million €
Tunnel technology	58.18 million €
Centre of road maintenance Beharovce	14.31 million €
Total	**256.43 million €**

Tab.5. Financial costs for construction of tunnel Branisko

Here it should be noted that despite the 6 year of construction and additional funding construction of the tunnel Branisko was previously constructed only one tunnel tube. Due to this fact, there is often a complete shutdown of the tunnel even in case of minor accidents or scheduled tunnel maintenance. These failures of tunnel Branisko as an element of critical infrastructure causes significant financial losses for its operator and its users from the private and public sectors. In the case of tunnel Višňové such failures would reach into wider dimension, since any tunnel operation failure would not touch only its direct users, but should result in decreasing transportation quality of passengers in the city of Žilina.

Acknowledgement

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Proposal of Stirling Engine Generator for Powering Alarm Systems

*Milan Kutaj, *Andrej Veľas
* University of Žilina, Faculty of Security Engineering, Department of Security Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Milan.Kutaj}@fbi.uniza.sk
* University of Žilina, Faculty of Security Engineering, Department of Security Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Andrej.Velas}@fbi.uniza.sk

Abstract: Article describes concept of electric generator based on Stirling engine which will be used for charging a backup power source of alarm system. This generator can be used mainly in objects which are not connected to the electric power grid but owner wants them protected. The generator has been designed for simple alarm systems and its output power is based on calculations and measurements of alarm system Paradox EVO 48.

Keywords: Stirling, engine, power, backup, alarm, Paradox

1 Introduction

For fully operational alarm system we need some primary components. One of these components is power supply unit which describe European standard EN 50131 Alarm systems. Intrusion systems. Part 1: System requirements. Power supply must provide continuous electric power in all its states. The standard is referring to three types of power sources:

Type A: The power supply unit – the mains and backup power supply, which is automatically charged from alarm system (rechargeable battery)

Type B: The power supply unit – the mains and backup power supply, which is not automatically charged from alarm system (non-rechargeable battery)

Type C: The power supply unit with limited capacity (non-rechargeable battery). The minimum lifetime cycle must be specified for this type of power supply **Chyba! Nenašiel sa žiaden zdroj odkazov.**[9].

All alarms systems with installed type A or type B power supply have backup battery which provides stable electric power for a certain time. This time is declared by the standard for each security grade. In case of long-term power outage, alarm system is no longer operational and protected asset is being more vulnerable for intruders attack. Electric power generator based on Stirling engine is designed to prevent this failure very effectively. There are many electric power generators available on market. Their output power exceeds needs of alarm system several times. Besides, they are too noisy, dimensions are too big and they are producing too much pollutions.

2 Stirling engine

Stirling engine is part of a heat engines family. The main difference over conventional internal combustion engine is a method of burning fuel. While gasoline engine placed in the generator leads to burning fuel mixture inside the cylinder, Stirling engine uses fuel combustion outside the cylinder. Besides, heat source is not just burning of liquid or gas fuel. Heat source may be also renewable alternative energy such as solar and biomass energy. Stirling engines can be connected to any source which generates heat sufficient to start up the engine **Chyba! Nenašiel sa žiaden zdroj odkazov.**.

Stirling engine has two spaces with different operating temperatures and volume of each is changing cyclically. They are connected through a regenerative heat exchanger and additional heat exchangers. These simple parts can be joined in a wide range of mechanical designs. Basically, there are three modifications – α, β and γ (fig. 1.) [10].

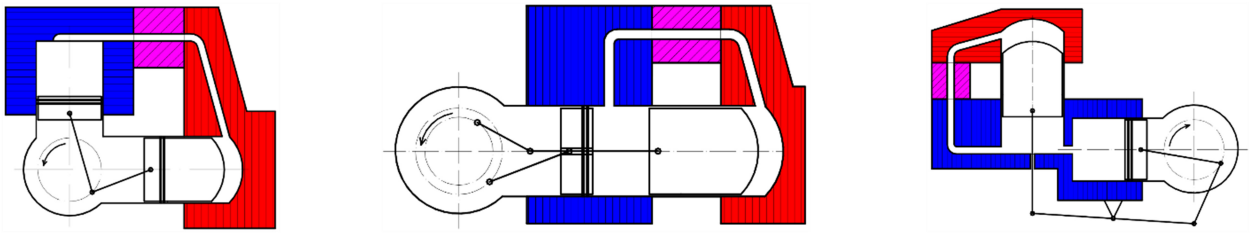

Fig. 1. Modifications of Stirling engine – α, β and γ

3 Components of the reference alarm

As a reference alarm system was used solution from the Canadian company Paradox. Alarm system is installed in the laboratory in the Faculty of Security Engineering, Department of Security Management and consists of the following components:

1) Control panel Digiplex EVO48
2) Keypad EVO641
3) LAN module IP100
4) Wireless expander Magellan MG-RTX3
5) Digital PIR motion detector DM50
6) Internal siren TS-668
7) VRLA battery Alarmguard 12 V / 7 Ah

4 Energy consumption of the reference alarm system

Necessary condition to create suitable alternative electric power source is specifying the energy consumption of the alarm system. Reference alarm system has installed *type A* power supply. Primary power supply in control panel is a transformer which converts mains 220 V_{AC} to 16 V_{AC} for control panel. This converted AC voltage is rectified on control panel mainboard.

4.1 Input power based on values provided by manufacturer

Technical specifications of each component are contained in datasheets. Company Paradox specifies only typical current draw at 12 V_{DC}. There are no current values for armed state and alarm state. Calculated values of components input power are summarized in Tab. 1. Input power of both charging modes has been also taken into account. Electric current flowing through battery in standby mode is very low so it hasn't been used in our calculations **Chyba! Nenašiel sa žiaden zdroj odkazov.**.

	Input power - armed [W]	**Input power – alarm [W]**
Control panel EVO48	1.2	1.2
Keypad EVO641	0.72	0.72
LAN module IP100	1.32	1.32
Expander MG-RTX3	0.6	0.6
PIR detector DM50	0.18	0.18
Siren TS668	0	3.6
Total input power	**4.02**	**7.62**
Total input power (charging at 0.35 A)	**9.06**	**12.66**

Total input power (charging at 0.85 A)	**16.26**	**19.86**

Tab. 1. Input power of alarm system components

4.2 Input power based on values measured with measuring equipment

For laboratory measurements was used system of two digital multimeters – first one was connected as a voltmeter, second one as an ammeter. Measurements has been done for both states of alarm system – armed state and alarm state – and summarized in Tab. 2. [5].

	Armed state	**Alarm state**
Voltage [V]	16.68	16.30
Current [A]	0.24	0.43
INPUT POWER [W]	**4.00**	**7.01**

Tab. 2. Measured input power of alarm system

To calculate total input power of alarm system was used maximum charging current in armed state. Calculations are summarized in Tab. 3. Values was calculated separately for two different charging currents of battery – 0.35 A and 0.85 A.

	Charging current 0.35 A	**Charging current 0.85 A**
Input power for charging [W]	5.04	12.24
Input power armed state [W]	4.00	4.00
TOTAL INPUT POWER	**9.04**	**16.24**

Tab. 3. Input power of alarm system while charging

4.3 Conclusion from datasheets values and measured values

Measurements show that measured values are almost identical with those obtained from datasheets of the manufacturer. The difference between measured and datasheets values in armed stated is only 0.02W, what represent about 0.5 %. In alarm state is the difference little bit higher, namely 0.61 W, what represent about 8.7 %.

5 The concept of Stirling engine generator

After consideration of multiple factors, measurements of input power of reference alarm system and analysis of available solutions we decided to use Stirling engine *Mini Ecoboy* (fig. 2) from Koichi Hirata. It's a compact Stirling engine based on modification γ with output power of 50 W at 4,000 RPM. Engine uses helium as working gas at mean pressure of 0.8 MPa **Chyba! Nenašiel sa žiaden zdroj odkazov.**.

Fig. 2. Stirling engine Mini Ecoboy

Heated section is a hollow cylinder which better accumulates heat. Cooled section is located above the case of rhombic mechanism and it is primary adapted for water cooling. Air cooling will be possible after modification of cooled section. Heat sink on cooled section must be bigger with high number of fins, bigger surface area of one fin and possibility to mount one or more fans. Even more efficient alternative is wind tunnel with two fans installed at each end (Fig. 3). Very suitable material for heat sink is aluminum [4].

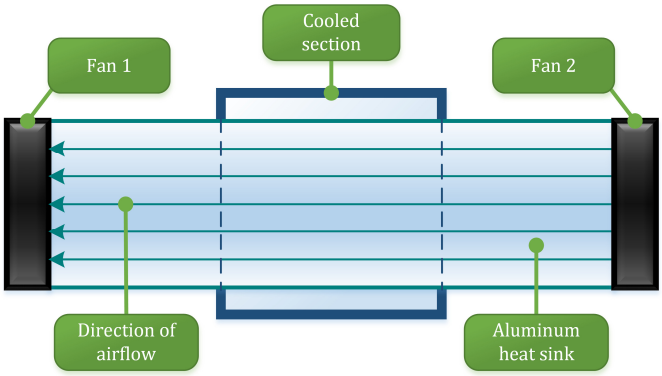

Fig. 3. Wind tunnel

5.1 Generator

As a generator of electricity will be used asynchronous AC motor *Turnigy 480S BL* with a maximum power of 145 W. Generator will produce three-phase electric current, which will need to be rectified to direct current. This will be done by installing modified Greatz bridge. Filter capacitor will be used to smooth the output voltage [5].

Unfortunately, due to lack of time and financial resources the generator couldn't be made. We do not have it physically available for testing so we can't measure output voltage precisely. Therefore, it's expected that there will be one of two possible states:

1) Output voltage of the generator will be ***lower*** than required input voltage of alarm system
2) Output voltage of the generator will be ***higher*** the required input voltage of alarm system.

The easiest way is to use voltage regulators. If the generated output voltage is lower than the required input voltage of alarm, to the circuit must be connected STEP-UP converter. If the generator output voltage higher than the required input voltage of alarm, to the circuit must be connected STEP-DOWN converter.

5.2 Control unit

There will be a number of operations to be automated for efficient and reliable operation of the generator. Generator must be controlled by a control unit. It contains a microcontroller, sensors, auxiliary circuits and modules. The most important component of the control unit is a microcontroller (MCU). The control unit is equipped with the *MCU Atmel ATmega328* ***Chyba! Nenašiel sa žiaden zdroj odkazov.***.

Device called *Stirling Engine Control Unit* (*SECU*) is able to provide automated start and smooth operation of the generator, which uses natural gas or propane as a source of thermal energy for Stirling engine. In this case the generator will be part of the alternative non-renewable power sources. SECU is powered by its own electric power supply. If there is a power outage, SECU won't depend on the back-up battery of alarm system.

The controller functions are divided into three groups.

1) Primary function:
- monitoring power supply of alarm system.

2) Secondary function:
- starting the generator and controlling its smooth operation.

3) Additional functions:
- time and date,
- chronological logging to microSD card,
- measurement of actual performance of the generator and power consumption of alarm system,
- measurement of gas flow,
- display time, date, performance and power consumption on LCD screen.

5.2.1 Monitoring power supply of alarm system

Primary function of SECU is monitoring power supply of alarm system. The most reliable way is to use an optocoupler, which galvanically separated power supply of alarm system and SECU. Optocoupler is connected to a digital input MCU.

5.2.2 Starting the generator and controlling its smooth operation

A secondary function of SECU is generator start-up. Since we decided to use natural gas or propane as a heat source for the Stirling engine, we need to consider at least three steps that are necessary for successful generator start-up:

1) Ignition
2) Warming
3) Spin-up of flywheel

The first step is the ignition of the gas, the gas flow is regulated by solenoid valve. Ignition of the mixture is initiated by a piezoelectric igniter. This process is initiated 10 minutes after power outage, which SECU recorded. Waiting time is there only as precaution.

After igniting the gas control unit monitors the temperature with a *thermocouple type K*. After the temperature reached 600 ° C, the control unit sends a signal to the starter, which spins the flywheel. As a starter will be used a three-phase motor itself due to simplification of the construction. After reaching the desired voltage level SECU connects rectified output of to the generator to the power supply of alarm system **Chyba! Nenašiel sa žiaden zdroj odkazov.**.

5.2.3 Additional functions

In addition to the foregoing functions SECU also includes additional features that allow user monitoring status of the generator on the LCD screen.

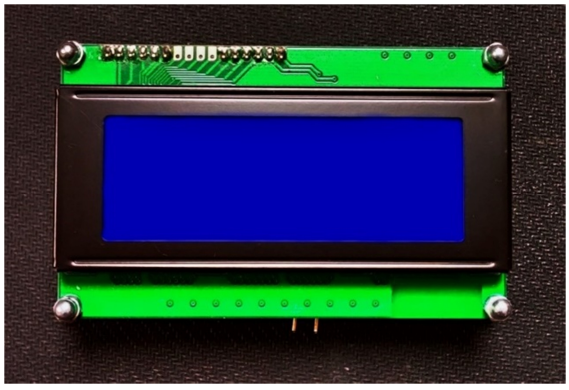

Fig. 4. Stirling Engine Control Unit – SECU

LCD screen can display up to 4 lines of text, each line can contain up to 20 characters. The display shows information about the current time and date, the name of the controller, status information, the actual performance of the generator, current input power of alarm system, output voltage of the generator, flow of gas and name of the log file.

6 Conclusion

Article includes the concept of the electric generator based on Stirling engine used as power supply of alarm system. The generator can be used in case long term power outage as a backup electric generator or in places which are not connected to the electric power grid. Despite the fact that it is just a concept, the proposal is feasible in practice, but due to lack of financial resources for manufacture the Mini Ecoboy, generator stays untested.

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The Testing of the Temperament and Character Inventory Method in Penitentiary Environment

[*]Ladislav Mariš
[*] University of Žilina, Faculty of Security Engineering, Department of Security Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Ladislav.Maris}@fbi.uniza.sk

Abstract. The findings of legal sciences, criminology, psychology and psychiatry were preconditions for the formation of an independent applied psychological science - forensic psychology. According to [1] forensic psychology deals with psyche of individual parties of legal process and the psychological and socio-psychological peculiarities of individual stages of its implementation (psychology of investigation, trial psychology, psychology of imprisonment). The forensic psychology also studies the personality of a crime offender. The personality is usually divided into temperament and character. The temperament and character can be measured using the Cloninger's personality theory. To meet this purpose there was developed the Temperament and Character Inventory. The process of its development took several years. The Temperament and Character Inventory revised (TCI-r) contains 240 questions. By determining the score of individual dimensions of temperament and character in TCI-r we can characterize the personality and its changes in time. The paper publishes the results of testing the personality characteristics using TCI-r on the sample of general population (n=218) and the sample of crime offenders (n=150). The testing took place in Slovakia from September 2014 to February 2015. This research is a part of doctoral thesis of author.

Keywords: Forensic psychodiagnostic testing, Cloninger, TCI-r, offender.

1 Introduction

The forensic psychology studies the psyche of individual parties of a legal process, thus the personality of a crime offender belongs to this field. The Criminal Code defines the term offender in a following way [2]: *„An offender of a criminal offence is the person who committed a criminal offence acting on his own. "*

The personality of a crime offender can be understood as [3]: *„an organized, dynamical and interindividually different entity of psychophysical dispositions determining the progress and manifestations of mental processes (reactions), reflected in the behavior and actions*".

The human personality can be understood as having two components: temperament and character. The temperament component is hereditary, is fully manifested in one´s childhood and is stable in the course of life [4]. The character is the acquired component of personality that we gain in the process of psycho-social learning in all the human development [5]. The temperament and character are measurable and enable us to consider the differences between people [6]. The Cloninger´s personality theory and its application in the form of the TCI-r questionnaire enables us to measure the temperament and character in their dimensions. The human personality is then the result of interaction of temperament and character and the personality model gets the form of a 7-dimensional model. By the score determination of individual dimensions we can subsequently characterize the personality and its changes in time. Prof. R. C. Cloninger distinguishes 4 basic dimensions of temperament, based on the functions of essential neurotrasnmitter systems of human brain [4]:

- HA - harm avoidance,
- NS - novelty seeking,
- RD - reward dependence,
- PE - persistence.

The character distinguishes the following 3 dimensions [4]:

- SD - self-directedness,
- CO - cooperativeness,
- ST - self-transcedence.

The individual dimensions of character and temperament in general population are considered stable if compared to the people suffering with mental illnesses or in the state of crisis. R. C. Cloninger recommends the use of this theory in clinical practice, especially with anxiety, mood, eating, addiction and personality disorders [4].

The psychological examination of personality (in forensic psychology) uses clinical and testing methods [1]. At present we are not aware of application of the Cloninger´s method and the respective TCI-r questionnaire in the process of forensic personality examination in Slovakia. The problem is that we do not know the scores of temperament and character dimensions of crime offenders. Our objective is to acquire the score values of the temperament and characters dimensions by testing the sample of crime offenders and to compare them subsequently with the general population sample.

2 Material and methods

We are able to measure the scores of individual dimensions using a special TCI questionnaire (Temperament and Character Inventory), or the specific revised version - TCI-r. In the same way we can consider the dimensions in people [8].

2.1 Temperament and Character Inventory revised

To consider the scores of individual dimensions of temperament and character we can employ the TCI-r questionnaire, that includes 240 questions (see Tab. 1) [7]. The subject answers the questions using the Likert´s 5-point scale from 1 to 5, where 1 means “not at all true“ and 5 “almost always true“. By summing the values of the selected questions in the questionnaire we acquire the scores for individual subdimensions and by their summing the scores for main dimensions [7], [4].

25.	My attitudes are determined largely by influences outside my control.	1
26.	I can usually accept other people as they are, even they are very different from me.	3
27.	Everyone should be treated with dignity and respect, even if they seem to be unimportant or bad.	4
28.	I wish I were better looking than everyone else.	5
29.	People involved with me have to learn how to do thing my way.	3
30.	My behavior is strongly guided by certain goals that I have set for my life.	2
31.	I enjoy getting revenge on people who hurt me.	1
32.	Most people seem more resourceful than I am.	5
33.	I think my natural responses now are usually consistent with my principles and long-term goals.	3
34.	I like to help find a solution to problems so that everyone comes out ahead.	4
35.	I usually try to imagine myself “in other people’s shoes”, so I can really understand them.	1
36.	Many of my habits make it hard for me to accomplish worthwhile goals.	5
37.	Dishonesty only causes problems if you get caught.	2
38.	I wish other people didn’t talk as much as they do.	5

Tab. 1. Sample questions from the Temperament and Character Inventory revised - TCI-r [7], [4]

2.2 Samples

To meet our purpose we selected two statistical groups. The first group A (n = 218) represents the general population. The second group B (n=150) comprises the sample of crime offenders from the prison Leopoldov and the prison Sučany. The average age of sample A was 42.3 and the average age of sample B 33.6. With regard to gender, the first group was divided into men (n=108) and women (n=110). In case of the second group we tested exclusively men with regard to the fact

that men represent 94% of the total number of convicted crime offenders in Slovakia. The conditions for both samples were: age over 18, literacy and compliance with anonymity. The questionnaire administration took place from September 2014 to February 2015. The method for completing the questionnaire was the pen-and-paper method.

3 The results of testing

As a result of TCI-r testing we obtained data matrix, from which we extracted the values of individual dimensions for each person. The following table (see Tab. 2) shows the selected statistical indicators of individual dimensions of temperament and character of the general population sample.

Statistical characteristic	NS	HA	RD	PE	SD	CO	ST
Number of subjects	218	218	218	218	218	218	218
Arithmetic mean	109,9	97,8	94,8	114,7	119,5	112,3	75,1
Mode value	103	98	91	98	123	113	73
Median	110	98	93	113	121	113	74
Maximum	136	118	114	153	152	134	108
Minimum	85	68	74	82	84	87	47
Variational range	51	50	40	71	68	47	61
Total variance	85,7	90,6	77,3	167,7	261,9	83,7	128,0
Standard deviation	9,3	9,5	8,8	12,9	16,2	9,2	11,3
1. Quartile Q1 (q = 25%)	104	93	89,75	106	105,75	106	68
3. Quartile O3 (q = 75%)	115,25	103,25	102	124	133,25	118	84
Interquartile range	11,25	10,25	12,25	18	27,5	12	16
Skewness (asymmetry)	0,08	-0,05	0,08	0,29	-0,03	0,09	-0,18
Kurtosis	0,59	0,44	-0,30	-0,26	-0,93	0,08	-0,18

Tab. 2. Selected statistical indicators of dimensions of the general population sample

In all dimensions we observe higher variational range with sample B - crime offenders than with sample A - general population. This value is very sensitive to outliers. In the interval (Q1, Q3) there is 50% of data from the measured values. If we focus on the interquartile range, we can notice smaller differences (shifts) in almost all dimensions. The following table (see Tab. 3) states the selected statistical indicators of the dimensions of temperament and character in the sample of crime offenders.

The values of RD dimensions - reward dependence, can be considered almost identical. We do not consider the values of arithmetic mean as the arithmetic mean can be very sensitive to outliers. If we consider the arithmetic mean a suitable indicator of the mean value, then the standard deviation measures the dispersal around the arithmetic mean. However, if the distribution of data is very skewed (the value of skewness), especially with sample B, the standard deviation does not provide reliable information about the data dispersal - with the exception of dimensions PE, SD, ST. In case of sample A, the dimension values can be considered symmetric (with regard to the skewness value).

Statistical characteristic	NS	HA	RD	PE	SD	CO	ST
Number of subjects	150	150	150	150	150	150	150
Arithmetic mean	114,7	104,1	97,0	120,0	124,2	117,1	77,2
Mode value	110	102	96	116	138	117	68
Median	114	103	96	119	123	117	77
Maximum	163	143	130	159	165	149	114
Minimum	86	79	74	76	87	91	36
Variational range	77	64	56	83	78	58	78
Total variance	123,9	142,2	94,8	256,6	231,2	128,5	193,1
Standard deviation	11,1	11,9	9,7	16,0	15,2	11,3	13,9
1. Quartile Q1 (q = 25%)	107	96	91	110	115	109	67,75
3. Quartile O3 (q = 75%)	121	111	103	131	137	124,25	87,25
Interquartile range	14	15	12	21	22	15,25	19,5
Skewness (asymmetry)	0,67	0,50	0,66	-0,16	0,01	0,31	-0,14
Kurtosis	1,80	0,71	0,92	0,02	-0,21	-0,12	-0,03

Tab. 3. Selected statistical indicators of dimensions in the sample of crime offenders

The following figure (see Fig. 1) shows the comparison of the scores of individual TCI-r dimensions of both samples using the boxplot chart.

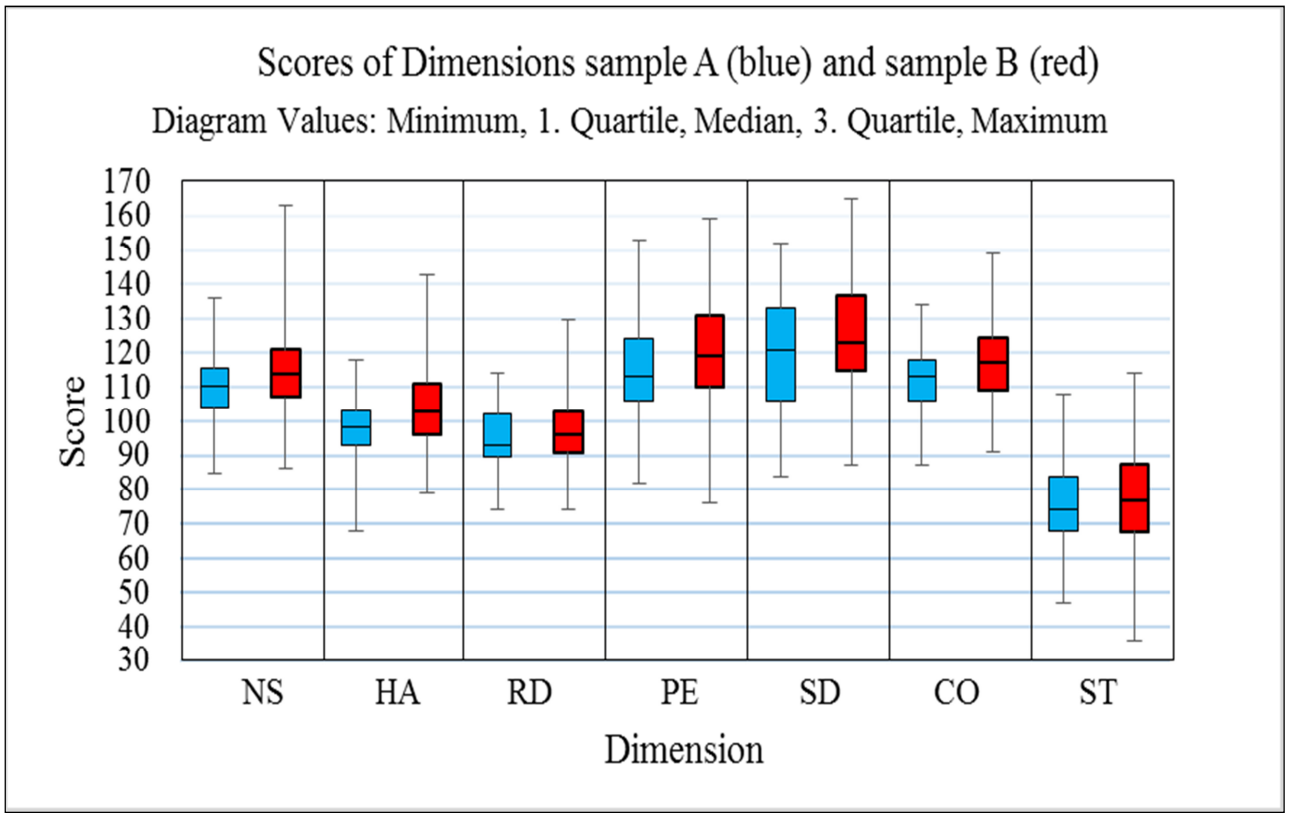

Fig. 1. The intercomparison of dimensions of the sample of general population with the sample of crime offenders

For better comparison we also show the comparative table (see Tab. 4) of arithmetic means, standard deviations and variational ranges for both groups.

Statistical characteristic	NS	HA	RD	PE	SD	CO	ST
Arithmetic mean – A	109,9	97,8	94,8	114,7	119,5	112,3	75,1
Arithmetic mean – B	114,7	104,1	97,0	120,0	124,2	117,1	77,2
Standard deviation – A	9,3	9,5	8,8	12,9	16,2	9,2	11,3
Standard deviation – B	11,1	11,9	9,7	16,0	15,2	11,3	13,9
Variational range A	51	50	40	71	68	47	61
Variational range B	77	64	56	83	78	58	78

Tab. 4. Comparison of the values of arithmetic mean, standard deviation and variational range of TCI-r dimensions in both samples

4 Conclusion

We studied the psychometric characteristics of general population and crime offenders using the Cloninger´s Temperament and Character Inventory - revised. The first difference is the obvious difference in the number of participants in the samples. The sample of crime offenders includes 150 subjects, whereas the sample of general population includes 218 subjects. From this point of view they are not identical but all the other statistical indicators are proportional to the sample size.

Having examined the test results in greater detail and been aware of criminological characteristics of crime offenders´ personalities, we can assume which dimensions and subdimensions will acquire different or identical scores. These results will serve for further processing, the crime offenders will be divided according to the selected criteria, e.g. age, recidivity, type of crime, etc. We are convinced that this paper can contribute to the quest for answers to the problem why some people behave in compliance with law and others do not.

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Proposal of Systems Approach to Critical Infrastructure Determination in European Union Countries

*Petr Novotný, *Jiří Markuci, *David Řehák, **Ibrahim Almarzouqi, *** Lucia Janušová
*VSB-Technical University of Ostrava, Faculty of Safety Engineering, Department of Civil Protection, Lumírova 13/630, 700 30 Ostrava-Výškovice, Czech Republic
**Northumbria University, Department of Geography and Environment, Ellison Place 2, Newcastle upon Tyne NE1 8ST, United Kingdom
*** University of Zilina, Faculty of Security Engineering, Department of Technical Sciences and Informatics, 1. Mája 32, 010 26 Žilina, Slovakia

Abstract. The contribution deals with the issue of determining critical infrastructure elements. Based on approach analysis in selected countries, where sufficient attention is paid to the area of critical infrastructure, the aim of the article is to propose a systems approach to critical infrastructure determination in European Union countries. The aim is determined by the fact that a significant number of EU countries do not currently apply the systems approach and determining of elements is realized via sectors approach, i.e. without taking possible bonds with other sectors into consideration. Therefore, using the systems approach may be a solution to realizing further necessary steps in the area of critical infrastructure protection, for example complementing the issue of resilience and modelling dependences in the area of critical infrastructure.

Keywords: Critical infrastructure, system approach, critical infrastructure protection, European Union countries.

1. Introduction

The primary demand for sustaining development of EU countries´ economy and sustaining required level of society´s welfare [1] is providing continual supply of commodities and services via the infrastructure system [2]. These infrastructures may be divided according to functional specifications into technical (e.g. energy, transport) and socioeconomic such as the health service or financial market [9]. The individual infrastructures then come into effect as to expanse and value of the area for which they provide their services (European, national, regional), as well as regarding the importance or indispensability of the given services [1][2]. Infrastructures are growing more and more interconnected and in some cases even mutually dependent [3][4]. Functionality of these infrastructures and providing continual supplies of products and services is continually exposed to the impact of natural and anthropogenic threats [14]. That is the reason why significantly more attention has been paid to chosen, vital, even critical infrastructures [5][6], as well as to methods of its risk analysis, critical elements evaluation and their protection [7][8].

Building protection and resilience [13] of critical infrastructure elements is above all based on identification of critical infrastructure elements themselves, which is carried out via various approaches in the European Union and other parts of the world. These approaches are based on risk analyses [11][12], criticality analysis via various criteria [9], cross-section and sectoral criteria [2] or modelling and simulations [10]. The core of various approaches comparison is its evaluation from the point of view of gestion responsibility for the critical infrastructure as well as the way of marking elements on various vertical levels.

2. Description of the system approach in selected countries

The system of critical infrastructure determination in the European Union proceeds from historical connections and the presented Green Paper [1]. The European Union member countries are bond to implement the procedures stated in the directive [2]. Since individual member countries approach the critical infrastructure determination in different ways, four countries whose critical infrastructure determination is system based were selected. System approaches of these countries will be used as the basis for proposing a system solution of critical infrastructure determination for European Union member countries which have not had the system approach yet. The key to the choice of critical infrastructure determination systems is the following. The Swiss system of critical infrastructure determination was chosen as a model one, because specific authorities are involved in the whole system. On the other hand, the British model was selected as the representative of traditional involvement of state authorities and rescue services in the choice of the critical infrastructure determination. Further, the system approach in Netherlands has been selected as a representative of the traditional system solution, which is specific for developed European countries. Last, but not least, there is the long-term approved system of critical infrastructure determination in New Zealand. To contrast the system approach, the way of critical infrastructure determination in the Czech Republic will be presented in the following chapter.

2.1. Switzerland

The critical infrastructure system in Switzerland has developed. The Federal Council`s Basic for Critical Infrastructure Protection [15] (also used as “CIP”) was the key foundation for processing the crucial document for critical infrastructure determination process, which is the method for creating critical infrastructure protection inventory (Schutz Kritischer Infrastrukturen – SKI) [30]. The method´s aim [30] is to determine elements of infrastructure which show a high level of criticality. Criticality is connected to consequences that may occur at failure, malfunction or destruction of the relevant infrastructure element, however, the probability is not considered (this classification should enable an adequate determination of funds and measures). Besides other things, critical infrastructure elements on a national or regional level are to be identified. During the inventory preparation there are three groups of participants [30]. The basic group that works on the inventory development and creates the basics for a thorough analysis of individual processes, an expert committee participating in critical infrastructure elements identification. The last group of participants is represented by cantonal contact authorities of the SKI inventory that may identify objects important from the cantonal point of view as well as nationally critical.

Within critical infrastructure protection, a list of objects, by the failure or damage of which the population and their living conditions may be endangered, has been created. These are objects who are of great importance for basic goods and services supplies, and objects where dangerous substances are stored [30]. Identification of critical infrastructure elements [15] follows a standardized process on the basis of three unified criteria (quantitative evaluation, qualitative evaluation, potential threat) and it is based solely on detailed process analyses in individual sub-sectors which are created by authorized national subjects. Five following steps are taken in order to identify and classify critical infrastructure subjects in individual sub-sectors [30]: (1) Creating a functional group for criticality evaluation, (2) preparation for criticality evaluation, (3) detailed data gathering, (4) objects classification, (5) amendment for cantonal subjects. Such list of critical infrastructure elements [15][30] is classified as top secret from the point of view of secret information protection. Creating of the inventory is carried out and managed by the basic group only.

2.2. Great Britain

The main responsibility for the matter in question is borne by the Cabinet Office (evaluation of critical infrastructure elements vulnerability). Monitoring is continually realized by the ministries and authorities, however, once in 5 years there is an overall inspection, so called National Risk Assessment, carried out [31], the outcome of which is evaluation of the found risks (natural disasters, serious accidents, deliberate attacks) which may affect the whole country or its significant part. The National Risk Register [31] has been processed since 2008 as meeting liabilities coming out of the National Security Strategy [16]. Local rescue services are integrated into the risk evaluation system. Each local rescue service publishes its own Community Risk Register [31] for its area of interest and for the relevant territory on web pages. All organizations and providers planning measures should draw from the National Risk Register. The document of Strategic Framework and Policy Statement [32] for the area of improving the critical infrastructure resistance to natural threat provides instructions for how to evaluate the criticality of critical infrastructure area to all subjects involved. The document outlines possibilities for regional critical infrastructure determination (the term Vital Infrastructure corresponding with local infrastructures is used).

The national critical infrastructure in Great Britain is divided according to the Criticality Scale [32] into 9 sectors and 29 sub-sectors, including determining responsibilities for sub-sectors in the whole kingdom and individual countries. Seven categories of criticality draw from such evaluation (CAT 0 – CAT 6). CAT 3 forms the border between the Critical National Infrastructure and an infrastructure that may be interpreted as a regional critical infrastructure, since the possible impact on a geographic region or several hundred thousand people is defined here. From this level downwards we speak about Wider National Infrastructure including the above mentioned vital infrastructures providing services in certain location [32]. The level of criticality is thus determined merely for the national level of critical infrastructure. Any criticality evaluation under this level means determining the infrastructure as Wider National Infrastructure, not as critical. For that reason, only the national level is determined as critical. The risk evaluation system is also projected in the system of infrastructure criticality determination [32]. The planned measures for critical infrastructure protection draw from risk evaluation. All activities in the sphere of CIP in Great Britain strictly stick to standards of the Business Continuity Management (BS 25999). Therefore, following all determined processes from the level of central authorities down to the local level is emphasized. At the same time, doing all pre-determined duties is ensured.

2.3. Netherlands

The Government of the Netherlands - The Cabinet is an authority responsible for the area of critical infrastructure protection in the country and this authority approved the National Safety and Security Strategy in 2007 [22][34]. According to this strategy, the national safety cannot be taken out of the complex safety context which proceeds from the partnership within the EU and NATO member countries. The performance of some entrusted activities in the sphere of critical infrastructure also belongs to risk management authorities across the risk management levels, including the public administration authorities. In Netherlands, the original definition of „critical infrastructure“ [33] included only the areas of public administration and industry (including the ICT area) and the original plan comprised the following steps: a fast analysis of the Dutch critical infrastructure, stimulation of bonds between the public administration and private subjects, threats and vulnerability analysis, analysis of safety measures gaps. After fulfilling the National Safety and Security Strategy, [22] A Quick Scan was created and used [34]. Since cross-border bonds were found out, some of the materials were given to the European Union.

The Ministry of Security and Justice and Ministry of Interior and Kingdom Relations [22] bears the primary responsibility for determining critical infrastructure elements. In order to increase the system flexibility, two working groups were appointed across the central authorities, which are Interdepartmental Working Group on National Safety and Security and Steering Group on National

Safety and Security. First, the working groups evaluate the possible dangerous scenarios on a national level, based on The National Safety and Security Method, then consequences are described and probabilities of relevant scenarios are evaluated. Such scenarios are projected in the National Risk Assessment and consequently final summary of scenarios and its evaluation with respect to interest and consequence (territorial safety, physical security, economic security, and ecological security, social and political stability) is carried out. After evaluating the consequences it is possible to use the gained date further on, e.g. for public administration purposes [22].

For the needs of critical infrastructure determination in Netherlands, a boundary was set between services and products that are vitally important on the national level and those which are "only" very important [34]. Because of bonds and dependencies, operation-oriented analysis is required, in which the ICT sector plays an important role, as it currently connects and controls most infrastructures. The process of determining the vitally important infrastructure had not been easy until "Vital Importance" was determined within a company. According to the definition, these are products and services which [34] contribute to providing basic services for a society and define the basic level of its providing for (1) national and international law, (2) public safety, (3) economics (4) public health, (5) environment. These products and services may also reduce providing services for the population or public administration below the minimum level also in the national scale.

11 vitally important sectors with 31 vitally important products and services (an analogue of sub-sector) have been determined for the national critical infrastructure of Netherlands. From the point of view of the national critical infrastructure of Netherlands, it is these vitally important products and services (direct and indirect ones) which form the core of the system, while other products and services (not of vital importance) supplement the function of the whole system [34].

2.4. New Zealand

The core document for the civil protection of New Zealand is the Civil Defence Emergency Management Act 2012 [35]. This crucial document determines authorities, responsibilities and involvement of all involved services in the civil protection in the country. Based on the provisions of sections 39 and 45 of the Civil Defence Emergency Act, a new National Civil Defence Emergency Management Plan [24] has been created, in which all substantial requirements for the area of critical infrastructure defence are elaborated and stated. The aim of the plan is to increase public awareness, understanding and readiness in the field of Civil Defence and Emergency Management (CDEM), to reduce risks, to increase capacities for emergencies control and to increase the capacity for recovery after emergencies. The CDEM Plan also states tasks and responsibilities of subjects involved in protection of critical infrastructure elements, such as the Ministry of Civil Defence and Emergency Management for the national level, Local Civil Defence Groups and Local Authority for the local level. The working authority is always the group appointed for the relevant level, the so called „CDEM Group". There are so advisory authorities called Clusters, i.e. groups comprising agencies across sector in order to cooperate effectively and reach practical outcomes. The above mentioned authorities participate in CIP.

However, the term of critical infrastructure is not used in New Zealand [35]. On the contrary, it is common to label some subjects as Health infrastructures and the term Lifelines is used instead of the term of critical infrastructure to mark basic systems for which it is necessary to remain in function, e.g. water supplies, transport (road, rail, sea and air), gas supplies, communication networks and sewage systems (water and sewage management). The primary aim of supporting the Lifelines evidence by Central authorities is recognition, effective evaluation and evaluation of the subject´s importance [35]. Individual regions thus carry out evaluation and report data to the central level of the Ministry of Civil Defence and Emergency Management. In case some of the Lifelines shows high criticality and the consequences of its failure affect society outside the region, we speak about the national level, etc. The term Lifeline Utilities is used for the national level of critical infrastructure in New Zealand. Another option to determine such infrastructure on a national level is a direct determination in a legal regulation [35], (for example keepers of enumerated airports,

harbours, gas suppliers, etc.) or subjects mentioned in the following part that run enumerated businesses (running a national motorway network, railway network, electricity and water suppliers, etc.). In total, we can categorize the elements into eight sectors (or, as the case may be, determine specific elements) [35][36].

Determining the criticality of Lifeline Utilities [27] is based on the CDEM Plan. Categorizing Lifeline Utilities into relevant categories is carried out according to the outcomes of criticality determination. Criticality 1 for the national level of Lifeline Utilities, Criticality 2 for the regional level of Lifeline Utilities, Criticality 3 for the local level of Lifeline Utilities. Runners of Lifeline Utilities are obliged to abide carrying out of the prescribed activities in New Zealand, e.g. constant verifying and developing emergency plans, risk evaluation and preparation for reaction including constant reporting of the updated data to the subjects responsible [36].

In the above mentioned crucial document, [35] the need to protect the so called *Assets* is also stated. These are key elements like cultural and historical heritage. These subjects may also be determined as "critical infrastructure" elements in New Zealand. On the other hand, another commonly used term of Infrastructure Hotspots means cumulation of entries into several "critical" infrastructures on a single location (e.g. harbours) [27]. A similar term is used in other countries, e.g. in relevant literature [20] such cumulative entries are called Hubs. At the same time, dependencies were determined under the term of Infrastructure Interdependencies across sectors and currently programmes for resilience improvement are being specified [27].

3. Sector approach description in the Czech Republic

Since 2010 and with effect from 2011, the critical infrastructure in the Czech Republic has been in function by implementation of Directive requirements [2] into the National legislature via the Crisis Management Act [17] and its implementing regulation [19]. The Ministry of the Interior – General Directorate of the Fire Rescue Service of the Czech Republic is the guarantor of the critical infrastructure in the Czech Republic. Thus, in the Czech Republic, critical infrastructure elements are determined in two vertical levels by law (National and European), while the national level is the implicit one. In the Czech Republic, elements on the national level are determined in nine sectors altogether (Energy, Water management, Food Industry and agriculture, health service, transport, Communication and information systems, Financial market and currency, Emergency services, Public administration). The way of determining elements for individual levels is, in accordance with the Directive, [2] based on cross-cutting and sectoral criteria [17][19]. The cross-cutting criteria serve to evaluate the impact caused by potential malfunction of the evaluated element of the relevant critical infrastructure sector. These criteria serve to evaluate the impact with regard to possible casualties, economic impacts and impacts on public [18]. Limit values of these criteria on a national level are stated by a decree of the Czech Republic government [19].

In case the critical infrastructure subject (Owner, Runner) is an organization bureau of the state, ministries and other central administration authorities send their proposals for elements to the Ministry of the Interior who prepare a list based on these proposals. In the following stage, the list is presented to the government who adopts a resolution about the critical infrastructure elements, the runner of which is the organization bureau of the state [26]. In case of determining the critical infrastructure elements the runner of which is not an organization bureau of the state, the decision-making process is realized by gestion ministries and other central administration authorities. These, in accordance with the law, apply relevant definitions and criteria and subsequently determine elements by general measures and immediately inform the Ministry of the Interior about their decisions.

It is the critical infrastructure subject itself who bears the responsibility for the critical infrastructure element protection [17]. For this purpose, the subject is, apart from other responsibilities, obliged to make a plan for the crisis readiness of the critical infrastructure subject [25][23]. Within the plan, the following areas should be considered: (1) overview and evaluation of

possible risk sources, (2) threat analyses, (3) possible risk impact on the subject´s activities (4) a list of critical infrastructure elements within the subject´s gestion, (5) identification of possible threats of individual elements of the critical infrastructure, (6) measures overview arising from the emergency plan of the relevant risk management authority, (7) ways of securing realization of the mentioned measures, (8) ways of securing the subject´s action readiness to realize the emergency measures and subject´s activity protection and (9) procedures of solving emergency situations identified in the threat analysis. The necessity to increase the resistance and protection of critical infrastructure elements to possible risks and securing a broader involvement of critical infrastructure subjects in the process of preparation for emergency situations is one of the strategic priorities of population protection stated within the current population protection concept [21].

4. Summary and Suggestion and Discussion

This chapter summarises the above mentioned approaches as materials for creating a system approach proposal. From the point of view of the state administration involvement there were no fundamental differences found, since in the selected countries it is always the top authority that bears the responsibility on the national level, alternatively it is the authority affiliated to the top management level. The involvement of the home rule in the critical infrastructure determination system is similar, though there are minor differences among the individual systems. In several cases the rescue services are involved, in other cases the home rule is involved. The responsibility for critical infrastructure determination is more varied – it is possible to leave the responsibility on the central level, divide it between the state administration and the home rule, leave it on the created authorities, shift the responsibility to the relevant level of management, alternatively to the owners or runners themselves, or a combination of any of the above mentioned approaches.

The initial framework of determining critical infrastructure elements differs in individual countries. It may be a clearly stated procedure according to an obviously described manual with clear outcomes, or a procedure stated only by conceptual material. It is similar with the case of the methodology used, when individual countries use their own procedures. However, there is a significant difference in the terminology used in individual countries. It is not always “critical infrastructure” that is in question; the terminology may be set in a different way. The numbers of sectors vary in a narrow interval, just as the numbers of sub-sectors on a national level do not vary significantly. The number of levels does not vary much either. In the European Union countries it is obligatory to determine the supranational critical infrastructure (or the European level). From the national level upwards, the system stays similar – in most cases it is the national, regional, or local level (in some cases with different terminology though). In the Czech Republic there is no other critical infrastructure determined but national. For this reason, the proposal for determining the critical infrastructure on a regional level is justified further on in the contribution.

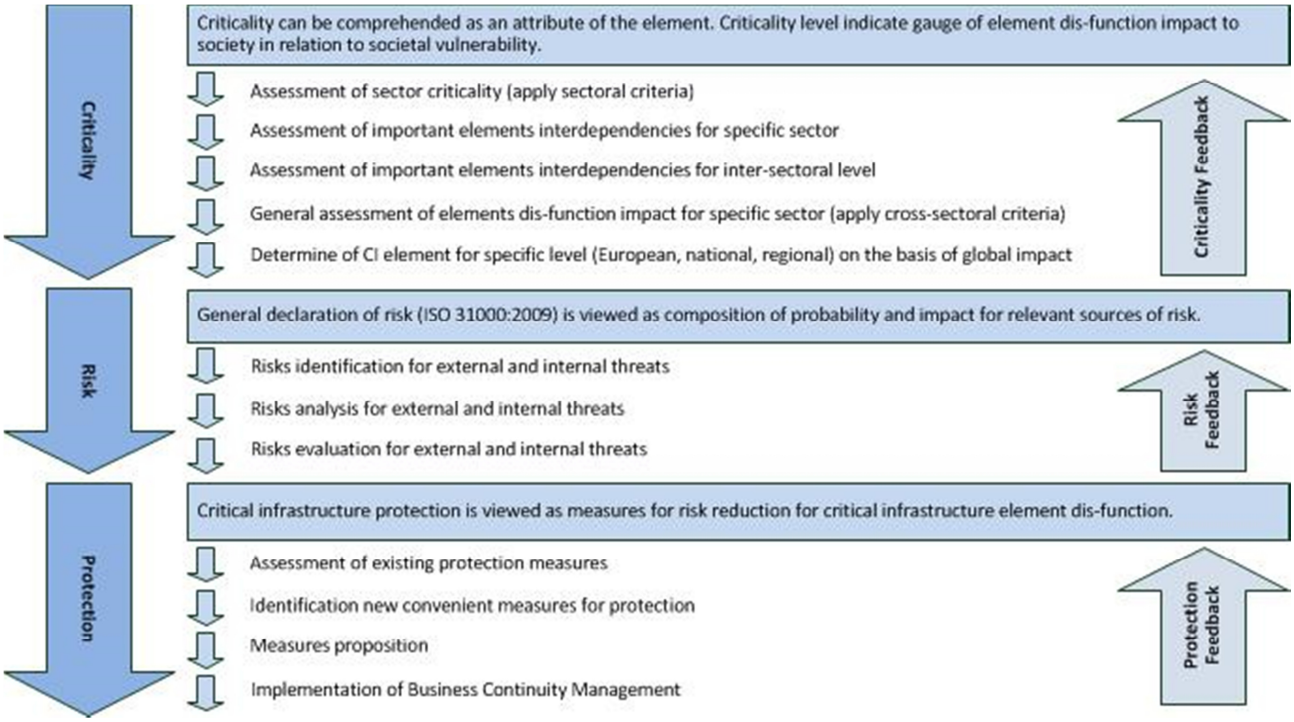

Figure 1: Proposal of systems approach to critical infrastructure determination.

On the bases of comparison of the above mentioned approaches to determining the critical infrastructure, a general proposal has been created. This proposal may be applied in countries which do not have such elaborate systems, e.g. the Czech Republic (see figure 1).

From comparison of the approaches to determining critical infrastructure elements it is obvious that the first suitable step to assess which elements belong to which level (e.g. the regional level) is assessing their criticality. Such assessment is based on various principles in different countries (cross-cutting and sectoral criteria, assessment of impact and vulnerability, etc.). A common aspect can be seen in assessing the extent of impacts on protected interests (lives, health, properties, and economy). Assessing criticality should not be based on probability of occurrence of those impacts, which are mainly because of the fact that a failure of a critical infrastructure element is very improbable. Nevertheless, there is still little probability of its occurrence. During criticality assessment it is also suitable to implement the issue of mutual dependencies and perceive it from the viewpoint of impacts that may be caused by bonds of the spreading disturbance among the critical infrastructure elements across the sectors (sub-sectors).

The second step is risk assessment [37] of a critical infrastructure element (determined according to step one) considering external as well as internal threats that may cause an element function disturbance. The risk extent is usually stated as a product of occurrence probability and impact extent. It is necessary to plan relevant measures based on the assessment. The planning documentation of critical infrastructure elements protection differs in individual countries (Operator safety plan, Emergency readiness of the critical infrastructure subject Plan, Business Continuity Plan). Nevertheless, the aim of all this documentation is identical – to provide a continuous supply of commodities and services [38] provided by the critical infrastructure element.

5. Conclusion

It is important to carry out critical infrastructure safety measures by relevant procedures, i.e. besides other things, make a suitable analysis, and not use common procedures without considering their suitability. Wrong usage of the Paret´s principle can serve as an example, which states that 20 % of causes bring about 80 % of all effects. In spite of that, excluding all other causes

and concentrating only on some of them may be a mere overlooking other causes which does not lead to a system solution. A similar summary is presented in the risk matrix where the most numerous incidents do not cause any significant effects; on the other hand, rare incidents may cause extreme effects. For that reason, it is not purposeful to concentrate only on the most frequent causes and effects, but we should concentrate on system solution with all its causalities.

Based on the above mentioned approaches in selected countries, it would be suitable to set a system way of critical infrastructure determination that could be used e.g. in countries that do not have a similar system approach for all levels of critical infrastructure. In the Czech Republic, there has not unfortunately been a similar system way of critical infrastructure determination stated yet. The proposed Stating such approach would undoubtedly contribute to society´s safety and at the same time, it would increase the land potential as well as possible hidden drawbacks in the current way of critical infrastructure determination in the Czech Republic and elsewhere.

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Sanctions and Embargoes as a Crisis Response Instrument

[*] Veronika Oriešková, [**] Ján Havko
[*]University of Žilina, Faculty of Security Engineering, Department of Crisis Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Veronika.Orieskova}@fbi.uniza.sk
[**] University of Žilina, Faculty of Security Engineering, Department of Crisis Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Jan.Havko}@fbi.uniza.sk

Abstract. The paper analyses importance of sanctions and embargoes as a tool used by organizations of international crisis management to resolve large-scale crisis events in a peaceful way. On the basis of value selected parameters, which are the change of exchange rates and inflation growth in particular countries, it reviews their impact to both stakeholders, namely the countries of the European Union and the Russian Federation.

Keywords: Crisis, sanctions, embargoes, inflation, change of exchange rates.

1. Introduction

International organizations use the whole spectrum of crisis management instruments to prevent and solve existing crisis events. Deployment of armed forces is the last resort. The focus is on a peaceful resolution of the crisis. Sanctions and embargoes are one part of them. Through economic and political measures, international organizations try to affect and force the target country to change its behavior. The content of actions varies depending on the specific situation, the nature of the crisis event and other important factors.

2. Theoretical background and importance of sanctions and embargoes

Sanctions and embargoes are political and trade restrictions, they are imposed on target countries to maintain or restore peace and security in the region. According to Filip, sanctions are economic instruments used in international crisis management. They keep on influencing the state of a crisis development through the prosperity of another country [1]. They are divided into economic rewards and economic sanctions, the sanctions are a particular form of economic punishment against the target country.

Sanctions and embargoes are put in place by international organizations, namely the United Nations (hereinafter "UN"), the Organization for Security and Cooperation in Europe (hereinafter „OSCE"), but also the European Union (hereinafter "EU"). The main aim is to maintain or restore peace in the affected area. The basis for the use of these instruments is Chapter VII. Article 41 of the UN Charter, which stated: "The Security Council may decide what measures not involving the use of armed force are to be employed to give effect to its decisions, and it may call upon the Members of the UN to apply such measures. These may include complete or partial interruption of economic relations and of rail, sea, air, postal, telegraphic, radio, and other means of communication, and the severance of diplomatic relations "[2].

EU uses sanctions and embargoes as a tool of the Common Foreign and Security Policy. Through economic and diplomatic sanctions EU tries to influence the policy of countries, where international law, human rights and freedoms or democratic principles are violated. Their application is in accordance with Article 215 of the EU Treaty [3]. Specific sanctions are applied after approval by the UN Security Council in accordance with the accepted resolution. If necessary, however, EU can also decide to apply further restrictions. It must always choose the kind which will

effectively deal with the situation from a range of possible measures. Types of sanctions are shown in Fig. 1.

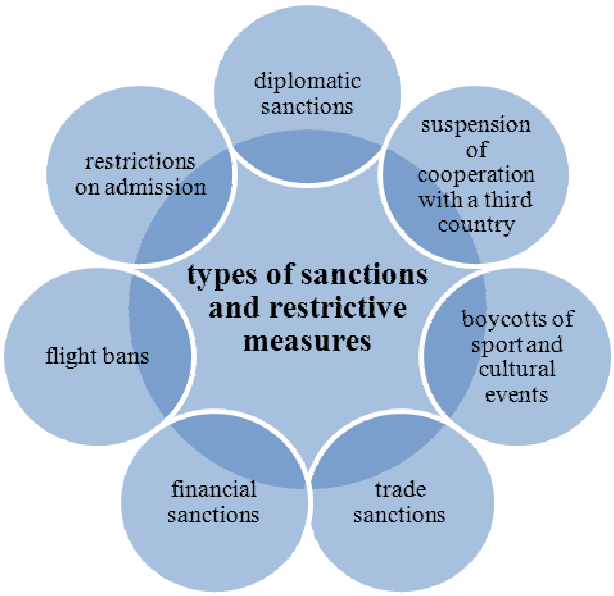

Fig. 1. Types of sanctions and restriction measures imposed by EU [4]

Sanctions and embargoes are imposed to stabilize and improve situation in affected area by changing the behavior of main leaders of the country, but also high profile individuals or groups. Of course, the main objective depends on particular circumstances. E.g. an arms embargo, a ban on the export of certain goods and other restrictive measures are aimed at limiting the inflow of financial resources to terrorist groups or other destabilizing groups. Imposition of sanctions and embargoes affect mainly the most vulnerable population groups in negative way, so the UN Security Council adopted a more sophisticated approach for planning and imposing sanctions. It is possible to direct them to specific individuals or groups, for example frozen assets, blocked financial accounts and transactions. These sanctions are called smart sanctions [5].

3. Ukrainian conflict solution through sanctions and embargoes between the EU and Russia

The conflict between pro-Russian separatists and Ukrainian armed forces threatens peace and security in Europe. It is difficult to clearly identify what launched a chain of events which resulted in the current situation. We can only assume that it is caused by dissatisfaction of Ukrainian people associated with the results of the elections in 2004 or suspension of negotiations about the EU Association Agreement. Organizations of international crisis management take initiative to end the conflict in a peaceful way and as soon as possible. The EU decided to solve the situation in February 2014 by imposing sanctions (for example freezing Ukrainian National Accounts), then the sanctions were imposed direct towards the Russian Federation, which supports, according to the media information, activities of pro-Russian separatists. Mentioned sanctions imposed against the Russian Federation include:

- an asset freeze for certain individuals (total of 151) and entities (total of 37) and a travel ban for certain individuals because of their direct involvement in the situation development in Ukraine [6];
- the sectorial sanctions target Russia's oil industry, financial sector and the military or arms industry, which include following restrictions:
  - restrictions on financing some companies owned by the Russian government (banks, oil companies and companies and entities engaged in production, conception, sales or

export of military equipment or services); this restriction includes a prohibition to deal in security and money market instruments, issued by the companies mentioned above, with a maturity above 30 days;
    - restrictions to provide, directly or indirectly, loans or credit to mentioned companies with a maturity exceeding 30 days;
    - restrictions on export of military and dual-use items to Russia and for use in Russia;
    - restrictions on the export and supply of certain oil-related goods and technologies to Russia and for use in Russia [7, 8, 9];
- imposition of the strictest sanctions targeted towards trade with Crimea and Sevastopol.
- General Assembly of the UN adopted resolution no. 68/262 about territorial integrity of Ukraine which recalls the obligations of all states under Article 2 of the Charter of the UN to refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any State, and to settle their international disputes by peaceful means [10]. This resolution notes that the referendum held in the Autonomous Republic of Crimea and the city of Sevastopol in March 2014 was not authorized by Ukraine. In direct connection with the UN resolution, EU Council adopted decision No. 2014/386/CFSP and EU Regulations No 692/2014 (June 2014) and No 825/2014 (July 2014), which were significantly extended by the EU Regulation No 1351/2014 in December 2014. Through this regulation any trade and investment in Crimea and Sevastopol was practically restricted.

Russian Federation responded with sanctions against the EU through adoption of retaliatory measures in March 2014. At first, it was asset freeze and travel ban for people, also even government officials to the Russia. In August, the Russian president V. V. Putin signed a decree on the application of specific economic measures, which imposed annual ban on import majority of agricultural products from countries, which had adopted sanctions. Next day, the Russian Federation government adopted a decree with list of countries and different products to which is the embargo targeted. It should be noted, that before imposing an embargo, food export from the EU to Russia was approximately about 11.8 billion €, which represents 10% of Russian consumption [11].

4. The consequences of sanctions on changes in exchange rates and inflation growth

The most apparent consequences of sanctions are in the economic field. It also includes changes of euro and ruble exchange rates in relation to US dollar. Imposition of sanctions also affects the inflation growth in selected countries. We perceive it as a direct consequence of adopting the restriction measures. Changes of several commodities price, for example crude oil and gas, can be considered as an indirect consequence. Sanctions against Russia were adopted in March and December. Restriction measures adopted in December can be classified as more strict. In August, Russia responded by imposing an embargo on import of agricultural products from countries which had adopted restrictive measures against it. This paper pays attention mainly to the development of mentioned indicators, namely in short term after imposition of sanctions.

Progress of exchange rate reflects the confidence level of financial markets to a specific country. Fig 2 shows change of euro and ruble exchange rates against exchange rate of US dollar. Although euro is relatively stable, it depreciates gradually since September 2014. That decrease can be caused by solving the Greek debt issue. It is influenced by embargo from August 2014 only partially. On the other hand, ruble exchange rate is significantly influenced by EU sanctions. Due to first sanctions from March 2014, its exchange rate decreased. However, the decrease was not so significant, so the ruble remained relatively stable. After stricter sanctions were imposed in December 2014, exchange rate of the ruble had already declined significantly, namely over 10% per month.

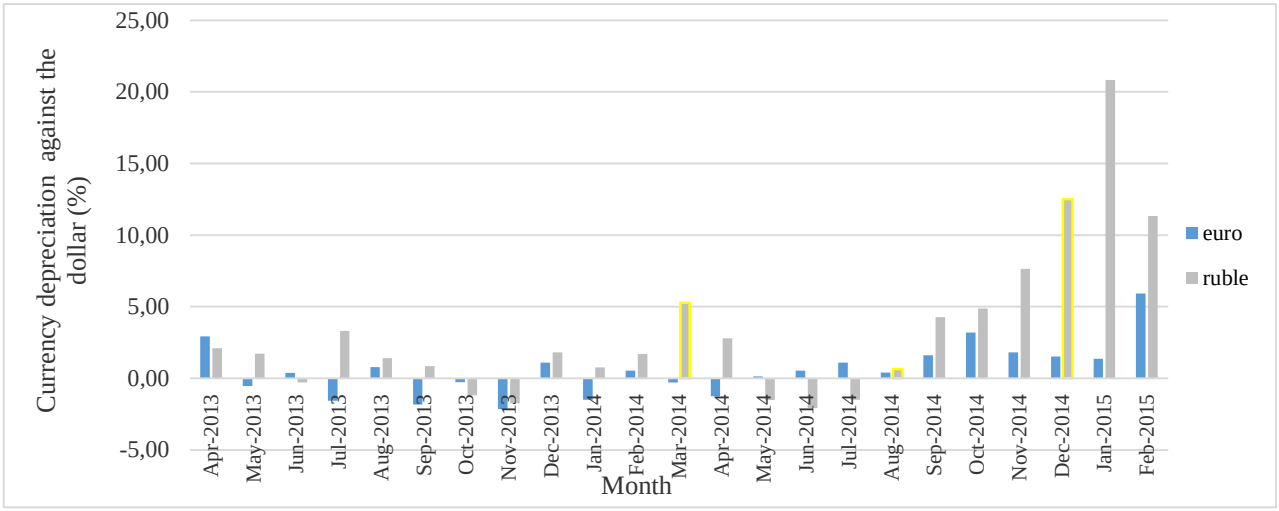

Fig. 2. Graph of the euro and ruble exchange rate development [13]

Inflation, as an indicator, expresses the increase of the price level. Embargo from August 2014 connected with import of agricultural products should cause, according to the economic theory, an increase of inflation in Russia and deflation in the EU. Fig. 3 shows progress of inflation in the Visegrad group (V4) countries and Russia. We can see in it a significant progress of inflation in Russia after August 2014, due to the lack of goods, which were related to the embargo. It is possible to observe slight changes in inflation developments in the V4 countries after the adoption of the embargo. The most evident decrease is in Poland and Hungary. We assume, that it is directly related to agricultural specialization of the mentioned countries.

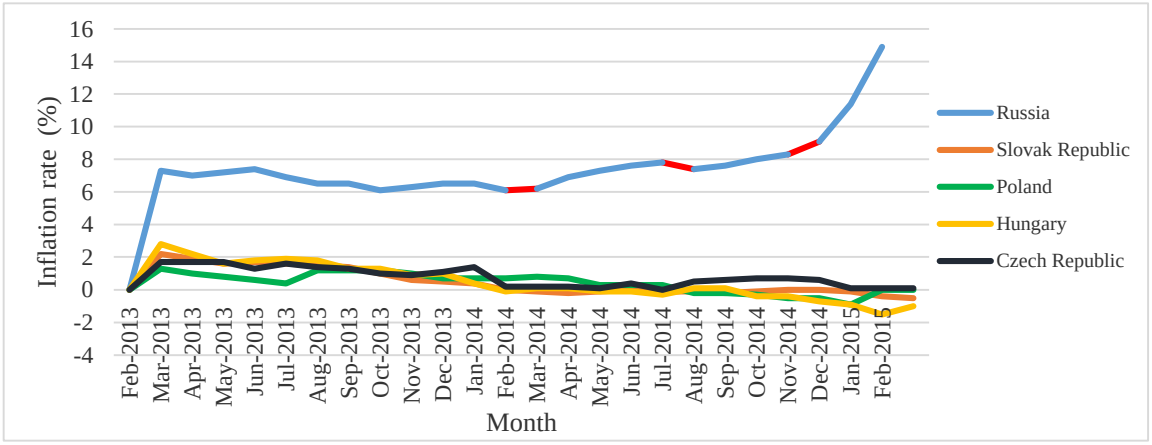

Fig. 3. Graph of the inflation rate development [14]

Based on the selected indicators, we can conclude that the EU sanctions significantly influence economy of the Russian Federation. The European Commission estimates that gross domestic product (hereinafter "GDP") growth in Russia will decrease at least by 1.1 % in 2015 and it will be influenced by sanctions against Russia. Furthermore, ruble exchange rate decreased and significant outflow of capital from Russia began. Overall, capital value is in the amount of 130 billion dollars. According to estimates of the European Commission, the sanctions will also reduce GDP growth in the EU by 0.2-0.3 % in 2015. According to available information sources, decrease of export from the EU to Russian federation is in the amount of more than 60 % [12].

In addition to the changes in exchange rates and inflation rate caused directly by sanctions and embargoes, there are also other indicators which should be paid attention to. It can be, for example, price of strategic raw materials, where is inherently oil and natural gas. These commodities are among the most important sources of Russian Federation income. The EU together with the United

States has the political and economic instruments to reduce prices of these commodities, either by influencing the world stock exchanges, or pressure on OPEC members (OPEC means Organization of the Petroleum Exporting Countries). In Fig. 4 we can see a decline in oil prices by more than 50% in one year. However, we can only assume, that oil prices decline was an indirect revenge of United States and other countries to which Russia imposed embargo of goods import. The price of gas did not fall as much as the oil price (Fig. 4). The gas price declined more than 25% in one year. More significant decline was after imposing sanctions against Russia in December 2014.

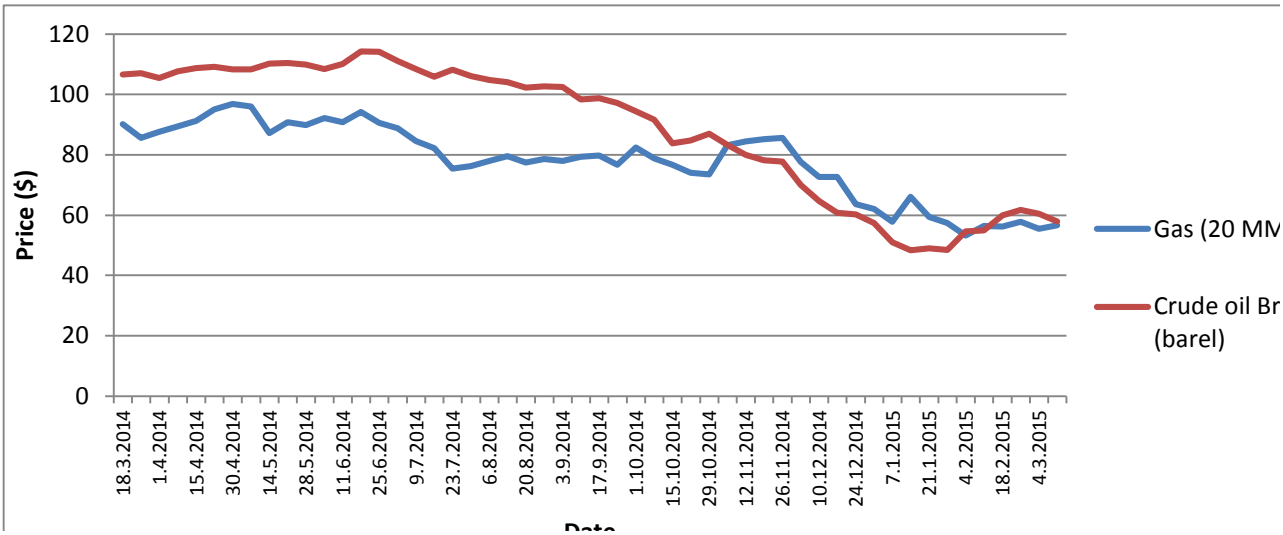

Fig. 4. Graph of the gas and oil stock market price development [15]

Situation in Ukraine influences the global security environment. Changes in the security environment also reflect on the economic environment, for example by growth of strategic commodities prices, namely oil and gas. Sanctions raised concerns about the possible suspension of raw materials supply to Europe. Commodity prices did not increase, on the contrary, price decreased. Based on the current prices development, it can be stated, that they will be regulated in some way by countries, which adopted sanctions against Russia. It could be meant, from one point of view, as another form of sanctions against Russia. However, this statement is not possible to substantiate by any official sources.

5. Conclusion

We can make some conclusions based on the description of sanctions and embargoes as such, but these conclusions are mainly based on characterization of specific measures imposed by the EU against the Russian Federation. Imposition of sanctions by the EU definitely disrupted economy of the Russian Federation. The exchange rate of ruble decreased and inflation rate in the country increased. Whether the adoption of specific restrictive measures fulfilled the primary purpose is already difficult to say with certainty. The main purpose of all these measures was the peaceful resolution of the conflict in Ukraine. Another purpose was to achieve, that Russia ceased to support efforts of Crimea inhabitants to affiliate to the Russian Federation by its activities. Despite of the ceasefire, there are still a lot of attacks and fights, so the effectiveness of measures is questionable.

The consequence of sanctions imposed by the Russian Federation to the EU in the context of criteria selected by us does not seem so significant. However, we paid attention only to development of euro and ruble exchange rates, inflation growth and changes of oil and natural gas prices, this finding is not absolute. It is also necessary to take into consideration other factors to comprehensively assess the impact of the adopted measures. Because of the limited scope of the paper, it is not possible.

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University of Žilina, Žilina, Slovak Republic

Safety of Persons in Shopping Centres in the Czech Republic

[*]Jana Pupíková, [*]David Řehák, [**]Sarah-K. Hahn
[*] VŠB-Technical University of Ostrava, Faculty of Safety Engineering, Lumírova 13/630, 700 30 Ostrava, Czech Republic, {jana.pupikova, david.rehak}@vsb.cz
[**] University of Applied Sciences Magdeburg-Stendal, Department of Civil Engineering, Breitscheidstr.2, 39114 Magdeburg, Germany, {sarah-katharina.hahn}@hs-magdeburg.de

Abstract. To some extent, shopping centres are a phenomenon of today and its popularity has been increasing over the last few years. There is an increasing number of customers who come to shopping centres, which is a fact that makes the centres more vulnerable to potential threats which may lead to emergencies. Therefore, it is vital to pay close attention to safety of these centres in order to prevent disturbance of their stable operation in case of emergency, as well as to prevent endangering of people´s lives and health, material damage and other interests. Thus, this contribution deals with the issue of safety of persons in shopping centres and presents approaches to ensuring safety at these places based especially on providing suitable technical and organization measures against current threats.

Keywords: safety of persons, shopping centres, risk assessment, technical and organization measures, population protection measures

1. Introduction

Attractiveness of shopping centres is very high in these modern times. The combination of shops, services of all kinds, catering, cultural and sports events makes shopping centres the destination of all-day family trips, meeting point and social life. Owing to the attractiveness of shopping centres, the concentration of people in such places increases, and in some cases, the capacity of the centres is exceeded. In emergency, a high number of people may be endangered in a limited space, which may lead to a significant number of casualties. This hot issue is current not only in the Czech republic, as proved by examples like the fire in Admiral shopping centre in Kazan (Russia, 2015) [1] or the roof collapse in Maxima shopping centre in Riga (Latvia, 2013) [2]. There are records of emergencies connected with deliberate threat of civilians with the use of conventional weapons. Occurrence of such incidents in shopping centres was recorded especially in countries like the USA, Russia, Israel, and some African countries. The most well-known incidents are for example the attack on Westgate shopping centre in Nairobi (Kenya, 2013) [3] or shooting in Tacoma Mall shopping centre in Washington (USA, 2005) [4]. The reason may be the active participation of these countries in fighting terrorism, current security, political or economic situation.

2. The current state of ensuring safety of persons in shopping centres

Ensuring safety of persons is an inseparable part of the safety strategy of every company and shopping centres are no exception. Safety of common operation in shopping centres is based on support and observation of the necessary legislative and normative regulations. Within these regulations there are stated conditions for providing safety during planning and building these centres. One of the conditions is the localization of the centres, so as to minimize the threats to its inner safety, including the employees´ and visitors´ safety. Within providing safety of persons in shopping centres during non-standard situations or emergency caused by threats, selected

population protection measures, like warning and informing, evacuation and hiding are currently used in the Czech Republic [5].

2.1. Threats that have influence on safety of persons in shopping centres

Safety of visitors and employees in shopping centres is affected by numerous common threats like pick pocketing. However, there are other threats that may lead to emergency and have influence on lives and health of people in these centres in a negative way.

To make it simple, threats may be divided into two basic areas, i.e. inner and outer ones. Outer threats act from the surroundings of the subject or community. General typology of safety risks may be used to classify them [6]. In connection with shopping centres we speak about natural, technological and criminal threats. Natural threats may further be divided into meteorological, geological and biological. Inner threats emerge from internal environment and activities of the subject or community. In connection with shopping centres we talk about personal, process and technical threats. See Tab. 1 for a short classification overview of threats that have influence on people in shopping centres.

Threats that have influence on people in shopping centres	**External threats**	Meteorological threats	
		Biological threats	
		Geological threats	
		Technological threats	
		Criminal threats	
	Internal threats	Personnel threats	Intentional
			Unintentional
		Process threats	
		Technical threats	

Tab. 1. Classification of threats that have influence on people in shopping centers

Arising from the above presented threats related to shopping centres, there is a need to concentrate on its impacts, i.e. emergency situations caused by these threats during which many people´s lives and health may be endangered and there might be a big material damage.

Every year, there are approximately 800 emergency situations requiring the Integrated Emergency System rescue services´ intervention in domestic shopping centres [7]. In most cases, it is a false alarm or providing technical aid with removing dangerous states (especially with electric wiring or transformer station failures or with drawing water from flooded spaces). There are records of cases with immediate threat of people that occur for some of the following reasons:

- fire (e.g. the fire in underground garages of the Tesco shopping centre in Ostrava in 2007, the fire in the Haná shopping centre in Olomouc in 2009, the fire in The Galerie Fénix shopping centre in Prague in 2012),
- gas and dangerous substances leak (e.g. ammonia leak in the Tesco hypermarket in Kralupy nad Vltavou in 2008, unknown in the Nový Smíchov shopping centre in Prague in 2013, gas leak near the Billa shopping centre in Roudnice nad Labem in the same year),
- floods (which caused e.g. flooding the STOP SHOP centre in Příbram and parts of Tesco shopping centres in Zubří a Milovice in 2009),
- whirlwinds (that caused e.g. loosening the ceiling constructions in the Centrum shopping centre in Děčín in 2007, or loosening the roof construction over one part of the Tesco hypermarket in Aš in the same year),

- other incidents (e.g. ceiling collapse in the Plaza shopping centre in Plzeň in 2013, a bomb report in the Central Most shopping centre in the same year) requiring intervention of rescue services.

From the regional point of view, the highest number of emergencies has been reported in the Moravskoslezský region. The reason may be a rapid growth of the number of new shopping centres in recent years, also the density of population of the region.

2.2. Population protection measures on the premises of shopping centres

An important aspect in reaction to these threats or emergencies caused by them is realization of measures used for minimizing the impacts. In shopping centres, selected measures of population protection like warning and informing, evacuation and hiding are used.

Warning and informing is currently being dealt with on a general level [8]. Domestic shopping centres have not dealt with this issue at all yet, though it is necessary for successful managing all stages of an emergency situation. Although subjects often use the local PA systems, outcomes of the analysis of the current public warning system in buildings where high number of people may gather [5] show that in most cases these systems do not meet the requirements of the Ministry of the Interior – General Directorate of Fire Rescue Service of the Czech Republic. These requirements concern end elements of warning incorporated in the Unified system of warning and notification and once the systems do not meet the requirements, they may not be incorporated in the system. In case of emergency it means that people on these premises are warned and informed only via end warning elements. The analysis also brought up the fact that warning and informing population via the end warning elements is not suitable due to poor signal audibility and intelligibility of verbal information.

Another requirement for population protection in shopping centres is **evacuation**. Technical conditions for people´s evacuation from shopping centres are determined by legal and normative regulations. In case of necessity of evacuation from shopping centres, particularly building evacuation, which can be defined as a short-term and fast leaving the building via emergency exits to get out of reach of impacts threatening lives and health of the evacuated, is planned. Building evacuation is primarily connected with fire protection. Therefore, the evacuation plan which is a part of fire protection documentation is used to evacuate people from the premises of buildings. People´s evacuation from shopping centres is problematic though and its course depends on many factors, e.g. type and course of emergency, time of reporting the evacuation, people´s positions within the shopping centre, their density and speed of movement, crowd reaction to emergency or communication permeability.

Another requirement for people´s protection within shopping centre buildings is their **hiding**, in case the emergency does not enable an immediate evacuation. However, permanent non-military shelters for civil defence cannot be used in case of emergency. That is due to the limited number and capacity of permanent shelters, its uneven location and the time needed to make it. The process of possible hiding people in the actual buildings of shopping centres has not been defined yet and it is not provided for neither legislatively nor normatively. Thus, it is recommended [9],[10] to use natural protective qualities of buildings with additional minimal adjustment of the space (closing windows, doors, sealing openings, switching off the ventilation, etc.) for provisional hiding. Using this form of hiding is recommended particularly at emergencies with the risk of contamination with dangerous substances and impacts of strong radiation.

3. Proposal for a complex approach to ensuring safety of persons in the shopping centres

The above stated facts present a solution to strengthening weak or vulnerable spots on the premises of shopping centres, determining measures for minimizing undesirable threats and

increasing safety and protection of these centres and people in them. The initial point within ensuring safety of shopping centres is risk assessment, including threat identification and a detailed risk analysis, which emerge from threats and are connected with safety of persons in shopping centres, as well as determining the importance of individual threats. For the most significant risks, it is necessary to establish further technical and organization measures suitable for ensuring safety and protection of the people in question. Such measures are presented in Fig. 1, and together with the procedure of risk assessment, they are described further in the contribution.

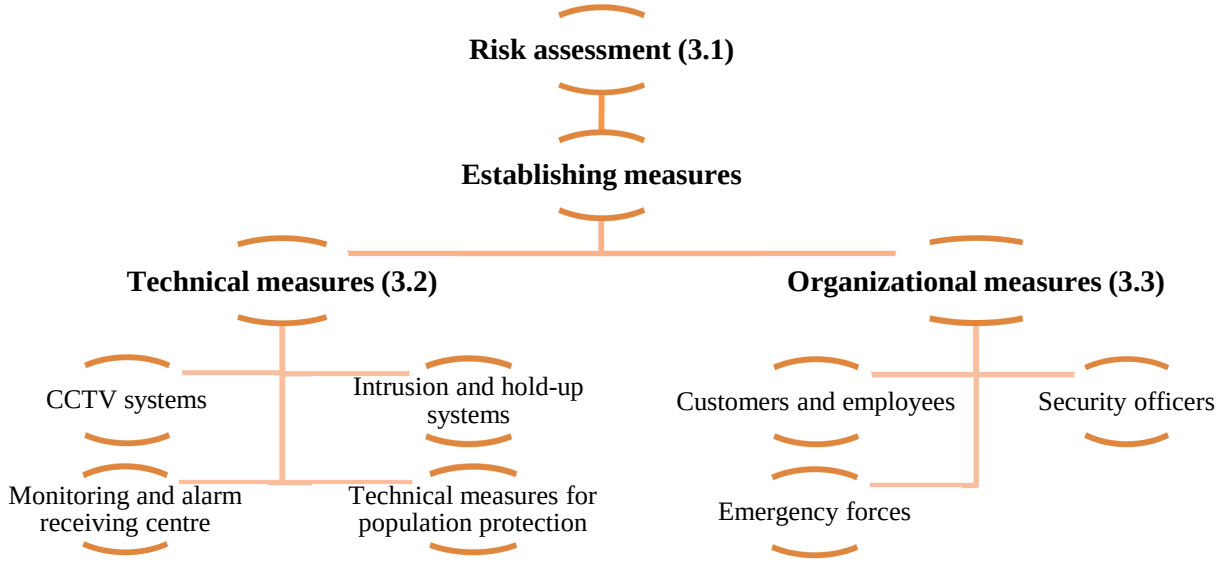

Fig. 1. Diagram of procedure and established measures to increase safety in shopping centers

3.1. Risk assessment

Risk assessment is a vital step for determining priorities in measures needed to minimize risks to an acceptable level. [11] Without realization of some form of risk assessment process it would be very difficult to decide what strategies should be used to protect specific interests (in this case, ensuring safety of persons in shopping centres).

Risk assessment should be carried out in a typical risk management process cycle - threat identification, risk analysis, risk evaluation, i.e. establishment of measures. During this process, the qualitative nature of the potential adverse consequences of individual threats (sources of risk) is determined so as to create a complex list of inner and outer threats which will be further analysed. During analysis of the identified sources of risk, the risk importance should be considered (an estimation of the risk impact strength on the system or people), as well as the probability of the occurrence of the given risk, its detection (the possibility of an early detection and risk elimination) and the current measures. This data serve as an input for detecting the extent of individual risks and for making decisions about solution priorities.

There is a number of ways and methods which may be used to assessment risks. Its choice depends on the purpose of the evaluation, nature of the evaluated data, financial sources and often also on the political context. As an example of a method suitable for risk analysis in shopping centres, the FMEA method (Failure Mode and Effects Analysis) can be used [12], or more precisely, its adapted process. The FMEA method belongs to the most common qualitative methods and it is one of the methods recommended by the IEC/ISO 31010 standard [13]. In the standard all factors within the risk analysis are considered and it shows relevant results.

3.2. Technical measures

It is necessary to determine technical and organization measures to reduce impacts of individual threats and to ensuring safety and protection of the people.

In order to reduce the impacts of individual threats and to ensuring safety and protection of the people in shopping centres it is necessary to establish technical and then also organization measures. Establishing suitable technical measures and its prioritization follows from the previous risk assessment in the subject. However, there are measures that can be generally used for ensuring safety in shopping centres for all kinds of threats. These are especially the CCTV surveillance systems, intrusion and hold-up systems, monitoring and alarm receiving centres and technical measures of population protection.

There is a modern trend in using the **CCTV surveillance systems** [14] for ensure the safety in shopping centres, or to be more precise, its analytical (intelligent) functions which are able to evaluate the picture in real time, and owing to the received data, they can also evaluate the non-standard situations (e.g. a fire occurrence) or various kinds of non-standard behaviour, often connected with criminality. The evaluated emergencies may be connected to alarm systems via "intelligent cameras" and transferred to the monitoring workplaces to be evaluated by the operator or security service via video-alarms. The CCTV surveillance systems are commonly used in shopping centres to monitor the customer attendance and it also serves as a powerful tool to improve the sales productivity, profitability and optimization of operating costs. Thus, by interconnecting suitable functional qualities of the CCTV surveillance systems it would be possible to gain a suitable device for marketing purposes as well as for supporting the security policy in shopping centres.

Apart from the subject monitoring, another current trend shows to be guarding subjects by **intrusion and hold-up systems** [15],[16] used to signal danger. This combined system which is used for detecting intrusion and distress alarm belongs to the category of technical protection. Intrusion and hold-up systems are widely used in shopping centres. They serve to ensuring safety and protection of the guarded subjects, spaces, products and people from theft, damage or attack. Also, they are used by insurance companies to determine the insurance payments. It is possible to connect this system to the monitoring and alarm receiving centre and thus ensure permanent monitoring of the whole subject.

Monitoring and alarm receiving centre (DPPC) [17],[18],[19] is a centre with a non-stop service – controller or another monitoring and alarm receiving centre, into which all data that the system is available to provide may be transferred. Within shopping centres, it is possible to use the DPPC centres to provide an early reaction to alarm and distress information, to inform the owner or runner of the shopping centre, or to inform rescue services in case of endangering people during emergency.

In order to reduce the impacts of individual threats, it is also necessary to determine effectively practicable measures for population protection. From this point of view, technical measures are particularly important, including warning and informing the relevant people, informing the rescue services, evacuation of people and their possible hiding, or other measures of protection specified on the basis of risk assessment outcomes.

For early and effective **warning and informing** people on the premises of shopping centres, sufficient audibility of the warning signal and intelligibility of emergency information is vital. At the same time, it is the independence of the warning system on electricity supply and the possibilities of its control. A suitable device for warning people in shopping centres that meets all the above mentioned requirements is for example SARAH III [5]. It is a multifunctional wireless device used for warning and informing in case of fire, flood or another kind of emergency. It is possible to be controlled from DPPC, a computer or notebook. The SARAH III system enables connection with the Unified System of Warning and Notice and meets the requirements of the Ministry of the Interior – General Directorate of Fire Rescue Service of the Czech Republic.

During **evacuation of people** from shopping centre buildings, a special attention must be paid to its duration. Any time lag may cause endangering more people exposed to the mentioned threats. In order to leave the dangerous premises quickly, it is necessary that the emergency and fire exits are freely accessible with no obstacles and meet the relevant legal requirements. The exits must lead

to a free or safe space via a suitable rout. Emergency and fire exits and emergency lifts on escape routes must be permanently labelled as escape and evacuation exits. So as the labels fulfil its presupposed function, they must form a coherent and effective system and meet the following conditions [20]:

- Individual signs for escape and evacuation of people must be visible in order to enable leading people out to a safe place.
- Labelling emergency and fire exits must meet requirements of relevant legal regulations (e.g. the Labour Code, Fire Protection Act, Construction Act, etc.).
- Labelling must warn the escaping people about all possible dangers on the route – particularly collisions with obstacles like load-bearing constructions or overhanging construction edges) or a danger of fall.
- Labelling must not be changed or damaged during people´s escape.

To **hide people** provisionally in shopping centres, as mentioned above, it is recommended to make use of natural protective qualities of the building with minimal additional adjustment of the space. There are, however, several factors that the suitability of provisional hiding spaces depends on. These are:

- Accessibility of the space – is important due to time as it must be immediately accessible for the endangered people in case of emergency.
- Location of the space
  - On higher floors – is suitable for protection from the impacts of dangerous substances which are heavier than air, poisonous substances and biological means; it is recommended to hide on the far side of the building,
  - In the underground part of the building – is suitable for protection from the impacts of radioactive fallout, dangerous substances which are lighter than air, and from some forms of terrorist attacks.
- The capacity of the hiding space – it is necessary to hide as many people as possible in shopping centres so the capacity should be as big as possible.
- Building material – the quality of the provisional hiding space is dependent on materials used for the building construction and its resistance to various influences that will affect it [10],[21]. Building materials should be maximally leakproof to prevent liquid substances from penetrating the building material and contaminate the hiding space. The most important factor is solidity and strength of the building material (pressure, crash and dynamic), as well as its durability, flexibility of the material and its hardness.

3.3. Organization measures

Within ensuring safety and protection of people in shopping centres it is necessary to determine organization measures in order to gain intended goals and values. For the needs of this contribution it means accessible and needed powers usable for overcoming emergencies, as well as ensuring safety and protection of people out of the times of emergency. For the needs of ensuring safety within organization measures, rights, duties and responsibilities during ensuring safety and protection in shopping centres should be determined, as well as professional training of the staff and people participating. Last, but not least, readiness of the security workers and rescue services intervening in emergencies is vital.

Safety and security in shopping centres during the common routine is provided especially by **security staff** of private security companies. Above all, their task is to provide safety integrity as such to prevent injuries or material damage. The security staff may be used during emergencies, especially in case when an immediate action is needed, e.g. for:

- Covering for fire patrols,
- Physical guarding of the building,
- Noticing security and rescue services,
- Cooperation with these services during rescue and liquidation work.

Variability of shopping centres requires specific training of these workers. The training should be based on deepening their knowledge of law, physical guarding during ensuring safety of the staff and customers, tactics during overcoming fire, process of activities during emergency occurrence, evaluating signals from security systems and reacting to them, and last, but not least, first aid to the injured people.

Another important aspect during ensuring safety integrity in shopping centres is the care for safety and protection of **staff and customers.** Safety and protection of the staff lies in providing safe conditions at the workplace including providing personal protective gear, maintaining occupational hygiene, safety labelling, information about security and health protection, maintaining safety of machines, technical devices and instruments which the staff gets into contact with. During ensuring safety, personal responsibility of the staff should be a must for the sake of their own safety. For such purposes, it is suitable to organize a staff training to gain knowledge and skills for self-protection and protection of the company´s interests during individual threats that may lead to an emergency. The extent and content of the professional training must correspond with performed activities and work position of the staff. Safety of customers lies in ensuring safety of products and services and in providing personal security by security staff in charge. An important role in safety is played by customers themselves, i.e. their desirable behaviour. For these purposes, it is suitable to determine instructions for customer behaviour during common routine of the shopping centre and rules for behaving during emergencies.

Intervening rescue services are of the main help during overcoming emergencies and during providing protection of people in shopping centres. These are especially the basic services of the Integrated Emergency System (Fire Rescue Service of the Czech Republic**,** fire prevention units included in the broad coverage, Emergency Medical Service and Police of the Czech Republic). In case of specific needs during overcoming emergency situations in these centres, other IES services, e.g. other armed security services, public health protection authorities, breakdown, standby and professional services and non-profit organizations may be used for rescue or liquidation work. The extent of measures carried out by the intervening services in shopping centres depends on the extent of consequences caused by the emergency. Regardless of the extent of the emergency, the intervening services must proceed in their activities with regard to the assigned competences, professional knowledge and accessible material support. To ensure safety and protection of people in shopping centres with conditions that are difficult to intervene in, it is vital to carry out practice and tactical drill in advance in order to maintain good coordination of the proceedings during rescue and liquidation work, as well as to prevent unnecessary casualties.

4. Conclusion

Ensuring safety in buildings where a higher number of people gather, including shopping centres, currently represents one of the security areas of high priority. This is due to the high concentration of people in a limited space, an easy access of public to shopping centres premises with no control of bringing dangerous devices and substances, the attractiveness of these places to terrorist attacks and in case of emergency also a high number of endangered people. To ensure safety of persons on the premises of shopping centres it is vital to take measures to minimize threats, or as the case may be, to minimize their impacts on health and lives of people.

Ensuring safety of persons should lie particularly in optimal interconnection of organization and technical measures realized before, as well as during the emergency occurrence. Establishing suitable measures and determining its priorities follows from previous risk assessment in shopping centres. Regardless the type of threat it is possible to use the CCTV surveillance systems, intrusion and hold-up system, monitoring and alarm receiving centres and population protection measures. There is another vital step to reduce impacts of individual threats, and that is determining rights, duties and responsibilities, professional training of staff and people participating in ensuring safety and protection in shopping centres.

Acknowledgement

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Risk Analysis and Transport of Dangerous Goods

[*]Martin Rázga, [**]Eva Jančaříková
[*] University of Žilina, Faculty of Civil Engineering, Department of Construction Management, Univerzitná 8215/1, 01026 Žilina, Slovakia, {martin.razga}@fstav.uniza.sk
[**] University of Žilina, Faculty of Civil Engineering, Department of Construction Management, Univerzitná 8215/1, 01026 Žilina, Slovakia, {eva.jancarikova}@fstav.uniza.sk

Abstract. Risk analysis for the Slovak road tunnels is carried out according technical specification TP 02/2011, which were adopted on the basis of the requirements of the European Directive 2004/54 / EC on minimum safety requirements for tunnels in the trans-European road network with a length of more than 500 meters by Government Regulation no. 344/2006. Model of risk analysis examines the personal risk of tunnel users and counted statistically expected value of the number of victims per year. For a more detailed examination of the risks of transporting dangerous goods through the tunnel, it is necessary to use a special risk model. A suitable example is specific risk model DG-Q_{RAM} (Dangerous Goods - Quantitative Risk Assessment Model), developed in partnership with OECD-PIARC.

Keywords: Tunnel, risk analysis, transport, dangerous goods, safety.

1. Introduction

Safe operation of tunnel is very important, because tunnels are specific engineering structures, which are constructed in order to shorten transport routes and improve road safety. Road (highway) tunnels under consideration of the safety documentation require the risk analysis. In Slovak Republic the assessment method is utilized according to the Austrian experiences. Risk analysis methodology is important for a safety in road tunnels, because in Slovakia there will be 33 or 34 road (highway) tunnels in the future. Also transport of dangerous goods through the tunnel affects the overall safety of the tunnel.

2. Risk analysis

Risk analysis of road tunnels in Slovakia is performed according to specifications TP 02/2011 Risk Analysis for Slovak road tunnels. This regulation was created primarily to be clearly define the exact methodology for risk analysis of the safety of road users in tunnels. For the calculation of risks in road tunnels is in TP precisely defined and explained the risk model, which was developed based on the Austrian model for risk analysis of tunnel TuRisMo.

2.1. Method of risk analysis

The risk analysis model consists of two main elements Fig. 1:

- quantitative analysis of frequency,
- quantitative analysis of accident.

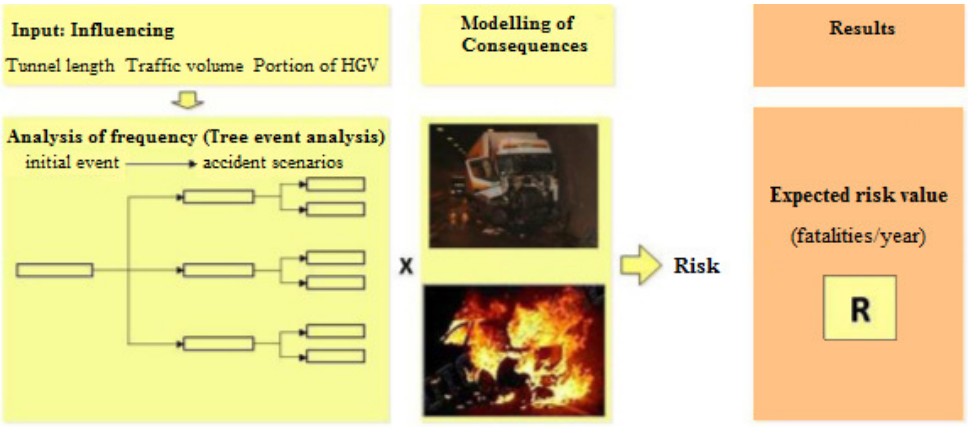

Fig. 1. Risk analysis structure of road tunnels [1]

2.2. Relative risk evaluation

Relative risk evaluation consists in axiom that the tunnel with its all specific safety-technical relevant characteristic cannot allocate higher risk as a similar reference tunnel which satisfies in all points and authoritative parameters to minimal requirements of government regulation. This approach enables achieve that through the medium of prescriptive measures is possible to keep minimal safety level also by respecting of specific curiosities of individual tunnel.

2.3. Calculation of risk

Evaluation of the results of quantitative analysis is made from the relative risk evaluation comparison with a reference tunnel and absolute risk evaluation assigning to hazard classes. Relative risk assessment is that the tunnel complying with all relevant technical safety characteristics cannot show a higher risk than similar reference tunnel which satisfies relevant minimum requirements. In this way, it should be possible to prove that using prescriptive measures can keep a minimum level of security. However, experience shows various weaknesses in the model for calculating risk reference tunnel.

Absolutely risk evaluation complements the relative evaluation and its goal is to provide information about absolute risk margin. Based on the expected value of risk (specified risk analysis) the studied tunnel is assigned to risk (hazard) class according to Tab. 1:

The expected value of risk		The degree of risk
Lower limit	Upper limit	
-	$2 . 10^{-2}$	I
$2 . 10^{-2}$	$1 . 10^{-1}$	II
$1 . 10^{-1}$	$5 . 10^{-1}$	III
$5 . 10^{-1}$	-	IV

Tab. 1. Distribution of hazard classes [1]

For the calculation of the risk analysis it is necessary first determine the necessary input data are entered into the calculation.

Input data for the risk´s analysis on calculation of the tunnel:

- transport system,
- speed limit in the tunnel,
- tunnel length,
- longitudinal gradient in the tunnel,
- congestion,
- proportion of passenger cars,
- proportion of trucks,

- proportion of buses,
- share transports dangerous goods on a number of trucks,
- frequency congestion,
- distance between emergency exits,
- ventilation system.

3. Transport of dangerous goods

For a more detailed examination of the risks of transporting dangerous goods, it is necessary to use a special risk model. Suitable is for example QRA software, which was developed at the OECD-PIARC. This program is part of the equipment of the department of technology and management structures and in the doctoral thesis of one of the authors will be devoted to the analysis of the risks carriage of dangerous goods by applying the QRA model. Therefore he calculate expected value of risk for transport of dangerous goods for Slovak tunnels which are already in operation and also for tunnels under construction and tunnels then assigned to the relevant category under ADR.

3.1. Exploration of ADR

University of Žilina made the exploration of proportion of dangerous goods in transport through the tunnel. This research was aimed mainly to be objectively determination how much of transport dangerous goods is in the section of the road network. Although it was found out how many of these vehicles use a detour of tunnel, because in Slovak Republic there is transport of dangerous goods through tunnel forbidden, and how many these vehicles drive through the tunnel despite the entry ban. The research was carried out three days in the period from 5.3.2013 to 7.3.2013 from the place before the tunnel, where were two observers 24 hours a day. Result of the research showed that proportion of dangerous goods in this section is 2.19 % from the transport of HGVs (heavy goods vehicles). It was also found that approximately 26.32 % of these HGVs with dangerous goods (marked as ADR) go through the tunnel despite the entry ban the transport of dangerous goods in road tunnels in Slovakia and 76.68% use the detour.

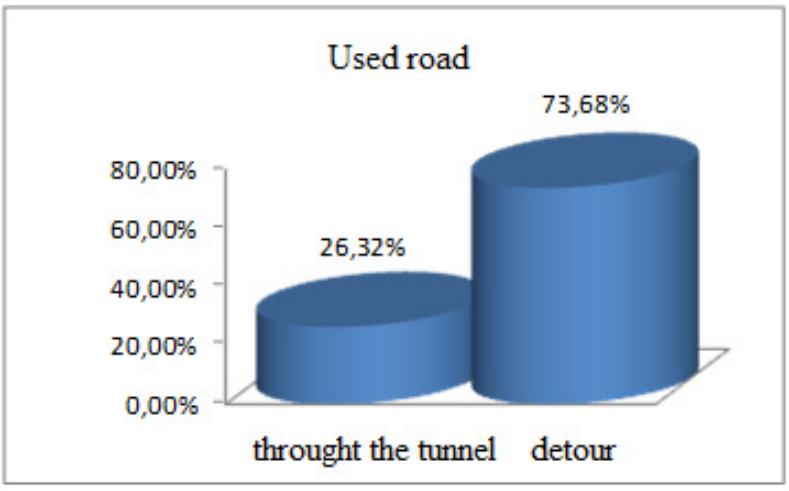

Fig. 2. The use of the tunnel with the transport of dangerous goods [2]

4. Calculation transport of dangerous goods through the tunnel using the software Q_{RAM}

Q_{RAM} (Quantitative Risk Assessment Model) is software that enables the quantification of the risks associated with the transport of dangerous goods by road tunnels. The program is used to

support the decision to allow or exclude Tunnel, vehicles carrying dangerous goods already in several European countries. With the help of the program can be compared not only risks the tunnel itself with selected criteria but also risks for the entire route with tunnels and possible detours. The program consists of 11 scenarios accidents heavy goods vehicles carrying dangerous goods and is accompanied by two fire scenarios heavy vehicle dangerous goods. For all scenarios were constructed mathematical equations, in which the values appoint an describing how ventilation, drainage, tunnel geometry, distance escape routes, traffic volume, composition of traffic flow and other parameters. Subsequently, the program evaluates the consequences caused of transport of dangerous good like, fire, explosion and leakage of dangerous goods. Not intended for evaluating the effects of vehicle collisions.

4.1. Accident scenarios

The program can determine the expected risk for 13 different scenarios. Description of the events of these scenarios is given in Tab. 2.

Scenario 1	HGV (heavy goods vehicles) fire 20 MW
Scenario 2	HGV (heavy goods vehicles) fire 100 MW
Scenario 3	BLEVE of LPG in cylinder
Scenario 4	Motor spirit pool fire
Scenario 5	VCE (vapour cloud explosio) of motor spirit
Scenario 6	Chlorine release
Scenario 7	BLEVE of LPG in bulk
Scenario 8	VCE (vapour cloud explosio) of LPG in bulk
Scenario 9	Torch fire of LPG in bulk
Scenario 10	Ammonia release
Scenario 11	Acrolein in bulk release
Scenario 12	Acrolein in cylinder release
Scenario 13	BLEVE of liquefied refrigerated CO2

Tab. 2. Accident scenarios transport of dangerous goods [5]

It is then determined a value of the expected risk at events of Dangerous Goods (EV- expected value) for each scenario and also progressions F/N curves (frequency/number of victims) of each scenario. This value is based on the monitoring data from the survey and also from the parameters of the tunnel. According to PIARC each tunnel has to be placed into one of five categories according to the transport of dangerous goods. The categories are shown in Tab. 3. Consequently, it is necessary to support each of accidents Tab. 2 incorporated in Fig. 1 in each category and assign the resulting expected value EV risk (victims/year). Based on the findings of the expected values for each category of the tunnel we classified the tunnel to the appropriate category.

Category	Restriction
A	All dangerous goods loadings authorised on open roads.
B	All loadings in grouping A except those which may lead to a very large explosion (“hot BLEVE” or equivalent).
C	All loadings in grouping B except those which may lead to a large explosion (“cold BLEVE” or equivalent) or a large toxic release (toxic gas or volatile toxic liquid).
D	All loadings in grouping C except those which may lead to a large fire.
E	No dangerous goods (except those which require no special marking on the vehicle).

Tab. 3. Classifications tunnel according to transport of dangerous goods [5]

5. Conclusion

Expected value of risk is the result of risk analysis for road tunnels and is defined as a statistically expected value of number of fatal casualties per year. Designers able to judge tunnel using risk analysis for safety and potential corrections already in the preparatory phase.

Acknowledgement

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Use of Simulation Technology in Crisis Management

[*]Tomáš Riska, [**]Jozef Ristvej
[*]University of Žilina, University Science Park, Univerzitná 8215/1, 010 26 Žilina, Slovakia, {Tomas.Riska}@uvp.uniza.sk
[**] University of Žilina, Faculty of Security Engineering, Department of Crisis Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Jozef.Riska}@fbi.uniza.sk

Abstract. The submitted article is focused on use of simulation technology in field of crisis management. The aim of the authors of the article is mention usage of Computer Assisted Exercise (CAX) and how important is incorporate constructive simulation to the crisis management practices. In particular section, we identify the main objectives, research opportunities, focus and uniqueness of research laboratory "Modeling and simulation of crisis phenomena in transport to increase the efficiency of decision-making" at the University of Žilina in the University Science Park.

Keywords: Computer Assisted Exercise (CAX), simulation technology, crisis management, constructive simulation

Introduction

Information and communication technology nowadays increasingly pervade our personal daily lives, they become a part of it and sometimes we become addicted to them. Information technology and its applications, information systems and application software are part of the rapidly growing relatively young department, which shall apply in various areas of life of modern society. In our latitudes today almost everyone uses a personal computer, a mobile phone, using tablets, smart phone works on the Internet. Nowadays we need to focus our attention to train strategic and operational managers in the tasks of crisis management and it through using constructive simulation in crisis management practices.

1. The Computer Assisted Exercise (CAX)

Throughout the history people want to be aware and prepared for the incoming threats to their existence. It has been always question about their perception of security and readiness to react properly in order to protect themselves, society and societal values.

In case of unexpected, unplanned, unprecedented, and definitely unpleasant events, society has to have appropriate counter measures in place, in order to neutralize unwelcome effects. Emergency responders which must apply favorable activities for protection of the lives and assets are representing operational elements of national security system in each country worldwide. Emergency responders consist of military, police and civilian forces. All of them have skills including decision making, communication, situational awareness, team work and stress management. Up keeping of these skills requires faithful exercising with the different training methods such as command post exercise (CPX), crises management exercise (CMX) and computer assisted exercise (CAX).

Simulation at the hand of information systems is experimental method in which the real object or system is replaced by the computer model. In this model are carry out experiments, which are subsequently evaluated, optimize and the results are re-applied in the real system.

Currently, there are three basic types of simulations using information systems:

- **virtual simulation** means that real people use simulated (virtual) equipment in a simulated environment called a virtual environment,
- **live simulation** means that real people use simulated (virtual) equipment in the real world, in particular the various simulators such as aerospace, automobiles, etc. and the use of armed forces for training combat troops,
- **constructive simulation** means that simulated (virtual) people use simulated (virtual) equipment in a simulated (virtual) environment. For its similarity to the military is constructive simulation understood as strategic computer game is often described as a military simulation. Constructive simulation is able to design and conduct simulated scenarios for most areas dealing with crisis management practically across the whole territory.

In this article we would like to focus on constructive simulation. Constructive simulation is referred to as extensive simulation. Simulated are the entities that represent individuals, plant and equipment in the virtual environment. This type of simulation for teaching and training is called the "computer-aided exercises - CAX (Computer Assisted Exercise)". Computers simulate processes and phenomena in real time, or a generic environment to achieve in trained entities impression of the actual implementation of the operations and activities as if they were performed in real environments and in real terms. Originally this type of simulation were using mainly for the armed forces. At present, this system is also widely using in civilian areas mainly in crisis management.

The objective of the simulator of constructive simulation is stochastically simulate the behavior of the incorporated forces and resources in a virtual world. The simulation is performed on the basis of defined parameters and algorithms that ensure system behavior under those rules and principles.

Solving within the exercises allows assign set tasks and commands vehicles, individuals or entire clusters simultaneously. Computer operator can clearly see current status in area as well as the conduct and outcome of planned activities.

The constructive simulation is also designed tool used for the analysis and evaluation of the activities after the end or during the simulation (AAR tool - After Action Review tool), including filing system Data Logger, which continuously records all kinds of activities during the simulation.

Simulation in the field of crisis situations through CAX is suitable for practicing management bodies and bodies of crisis management to assist in their decision-making process. CAX exercises have prescribed so called "life cycle". During this life cycle is carried out the preparation and the realization of exercises by course of prepared and verified procedures.

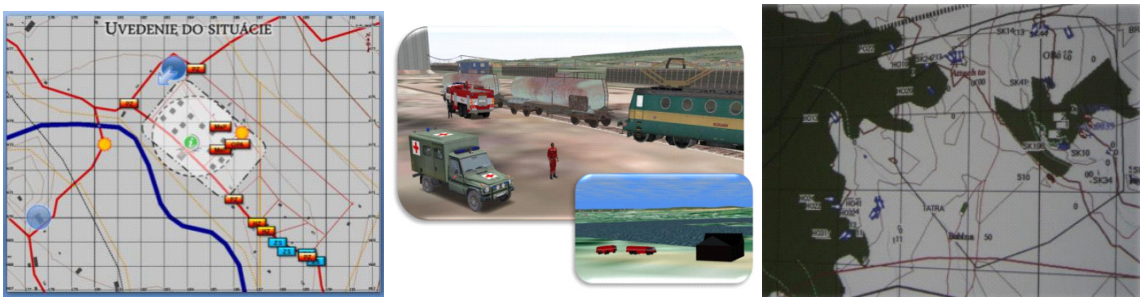

Fig. 1 Crisis Management Simulator - constructive simulation (training staffs crisis management) [1]

2. Trends in constructive simulation

Since the beginning simulation technology has been use in the armed forces. In developed and relatively densely populated countries the grew pressure of environmental initiatives since 60's of last century to use simulation technology which can greatly eliminate the environmental risks of military activities and effective practice management units.

Permanent innovation and new developments in information technology in the United States are on top of technological development in this area. They have a significant impact on their development and use also in other parts of the world.

During implementation of simulation technologies were followed objectives to improve the effectiveness of training and reduce environmental impact on the surroundings. With the objectives transformation for deployed armed forces increasingly spread abroad the area simulated activities of armed conflict on tactical direction to the urban operations and operations other than war (peacekeeping). Currently constructive simulation is able to prepare simulated scenarios for most areas dealing with crisis management practically all over Slovakia.

In the global context in practice a large number of software tools for crisis management, which are becoming increasingly sophisticated and used. These software tools are used also to acquire relevant data from the field of meteorology, simulation of storms, emergencies such as earthquakes, soil movements, modeling the spread of dangerous substances. Important aspects are also the models for managing of evacuation. In the cycle of crisis management simulation tools must be designed for different types of emergencies as well as to predict the likelihood of incidents and analysis of loss of life and property of people. The most important research laboratories crisis management around us also includes the following.

The national super-computer center IT4Innovations

The main objective is to work on the excellent scientific research in the fields of embedded high-performance computing with great benefit to the industry. Under the National super-computer center IT4Innovations researchers solve and participate in dozens of domestic and international projects. One of the projects which was solved in the center is a project called Floreon +. Objective of the project Floreon + is create an integration and operating platform for monitoring, modeling, forecasting and support crisis management, particularly with a focus on the Moravian region.

Crisis Management Centre (CEKR)

This center was established at the Department of Security Studies at Faculty of Political Science and International Relations at University of Matej Bel. Crisis Management Centre focuses on areas of national and international security, crisis management and process control of crisis management with emphasis on the development of scientific research potential of the Faculty of Political Science and International Relations. The main task of CEKR UMB in the field of crisis management is to increase the efficiency of decision-making processes, as well as process optimization of crisis management to deal with different types of crisis situations with support of models of crisis scenarios especially in the area of social risks, such as demonstration and crowd situations.

European Crisis Management Laboratory (ECML)

The European Crisis Management Laboratory acts as a research, development and test facility for ICT. ECML integrate devices, applications, and crisis management related information to support crisis management needs, such as threats analysis, common situation awareness, and collaborative decision making. There is also possibility to distributed crisis management training across relevant services of the European Commission, as well as with partners in the EU Member States and others engaged in crisis management. ECML will be tested in a variety of crisis scenarios ranging from intentional threats and natural disasters to health crises.

VSTEP

VSTEP is the leading European developer of simulators and virtual training software. They create educational applications, games and simulators that allow people to build their skills in a virtual world, which is less expensive than an exercise in the real world and real terms. It is done by creators and producers of computer games industry with support of interactive 3D technology. VSTEP together with other partners has created software RescueSim. This software tool is designed to train and prepare professionals ensuring the security of society. RescueSim allows to units of Integrated rescue system to experience the crisis phenomena as in real life. The intention is assess the situation and determine the best strategy for tackling the crisis phenomenon and then to implement it with the ability to watch the consequences of their decisions. RescueSim consists of several basic modules such as the crisis management module, management of accidents at the

airport, the management of industrial accidents, management of accidents at the ports and management of accidents at the boats.

3. The benefits of constructive simulations and why it is important to modeling and simulation in crisis management

Simulations of crisis management are a special group of simulations. During the emergency it is necessary to have a pre-prepared an emergency plans and know what effect they might have an adopted measure. We can verify these measures also with use of simulation technology that can provide relevant information.

The specific use of the existing virtual reality environment is a prerequisite to the creation of correct models and algorithms for the simulation of a higher type - constructive simulation.

Simulation technology allows us to create an environment for simulating reality, which represents an environment of the real world. Simulation technologies are supported by a wide range of applications and technologies. Available technologies were initially used in the military field, then in the field of computer games, medicine and other fields. Today it can be effectively used in the field of public administration during dealing with incidents of crisis management. Preparation of future solutions by using simulation technology is currently one of the major challenges. It requires a thorough preparation of parameters and algorithms for represented entities.

Preparation of future professionals and solutions through the use of simulation technology is one of the major challenges of today. University Science Park at University of Žilina (USP UŽ) will be in the field of intelligent transport systems, among others, also covers The Laboratory of modeling and simulation of crisis phenomena in the transport sector to increase the efficiency of decision-making which is to be a unique department of its kind in the Slovak Republic and the European Union, which will be simulate different types of crisis phenomena in different environments (in social, technical, technological and natural environment). During emergencies is necessary to have a pre-crisis scenarios. Understand what effect they can have negative impacts of the different events and what measures can be taken. It is also possible to verify these measures, which may be also due to simulation technologies that can provide relevant information, in particular at the time of preparation and prevention to deal with crisis phenomena of present.

The main purpose the of Laboratory for modeling and simulation of crisis phenomena in transport for improvement of efficiency decision-making is to create a center of expertise for analysis, diagnosis and quantification of external influences on human - computer interaction and to improve the quality and effectiveness of training decision-making processes. Simultaneously of the research activity is also expertise on the situation in the real environment as well as the environment of simulations focusing on crisis phenomena in the field of transport. To support decision making of crisis management is essential and sufficient information about the strengths, resources and means prepared in a state of security at the level of government and designed to deal with emergencies and crisis phenomena.

The objective of the laboratory is to create a virtual environment enabling:

- improve the quality of training and efficiency of decision-making in crisis management,
- increase mental endurance of emergency managers working under constant stress,
- model and simulate crisis phenomena in social, technical, technological and natural environment,
- collection, processing and evaluation (analysis, synthesis) gathered data, and
- increase the efficiency and reliability of the decision-making of the human factor of the focus for crisis phenomena in transport,
- to model and simulate the behavior of an intruder in a guarded area,
- to model and simulate the tactics intervention force in eliminating intruders.

Predicted research and innovation areas of Laboratory for modeling and simulation of crisis phenomena in transport for improvement of efficiency decision-making at this stage are:

- the security environment, crisis management and emergency planning,
- the creation of new methods and procedures of risk analysis, their optimization for individual areas of human activity (social, technical, technological and natural environment),
- a comprehensive risk assessment in social, technical, technological and natural environment and propose preventive measures of managerial and technological character,
- verification and optimization of the structure, scope and role of the security system of the country and its elements,
- dealing with emergencies and crisis situations in the natural, economic and social environment,
- addressing current problems in the integrated rescue system with emphasis on efficiency deployments and resources for dealing with emergencies,
- verification and optimization of emergency planning, ensuring the prevention and resolution of major industrial accidents and their environmental implications,
- assessing the functionality of critical infrastructure and ensure its protection in crisis situations,
- design and technical support of process to protection persons, property and buildings,
- verification and force planning, resources and funds to deal with emergencies and crisis phenomena in the various departments of the Slovak Republic,
- develop integrated crisis management systems,
- comprehensive training of future professionals for dealing with crisis situations and security incidents within the study programs,
- simulate of mass car accident and release of hazardous and radioactive substances,
- verify the accuracy and intervention unit tactics times and times of movements of intruder in the protected space of time from initial detection of an intruder.

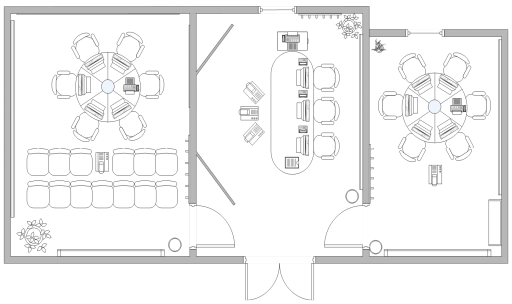

Fig 2. 2D model of Laboratory for modeling and simulation of crisis phenomena in transport for improvement of efficiency decision-making

In terms of crisis management, we are mainly interested in the application of simulations carried crisis phenomena in education, training, and practice of responding to crisis events, and research opportunities in this field, with emphasis on constructive simulation The virtual environment of computer simulation brings to the crisis management dimension of "safe" environment whereas in the virtual environment are not a direct consequence of the crisis phenomena in terms of threat to life, health and property. It is on one hand, the possibility of extricating themselves from the pressure of imminent physical threat, however on the other hand reduces emotional pressure and a sense of moral responsibility.

In the field of teaching concerns in particular the training of professionals for crisis management in different areas, with emphasis on training to deal with different situations, which require a quick and adequate response. Therefore it is necessary to teach at the university during the preparing graduates of study programs focused on crisis management, use different kinds of simulators and scenarios simulating real crisis phenomena and processes to address them.

In practice we need focus in particular on quality management of stressful situations of crisis management by the individual components separately in phase reaction using various kinds of simulators, scenario simulating crisis phenomena, and polygons.

In the field of research we are interested in to the possibility of using information technology and information systems in the implementation of simulation management of crisis phenomena and their solutions in crisis management.

Conclusion

Laboratory for research of modelling and simulation of crisis phenomena in transport to increase the effectiveness of decision-making will be used to simulate the movement and behavior of ground and aerial environments entities on digitized 2D and 3D views, allowing modification algorithms and implementation of new modules. Laboratory will be compatible with DIS and HLA protocols and allows Real -time simulation. Comprehensive preparation of future professionals to deal with crisis phenomena in study programs at the Faculty of Security Engineering, University of Žilina (FSE UNIZA) requires constant innovation in terms of fulfilling the study programs at the FSE UNIZA. Build-out of material base in the form of specialized classrooms and laboratories, innovation of existing objects, or the introduction of new subjects in the existing study programs will moves us forwards. Innovated or newly introduced study programs guarantee progress not only in crisis management.

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Methods of Tracking Illegal Use of Proprietary Software

[*]Andrzej Sobczyk
[*] Politechnika Świętokrzyska, Wydział Elektrotechniki, Automatyki i Informatyki, Katedra Telekomunikacji, Fotoniki i Nanomateriałów, Zakład Telekomunikacji, 25-314 Kielce, al. Tysiąclecia Państwa Polskiego 7, asobczyk@tu.kielce.pl

Abstract. Nowadays computer software is more and more complicated, often to develop a piece of software company utilises a load of resources. It is not surprising that software suppliers want to secure their work from illegal use, to call a spade a spade they do not want to be robbed. There are many tools and ways to protect the software, but also there are a lot of ways of breaking through the protections. Therefore beside strict protection is also need for tracking of use of proprietary applications. In the paper author were aimed to research typical ways of blocking monitoring tools by dishonest users and present various tools that allow break through such blockages.

Keywords: proprietary software protection, firewall, forensic, tracking, illegal software use.

1. Introduction

To develop a piece of computer software a company must bear some expenses as salaries for coders, graphic designers as well as costs of marketing, distribution, promotion. It is obvious that every commercial company wants to prevent illegal use of its products.

There are a great selection of software protection tools. Basically, they work like a door lock, in order to use particular application we need to obtain a key. Unfortunately there are not only clean-handed people, some individuals are able to break the protection, produce fake keys or just use the software in illegitimate way. It is important to use tools that monitor use of the software and detect illegal use accidents.

Nowadays, we can assume that almost all personal computers are connected to the Internet network, therefore it seems to be extremely easy to implement an algorithm that sends information concerning every use of the software to the supplier. Alas, dishonest software users have their own tools to spoil above mentioned algorithm. For instance they can block all outgoing network connections from the software on system firewall, they can change local domain name system to redirect connection to wrong or non-existent address and so forth.

In the paper author was aimed to do white hat research on selected approaches of tracking use of computer software as well as methods of blocking such tracking.

1.1. Method and scope of research

During the research some test applications were build, the only goal of them was to send test data to an Internet server. In real production environment the data might consist of application and computer specific identifiers, for instance: serial numbers, IP addresses, domain names etc., but during this research just plain text string was used.

The test procedure used protocols, techniques based on both TCP /Transmission Control Protocol/ and UDP /User Datagram Protocol/ protocols in transport layer.

On the other hand various system tools were used to prevent the test application from sending any data outside. Intentionally tools not included in standard system installation were omitted.

Test were conducted in following environments:

a. client side:
   - operating systems: Windows 7, Windows 8, Linux CentOS Distribution 6.6. All systems were installed with default settings, all recommended security settings were applied;
   - test applications developed by the author. For Windows family systems Embarcadero® Delphi XE 4 were used, for Linux system software based on: Python 2.4.3;

b. server side:
   - operating system: Linux 3.10.9;
   - test software based on: Python 2.4.3, Perl v5.10.1, PHP 5.3.3;
   - tcpdump tool was used to monitor server network interface.

2. Test results

2.1. Default system configuration

Background:

None of operating system parameters were changed.

Results:

All of tested systems did not block outgoing network connections, therefore test application successfully send all necessary data to the server regardless used protocol.

Surely, there is possibility of blocking some TCP and/or UDP ports by internet service providers, to improve reliability in that cases the server should listen on all possible ports, and monitoring application should try to connect to any of them.

Remarks:

There some tests were done on such “unfriendly” environments and the most popular port that were remain opened were 443/TCP (HTTPS - Hyper Text Transfer Protocol Secured) and 123/UDP (NTP - /Network Time Protocol/). To make the server listen on all possible ports there is no need for open thousands of listening network sockets, it is enough to redirect all connections from a network interface to single opened port on another interface.

2.2. Application blocking

Background:

On windows family operating systems user can block particular application on system firewall. When the test application was blocked all attempts to send any data were unsuccessful. Tries used TCP protocol ends with failure at connection state, while UDP based attempts received no data. On the server side no network activity were recorded.

Method:

To break the blockage helper application can be used. Since system firewall blocks only one particular application, defined by its path and name, there were prepared additional small application that was included into main application as a resource[1], when application is unable to connect to the server the helper was extracted to disk and executed as standalone application. To ensure communication between main application and the helper any interprocess communication tool might be used. During test procedure anonymous pipes[2] were used.

Results:

The helper application could freely communicate with the server despite blocking main application on the system firewall.

Another option to pass some data to the server is using default system Internet browser and HTTP protocol[3]. The application prepared special URL /Uniform Resource Locator/ that include the data as GET parameter then pass it via API to the operating system. For instance ShellExecute function could be used.

The second way has disadvantage of being visible to the user, even if the application tries to hide the Internet browser window by using SW_HIDE parameter, the browser window remain visible and requested URL was opened in new tab.

Since only windows operating system can easily block single application from network access test procedure on Linux system was skipped.

2.3. DNS spoiling

Background:

Internet communication basically is based either on IP addresses or domain names. As far as software use monitoring is considered both approaches have their advantages and disadvantages. When we provide server address as an IP address the communication will fail when the server IP address is changed, user can also block easily single IP address. On the other way using domain names makes the communication independent of IP changes and what is more important it is more difficult to block communication by domain name. Unfortunately user can spoil DNS system by adding fake entries in system *hosts* file[4].

Results:

There is no universal recipe to avoid DNS spoiling, hybrid systems or own DNS mechanisms should be working.

2.4. Server address blocking

Background:

User can block the server IP address on system firewall, then all attempts to make connection with the server will not be successful. What is more all above mentioned ways to break this block do not work.

Method:

On all tested operating systems we can block single IP address, on Linux system we can use iptables tool to drop all outgoing packets, on windows family systems we can use built-in system firewall. It is important that in some Windows 7 operating system installations there were need to create two separate firewall rules one for TCP protocol and other for UDP protocol. When we create single rule select all protocols. Sometimes Windows 7 changes the protocol to HOPORT on itself and the rule does not work at all, it seems to be a system bug.

Beside blocking traffic between the application and the server on local computer firewall we must be aware that communication may be blocked at Internet Service Provider infrastructure.

To send data in a such difficult circumstances author decides to utilise features of DNS/Domain Name System/ protocol[5].

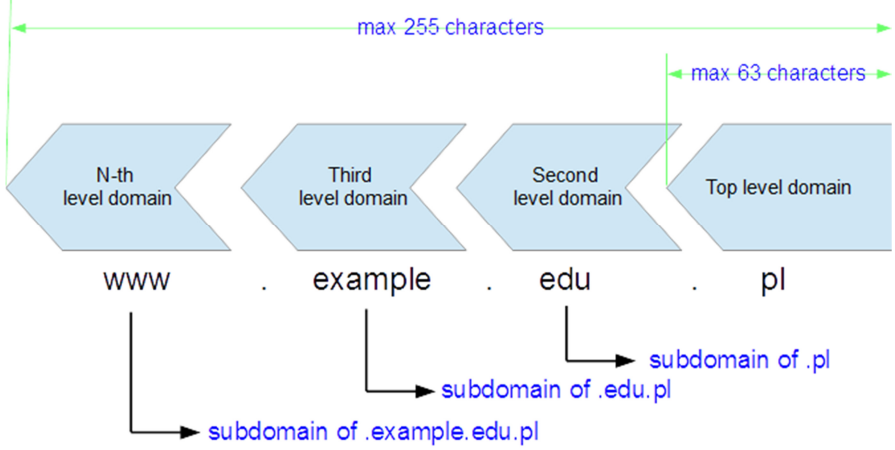

Fig. 1. Structure of a fully qualified internet domain name.

In the case study special DNS server daemon were prepared, fully qualified third level internet domain was redirected to the server. Having known that maximum length of domain name is 255 characters, thus capacity of single data "packet" is 255 minus length of the suffix subdomain and all required dots. During the research test data consist of one packet, additionally prefix of unix timestamp was added to prevent caching the data by intermediate name servers.

Since domain name must consist only of small Latin letters, digits and hyphen sign, to transfer binary data Base32[6] encoding were used.

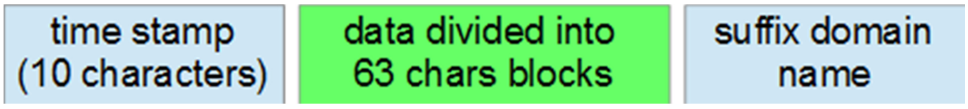

Fig. 2. Structure of domain name used during research.

After packing the data into domain name standard network functions, (for example GetHostByName) were used.

Results:

The system based on the DNS solution could send all data even if IP address of the server was blocked. The system works even in an environment where only possible internet communication was www access via proxy server.

Remarks:

It is worth to notice that due to hierarchical structure of DNS servers in the most cases it was not the tracked user computer that connect to our server, but it was internet service provider (or other selected in network configuration) name server, so it is crucial to include local IP address in the data.

3. Conclusion

The aim of the research was to present ways of monitoring use and detection illegal use of computer software, ways of blocking tracking software by dishonest users and at last but surely not at least ways of breaking through such blockages. The summary is shown in the table 1 bellow.

#	Connection blocking tool used	TCP Connection	UDP Connection	Helper application	System internet browser	Data over DNS
1	**None**	Works	Works	Works	Works	Works
2	**Application blocking** (Tested only on windows family OS)	Do not work	Do not work	Works	Works, but might be visible to user.	Works
3	**DNS spoiling**	Works only when server address is provided as IP	Works only when server address is provided as IP	Works only when server address is provided as IP	Works only when server address is provided as IP	Works
4	**IP blocking**	Do not work	Do not work	Do not work	Do not work	Works

Tab. 1. Comparison of blocking tools and tracking methods.

Given the above, transferring data over DNS protocol seems to be the most efficient system to track using of proprietary software. Nevertheless it is the most complicated method with many disadvantages due to limitations of very simple Domain Name System protocol. In the most cases amount of data that is to be passed to tracking servers is not too big, therefore only small modifications of above mentioned approach will be necessary to transfer the data exceeding size of single packet.

Author know that there are many more blocking tools and believe that there is much more ways of tracking users that use software in an illegal way.

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Contribution to the Analysis of Municipal Polices to Promote Security in Slovakia

[*]Viktor Šoltés, [*]Ján Mišík
[*] University of Žilina, Faculty of Security Engineering, Department of Security Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Viktor.Soltes}@fbi.uniza.sk
University of Žilina, Faculty of Security Engineering, Department of Security Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Jan.Misik}@fbi.uniza.sk

Abstract. All municipalities in the Slovak Republic, which have established its own police, had to prepare a report of their activities since 2004. This report describes basic tasks, implemented prevention activities and projects, material and technical equipment, cooperation with other authorities, repressive activities, as well as various statistics in reports. 10 years have passed, so it is appropriate to assess how individual municipalities lay themselves out to preparation of reports considering the activities of municipal police, also it is no less important to evaluate the development of number of municipal police and the number of its members. Likewise it is appropriate to analyze the evolution and structure of offences recorded. Based on these analyses, it is possible to propose measures that should help improve activities of municipal police, as well as supervision of municipal police.

Keywords: Municipal police, municipalities, offense, activity report, security.

1. Introduction

Regulation of Ministry of Interior of the Slovak Republic (hereinafter the "ministry") no. 532/2003 entered into force in 2003, from which follows the obligation for municipalities with the establishment of police to do and approve a report of the activities of the police. The report after the approval of the municipal council shall be signed by the mayor of the municipality and then the previous year's report is sent to Ministry by 31st of March. Ministry serves as the supervisor of the municipal police. In the case of no delivery of activities report, municipality could be fined by Ministry up to € 1,659.

Municipalities had a duty to write these reports in 2005 for the previous calendar year for the first time. The situation in Slovakia has changed for ten years. The social situation, the security environment, but also citizens' lives were affected by the financial crisis to a large extent. The financial crisis has caused less income to municipality budgets, which result an investigation in all areas. Security area was also affected by many factors, which is why there were a different changes both in the number of municipal police, but also the number of their members, not least the number and structure of violations detected [5].

1.1. Activities report of the municipal police

The form and content of the activities report of the municipal police is already given by the mentioned regulation. It is divided into descriptive and tables from a formal point of view. The descriptive section provides information on the performance of the tasks of the municipal police in emergencies, tasks to ensure public order and in violation of the prohibition of alcohol ingestion. It also includes a description of the co-operation with other authorities, the names and descriptions of performed prevention projects, information on used vehicles, equipment and gear, tools, CCTV and other important facts related to the activities of the municipal police [6].

Table section can be considered as a statistical section. It consists of a statement of statistical data, which has 5 parts. Each section contains information on the number of members of the

municipal police, the number of complaints against members, on interventions and coercive measures activity, on the tasks of the municipal police as well as information on violations registered.

1.2. Violations dealt with municipal police

The functions of influence of the municipal police are preventive and repressive. Crime prevention means purposeful activity, which aims to prevent, suppress and avoid the commission of crime. Complementary concept to the concept of prevention is repression – suppression of crime by legal ways. Repression starts at the time of failure means and methods of crime prevention - If despite preventive measures will be committed crime [1].

One of repression tasks of the municipal police is the investigation of violations. Violations which are competent to handle municipal police can be divided into following groups:

- disturbing of traffic regulations,
- offences against public order,
- offenses against civil coexistence,
- offenses against property,
- violating local binding legal regulations,
- other violations.

Other violations can include, for example, violations within protection of the environment, culture, protection against alcoholism etc. [7].

2. Trend analysis of municipal police in the Slovak Republic

Municipalities meet the obligation to submit activities reports of the municipal police by the deadline in most cases. Ministry can thus draw up a comprehensive activities report of municipal police in the Slovak Republic, which provides an overview of the most important areas of activity of individual police for the year.

2.1. Fundamental analysis of municipal police activities

The number of municipal police is a key indicator. There was a slight increase in the numbers municipal police founded since the beginning of monitoring activities of municipal police in 2004, which is related to another indicator – the number of municipal police members. It is also a growing trend and in 2012 for the first time exceeded 2,500 members. Fig. 1 shows the trend of these indicators [3].

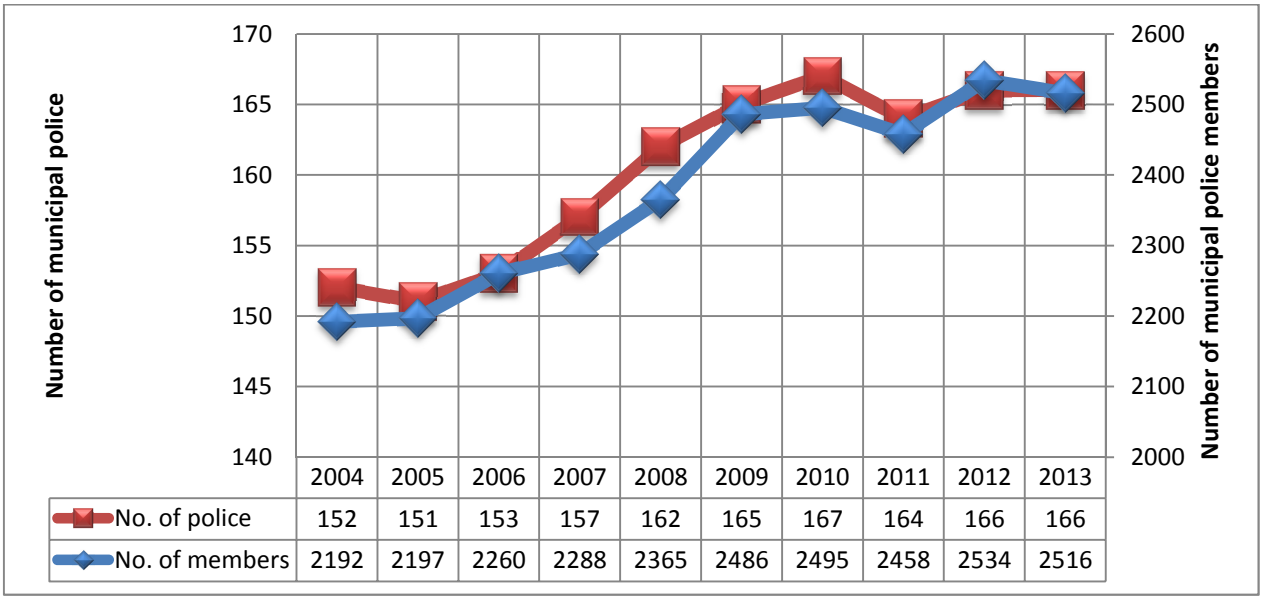

Fig. 1. The trends of numbers of municipal police and numbers of municipal police members

It can be concluded from the graph that on a number of municipal police and the number of members is strong correlation dependence. Harmonious growth of both indicators only undermines in 2011. There has been a reduction in the number of municipal police, but also a reduction in the number of members in 2011 [2]. It is seen that number of municipal police keeps the value of 166 and the number of members oscillates above 2500 in the last two years. Tab. 1 shows the trend of number of municipal police from regional point of view.

Region	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Number of police
BA	7	7	7	8	10	11	11	11	11	11	**73**
TN	17	17	17	18	18	18	18	18	18	18	**276**
TT	15	15	15	16	16	16	16	15	16	16	**251**
NT	37	36	36	36	36	37	38	38	39	39	**354**
ZA	18	18	19	20	21	21	21	22	21	21	**315**
BB	22	20	21	21	22	22	22	21	21	21	**516**
PO	20	21	17	20	21	22	22	21	22	22	**665**
KE	16	17	21	18	18	18	19	18	18	18	**440**

Tab. 1. The trend of number of municipal police in Slovak regions

An interesting fact is that 20 towns in Slovakia did not set up municipality police. The most towns (6) without municipal police were in Banska Bystrica region, while every town in the Žilina region had founded own municipality police. There was only one town without founded municipal police in Bratislava and Nitra regions two towns in in Trenčín region, three towns in Trnava and Košice regions and four towns in Prešov region.

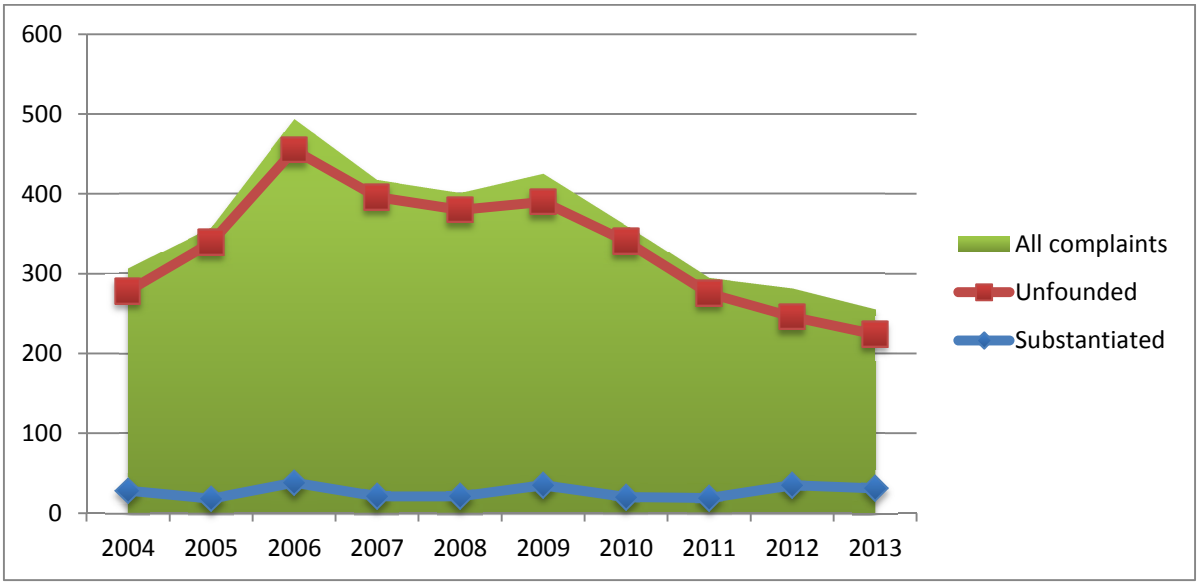

Fig. 2. Trend of complaints to members

Citizens are able to complaint about members of the municipal police. The number of complaints has a decreasing tendency. The most complaints about the work of members were recorded in 2006. Over 90 percent of complaints have been evaluated as unfounded by Department of supervision over the activities of the municipal police. Number of substantiated complaints oscillates around the value 27.

2.2. Activities in the field of investigation of violations

Detecting and investigating violations is the most important activity of municipal police. Recorded violations can be grouped according to whether they were identified by own activities of municipal police or have been notified to the municipal police department by citizens. On average, 85 percent of all violations were detected by own activities of municipality police while the remaining 15 percent were notified.

Municipality police can resolve violations by rebuking or awarding a fine. Fig. 2 shows the trend of violations recorded and trend of income from fines.

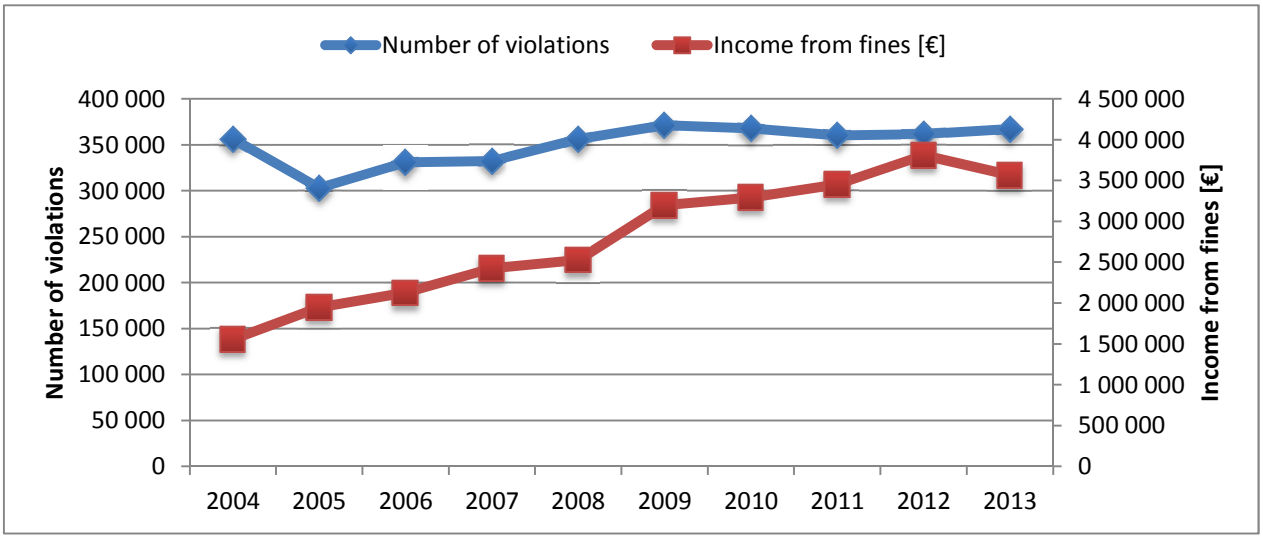

Fig. 2. Number of violations recorded and income from fines.

The only significant decrease in the number of violations was recorded in 2005. The number of violations against civic coexistence significantly decreased from 71,620 to 1,504 violations in comparison with the previous year. Funds obtained municipal police for fines increases every year

except for the last examined year. Traffic safety is priority for municipal police in view the structure of violations. Violations of this kind shall regularly almost 60 percent shares of all violations. Fig. 3 shows the average structure of violations recorded for all 10 years.

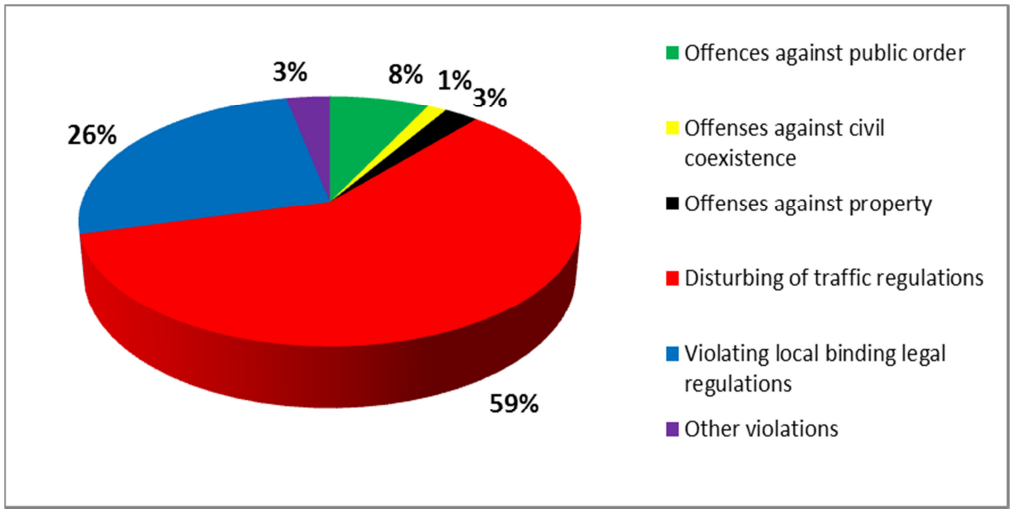

Fig. 3. The structure of violations from 2004 to 2013

A closer analysis shows that the structure of the violations for each year is stable and has not changed significantly. The exception is traffic violations, the number of which is from 2008 to 2010 increased by about 75,000 and has since held steady at around 250,000. Number of violations of local binding legal regulations fell from 141,000 in 2008 to 60,000 in 2011.

3. Conclusion

Economic, political, social and educational as well as the demographic situation affects the development of society. Security is one of the indicators of the quality of the society in which we live. Armed security forces as the Police corps of the Slovak Republic and Slovak Armed Forces supervise the external but also internal security of the State. Municipal police provide protection of persons and property on a regional basis.

The activities of municipal police are monitored by the Ministry of Interior. There exists obligation for municipalities with established municipality police to send a report of the activities of the police to Ministry since 2004. The report describes the activities of the various factors of the municipal police. Basic indicators are the number of members and the number and structure of violations recorded. The report also contains other information as description of prevention projects, the co-operation with other authorities, on used equipment and gear, tools and other important facts related to the activities of the municipal police.

The number of municipal police increased by 14 for 10 years with the result that security is an important factor for the municipality, since despite the economic crisis some municipalities have established municipality police. The number of members was also continuously rising. The number of members for the first time in history exceeded 2,500 members in 2012. Nevertheless, Slovakia is not able to achieve optimum state – one member per 1,000 inhabitants. To compare, the Czech Republic, there is one municipal policeman for 800 people in average [4].

The number and structure of violations can be considered as the second most important indicator. In view of the number of violations is seen a slight rising trend. Only the year 2005 marked the significant reduction in the total number of violations because of reducing violations against civil coexistence of 70 000 compared to 2004. Amount of funds rose from fines for violations continuously increased every year until 2013, when it first decreased. Traffic violations accounted for more than half of the recorded violations in view of structure. This may be related to

the fact that the highest income from fines flow to municipalities for such violations. Violations of general regulations of municipalities represent about 25 percent of all violations and other violations can distribute the remaining 15 percent.

In the future, it is necessary to reach the number of municipal police as well as the number of their members will increase and approach the optimal condition – one member for 1,000 inhabitants. It is also important to think about modifying statistical part of reports and to supplement it, for example, information about CCTV, ARC or the functioning of a sheltered workshop.

Acknowledgement

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Proposal of the Criteria for Identifying the Critical Rail Transportation Infrastructure

*Michal Titko
*University of Žilina, Faculty of Security Engineering, Department of Crisis Management, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Michal.Titko}@fbi.uniza.sk

Abstract. The critical transportation network is important to serve the national priorities such as economic sustainability and growth, but as well plays important role in disaster management and is subject to hazards. Choose adequate criteria for identification of the critical elements is important for the national security. In this work we focus on these criteria. We analyse existing criteria and propose new criteria and new critical limit values for potential elements of the critical infrastructure in the rail transportation. The proposed criteria are intended to be applied in real conditions of the rail transportation to identify the potential elements of the critical infrastructure.

Keywords: Identification of Critical Infrastructure, Rail Transportation, Sectoral and Cross-cutting criteria.

1. Introduction

The transportation network (TN) is important to serve the national priorities such as economic sustainability and growth, social development, providing security and public order, operational capability of the armed forces, it plays critical role in delivering disaster relief, or facilitating mass evacuations, etc. Some parts of the transportation network are more important than the others, resulting in identification of the notion of critical infrastructure (CI) – a subset of the transportation infrastructure that is of the particular importance and interest.

Elements of the rail TN or other systems can be considered as critical if their serviceability disruption or destruction can have a major impact on fulfilling the basic functions of state and its security. The identification of these elements is primarily based on the selected criteria. These criteria are divided into two groups: (1) sectoral and (2) cross-cutting criteria. Sectoral criteria identify significant elements within the chosen sector and cross-cutting criteria are the same for all sectors of CI. Both of them have determined critical limit values. To qualify the elements as critical infrastructure required to meet at least one of the sectoral criteria and at least one of the cross-cutting criteria.

In this work we propose criteria for identification of CI in the rail transportation, specifically on its linear parts (bridges, tunnels, railways). The passenger and cargo station as object elements will not be consider due to research focus. The proposal is based on proportion of the population of EU and the SR.

Establish relevant criteria for identifying CI elements required to implement a critical analysis of existing conditions. Based on the analysis of existing criteria is possible (1) to accept these criteria (or some of them), (2) accept them but modify limits values or (3) refuse existing criteria and then identify new ones. Subsequently are selected the relevant criteria and limit values for further work and can be identified the potential elements of the CI (PECI) in the rail transportation. The proposed criteria are intended to be applied in real conditions of the rail transportation.

2. Analysis of the existing criteria for identifying of the critical infrastructure

The criteria for the identifying elements of ECI were outlined in Directive [1] and were recommended for the member states of the European Union. Several states have implemented them into their CI protection systems but borderline values of criteria were determined by each state independently. Most of these limit values are subject of some classification level (except the Czech Republic (the CR), Hungary). Therefore are limit values not publicly available.

Under the Act of critical infrastructure [2] is identifying of the CI in the Slovak Republic (the SR) based on implementation of the sectoral and cross-cutting criteria. In order to make first selection of CI through CI sectors are first applied sectoral criteria. Subsequently, cross-cutting criteria are applied. Element of CI must meet at least one sectoral criterion and one cross-cutting criteria.

2.1. Cross-cutting criteria

First steps in the process of determining of CI in the SR were carried out in "Conception of CI and methods for its protection and defense in Slovak Republic". This conception was approved by Government Resolution [3]. Next step was adoption of the Act on critical infrastructure [2] by which were established the cross-cutting criteria relevant to all sectors. The criteria in this Act are different from the Concept and based on predefined criteria that were established by the EU [1]. By Act [2], cross-cutting criteria are set down by expected:

- casualties criterion (assessed in terms of the potential number of fatalities or injuries),
- economic effects criterion,
- public effects criterion.

Under the Act are not set borderlines for CI identification because they are subject to a degree of confidentiality. This fact creates a room for their own interpretation and determination. The existing borderlines of the criteria for CI of CR, for proposal in dissertation of Barčiaková [4] and for proposal of the Transport Research Institute (TRI) [5] are based on the Directive on the identification and designation of European CI [1]. Specific values are given in the tables 2, 3 a 4. The borderlines of these criteria are not justified. Therefore, was designed a common proportion proposal for borderlines calculation based on known values of the ECI borderline and population of EU and SR.

Casualties criterion

The borderline values for ECI identification (given in the table 2) according to the non-public part of the European Directive [1] which is interpreted in articles [4], [6] and [7]. These borderline values were established on 5000 injuries and 500 fatalities. In addition, at least 50% of these values must be in another state. It assumes transnational impact within at least two states. CR in Government regulation have set half of the values [8]. Hungary also adopted Government regulation [9], which states specifically borderline values for cross-cutting criteria. In the Slovak law there are not publicly known borderline values of any criteria.

Population of the CR is about two times higher than in the SR but the CR set 10 times higher levels (compared to Barčiaková and TRI). Significant differences are also between the Hungarian borderline values but these are divided by time exposure. Half ratio from ECI borderline value used by the CR says on the one hand that if this condition is fulfilled just in the CR and other injuries or fatalities in another state will not occur, it should be intended to be part of the CI. On the other hand, this value appears to be excessively high because such an impacts on the population may cause only few elements in CR and only when catastrophic scenarios are taken into account. The borderline values according to dissertation of Barčiaková and TRI are set at 5% compared to the European borderline value but this level is not justified.

The borderline values of the criteria can be determined based on the proportion of the population of the EU and the SR and the borderline values of cross-cutting criteria for ECI. To calculate these values information about the EU population (Table 1) are required [10] The average

population number in an EU states is about 18,01 million. Fulfilling the borderline value of criterion for ECI assumes two states with average population of 2*18,01 which is equal to 36,02 million residents. The borderline value for causalities criterion can be designed by a simple relation - the proportion of fatalities (injuries) for ECI and CI of the SR and the average number of residents in two EU states and population of the SR. The calculation is expressed by the formula (1) and (2), results are shown in table 2 as a proportional proposal.

Indicator for 2013	EU	EU average	the CR	the SR
Population [mil]	506,70	18,01	10,52	5,41
GDP [mld €]	13650,01	-	158,00	75,60

Tab. 1. Basic data on population and GDP of EU, the CR and the SR [10]

$$I_{SR} = \frac{I_{EU} * P_{SR}}{2 * AP_{EU}} \qquad (1) \qquad F_{SR} = \frac{F_{EU} * P_{SR}}{2 * AP_{EU}} \qquad (2)$$

where: AP_{EU} – the average population of the EU,
P_{SR} – the population of the SR,
I_{EU} – number of injuries for ECI,
I_{SR} – number of injuries for CI of the SR,
F_{EU} – number of fatalities for ECI,
F_{SR} – number of fatalities for CI of the SR.

CI in the given state		Injuries	Fatalities
ECI		5000	500
CI of the CR		2500	250
CI Hungary	within 24 hours	75	20
	within 72 hours	150	40
CI of the SR	Barčiaková	250	25
	TRI	250	25
	Proportional proposal	**750**	**75**

Tab. 2. Borderline values of casualties criterion for identification of ECI, CI of the CR and CI of the SR

Economic effects criterion

Economic effects criterion is assessed in terms of the significance of economic loss and/or degradation of products or services; including potential environmental effects. The borderlines values of this criterion for ECI, CI of the CR and CI of the SR are given in table 3. The values were calculated based on GDP in 2013 (table 1) [10].

Economic effects borderline value for identification of CI in the CR are identical with the borderline value criterion for identification of ECI (0,5% GDP). Compared to the level of 500 million € for ECI (what is alternative borderline value to 0,5% GDP) represents 0,5% of GDP for CR value 790 million €. For the SR it would be 378 million €. These are very high values and therefore the borderline value based on percentage of GDP does not seem appropriate.

Proposals from the dissertation of Barčiaková and TRI represents a proportion amount of 0,5% of the borderline value of 500 million €. None of the values is supported by deeper reasons and therefore it is possible to discuss if they have been defined properly.

For the calculation of the borderline value will be again used proportional proposal (3) under the borderline value of ECI and the population of the EU and the SR. In this case, not the average population in states of the EU but the total population of the EU is used because the criterion does not deal with transnational impacts.

$$EE_{SR} = \frac{EE_{EU} * P_{SR}}{P_{EU}} \qquad (3)$$

where: P_{EU} – the population of the EU,
P_{SR} – the population of the SR,
EE_{EU} – economic effects borderline value for ECI,

EE_{SR} – economic effects borderline value for CI of the SR.

CI in the given state		Borderline values of economic effects criterion		
		Share of GDP [%]	**Value [mil. €]**	**The financial expression of share of GDP [mil. €]**
ECI		0,5	500	GDP of given state
CI of the CR		0,5	-	790
CI of the SR	Barčiaková	-	2,5	-
	TRI	-	2,5	-
	Proportional proposal	-	5	-

Tab. 3. Borderline values of economic effects criterion for identification of ECI, CI of the CR and CI of the SR

Public effects criterion

Public effect is considered to be significant if there is a physical suffering or disruption of daily life of the population. This criterion includes within the transportation sector a number of passengers using the railway section. The borderline values for ECI, CI of the CR and CI of the SR are in the table 4. The proportional proposal is also included.

Compared to the borderline values established for ECI (250 000) CR set 50% of this value, Barčiaková [4] in her dissertation set 5% and TRI [5] set value 60 000. These borderline values also have not been more substantiated, although they are based on the ECI borderline value. The value of 12 500 appears to be very low, since the criterion should be suitable also for road transport. In the road transportation are reached significantly higher values of daily transport intensity. Therefore is proposed the borderline value (table 4) based on the population proportion of the EU and the SR (similarly to casualties criterion). The calculation was performed by formula (4).

$$PE_{SR} = \frac{PE_{EU} * P_{SR}}{2 * AP_{EU}} \quad (4)$$

where: AP_{EU} – the average population of the EU,
P_{SR} – the population of the SR,
PE_{EU} – public effects borderline value for ECI,
PE_{SR} – public effects borderline value for CI of the SR.

CI in the given state		Physical suffering	Disruption of daily life
ECI		250 000	250 000
CI of the CR		125 000	
CI of the SR	Barčiaková	12 500	12 500
	TRI	60 000	
	Proportional proposal	37 500	

Tab. 4. Borderline values of public effects criterion for identification of ECI, CI of the CR and CI of the SR

2.2. Sectoral criteria

The sectoral criteria are technical and functional criteria of the specific CI sector. Act on critical infrastructure of the SR [2] does not established specific sectoral criteria. Sectoral criteria were determined within the research project of the TRI (an initiative of Ministry of Transport, Construction and Regional Development). TRI provides a mechanism for identifying the CI in transportation (for road and railway transportation). Research addresses sectoral criteria of TN (important sections of the transportation network) and sectoral criteria of transportation elements (elements of the same function - bridges, tunnels, stations, etc.). In terms of the CR sectoral criteria are known as well as cross-cutting criteria. In this article are considered only the proposed criteria by TRI and the CR because there were not obtained other criteria and their borderline values. Based on the analysis were selected appropriate criteria for our proposal.

Sectoral criteria of TN

In the mentioned research project were established sectoral criteria of TN and sectoral criteria of elements. Sectoral criteria of TN were determined as follows [5]:

- impact on the mobility,

- impact on the economy,
- part of the TEN-T network,
- impact on transit transport,
- daily average traffic intensity by railway category.

Among CI in railway transportation in terms of the CR would belong (1) national railways which serve to the international and national purpose (part of the European railway system) and (2) operational systems and systems of organization of rail traffic in relation to the European railway network (central, regional and local dispatching center [8].

Criterion impact on mobility is not expressed by the borderline value. It examines if the connection of lower levels centers (smaller cities) with higher levels centers (big cities) is provided. Some railway sections provide only cargo transport and therefore they have no impact on the mobility. The impact on mobility is widely based criterion. All railway sections provide a certain level of mobility, therefore, for our proposal will not be considered.

Similarly, the criterion impact on economy discusses the significance of the railway sections which ensure the availability of industrial parks and intermodal transport terminals for cargo transportation. In the proposal of the criteria is this criterion not considered because there are always possibilities to deliver cargo by the other type of transportation (mainly road transportation).

Important factor for our proposal is the criterion "part of the international corridors of the European TEN-T". The importance of these corridors is stressed by national cargo transportation but mainly by using those corridors in international level and for transit transportation. This criterion considered also the CR as one of the determined criterion deals with the international transportation.

Criterion impact on transit transportation appears to be redundant, taking into account the fact that transit transportaiton is composed by three international railway corridors that are included in the criterion "part of the TEN-T". In terms of CI appear other railway sections of transit transportation to be less significant, so it’s not necessary to consider these section and also this criterion.

The average daily traffic volume is very important in the context of the proposed criteria but the borderline value will be determined only on the daily intensities basis of railway sections that are related to the part of the TEN-T corridors, not by individual categories of railway sections as was proposed by TRI.

Sectoral criteria of transportation elements

For purpose of this article are in terms of sectoral criteria of transportation elements important only sectoral criteria relating to the railway bridges and tunnels.

For railway bridges was determined criterion “bridge length” and borderline value was determined to 250 m [5]. The value 250 m takes into account the assumption that the railway bridge of which length will not exceed this value will in case of destruction temporarily recovered by a steel truss separable bridge type ŽM 16 - 1p2s (composed of three fields of 64 m and 58 m box). In the case of bridge which exceed borderline value is not considered to be temporarily restored but will be build new one (estimated duration is longer than one year). This criterion is relevant for our proposal and will be considered in the identification of the critical elements of railway TN.

For a railway tunnels is the basic characteristic “length of the tunnel tube”. By TRI [5] was determined borderline value for this criterion at 1000 m. The railway tunnels which length does not exceed 1000 m, can be restored in such a time period during which there will be no considerable economic losses. For our purpose will be this criterion taken into account but this borderline value is questionable because TRI does not consider some aspects such as structure of the subsoil, rock type, etc.

3. Proposal of the criteria for the identification of the critical rail transportation elements

After evaluating the existing sectoral criteria and taking own reflections into account were determined criteria and borderline values for identification of CI elements (table 5).

Sectoral criterion	Specifications / Value	Potential CI element
Significance	The railway section is not part of the TEN-T or is not classified as 1. category railway section	NO
	The railway section is part of the TEN-T or is classified as 1. category railway section	YES
Performance	< then average performance of passenger or cargo transportation on specific railway section	NO
	≥ then average performance of passenger or cargo transportation on specific railway section	YES
Bridge length	< 250	NO
	≥ 250	YES
Tunel length	< 1000	NO
	≥ 1000	YES

Tab. 5. Borderline values of sectorial criteria for CI identification

After evaluating the existing cross-cutting criteria and calculating were determined borderline values for identification of CI elements (table 6).

Cross-cutting criterion	Value	Potencial CI element
Fatalities	< 75	NO
	≥ 75	YES
Injuries	< 750	NO
	≥ 750	YES
Economic effect	< 5 mil.	NO
	≥ 5 mil.	YES
Public effect	< 37 500	NO
	≥ 37 500	YES

Tab. 6. Borderline values of cross-cutting criteria for CI identification

4. Conclusion

There is no common methodology for the implementation of cross-cutting and sectoral criteria, together with the determination of the borderline values. Therefore each member state of EU determines CI differently. The actual criteria give a lot of space to own interpretation and there is not clearly established their content. In the article were analyzed existing criteria and their proposals. Just few criteria or borderline values was appropriately explains and therefore their accuracy is uncertain. From this reason have been selected and proposed new criteria and their borderline values. As discussed, the proposed criteria are intended to be applied for identification process of critical infrastructure elements in rail transportation and this is our intention to do so.

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Fire Characteristic of PVC Flooring by Results of Tests on a Cone Calorimeter

[*] Juraj Vácval, [**] Jana Müllerová
[*] University of Žilina, Faculty of Security Engineering, Department of Fire Engineering, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Juraj.Vacval}@fbi.uniza.sk
[**] University of Žilina, Faculty of Security Engineering, Department of Fire Engineering, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Jana.Mullerova}@fbi.uniza.sk

Abstract. The theme of this article is to establish a fire characteristic of the selected material using a data obtained from tests performed on a cone calorimeter. For this purpose, is on a cone calorimeter tested specimen of PVC flooring, which description is made in the first part of this article. The second part is already working with the test results. This part shows the resulting table that lists all the measured parameters and their values. The end of article is devoted to a fire characteristic of the floor using the major parameter - the heat release rate during the test.

Keywords: Cone calorimeter, heat release rate, PVC flooring, fire safety.

1. Introduction

Cone calorimeter is a device that can detect a many parameters of tested material. Main parameter, the heat release rate is definitely best to characterize the combustion of any material. Testing of materials but brings many questions, that must be solved. One of them is the treatment of the material, because although with the calorimeter can be tested, so to speak, any type of material, but naturally flat products represent the most typical example and in terms of representativeness and the comparability of the results the best variant. Use flooring for testing for purposes of this article is therefore simple solution to this question. Another question is the data collection during the test. On the one side, there is the table of measured parameters with those values (some with time of their maximum reach) and the other side represents the continuous data collection at specified intervals. Result of a continuous data collections is XY graph, which showing the evolution of the parameters over the test. Comparing both methods can solve the problems of good characterization of each tested material.

2. Tested material

To characterize the behavior of the material was chosen PVC flooring, which is a product of Slovenian company Juteks, d. o. o., focusing its activities exclusively to the production of PVC floor. Tested flooring was called Actual Plus. This model is designed to use in accommodation spaces, with an average load such as living room, dining room or interior hallway. Total thickness of this model is 2.8 mm and sub-layer floor has a foam structure, that this floor is soft and very flexible. The manufacturer also declares the suitability of the premises with underfloor heating [1,2].

3. Test conditions

Test was carried out according to ISO 5660-1 on a cone calorimeter, belonging to the Institute of safety, environment and quality. This institute falls under the Department of Industrial Safety

Materials Science STU based in Trnava. Basic data about the specimen, the default setting of the calorimeter and the surrounding atmospheric conditions at the time of the test are mentioned in Table 1.

informations about the specimen	
exposed surface area	88,4 cm^2
distance from emitter	2,5 cm
orientation	horizontal
calorimeter settings	
heat flux of cone emitter	30 $kW.m^{-2}$
flow rate in duct	24 $l.s^{-1}$
calibration constant C	0,04215
duct diameter	11,4 cm
delay from analyzer O_2	15 s
delay from analyzer CO_2	15 s
delay from analyzer CO	15 s
atmospheric conditions	
O_2 concentration	20,951 %
CO_2 concentration	0,066 %
temperature	22 ºC
pressure	99,26 kPa
relative humidity	50 %

Tab. 1. Information about the specimen and test conditions

4. Test results

The test results are summarized in Table 2 and Table 3. Table gives the values of monitored parameters, together with their units, possibly with time to achieve value during the test. Evaluation of the test results follows the Table 2 and Table 3.

informations about specimen	**parameter**	**unit**	**value**	
	thickness	mm	2,8	
	start mass	g	13,85	
test times	time to igniton	s	15	
	time of non-flame combustion	s	195	
	end of test	s	300	
	70% mass lost	s	80	
maximum values of parameters	**parameter**	**unit**	**value**	**in [s]**
	heat release rate	$kW.m^{-2}$	173,612	70
	heat of combustion	$MJ.kg^{-1}$	39,856	105
	mass lost rate	$g.s^{-1}$	0,1167	55
	specific extinction area	$m^2.kg^{-1}$	1736,2	85
	CO yield	$kg.kg^{-1}$	3,1437	240
	CO_2 yield	$kg.kg^{-1}$	43,0096	240

Tab. 2 Test results part 1

test results	parameter	unit	value (in 15 s - 300 s)
	total release heat	$MJ.m^{-2}$	14,204
	total oxygen consumption	g	9,2903
	average heat release rate	$kW.m^{-2}$	49,8392
	average heat of combustion	$MJ.kg^{-1}$	14,9523
	average mass lost rate	$g.s^{-1}$	0,02911
	average specific mass lost rate	$g.s^{-1}.m^{-2}$	7,9997
	total mass lost	g	8,3977
	average specific extinction area	$m^2.kg^{-1}$	641,654
	average CO yield	$kg.kg^{-1}$	0,04488
	average CO_2 yield	$kg.kg^{-1}$	1,10101
	total smoke volume	$m^2.m^{-2}$	610,345
	total smoke production	m^2	5,39544

Tab.3 Test results part 2

Data in Table 2 and Table 3 shows that a many parameters of the tested material can by determined using a cone calorimeter. Data can be excellently used to compare with the results of tests another materials but each value as given in the table not to have a high information value. Much more important is the monitoring of the development parameters in intervals and their transformation into the XY graph.

5. Characteristic by heat release rate

As mentioned above, although the data in Table 2 and Table 3 represent the great source of information for the comparison with other materials, do not provide a sufficient picture of the development of combustion flooring during the test. For this purpose allows the cone calorimeter continuous collection of values measured parameters. With this data can observe the development of the monitoring parameters to determine the fire behavior of flooring during the test. Best parameter, which can thus be used, is the heat release rate. It is a basic variable which is determined by cone calorimeter. Following chart is compiled by data heat release rate for flooring Actual plus is shown in image 1. Characteristic of this flooring using this chart is made under Figure.

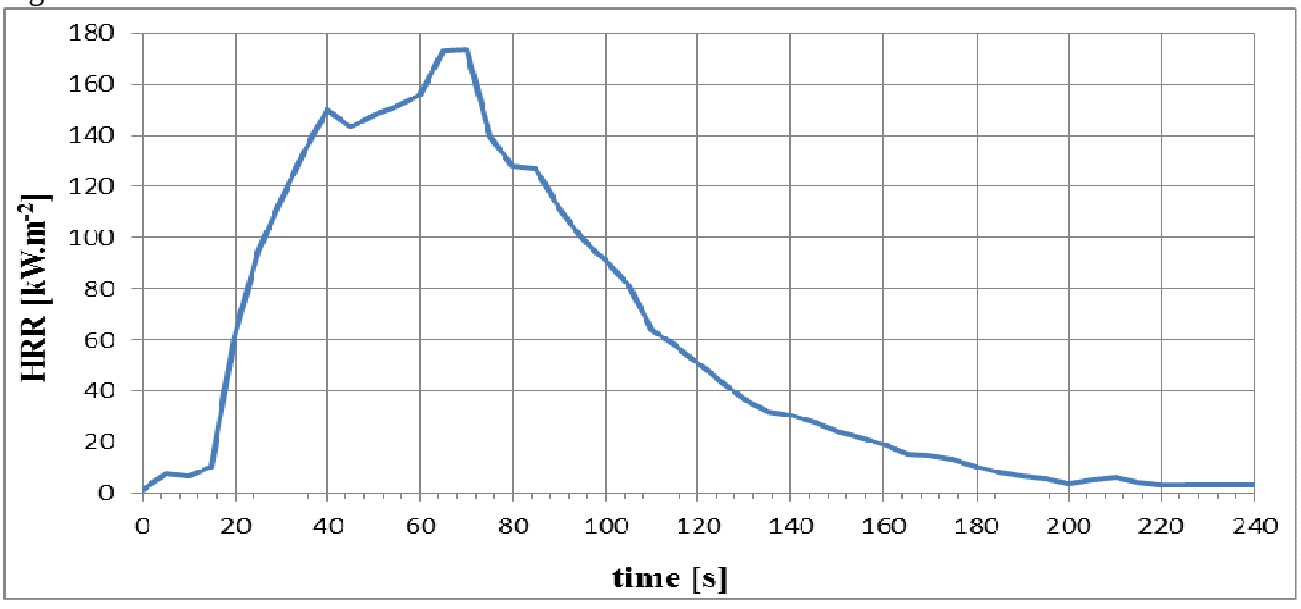

Fig. 1. Development of heat release rate for Actual Plus

On the curve of heat release rate can be seen that at the beginning tested material absorbs heat radiation from the emitter and the surface of specimen is gradually begin emit flammable gases. This can be seen in the relatively slow increase heat release rate at the beginning of the graph. In the 15-second test is release of flammable substances sufficient to form a flammable concentration and occurs to ignition and flame combustion, which are characterized by a sharp rise in velocity on the graph. In 20th second of test can be observed very little curvature nearly linear part of the curve. At this point there has burned a upper layer and now is exposed decorative layer. Rate even further increases until reaching its first peak in the 40th second, followed by a brief decline. This decline causes a burned decorative layer and uncovering layers of impregnated glass paper, which for a short time limit relatively quick combustion of another flooring layers. Overcoming this layer is revealed the main part of the flooring, which burns very well, as can be seen in the re-increasing rate. In 65th second curve is approaching its second peak and the rate is for a five seconds almost constant. In 70th second, rate reaches the highest value of the test. At this point, the greater part of combustible material burned, occurs because a gradual decrease in rate and burning in 195th second passes into phase with flameless steadily. The heat release rate is gradually lowered until the end of the test.

6. Conclusion

Based on the tests results listed in the table and graph evolution heat release rate can be argued that for good characteristic behavior of the material (in this case, flooring) is continuous data collection and subsequent processing of the graph is very useful. However must be noted that the correct characterization is needed more than just a description of the graph. It is necessary to know the composition of the material, its physical and chemical properties and of course follow visual signs of combustion material during the test. On the other hand, table of tests result provides only fraction of information from the test. But it can be well used when comparing large amounts of materials. In the end, therefore, it can be argued that the detailed and correct characterization is also needed development graph and table with the results, however, need not forget the overall knowledge of the material.

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Comparison of the Temperature Profiles in Prototype and Small - scales of the Fire

* Ľubica Vráblová, **Jana Müllerová
* University of Žilina, Faculty of Security Engineering, Department of Fire Engineering, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Lubica.Vrablova}@fbi.uniza.sk
** University of Žilina, Faculty of Security Engineering, Department of Fire Engineering, Ul. 1. mája 32, 01026 Žilina, Slovakia, {Jana.Mullerova}@fbi.uniza.sk

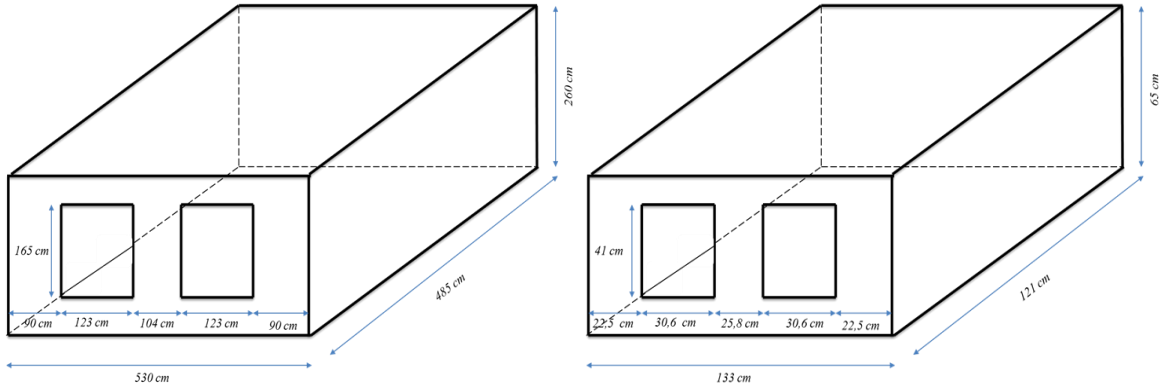
Abstract. The paper deals with fire tests made in a scale small-scale model of the object. Model construction is briefly described the through reducing the incremental method utilized for fire modeling. Fire packages of pine wood were used within the experiment as a fuel source. Selected measurement temperature results of original objects and models are compared.

Keywords: Temperature, small – scale model, original object - prototype.

1. Introduction

1.1. Fire scale modeling

Model of the fire compartment was geometrically reduced to ¼ dimensional original object object. The original object object [2] made of brick walls closest to their properties scaled-¼ match mineral wool 5 cm thick. Original object dimensions 530 x 485 x 260 cm were reduced to 133 x 212 x 65 cm.



A) Original object B) Model

Fig. 1. The figure caption is of the style Description; the figure itself is of the style Figure.

1.2. Wall insulation material

The inner walls of the model were covered with mineral wool 5 cm thick. The material was found out thanks to fundamental relations of scaling (Table 1). During the tests, the material was exposed directly to the hot gases. Mineral wool was fixed to 1.25 cm thick plasterboard embedded in the metal frame (0.3 cm thick and 3 cm wide). With the help of glue for thermal insulation systems was sealed mineral wool to drywall. Closing of outer walls was carried out by screws placed in 15 cm intervals.

Type	Dimensional scale group
Time (s)	$\frac{t_M}{t_p} = (s_M/s_p)^{1/2}$
Temperature (°C)	$\frac{T_p}{T_M} = 1$
Pressure (Pa)	$\frac{P_M}{P_p} = (s_p/s_M)^1$
Thermal inertia	$(k\rho c)_{s,M}/(k\rho c)_{s,p} \propto (s_M/s_p)^{3/2}$
Thickness	$(k/\delta)_{s,M}/(k/\delta)_{s,p} \propto (s_M/s_p)^{1/2}$

Tab.1 List of correlation scales for models [4]

1.3. Fuel source

The only source of fuel for the fire test was a wood logs placed inside the closed space. The weight of a package was 3.48 kg. The wood used for lumber represented pine wood with 15% humidity. The total weight was 20.88 kg of lumbers within the model, representing at full dimension fire load of 30 kg.m-2 of floor space. Packages were distributed into 6 boundaries, creating the streets, where the wood wool was added 0.30 kg (weight ratio of cotton and wood chips in a ratio of 1:70) (Fig.2). Initiation of Fire was performed by electrically ignited 0.030 liters of alcohol. With emphasis on safety, fire initiation was carried out with the assistance of a firefighter.

Fig.2. Fire wood pack and its placement during the experiment

1.4. Temperature measurement and hardware

Temperature measurements were made of thermocouple and compensating cable connected to the control panel ALMEMO 5690-1. Registration of temperatures was carried out in 10-second intervals. Thermocouples have been placed in three vertical planes (vertical dimension) inside the compartment, and 10 cm from floor level A; 32.5 cm from the floor, the plane B; 1 cm below the ceiling plane C (Fig. 3).

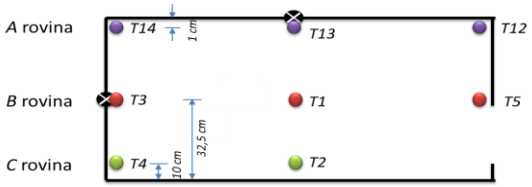


Fig.3. Location and marking of thermocouples

2. Comparing of thermo profiles of original and model

Fire test was carried out at High School of Fire Protection Ministry of Interior, Zilina (Stredná škola požiarnej ochrany MV SR v Žiline).

Test ID.	Date of measurement	Fuel Weight [kg]	Wind direction	Wind velocity [m.s^{-1}]	Ambient temperature [°C]
D/30	23/1/2014	20,88 + (0,30)*	SSZ	0...5	- 1,7

Tab. 2 Test description

2.1. Comparing of thermocouple installed inside the tested space

Fire test with fire load of 30 kg. m^{-2} on the floor space was realized as an input test of the accuracy of the compilation of the object model geometrically reduced to 1/4 and at the same time the application of area scale parameter s1/4.

The following graphs show the measured gas temperature inside the building. They compare test results with the same fuel (bales of pine wood with 15% moisture content) and the same amount of fuel. The curves 1 and 2 capture the mean of the temperatures in the planes A, B, C, curve 1 shows the experimental temperature gas fire determined as the average temperature in the horizontal plane and the (1 cm from the top), B (32.5 cm from the floor), C (10 cm from the floor). Curve 2 shows the temperature in the horizontal plane just below the ceiling structure (1cm).

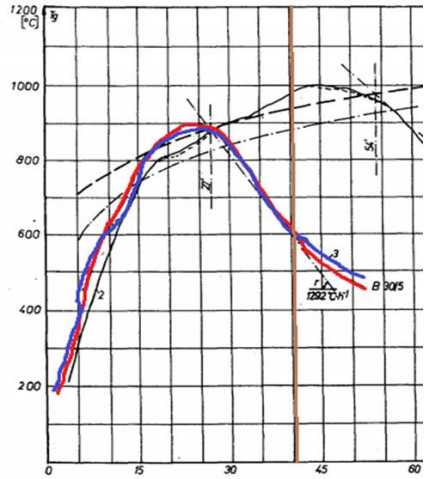


Fig.4. Average temperatures of object original object

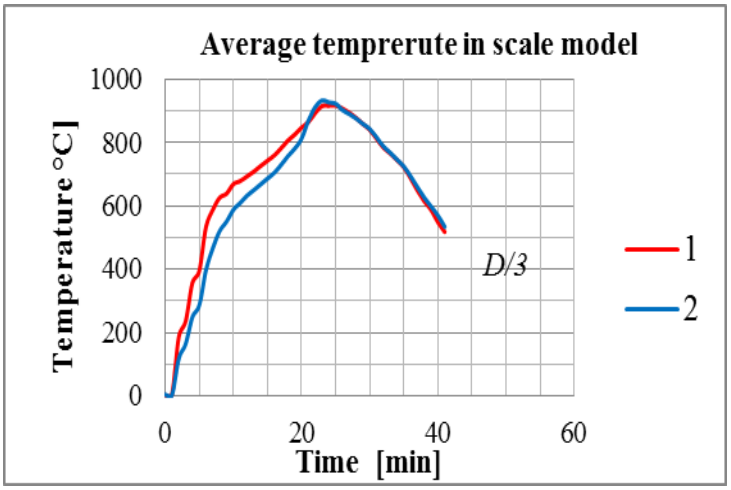


Fig.5. Average temperatures of model

We have made a comparison of the average internal temperature within the area of the measured full-scale (according to the curve of Temperature, Fig.4) and the model (curve 1, Fig.5) at a time of 5 min, 10 min, 15 min, 20 min, 25 min, 30 min, 35 min and 40 min. In the model, of course, the time was adjusted according the time scale.

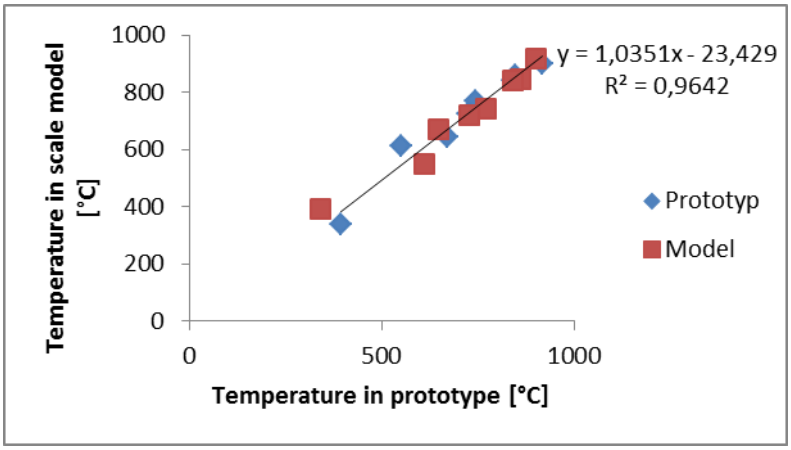


Fig. 6 Temperatures inside the space full scale original vs model

Figure 6 shows a comparison of internal average temperatures measured in a full-scale and in the model. Obviously, it turns very good correlation between full-scale object and the model. Figure 7 shows a comparison of the average ceiling gas temperature in a full-scale model. Although, it is shown that the internal temperatures of gas under the ceiling of the model are somewhat lower, at certain positions, is a very good correlation between the measured temperatures.

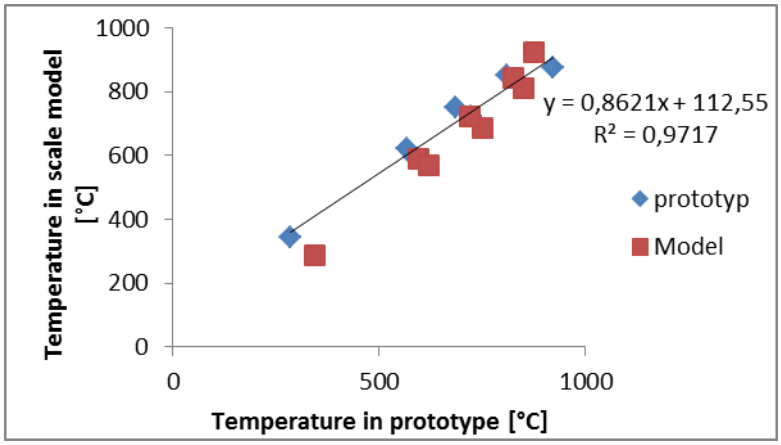


Fig.7 Temperature in space full scale vs. model

3. Conclusion

In case of fire modeling in a small scale, the entry test was necessary to find out the accuracy of the application of the laws of reducing on selected object. Fire test shows that the proposed method of reducing a confined space is useful for continuous fire tests. Scale of internal temperatures of small fire works well. The peak temperature of the ceiling gas measured at the inlet fire test shows good coincidence with the object original object. Time of various phases of fire embedded in the real fire shows high similarity between model and the original object.

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Experimental Measurement of the Blast Effect to the Windows System

[*]Zuzana Zvaková, **Lucia Figuli,
[*]University of Žilina, Faculty of Security Engineering, Department of Security Management, Ul. 1 mája 32, 01026 Žilina, Slovakia, {Zuzana.Zvakova}@fbi.uniza.sk
[**] University of Žilina, Faculty of Security Engineering, Department of Technical Science and Informatics, Ul. 1 mája 32, 01026 Žilina, Slovakia, {Lucia.Figuli}@fbi.uniza.sk

Abstract. The paper is focused on the problematics of windows system blast resistance field test. Blast resistance remains a top priority for last years with the increment of such terrorist attacks. The most destructive character of the all explosion effects has the blast wave. Fenestrations and mainly windows are not designed for such load for the high pressure. Windows systems are subjected to the blast load. The aim of the presented paper is the description of such field test, its course, aggrieved standards and codes.

Keywords: Fenestration, windows system, blast load, field test.

1. Introduction

Nowadays terrorism is one of the gravest problems and it is a real threat to states and peoples safety. The incidents happen not only at world's battlefields of Iraq and Afghanistan but also in centres of developed countries. The attacks of Madrid, Moscow, London, Oslo or recently of Boston had many innocent victims.

Blast resistance remains a top priority for last years with the increment of terrorist attacks using improvised explosive devices. During any blast-type event, building can be damaged or collapsed and building occupants can be injured or killed. There are various situations of loadings possible. The direct exposure to blast loading (pressure or shock waves), the impact of fragments and debris, impact with surroundings when either a structural element or person is impelled by the blast waves, or structural collapse.

The most vulnerable part of the building is fenestration (windows, doors, skylights) and glass façade systems due to the fact that normally fenestration is not designed as load bearing element and if it there is not an explicit requirement they are not design for carrying such for such extreme pressure (how the blast load is).

Our research is focused on the blast resistance comparison of old wooden windows and new plastic windows used for office buildings. We are presenting the setup characteristic for prepared open air experimental testing of such windows system.

2. Blast load

The source for the blast load is the detonation of the explosive. The real detonation of a spherical charge runs in such way that the detonation wave extends from the centre of the charge in all directions. Its front strikes against the surrounding environment at the charge brim. From this point the blast wave extends and after the gas explosions the reflected one is distributed. The effect of the blast wave depends mainly on the sort of detonation a stand off distance. The blast wave rapidly increases to a value of pressure above the ambient atmospheric pressure (positive phase). After a short time, the pressure may drop below the ambient pressure. This phase is called a negative phase.

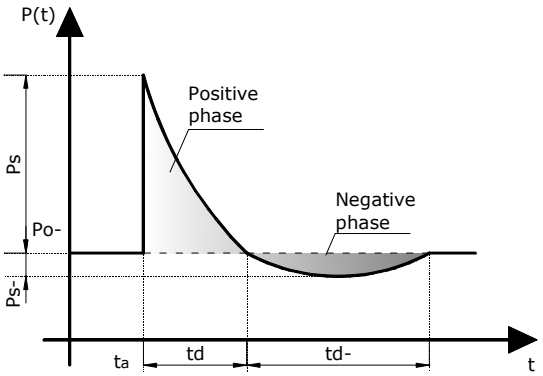

Fig. 1 Time profile of the blast wave where:

t is the time after the pressure wave arrival
P_s is the peak pressure
P_0 is the ambient pressure
t_d^+ is the duration time in the positive phase
t_d^- is the duration time in the negative phase

The real form of blast wave is approximated with the regular shape with one peak and then it drops below the ambient pressure. The peak pressure of the blast is dependent on the charge weight.

3. Windows system

3.1. Criteria for the design of blast-resistant fenestration system

The basic criteria for the design of blast-resistant or blast mitigating fenestration systems are that the glass should remain intact and in the frame, broken but not blown out; the frame must stay attached to the wall; and the wall must remain intact to hold the frame. Protective glazing measures would also be appropriate for buildings that are located near high-risk targets, even though the buildings themselves are not considered a target [1].

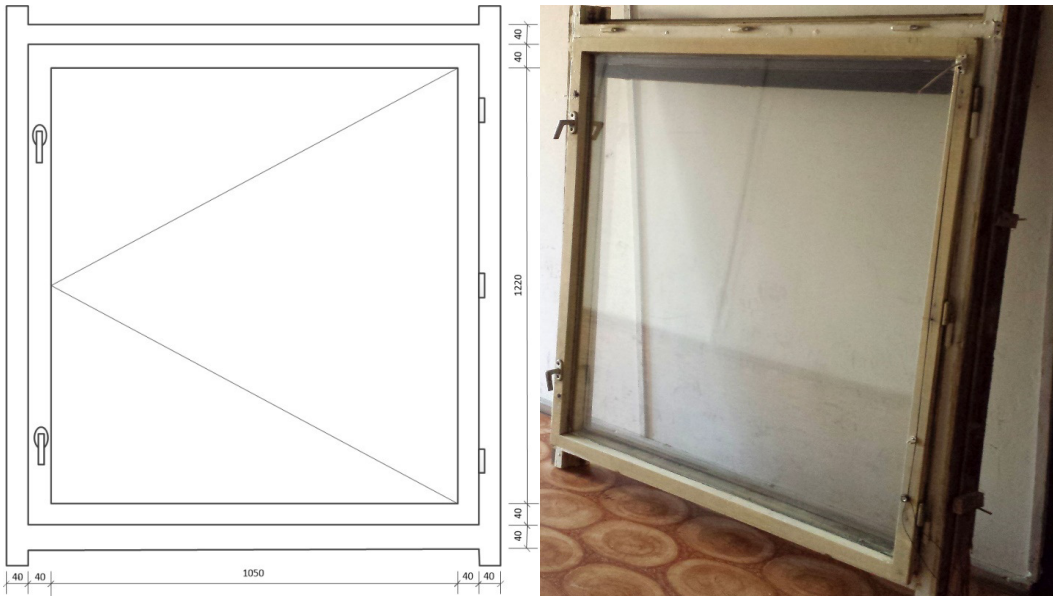

Fig. 2:.*Dimension of analysed window*

3.2. Description and mechanical characteristics

Old wooden windows in the comparison with new plastic windows were chosen for the testing. Both windows systems have same dimensions. The sizes of whole windows is 1210 x 1380 mm and the glass plate width is 1050 mm and height is 1120 mm. Glassing is plain plate glass. The age of

wooden windows is 51 years and the thickness of glass plate is 3 mm. The wooden windows system is an old uniform system of windows used in former Czechoslovakia in 1960s.

4. Field test

4.1. Standard and code background

There are any codes for the standards for the certification and classification of the security windows against the explosion

STN EN 13541- Glass in building. Security glazing. Testing and classification of resistance against explosion pressure. The technical code governs the test and the classification of the security glazing resistance in building against explosion pressure. The classification of the blast resistance is based on the maximal pressure of the blast wave created in explosion and the time of the positive phase blast wave. The requirements of the test sample and the description of the tests are characterised by the technical code. All required equipment (shock tube, equipment for the measurement, the carrier of test sample are described there. Classification of glazing is divided into four group according to maximal overpressure (50 to 250 kPa) and positive impulse (370 to 3250 kPa*ms). Positive phase duration has to be ≥20 ms [2].

Classification class	Blast wave characteristic		
	Maximal overpressure (kPa)	Positive impulse (kPa*ms)	Positive phase duration (ms)
ER 1	<50,100)	<370,900)	≥20
ER 2	<100,150)	<900,1500)	≥20
ER 3	<150,200)	<1500,2200)	≥20
ER 4	<200,250)	<2200,3250)	≥20

Tab. 1. Classification classes according to STN EN 13541 [2]

STN EN 13123 – 1 Windows, doors and shutters - Explosion resistance - Requirements and classification. Part 1 is focused on the test using a shock tube. Four classes are set according to maximal overpressure (0,50 – 2,00 bar) and specific positive impulse. Positive phase duration has to be ≥20 ms.

Blast wave characteristic		
Classification class	Maximal overpressure (bar[a])	Positive impulse (bar-ms)
EPR1	0,50	3,7
EPR2	1,00	9,0
EPR3	1,50	15,0
EPR4	2,00	22,0

Tab. 2. Classification classes according to STN EN 13123-1 [3]

The standards describes mathematical relationships for maximal overpressure of blast wave, positive impulse, the positive phase duration and there is the description of test conditions, methodology and required equipment for such testing [3].

STN EN 13123 – 2 Windows, doors, and shutters - Explosion resistance - Requirements and classification. Part 2 is dedicated to the Range testing. Classification group are based according to the test samples resistance. Description of explosive is described in the Standard appendix „A" of the STN EN 13124-2 [4].

Classification class	Explosion weight (kg)	Distance (m)
EXR1	3	5,0
EXR2	3	3,0
EXR3	12	5,5
EXR4	12	4,0
EXR5	20	4,0

Tab. 3. Classification classes according to STN EN 13123-2 [4]

Test method for the testing using a shock tube and for range tests is described in:

STN EN 13124-1 Windows, doors and shutters - Explosion resistance - Test method. Part 1: Shock tube.

STN EN 13124-2 Windows, doors and shutters - Explosion resistance - Test method - Part 2: Range test

Classification class	Explosion weight (kg)	Distance (m)	Position of explosives
EXR1	3	5	500±50
EXR2	3	3	500±50
EXR3	12	5,5	500±50
EXR4	12	4	500±50
EXR5	20	4	500±50

Tab. 4. Classification classes according to STN EN 13124-2 [5]

Above mentioned standards works with the explosives called Trinitrotoluene (TNT). The basic raw material for the production is toluene. The most preferred form in terms of transport, storage and use of TNT is the form of flakes. Trinitrotoluene crystallized in the form of pale yellow crystals, its melting point in pure form is 80.7 °C. Trinitrotoluene is insoluble in the water and soluble in organic solvents, particularly in acetone. It get brown in the light, which is accompanied by a small increment of sensitivity, it is neutral and does not react with metals, but it reacts with the bases and oxides of alkaline metals. The stability of trinitrotoluene is not influenced by the humidity. It is not very sensitive to mechanical impact. Trinitrotoluene is little toxic and does not attack the skin [6].

The explosive has to be formed in the shape of a sphere, be placed and be fired according to the standard during the test. There are allowed an alternative sources of explosion, but only if can be shown their equivalent effect. Test distance (3 – 5.5 m from source of explosion and test sample) and weight of explosive (3 – 20 kg) is set for each classification group.

In the USA there are two technical standards regulating of windows blast.

GSA-TS01-2003 - US General Services Administration Test Standard. This test standard ensure an adequate measure of standardization and quality assurance in the testing of window systems including but not limited to glazing, sealants, seats and seals, frames, anchorages and all attachments and/or secondary catcher or restraint mechanisms designed to mitigate the hazards from flying glass and debris [7].

Performance Condition	Protection Level	Hazard Level	Description of Window Glazing Response
1	Safe	None	Glazing does not break. No visible damage to glazing or frame.
2	Very High	None	Glazing cracks but is retained by the frame. Dusting or very small fragments near sill or on floor acceptable.
3a	High	Very Low	Glazing cracks. Fragments enter space and land on floor no further than 3.3 ft. from the window.
3b	High	Low	Glazing cracks. Fragments enter space and land on floor no further than 10 ft. from the window.
4	Medium	Medium	Glazing cracks. Fragments enter space and land on floor and impact a vertical witness panel at a distance of no more than 10 ft. from the window at a height no greater than 2 ft. above the floor.
5	Low	High	Glazing cracks and window system fails catastrophically. Fragments enter space impacting a vertical witness panel at a distance of no more than 10 ft. from the window at a height greater than 2 ft. above the floor.

Tab. 5. Categorisation according to GSA-TS01-2003 [7]

Protection and related hazard levels are categorized as a performance condition as indicated in Table 5. These conditions are determined based upon the posttest location of fragments and debris relative to the original (pre-test) location of the window.

ASTM 1642 – 1604 - ASTM Testing standard.

The test method provides a structured procedure to establish the hazard rating of glazing and glazing systems subjected to a blast loading. Knowing the hazard rating provides the ability to assess the risk of personal injury and facility damage. The hazard rating for a glazing or glazing material does not imply that a single specimen will resist the specific blast for which it is rated with a probability of 1.0. The probability that a single glazing or glazing construction specimen will resist the specific blast for which it is rated increases proportionally with the number of test specimens that successfully resist the given level of blast to the hazard level for which it is rated.

Standards regulating the resistance of so called mechanical barriers are focused on the windows only. There is a lack of standards regulated resistance classification and test methodologies of other type of barriers as a part of building protection system.

5. Methodology of windows resistance field test

Before the field test, preliminary analysis have to be done. Such analysis was done for the testing windows system [8].

Structure for windows system fixation has to be similar as a real one. As a charge will be used an ANFO explosive with the spherical shape for an equal distribution of blast wave.

These properties have to be measured during the field test:

- Air temperature,
- Air pressure ,
- Wind velocity and direction,
- Sample surface temperature ,
- Pressure behaviour of blast wave with the maximal overpressure ,
- Duration of positive and negative phases,
- Strains and dynamical displacement.

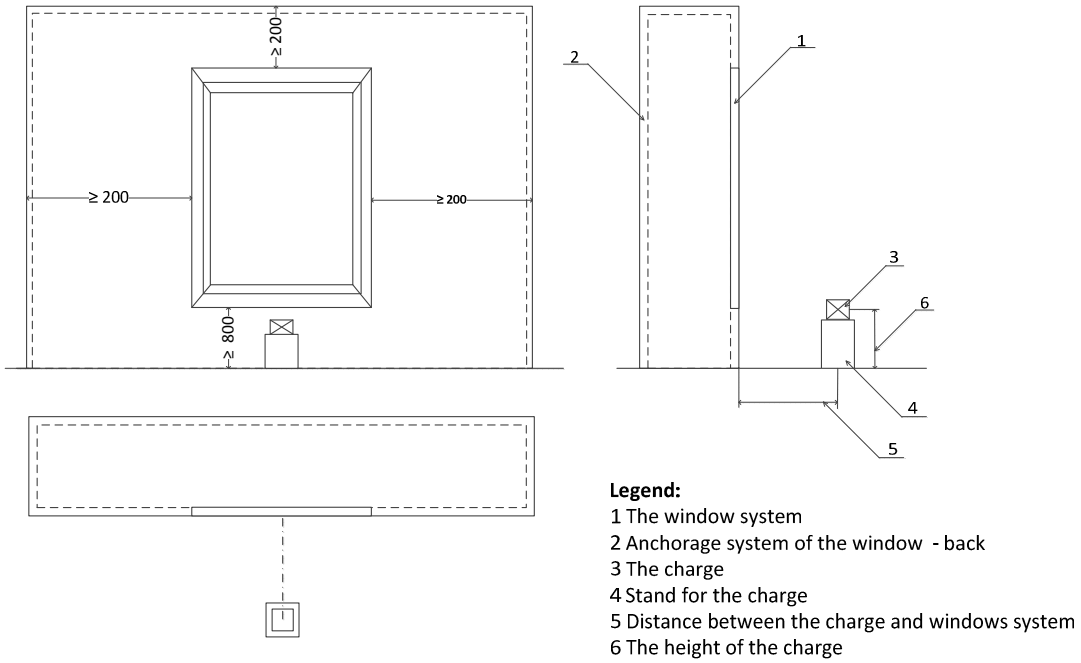

Fig. 3:.Arrangement of the elements during the test according [5]

The field tests are recorded using high-speed camera. Test field is composed from different steps:

1. To space the test sample and the carrier of explosive out. To space measurement equipment out.
2. To control the fixation of window system, explosive position and the setting of measurement equipment
3. To initiates the explosive, to record the relevant characteristic of the blast wave and other parameters
4. To record environmental condition 30 minutes after the test.

6. Conclusion

The research of breakthrough resistance using of blast load is very requisite due to the global security situation.

Fenestration and building façades are not designed as load bearing elements and if it there is not an explicit requirement they are not design for carrying such bearing – blast load. Modern architecture is based on pure and smooth design, airy looked buildings with the slim glass façade. This conception is very popular last years and huge amount of people reside there (airports, train and bus stations, banks, shopping centres etc.) The paper presents the background for the field test of windows structures loaded by blast. The aim of the test is to obtain the blast resistance of wooden and plastic normally used windows. Authors would focused their research on the glass façade system in the future.

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