Anna Łasińska

Training course in response to incidents with CBRN agents

The training course in response to incidents with CBRN agents was carried out at the Main School of Fire Service in Warsaw on 11–13 September 2017. The Main School of Fire Service (SGSP) is a public university of state services, educating firefighters of the State Fire Service, officers of other services and guards, as well as civilians in the field of general security and civil protection. The SGSP was established by a regulation of the Council of Ministers of January 18, 1982 regarding the creation of the Main School of Fire Service (Journal of Laws No. 3, item 21), operates on the basis of the Act of 27 July 2005 – Law on Higher Education (Journal of Laws No. 164, item 1365, as amended) and statute.

SGSP is the organizational unit of the State Fire Service, which operates under the Act of 24 August 1991 on the State Fire Service (Journal of Laws of 2009 No. 12, item 68, as amended). The school conducts research projects. Projects are implemented under registered school activities, as own research of commissioned projects, and as part of grants obtained from the Ministry of Science and Higher Education and implementation research topics, financed by national entrepreneurs. Research is also financed or co-financed by the European Commission and based on cooperation with national and foreign universities dealing with fire protection, civil protection, and environmental protection.

The idea of organizing training course appeared in connection with the ISA's activities involving prevention and countering terrorist threats. Professional implementation of such tasks requires special skills from experts employed at the Agency, educated and trained in this field. Their participation in the training which created probable situation of coming into contact with dangerous agents including those defined as CBRN indicates the need to increase their knowledge and skills to react in emergency situations when such a threat might occur. 14 officers from the Forensic Laboratory of Internal Security Agency participated in this training. The thematic scope of the training included biological, radiological and chemical threats. During the training, all-day exercises were carried out in Firefighting Forest Base "Zamczysko Nowe" of the Main School of Fire Service in the Kampinos Forest.

Dean of the Faculty of Civil Safety Engineering, Junior Brigadier PhD Eng. Anna Prędecka gave a lecture on biological threats. Firstly, she outlined the range of subjects. In the first part, she pointed out legal regulations in the area of biological agents. These regulations include:

- Act of 14 March 1985 on the State Sanitary Inspection, Journal of Laws 1985 No. 12 item 49,
- Act of December 5, 2008 on preventing and combating infections and infectious diseases in humans, Journal of Laws 2008 No. 234 item 1570,

- Regulation of the Council of Ministers of 27 June 2012 on the conditions and manner of preparation and use of medical entities for the state's protective needs and the competence of the authorities in these matters, Journal of Laws 2012 item 741,
- Directive 2000/54/EC of the European Parliament and of the Council of 18 September 2000 on the protection of workers from the risks related to exposure to biological agents at work (seventh individual directive within the meaning of Article 16(1) of Directive 89/391/EEC),
- Regulation of the Minister of Health of 22 April 2005 on harmful biological agents for health in the work environment and health protection of workers professionally exposed to these agents, Journal of Laws 2005 No. 81 item 716.

The definition of the biological agents was presented in detail. These are cellular microorganisms, internal parasites, non-cellular units capable of replication or transfer of genetic material, including genetically modified cell cultures, that may cause infection, allergies or poisoning. The harmful biological agents were classified in four groups based on the following criteria:

– probability of causing diseases in humans,
– possible consequences of human exposure,
– probability of spreading among humans,
– the likelihood of the spread among the people,
– effectiveness of prophylaxis and treatment.

- hazard group 1 – agents which are unlikely to cause disease in humans;
- hazard group 2 – agents that can cause disease in humans, can be dangerous for employees, but it is unlikely that they are spread to humans, usually effective methods of prevention or treatment exist;
- hazard group 3 – agents that can cause serious disease in humans, they are dangerous to employees, and their spreading among people is very likely, however there are usually effective prevention or treatment methods;
- hazard group 4 – agents that cause severe humans disease, thay are dangerous for employees and their spreading among humans is very likely, but usually effective methods of prevention or treatment do not exist.

The next part of the lecture was devoted to discussion of the quantitative and qualitative control of harmful biological agents in the work environment. Harmful biological agents are a significant problem of occupational medicine and environmental health.

When it is suspected that a specific group of employees is exposed to harmful biological agents that may cause symptoms of disease in this group, the validity of such a supposition should be confirmed by detecting the appropriate agents in the work environment and determining the amount of exposure and by direct or indirect determination of the presence of a biological agent in the body of the infected employee. The most important is the bioaerosol test to determine the presence of biological agents in the work environment and to determine the extent of exposure.

Microbiological testing of settled dust samples, biological material of employees and raw materials may be also crucial.

Methods of collecting bioaerozol particles are determined by their physical and biological properties.This process aims to capture as many biological particles from the air as possible and then to collect them (without changing them or damaging the structure) in such a way as to enable later analysis. For microbiological tests of air pollution, modern technical requirements recommend the use of volumetric methods. They consist in active sampling of air of a specific volume. For the sampling of bioaerosols, the most commonly used methods are: collision methods (impaction), impingement (uptake of particles into the liquid), filtration and electrostatic methods.

Impaction is one of the most widely used methods of sampling bioaerosols. This method uses an inertia force in order to separate particles from the airflow. The impaction process depends on such properties of inert particles as: their size, density, speed and on the physical parameters of the impactor used, like: nozzle size and their distance from the uptake surface (determining the flow speed of the airflow by a measuring instrument). In impactors, the direction of the airflow is rapidly changed when it passes through the aperture of the measuring device (most often at an angle of 90 degrees). As a result of the inertia force, particles with a larger mass fall out of the airflow onto the uptake surface. However, finer particles still remain in the airflow and pass with the airflow outside the device or to the successive levels of the impactor. There are three types of impaction used to capture biological particles from the air:

- inertial impaction,
- rotational impaction,
- impingement - impaction to the liquid.

Impingement, which is impaction to the liquid is a method of parallel deposition of aerosol particles in the liquid and their diffusion within the vesicles of the liquid. Water as an uptake medium is the most commonly used and liquids with viscosity similar to water or non-evaporative liquids whose viscosity is many times higher than the viscosity of water are also used (e.g. “light” or “heavy” mineral oil). Water and similar liquids evaporate quickly. Therefore, when using them the duration of sampling should be reduced. The use of low evaporation coefficient liquids (e.g. glycerol) allows to extend the sampling time of the biological aerosol.

Filtration is defined as the process of separating particles from the air in which they are suspended. The separation process is based on flow of the airflow through a porous medium (filter). Typical filters used for sampling bioaerosols are usually thin (usually <2 mm thickness) or multi-layered and contain numerous pores with a diameter of 0.2 μm to 3 μm. The efficiency of sampling depends on: the physical properties of the particles (their aerodynamic diameter), the properties of the filter (pore diameter and lamination) and the flow speed of the airflow. The most commonly used filters in bioaerosol measurements include: polycarbonate, gelatin, teflon, polyvinyl chloride, glass fiber, cellulose acetate and a mixture of cellulose esters.

Electrostatic precipitation is a method of bioaerosols sampling, in which the separation of particles from the airflow occurs due to electrostatic interactions. The bioaerosol particles contained in the airflow, naturally endowed with an electric charge flow through the ionizer, where they are additionally "charged up" electrically. The separation of electrified particles inside the measuring device is conditioned by their migration and deposition on a suitable medium (adapted for later analysis) in a strong electric field. This method is referred to as a "mild" and high-performance technique of bioaerosols sampling due to the use of natural electrostatic properties of the particles.

The next discussed topic was the occupational risk assessment in biological agents exposure under the Directive 2000/54/EC of the European Parliament and of the Council of September 18, 2000. While assessing occupational risk and exposure to biological agents is involvedthe following should be considered:

- list and classification of harmful biological agents,
- the type, grade and duration of exposure to the harmful biological agent,
- potential effects due to exposure (allergy, toxic, disease),
- path of transfer,
- existence of an effective vaccine,
- specific activities, e.g. causing formation of the aerosols,
- activities performed at high concentrations of biological agent,
- activities performed under conditions of exposure to a biological agent with a low infectious dose,
- performing activities involving factors that are in high risk group,
- performing activities involving highly infectious agents (with high risk of injury, etc.),
- information about:
  - allergenic or toxic potential of harmful biological agent,
  - diseases that may occur following exposure,
  - identified diseases that are directly related with work,
  - prevention,
  - time of document storage (cases when the register of employees exposed to the biological agent will be stored for more than 10 years after the last recorded exposure event).

Information about the allergenic or toxic potential of harmful biological agent is included in the list of biological agents (Annex 1 to the Regulation of the Minister of Health of 22 April 2005 on harmful biological agents for health in the work environment and health protection of employees exposed to these agents – Journal of Laws No. 81, item 716, with later change). In the list, the agents with sensitizing effects are marked "A" and agents that produce toxins are marked "T". The agents against which there is an effective vaccine have been marked "V". The factor has been marked "D" if the required storage period of the register of employees exposed to a specific biological agent is more than 10 years from the last recorded exposure case.

While assessing occupational risk when exposure to harmful biological agents is involved the procedure is similar to the assessment of other threats. In the assessment of occupational risk as far as exposure to harmful biological agents is concerned the first step is characterizing the workingposition considering the following elements:

- work processes,
- typical activities as part of the work process,
- biological agents that occur in the work environment,
- available general information on exposure.

The second step is the hazard identification and its characterization, where the following should be specified:

- type of harmful biological agent,
- the source of the threat (e.g. man, animals, soil, etc.),
- threat group,
- duration of exposure,
- potential action,
- path of transfer,
- signs of infection (only if the symptoms clearly indicate the disease entity),
- the possible effects of the infection,
- effectiveness of preventive methods and treatment,
- number of diseases in the workplace.

The next step is risk assessment:

- probability of infection,
- the effects of infection (diseases, possible allergenic and/or toxic effects),
- exposure to infection.

In the fourth step, the risk is assessed and its acceptability is determined. After risk assessment, mitigating or eliminating actions are selected. General protective measures are:

- structural and technical measures – easy to clean surfaces of floors and equipment, reduction and protection from aerosols and fumes,
- organizational measures – monitoring and operating procedures, suitable for existing biological agents,
- sanitary,
- sanitary and hygienic rooms (bathrooms and changing rooms),
- social rooms,
- hand washing,
- no meals or smoking in the workplace,
- regular cleaning (disinfection) of the workplace,
- training, etc.,
- personal protection – depending on the type of factor according to the risk assessment,
- prevention in the occupational health care – preventive checks, vaccinations.

Hermetic measures and hermetic levels are special protective measures for activities involving exposure to biological agents in part for the 2nd hazard group as well as 3rd and 4th ones. They are appropriately selected for the hazard group based on the requirements contained in the Annexes of the Regulation.

The issue related to personal protective measures used in exposure to harmful biological agents was discussed. In case of works which expose people to harmful biological agents, the rules of conduct and protection measures were defined in for health in the work environment and health protection of employees exposed to these agents (Journal of Laws No. 81, item 716, as amended).

Then the concept of biological weapons (weapons B) was discussed, i.e. the type of weapons of mass destruction where the combat charge are pathogenic microorganisms (e.g. anthrax bacilli) or viruses (e.g. the smallpox virus). Weapons based on biological toxins are also included in biological weapons (e.g. botulinum toxin, ricin). Biological weapons can be used during an attack on individuals, regular troops and civilians. The target of the biological attack may also be homogeneous plant monocultures or livestock farming (socioeconomic terrorism).

Given the importance of the potential biological weapon, there are three main groups (according to CDC) marked with consecutive letters of the alphabet:

- category A – are the highest priority pathogens that are characterized by ease of spread, and therefore high mortality. It imposes an obligation of special protection. These microorganisms cause the following diseases: anthrax, botulism, tularemia, plague, Lassa fever, numerous viral hemorrhagic fevers, smallpox;
- category B – are the second highest priority pathogens, with moderate ease of spreading, moderate incidence and mortality, but requiring increased supervision. Microbes from this group cause diseases like: Banga disease, glanders, melioidosis, Q fever, spotted fever, typhoid, coccidioidomycosis, western equine encephalomyelitis;
- category C – are the highest third priority agents which include newly emerging pathogens belong, that can be subject of manipulation in genetic engineering for mass spreading. They are easily accessible and easily spread, and therefore can cause high incidence and mortality.

A list of situations that are epidemiological signs of a hidden bioterrorist attack was also presented (according to CDC):

1. A large number of unexplained illnesses, disease syndromes or deaths at around the same time with a similar clinical picture, involving in particular skin or mucous membrane changes, symptoms of neurological damage, respiratory system, alimentary tract or multiple-system damage.
2. Emergence of unusual diseases in the population.
3. Sudden, unexpected, increase in diseases and mortality due to known diseases or syndromes.
4. Observation of ineffective treatmentof common diseases in routine therapy.

5. Even a single case of a disease caused by an exotic agent in a person who did not leave Poland, in recent time.
6. The occurrence of diseases in untypical season and geographical area for them.
7. The occurrence of numerous disease symptoms, which are untypical for some infectious agent.
8. Genetically similar types of etiological agents isolated from various sources which are distant in terms of time and area.
9. Unusual, atypical infectious agent, genetically modified or obtained from inactive sources.
10. Unexplained increase in endemic disease
11. The occurrence of similar diseases at the same time in hotspots which are not connected territorially, at home or abroad.
12. Untypical transmission of diseases (aerosol, water, food).

The last topic was the activity of the Fire Brigade including incidents of biological threats. Currently, the area of activity is governed by algorithm of proceedings and cooperation of services in the case of receiving reports about a suspected package, Resolution 3/2017 Interministerial Group for Terrorist Threats dated June 30, 2017 on the application of the algorithm and Regulation of the Minister of the Interior and Administration dated 3 July 2017 on a detailed organization of the national rescue and firefighting system in the event of a terrorist threat. In Poland, a valid document that normalizes biological threat ("biohazard" type) is the Regulation of the Minister of Health dated April 22, 2005 on harmful biological agents for health in the work environment and health protection of employees exposed to these agents (Journal of Laws No. 81 item 716 as amended) and the Act on prevention and eradication of infections and infectious diseases in humans, December 5, 2008 (consolidated text, Journal of Laws of 2013, item 947, as amended). The Act contains information about the obligation of the State Fire Service to cooperate with the leading services, designated to eradicate threats. However, the regulation includes a definition of biological agents with their classification. The competence of the fire brigade was determined in the "Principles of proceedings of the State Fire Service Units in the case of threats of particularly dangerous and highly contagious diseases" and "Principles of State Fire Service activities during the occurrence of threats with unidentified package and organization of transport of the biological materials to the Laboratory of the Military Institute of Hygiene and Epidemiology in Puławy".

In 2015, the rules were approved by the Main Chief of the State Fire Service and the Chief Sanitary Inspector of the Ministry of the Interior (Main Sanitary Inspectorate of the Ministry of the Interior). During incidents when there is a suspicion of biological hazards, the above-mentioned documents determine in detail the competence and responsibilities of the State Fire Service.

During the lecture related to radiological hazards, prof. Marcin Smolarkiewicz presented the rules of conduct with radioactive substances. The lecture was devoted

to explaining the concept of radioactivity according to the principles of nuclear physics and particle physics. Radioactivity is a feature that characterizes the atomic nucleus. There are two types of radioactivity: natural radioactivity and artificial radioactivity. Natural radioactivity is the ability of an atom of a given element to transform spontaneously into the nucleus of another element by sending radiation. To this day, about 60 nuclides are known. These are atomic nuclei that undergo spontaneous nuclear transformations. Artificial radioactivity is a phenomenon in which a stable atomic nucleus undergoes nuclear transformations as a result of its activation, e.g. bombardment with other particles. In contrast to natural radioactivity a artificial radioactivity is initiated by humans. All types of radiation can be divided in two groups: ionizing radiation and non-ionizing radiation.

Ionizing radiation is called the type of radiation that causes a change in electric charges, it means ionization in molecules or in electrically neutral atoms. We are not able to feel this type of radiation and it does not affect our senses. Corpuscular radiation, X-rays and γ (gamma) radiation are ionizing radiation. Non-ionizing radiation does not cause ionization of electrically neutral particles. This group includes: radio radiation, microwave, infrared and visible light.

Next the concept of half-life period was discussed. This is the time after which half of the initial number of nuclei of the radioactive isotope decays. This period can be very different, among known radioactive isotopes. It is estimated to be in the range from 10^{-17} seconds up to 10^{17} years. When the half-life period is known, the percentage of the initial amount of radioactive isotope that will remain after the multiplicity of the half-life can be estimated. Based on the value of the half-life period, it is possible to calculate how much of the initial number of nuclei decay after a certain time. For this purpose, the so-called rate of radioactive decay is used. It determines how the amount of unstable isotope changes over time.

Next topic were the types of ionizing radiation were discussed. These are alpha (α), beta (β), gamma (γ) and neutron radiation.

The α radiation is a stream of α particles. Alpha particles are helium-4 nuclei (two protons and two neutrons). The nuclide goes into the nucleus whose mass number is lower by 4, and the atomic number lower by 2. The α-rays are characterized by relatively low energy and hardness up to 10 cm in the air. The sources of radiation are the soil, radon present in the atmosphere and man-made heavy elements. It is stopped by human skin, paper and it is a risk when particles enter the body.

Beta-plus (β^+) radiation is the emission of positrons. These particles are positively charged electrons, it means that for electrons their mass is equal to zero. They are formed during the β + reactions. They occur when isotopes are obtained as a result of artificial nuclear reactions. The transformed nucleus is turned into a nucleus with the atomic number lower by 1. Typically, the transformation occurs for nuclides where the number of protons is higher than that of neutrons. This is because the β + particles are formed as a result of proton decay. The β + transformation is associated with particle emission called neutrino.

Beta-minus (β^-) radiation is the emission of electrons. They are formed as a result of the radioactive decay β-. Usually isotopes containing more neutrons than protons in the atomic nucleus undergo such changes. Particle emission β- is associated with the neutron decay. As a result of this transformation, the new nuclei are formed, with an atomic number higher by 1. The β changes are associated with particle emission, called anti-neutrino. Hardness is calculated up to several meters in the air or a few cm in plastic (crosses the skin). It can be dangerous to the skin, eyes or internal organs. It is emitted from sources used in research and medical devices (light elements). The beta rays can be stopped by a few centimeters of metal, plastic or organic glass.

A gamma ray or gamma radiation (γ), is penetrating electromagnetic radiation. It consists of photons in the highest observed range of photon energy. Gamma rays are the products of annihilation (or collision of particles with antiparticles, for example positrons with electrons). They are also emitted by the nuclei of radioactive elements that are spontaneous nuclear changes. The gamma radiation has the highest range compared to the abovementioned types of radiation. Hardness in the air is calculated up to several kilometers. This radiation penetrates the whole human body. It is emitted from sources used in research and medical devices (gamma radiation arises as a result of decay, X-rays in devices). The gamma ray stops a few meters of water or 10 cmof lead.

Neutron radiation is astream of neutrons which are particles with no charge. and their atomic mass is determined at 1u. This radiation is emitted during some nuclear reactions. It arises, among others, during the nuclear fission. Neutron radiation is the most penetrating – penetration to several meters in heavy concrete or metal. It penetrates the whole human body and is particularly harmful to the eyes. It is created as a result of forced nuclear transformations (reactors, accelerators). Water, polyethylene and paraffin slow down neutrons. Radiation is absorbed by cadmium and boron. The only one and natural source of neutron radiation is the californium.

Nuclear radiation can result from the decay of nuclei of certain and unstable radioactive elements, and can be produced artificially by accelerating charged particles. Among the radioactive elements can be mentioned those of natural origin as: actinium (Ac), astat (At), frans (Fr), neptunium (Np), polonium (Po), plutonium (Pu), radon (Rn), rad (Ra), protactinw (Pa), thorium (Th), uranium (U) and potassium (K) and those made artificially by man: ameryk (Am), kiur (Cm), lorens (Lr), berkel (Bk), farm (Fm), californium (Cf), mendelew (Md), nobel (No), promet (Pm) or technetium (Tc).

During the lecture on radiological threats prof. Marcin Smolarkiewicz presented a definition of radioactive material, according to Act of 29 November 2000 – Atomic Law (Journal of Laws of 2012, item 264, later amended). It is any material containing radioactive isotopes, in which both the radioactive concentration (c_A) and the total activity (A) of the package exceed the limit levels (c_{A0} and A_0, respectively). Fissile material is material containing any of the following isotopes: U-233, U-235, Pu-239 or Pu-24. This term does not include non-irradiated or irradiated U_{nat} or U_{dep}, only in thermal reactors. Non-fissile or fissile-off material is material not subject to the requirements for fissile materials. The exemption criteria exist, such as:

- limiting the mass of fissile material (up to 180 g or 400 g depending on the type of fissile material and average hydrogen density) on the package while limiting the minimum external dimensions of the shipment items and the mass of fissile material in the shipment items or hydrogen content or concentration of fissile material; the content of beryl and deuterium is also limited; or
- limitation of enrichment (up to 1% or 2%) for materials in a specific physical and chemical form, composition, structure, nitrogen content, etc.; or
- limitation of the mass Pu (up to 1 kg) in shipment items, while limiting the content of fissile isotopes Pu.

Next, the issue of radioactive contamination was discussed. It means that the radioactive substance is present on the surface either 0.4 Bq / cm^2, for beta and gamma emitters, and for low-toxic alpha emitters or 0.04 Bq / cm^2 for all other alpha emitters. Non-related contamination may be removed from the surface under normal conditions of carriage (without destroying it). Related contamination, it is contamination other than unrelated contamination. An important measurement parameter of the radioactive material is the following activity:

A1 – value of the radioactive material activity in a special form used to determine the activity limits for the purpose of legal regulations,

A2 – value of the radioactive material activity in a form other than special used to determine the activity limits for the purpose of legal regulations .

There are activity limits for individual radionuclides, e.g. for carbon C-14 A1 = 4×10^{1} TBq.

The issue of low specific activity (LSA) material was discussed. It is a radioactive material that due to natural properties has limited specific activity or radioactive material to which the limits of the estimated average specific activity are used (in the calculation of the estimated average specific activity, the materials used for external covers for LSA are not included). LSA materials qualify for one of three groups: LSA-I, LSA-II lub LSA-III.

The LSA-I (non-fissile or fissile-off) group includes ores and concentrates of U and Th ores and other ores containing the natural radioactive isotopes, non-irradiated solid or liquid U_{nat}, U_{dep}, Th_{nat} or their compounds and mixtures, materials for which the A2 value is unlimited and other materials for which the estimated average specific activity $\leq 30c_{A0,i}$. The LSA-II group includes tritiated water of limited concentration and other materials for which the estimated average specific activity is $\leq (10^{-4}$ lub $10^{-5})$ x A_2/g, respectively for solids, gases and liquids.

The LSA-III group includes solid materials excluding powders in which the radioactive material is apportioned evenly, the estimated average specific activity of the material $\leq 2 \times 10^{-3} \times A_2$/g, and the material has undergone a leaching test.

The next issue was the transport of radioactive materials. A surface-contaminated object (SCO) is an object in the form of a solid (object) that is not itself radioactive, but on its surface there is radioactive material (contamination). SCO subjects qualify for one of two groups: SCO-I lub SCO-II.

The SCO-I group includes the subjects where a non-related contamination on the available surface (for 300 cm^2) ≤ 4 Bq/cm^2 for βγ or 0,4 Bq/cm^2 for α, and related contamination on the available surface (for 300 cm^2) ≤ 4 x 10^4 Bq/cm^2 for βγ or 4 x 10^3 Bq/cm^2 for α, and the sum of non-related and related contamination on area have no access (for 300 cm^2) ≤ 4 x 10^4 Bq/cm^2 for βγ or 4 x 10^3 Bq/cm^2 for α. The SCO-II group includesthe subjects where a non- related contamination on the available surface (for 300 cm^2) ≤ 400 Bq/cm^2 for βγ or 40 Bq/cm^2 for α and related contamination on the available surface (for 300 cm^2) ≤ 8 x 10^5 Bq/cm^2 for βγ or 8 x 10^4 Bq/cm^2 for α and the sum of non-related and related contamination on area have no access (for 300 cm^2) ≤ 8 x 10^5 Bq/cm2 for βγ or 8 x 10^4 Bq/cm^2 for α.

Then the concept of the shipment item was discussed. It is the final product of packaging consisting of a package with contents that are ready for shipment. The category of the shipment item is one of three categories defined in the transport regulations, which include shipment items or multi-packs, depending on the value of radiological parameters (the level of radiation on the surface and the transport index).

The measurement parameters of the radioactive level is the dose strength expressed in mSv/h. The transport index (TI) appointed for the shipment items, multi-packs, container or unpackaged (transported loosely) LSA-I materials or SCO-I items means the number that is used to control exposure to radiation. Critical security index (CSI) specified for shipment items, multi-packs or container containing fissile material, means the number that is used to control the accumulation of shipment items, multi-packs or containers containing fissile materials.

The sole use (total contingent) is the use of a means of transport or a large container only by one sender, all loading and unloading operations – initial, temporary and final – are made according to the instructions of the sender or customer.

Special conditions (X) are determined on the basis of which package can be transported, containing radioactive materials that do not meet the relevant rules of transport regulations. Special conditions are approved by the appropriate authority. A shipment items classification has been created. These are:

- excluded (EXC);
- other than excluded;
  - industrial IP (IP-1, IP-2, IP-3),
  - type A,
  - type B [B(U), B(M)],
  - type C.

The type of package informs about the resistance of the packaging to the conditions of transport (routine, normal and emergency). The more dangerous content, the „more serious" (more durable) package should be used. Shipment items containing UF6 (both fissile and non-fissile) in the amount ≥ 0.1 kg are also subject to tests according to ISO 7195 and:

- structural examination,

- free fall examination,
- heat resistance test.

The test result is considered positive if tightness is maintained. In the shipment item, the amount of radioactive material should not exceed the appropriate limits for respective types of shipment items:

- excluded (non-fissile or fissile-excluded) – (10-4 A1 or 2 ÷ A1 or 2) depending on the form of the material, physical form and type of material (instrument or object or material),
- industrial – so that the radiation level at a distance of 3 m from the unprotected material or object did not exceed 10 mSv/h,
- type A – no more than A1 or A2 according to the material's form,
- type B, type C – no more than recognized for the package design according to certificate of approval.

The radiological parameters of the shipment item and vehicle, such as: dose strength on the surface and at a distance of 1 m from the surface, and related and non-related surface contamination were also discussed. The method of calculating the transport index of the shipment item was explained in detail. The categories of the shipment item were presented. The category of the shipment item is marked with the appropriate number and color and the appropriate warning sticker, depending on the dose strength. The category of the shipment item informs about the risk during transport. The vehicle transporting the shipment item must meet the appropriate equipment and marking standards, in the form of boards with the hazard number and material identification number, and have the required documents.

The superior document that regulates the international transport of dangerous goods by land is the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). Concluded in Geneva on 30 September 1957 under the aegis of the United Nations Economic Commission Federation for Europe, it entered into force on 29 January 1959. It consists of the relevant contract and Annexes A and B, being an integral part of it. The relevant contract defines the legal relations between the participating states, whereas the annexes contain regulations in a wide range the conditions for the transport of individual dangerous materials and objects in the international transport of dangerous goods by land. Annex A contains the division of all dangerous goods produced in the world into 13 hazard classes and contains a detailed classification of these goods in individual classes. In addition, in this Annex, general and specific conditions for packaging of dangerous goods, requirements for the labeling of goods, packaging and vehicles transporting dangerous goods and conditions for technical testing of packaging and their special marking were specified. In Annex B, the conditions for the transport of individual dangerous goods, the technical conditions of vehicles, the conditions for marking vehicles and their additional equipment, and the necessary documentation for these transports were specified.

At the end of the lecture a video from the conducted exercises in Chernobyl was presented. An international group of radiologists participated in the exercises.

Next, there were exercises related to radiological hazards conducted by dr Aneta Łukaszek-Chmielewska and a representative of the POLON-ALFA company, Mr. Daniel Jankowski. The radiation dose and transport parameters have been discussed and explained in detail. The determination of parameters needed to determine radiation dose and transport parameters were also discussed. Good practice of using radiometers was discussed. Radiometers are used to measure the degree of contamination, the presence of radioactive substances and other parameters associated with alpha, beta and gamma radiation activity. During the exercise, an external probe for the RK-100-2 radiometer used to measure alpha and beta contamination and three digital radiometer for measuring surface contamination with alpha, beta and gamma radioactive substances was presented. In addition, a simple sound radiometer to detect surface contamination was shown. The operation of the discussed instruments was shown using small sources of radioactive cesium and cobalt. Every participant had the opportunity to test each of the presented instruments.

A few interesting issues related to chemical hazards were presented by Junior Brigadier PhD Eng. Zdzisław Salamonowicz, head of the Chemical and Ecological Rescue Department.

A threat is a physical situation characterized by the possibility of danger to human health, the natural environment or causing material damage. The hazard may be caused by hazardous chemical substances that cause a fire, explosion or toxic contamination. Dangerous chemical substances are a potential source of threats to health and life of people, especially in the work environment, but also in the natural environment. Comprehensive information about the hazardous properties of individual chemical substances, the type and size of the threat and the rules of engagement, allows the rational and effective prevention in workplaces. In case of a failure, it provides protection for people and the natural environment outside the industrial area. Then, hazardous chemical substances were listed. For the purpose of unambiguous assessment of the quality of the hazard by chemical substances, legal regulations were created, (http://reach.gov.pl/reach/pl/akty-prawne/reach), which are included in the act and regulations of the Minister of Health. According to physicochemical, toxic, eco-toxic and specific properties , four groups of threats to human health were adopted as the basis. The groups of dangerous substances were presented.

Division of substances based on physicochemical properties:

1) explosive substances and preparations;
2) substances and preparations with oxidizing properties;
3) extremely flammable substances and preparations;
4) highly flammable substances and preparations;
5) flammable substances and preparations.

Division of substances based on toxicity:

6) very toxic substances and preparations;
7) toxic substances and preparations;
8) harmful substances and preparations;

9) corrosive substances and preparations;
10) irritant substances and preparations;
11) sensitizing substances and preparations.

Division of substances based on the analysis of specific effects for human health:

12) carcinogenic substances;
13) mutagenic substances;
14) substances that are toxic to reproduction.

Division of substances based on the analysis of the effects on the environment:

15) Substances and preparations dangerous for the environment.

Carcinogenic substances have been normatively divided into three categories.

Category 1 – substances with proven human carcinogenicity, these are substances in case of which there is sufficient evidence to indicate a causal relationship, between human exposure to the substance and the emergence of cancer.

Category 2 – substances that are considered to be carcinogenic to humans, these are substances in case of which there is sufficient evidence to assume that human exposure to these substances may result in cancer. Data obtained on the basis of appropriate, chronic animal tests and other relevant information, indicating that human exposure to these substances may eventually lead to cancer, allow for such assumption.

Category 3 – substances with a possible carcinogenic effect on humans, there are substances for which the available information does not allow for a satisfactory assessment. There is evidence for them from appropriate animal studies, but it is not enough to place this substance in category 2.

The addition of a substance to category 1 is made on the basis of epidemiological data, classification in category 2 or 3 is made primarily on the basis of the results of animal tests.

Dangerous substances and preparations are properly marked to identify them uniquely and identify the type of danger. X_n or X_i symbols are assigned to substances and preparations with sensitizing effects. T or Xn symbols are assigned to substances and preparations which are carcinogenic, mutagenic and toxic for reproduction. In addition, the type of threat is expressed in more detail by means of hazard phrases R (Risk), determined on a scale from R1 to R68 and combined phrases. In addition, to the numerical symbols used for notification of danger related to hazardous substance contact, graphic danger symbols are used. These markings are called warning labels and are placed on means of transport. They have the shapes of a square placed on one of the angles and they differ in pictogram and color. Detailed information about the threat resulting from the use of a given chemical substance, defined by danger symbols, is included in the List of Dangerous Substances - catalogue issued by the Minister of Health.

The effects of hazardous substances on the living organism were discussed. They depend on the following agents: the type of toxic substance, the way of penetrating the poison into the body, the dose of poison absorbed by the body, the physicochemical properties of the poison, the type of changes that the poison undergoes in the body, and the body's susceptibility to poisoning, etc. Examples of groups of chemical

compounds and their effects on the human body were presented. For example, acids in contact with the skin have a strongly corrosive-scalding effect and they are dangerous for the upper respiratory tract due to corrosive fumes. The alkali, also in contact with the skin, have a strongly corrosive and scalding effect. Hydrocarbon liquid fuels (gasoline, diesel oils, fuel oils) have an irritating effect on the human body, mucous membranes, skin and also have a narcotic effect. The liquefied gases are strongly irritating, toxic, and after contact with the skin they are strongly corrosive and scalding.

During the lecture, the types of combat poison agents were also mentioned. These are:

- irritants, e.g. chloroacetophenone, adamsite, CS, chloropicrin,
- psychotoxic, e.g. BZ, LSD-25, mescaline, sernyl,
- scalding, e.g. iperas, luistis,
- suffocating, e.g. phosgene, diphosgene,
- general-poisonous, e.g. hydrogen cyanide, arsenide,
- paralytic-convulsive, e.g. sarin, VX,
- toxins, e.g. botulinum toxin.

Databases have been developed because there are thousands of dangerous chemicals, and if these substances are released into the environment, immediate knowledge of their properties is needed. The most comprehensive data, given in an ordered manner is in databases similar to the Material Safety Data Sheets. Databases are developed in book form and issued on CD-ROM. The following databases are most often used to determine chemical threats:

Polish language:

1. Material safety data sheets issued by the Central Institute for Labor Protection (CIOP), both in catalog and multimedia format.
2. Dangerous substances issued by the WEKA Professional Information Publisher in the form of a book guide and on a CD.
3. ChemDat Chemical Data Base issue by MERCK in the form of a Chemical Data Bank CD (CDB) – developed by the Institute of Industrial Chemistry.

Foreign language:

1. CHEMDATA – multimedia English program.
2. MATERIAL SAFETY DATA SHEETS (MSDS) – developed by Sigma-Aldrich.
3. BIG – Belgian base.

Next, the concept of decontamination was discussed and the types and distribution of decontamination solutions were presented in the following groups:

RD 1 – 5% sodium carbonate solution Na_2CO_3 and 5% Na_3PO_4 sodium phosphate solution,

RD 2 – 10% solution of calcium hypochlorite $Ca(ClO)_2$,

RD 3 – 5% Na_3PO_4 sodium phosphate solution,

RD 4 – 1% hydrochloric acid solution HCl,

RD 5 – an aqueous detergent solution, preferably domestic use (soaps, detergents, washing powders or ZPC).

The purpose of decontamination is the fastest possible decontamination of the injured person and avoiding secondary contamination of third parties, equipment and buildings (including hospitals). The tasks of victim decontamination are performed by all fire and rescue units of the State Fire Service. The decontamination is a two-step process. The first stage is a rescue operation that is, carried out urgently, at the scene, called decontamination of the victims. The second stage is secondary activities, carried out outside the scene, supervised by medical personnel, with the support of KSRG units, called final victim decontamination. During initial decontamination, rescue actions, in relation to persons exposed to contamination consist of washing the skin of exposed parts of the body and contaminated skin by means of washing substances, deactivating substances or water and removal of contaminated clothing or likely to be contaminated and the use of a substitute clothing. During final decontamination of the victims the rescue operations include removing contamination from the entire body by washing and rinsing, using water with the addition of washing and deactivating substances in specially prepared hospital decontamination stations or on the scene using set of tents or decontamination containers.

Next, the elements of the rescue action were discussed, including: reporting/ notification, disposal, recon at the scene, organization, implementation and completing the action. Division and marking of the area of the rescue operation into zones were discussed. Three zones are designated. ZONE I (hot), where there are threats to life and health, it is a direct zone of work of rescuers. The first zone is: preliminary unrecognized zone (suspected threat), potentially explosive zone in which there is a deficit or elevated oxygen concentration, and a zone in which there is a significant increase in concentrations of gases, vapors, toxic aerosols. ZONE II (cold) is the area of work of emergency services outside the 1st zone and the area of logistic security including initial decontamination. ZONE III (initial decontamination) is a work area of the unit which implements activities urgently at the scene in relation to a person exposed to a dangerous substance by: removing contaminated clothing, rinsing/wiping of exposed parts of the body, replacing clothing/blankets, and initial decontamination of the equipment in order to minimize the negative influence of the dangerous substance on its efficiency. Activities in the threat zone must be conducted in accordance with the rules of conducting chemical rescue operations by a minimum of two firemen or rescuers. Firemen or rescuers working in the threat zone must be secured by a minimum of two rescuers, equipped with protective instruments, with the same degree of protection as rescuers working in the zone. Communication should be maintained with rescuers in the first zone and those acting as a backup team. Residence time of firemen or rescuers in the zone threats should be monitored. Introducing excess firefighters or rescuers in the immediate threat zone should be avoided. Before the firefighters or rescuers leave the zone, initial decontamination area for them should be prepared, if necessary.

On the last day of the training course in the Firefighting Forest Base "Zamczysko Nowe", all-day exercises took place as part of chemical hazards. Exercises were

conducted by Junior Brigadier PhD Eng. Zdzisław Salamonowicz and Cpt. MSc. Eng. Rafał Matuszkiewicz.

At the beginning of the exercise an average mass rescue vehicle with its equipment was presented which is used during carrying out rescue operations involving chemical rescue. It is used during chemical rescue operations. Next, the method and sequence of dressing the rescuer's personal protective equipment were presented and discussed. The elements of the rescuer's personal protection are respiratory protection equipment, such as compressed air breathing apparatus, dangerous substance absorbers, and chemical protection clothing (UOP). The selection of personal protection depends on many factors:

1. State of matter of the substance where the emergency operations are carried out:
   a) solid state – generally, partial protection of the body, in the form of shoes and chemical resistant gloves and upper respiratory protection equipment is sufficientl;
   b) iquid – it is appropriate to completely protect the body and respiratory tract without maintaining gas-tightness;
   c) gas – full chemical protection is necessary in the form of respiratory protection equipment and heavy gas-tight clothing.
2. The type of hazards caused by a chemical substance.
3. Chemical and mechanical resistance of clothing.
4. Place and the conditions in which activities are conducted.

On one hand, the correct selection of the type and level of chemical protection, affects safety but on the other hand, it also affects the comfort and efficiency of rescuers' work. Lightweight chemical protection clothes were presented. Each participant of the training course had the task of putting on full personal protective equipment together with the compressed air breathing apparatus and taking a chemical sample in the room located on the second floor of the training container and passing through the decontamination tent. The exercise was carried out in pairs in accordance with the rules of conducting chemical rescue operations.

Summary

One of the most difficult challenges in the field of security of CBRN mass destruction materials are actions aiming to reduce combined risks, e.g. a terrorist attack with using a "dirty bomb", where chemical, biological or radioactive materials are used in addition to the explosive. The elimination of such a threat requires specialist knowledge Both in terms of prevention methods and protection during risk elimination as well as the readiness of many response services in such a crisis situation. In the case of threats caused by biological and chemical agents or in situations potentially related to the possibility of such a threat, the use of personal protective equipment with appropriately selected protective efficacy, is necessary, which has been confirmed in laboratory tests conducted to verify the accordance with the *essential safety requirements.*

In the European Union respiratory protection devices and skin protection devices, designed for use in the case of exposure to biological and chemical agents, *fall into the category* of protection for which it is obligatory to obtain a certificate of compliance with Directive 89/686/EEC and a CE mark. In Poland, as in the EU countries, the same evaluation criteria to security measures are applied. Obtaining a certificate for the safety sign B and marking confirm a positive assessment. In Poland the certification of personal protective equipment as a safety mark (including those protecting against biological and chemical agents) is carried out by the Central Institute for Labor Protection as part of accreditation No. AC 19, granted by the Polish Center for Accreditation.

Personal protective equipment used to prevent contact of the whole body (protective clothing) or parts of it (e.g. gloves) with chemical substances or infectious agents and respiratory protective equipment must meet two basic protective criteria. It should prevent these substance from getting through the material, which is a protective layer and ensure tight fit and tightness of connections of components (e.g. filters and masks). Personal protective equipment *designed to be used* in the case of particularly dangerous substances: chemical compounds (in the form of vapors or gases) or infectious agents characterized by a high degree of penetration, mainly due to the size or shape of the particle (e.g. bacteria, viruses) is classified depending on the effectiveness of the action. On the market filters with an efficiency of 80% (designated P1), 97% (P2) and 99.99% (P3) are available, depending on the ability to stop such particles. *In practice this means that if* a filter of the highest protective class (P3), it has particle collection efficiency at 99.99 % in the case of aerosols, then the same level of protection can be expected in respect of pathogenic bacteria of similar physical characteristics (size and shape of the particle). For example, refering this data to the spore form of anthrax bacteria with a transverse dimension of 1μm, it can be assumed that the P3 class filters complete with masks or half-masks and P3 class filter respirators *are sufficient safeguards* for the *respiratory system*. The most important problem to ensure protection against high-risk chemical and biological agents is the choice of a solution corresponding to the existing hazard in terms of effectiveness. The difficulty of selecting personal protective equipment, especially against biological agents results from the fact that the *maximum concentration values* (NDS) are not defined whereas they exist for chemical agents.

The principle of the selection of equipment of maximum effectiveness should be applied, *according to* the following *conditions: possibility to identify* hazards, the type of activities performed by the protected person, the estimated time of using protection measure and the availability of equipment. Terrorists growing interest in the purchase and use of toxic chemicals, biological and radiological materials which they fit into the improvised explosive device, confirms the necessity for the services to have knowledge and practical skills in order to prevent any such threats. The aim of the training course was to enhance the skills of dealing with CBRN terrorist threat by the specialized units working for the internal security of the country, and increasing

cooperation skills with emergency services on the scene of a terrorist incident. Analysis of the key legal regulations in the area of rescue operations as well as proper application of the research procedures allows the threat to be identified swiftly. However, it should always be remembered that despite the most perfect legal regulations, their correct compliance lies primarily with those who apply them.