ISSN 2450-6869

Volume 1, No. 9, 2020

DEFENCE SCIENCE REVIEW

www.defencesciencereview.com.pl

DOI: 10.37055/pno/130387

NUCLEAR SAFETY AND RADIOLOGICAL PROTECTION IN POLAND

Original article

Accepted: September 2020

Published: November 2020

Peer review:

Double blind

Keywords:
nuclear safety, radiation protection, monitoring of radioactive contamination

Sławomir Kleszcz[1]
ORCID: 0000-0002-1866-4775

Military University of Technology in Warsaw,
gen. Sylwestra Kaliskiego 2, 01-476 Warszawa

Abstract

Purpose: This paper aims to present the nuclear security and radiological protection system in Poland. Method: The scientific methods used in this paper include critical analysis of literature as well as analysis and logical construction method. The research was conducted based on data relating to the Polish Armed Forces. Results: The article presents selected issues related to radiation security in the state defence system. It explains the essence of this problem. It presents entities responsible for the implementation of tasks related to nuclear safety and radiological protection in Poland, as well as legal acts that regulate these aspects of state security. Conclusions: The issue in questions has huge implications for both the natural and medical sciences, as well as for the psychological aspects. Compliance with strict safety requirements and work regulations is crucial for protecting workers' health and life and, in particular, the security of millions of citizens, as one of the biggest radiation disasters in the world history, the Chernobyl disaster in 1986, may prove. Rising some kind of public awareness and education in the area of radiation security is also extremely important. The society needs to understand the problem and then accept it as an inevitable process in building a new national power industry.

[1]Sławomir Kleszcz, Ph.D., teacher of the Institute of Security and Defense WAT. Research interests: crisis management in the national security system, defense against weapons of mass destruction

Introduction

Nuclear power provides a huge boost for industrial development, as well as allowing its potential to be peacefully exploited. Poland is now in a period when several decisions are being made in connection with changes in the state's power policy, including the construction of a nuclear power plant. This subject is the subject of discussions on the citizens' security, where arguments both for and against this nuclear energy policy are presented.

Please mind that, despite such extensive use of the potential of nuclear energy in many areas of our lives, it also carries risks that could have vital consequences in terms of nuclear safety.

Nuclear safety encompasses all scientific, technical and organisational issues and activities relating to the safety and protection of the public against threads arising, or likely to arise, from accidents, damage or the presence of systems, facilities, equipment and materials which are sources of ionising radiation.

According to the definition of the National Atomic Energy Agency, nuclear safety is *a condition achieved by the whole range of organisational and technical measures undertaken to prevent radiological events associated with activities involving nuclear materials (Państowa Agencja Atomistyki,* 2020).

The main area of interest for nuclear safety includes nuclear reactors generating nuclear power converted mainly into electrical power.

The methods for boosting safety of these facilities can be divided into two groups:

- increasing safety in the fuel elements design and production phase;
- increasing safety during reactor operation,
- increasing safety when replacing and storing used fuel elements.

A radiological emergency is an event that can occur both in Poland and abroad and which is connected with nuclear material, a source of ionising radiation, radioactive waste or other radioactive substances and results in the possibility of exceeding the limit values for ionising radiation. Radiological events may include not only a reactor failure but also an accident in an isotopic laboratory, theft or smuggling of a source of radioactive radiation. In Poland, by the President of the National Atomic Energy Agency, with the assistance of the Centre for Radiation events, is responsible for assessing the radiation situation.

During a radiological event causing a threat for the whole country, the minister in charge of internal affairs manages intervention measures. Introduction of intervention measures related to a radiological event that affects an area not larger than one voivodship is initiated by way of an act of local law issued by the voivode competent for the place of the event. Introduction of intervention measures related to a radiological event that affect an area greater than one voivodship is initiated by way of regulation of the Council of Ministers.

Non-state actors (international corporations, non-governmental organisations, social movements or extremist groups) are another disturbing phenomenon shaping the security environment. They constitute a very wide and diverse group, with extremely different motivations, methods and objectives for their actions. Please mind that in the future it will be increasingly difficult to track their actions. They may attempt to get access to increasingly newer technologies, including WMD agents defined in the NATO nomenclature as CBRN (chemical (C), biological (B), radiation and nuclear (RN) agents). It is also to be expected that some will develop their advanced solutions, which are not available to state institutions.

There is no doubt that the proliferation of weapons of mass destruction entails exceptionally negative consequences for the whole world. It can be reduced to three 'black scenarios':

- “nuclear anarchy” as a result of the disintegration of the global non-proliferation regime (based on the Treaty on the Non-Proliferation of Nuclear Weapon);
- the destabilisation of a state that has nuclear weapons;
- access to nuclear resources by non-state actors, in particular terrorist organisations.

In the latter case, it may be technically the easiest to use a conventional explosive device to atomise radioactive materials (the so-called Dirty Bomb) (Koziej, 2012). Diversion actions in nuclear power facilities may also occur.

1. Legal provisions on radiation safety in Poland

The procedure in case of occurrence of a radiological event in Poland is regulated by the Resolution of the Council of Ministers of 18 January 2005 on emergency action plans in case of radiological events (Journal of Laws No. 20, item 169). It has been defined separately for events limited to the area of an organisational unit (“company” events) and for events that affect areas outside the organisational units (“voivodship” and “national” events, including cross-border effects). Depending on the area affected by the radiation event, the head of the unit (company event), the voivode in cooperation with the voivodship sanitary inspectorate (voivodship event) or the Minister of Interior and Administration with the assistance of the President of the National Atomic Energy Agency (national events) are responsible for managing the thread neutralization and eliminating the consequences of the event. In all cases, the President of the National Atomic Energy Agency, through the Centre for Radiation events (CEZAR), which he or she directs, plays an informational and consultative role, also in assessing the doses and contamination levels and other expert opinions and on-site actions, informing the communities exposed on consequences of the event, providing information to international organisations and neighbouring countries (24-hour National Contact Point).

Close surveillance and control of nuclear facilities and activities with radiation sources make it unlikely for radiation risks to the Polish population to occur, but the President of the Polish Atomic Energy Agency (PAA) has a system in place for assessing the radiation situation in Poland and deciding on the necessary intervention measures *(Państowa Agencja Atomistyki,* 2020).

1.1. Radiation events

A radiation event is defined as an event occurring in Poland or abroad and relating to nuclear material, a source of ionising radiation, radioactive waste or other radioactive substances which causes or is likely to cause a radiological emergency and which has the potential to exceed the dose limits laid down in the legislation in force and therefore requires urgent action to protect workers or the general population *(Państowa Agencja Atomistyki,* 2020).

1.2. INES scale

INES International Nuclear and Radiological Event Scale is a tool for quick and unambiguous classification of incidents and events relevant to nuclear safety and radiological security.

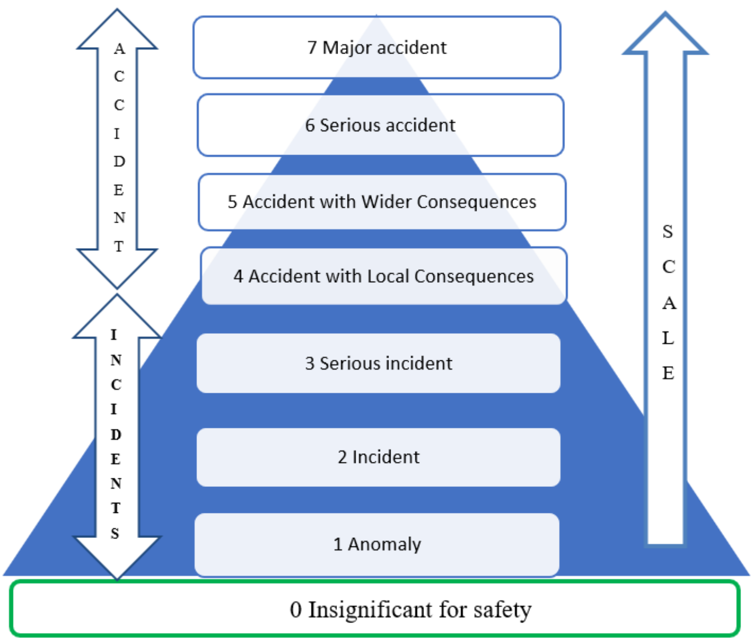

Figure 1. Radiation event scale.

Source: National Atomic Energy Agency

The seven-stage INES scale was developed in 1990. It was initially dedicated exclusively to classify events occurring in nuclear facilities. Over time, it started being used to classify events occurring during transport, storage and use of radioactive sources.

The scale is widely used by member countries of the International Atomic Energy Agency (IAEA) and the OECD Nuclear Energy Agency (NEA OECD).

2. Nuclear facilities and radioactive waste disposal sites which may endanger radiological safety in Poland

According to the Nuclear Law, nuclear facilities in Poland include the MARIA, the reactor (the first nuclear reactor in Poland, operating from 1958 to 1995, and currently at the decommissioning stage) and the used fuel storage bunker (facilities 19 and 19A and the MARIA reactor technology pool). These facilities are located in Świerk, in two separate organisational units: the MARIA reactor - in the National Centre for Nuclear Research, and the decommissioned EWA reactor and facilities 19 and 19A - in the Radioactive Waste Disposal Site (ZUOP), which also operates the National Radioactive Waste Disposal Site (KSOP) in Różan. A provided for by the Atomic Law Act, directors of these facilities are responsible for their safe operation and physical protection.

The National Atomic Energy Agency publishes annual safety assessments of nuclear facilities and radioactive waste disposal facilities.

2.1. MARIA reactor

The research MARIA reactor, currently the only active nuclear reactor in Poland, is a high-flux pool-type research reactor, with a rated thermal power of 30 MW and a thermal neutron flux density in the core of 1014 n/cm2s. The MARIA reactor has been in operation since December 1974 at the Institute of Nuclear Research, and then since 1983 at the Institute of Atomic Energy in Świerk. It was decommissioned for modernisation in 1985-93. The reactor is now operated by the National Centre for Nuclear Research.

Between 1999 and 2002, the MARIA reactor was converted from highly enriched fuel (80%) to 36% enriched fuel, and between 2012 and 2014 to low-enriched LEU fuel (U235 < 20% content). The fuel is placed in separate channels, laid on a beryllium matrix and cooled by water. The MARIA reactor is used for irradiation of target materials used for the production of radioactive preparations, for physical research using horizontal channels (mainly in the physics of condensed matter), for irradiation of crystals and creating silicone admixtures, for applied research, e.g. using neutron activation analysis, and for training purposes.

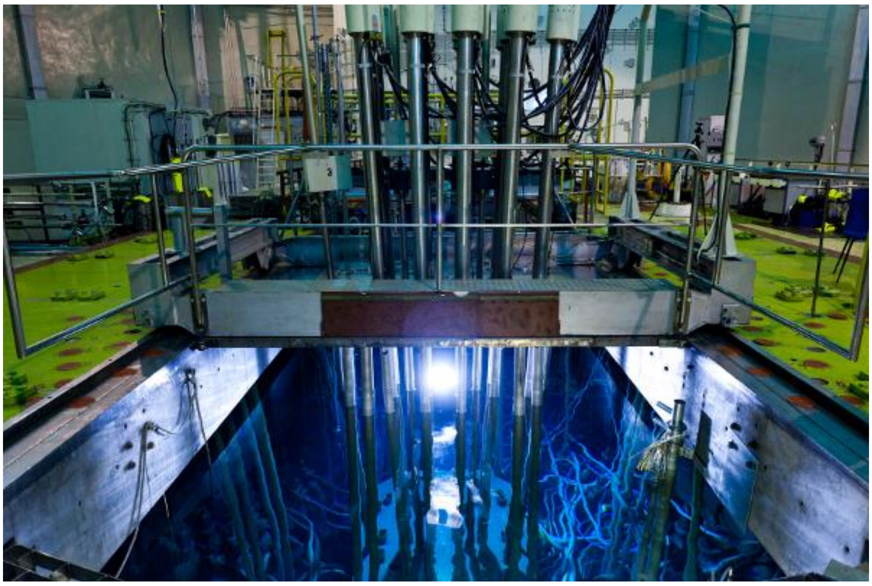

Figure 2. Interior of the MARIA reactor hall.

Source: National Atomic Energy Agency

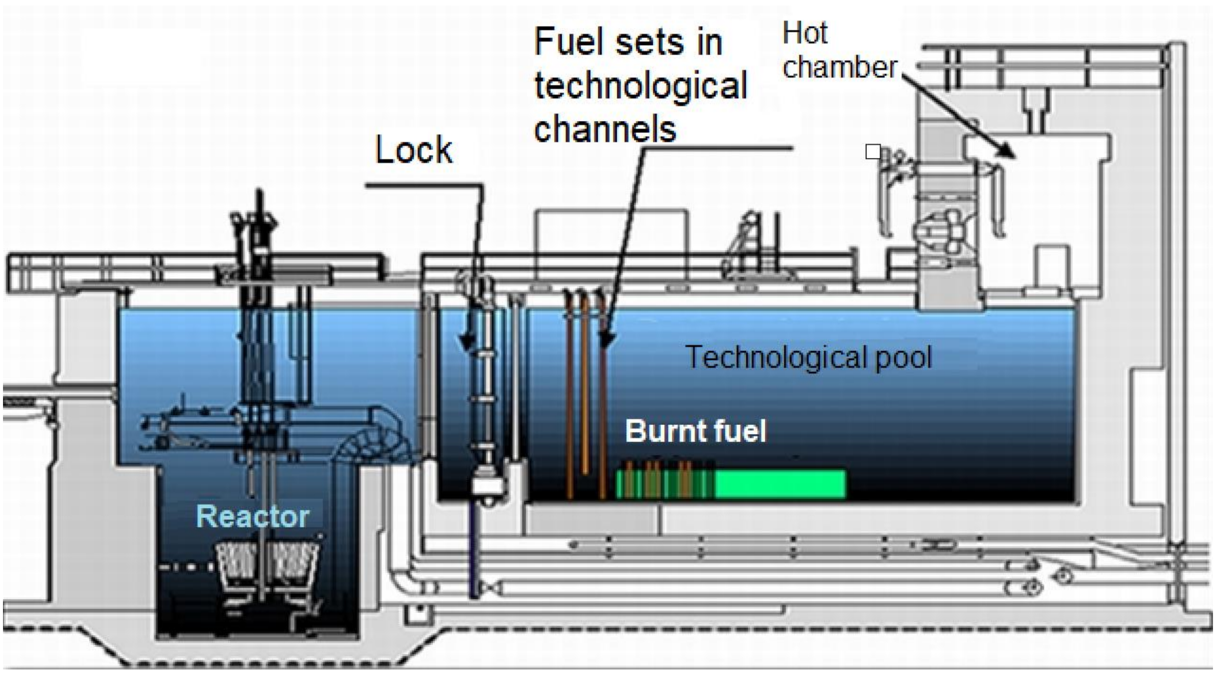

Figure 3. Cross-section of the MARIA reactor and the technological pool.

Source: National Atomic Energy Agency

2.2. EWA reactor

Apart from the MARIA reactor, from 1958 to 1955 the Institute for Nuclear Research (later the Institute for Atomic Energy) was operating the EWA research reactor.

Apart from the MARIA reactor, from 1958 to 1955 the Institute for Nuclear Research (later the Institute for Atomic Energy) was operating the EWA research reactor. Initially, its thermal capacity was 2 MW and was later increased to 10 MW. In 2002 decommissioning of this reactor, which began in 1997, reached the state defined in the relevant legislation as the end of Phase II, which means that nuclear fuel and all radioactive substances whose level of activity may be relevant for radiological safety has been removed from the reactor. Then, the works have been halted and decommissioning to a 'green grass' condition (Phase III) is not currently envisaged given the potential use of the reactor's biological shield body as a dry bunker for spent fuel from the MARIA reactor.

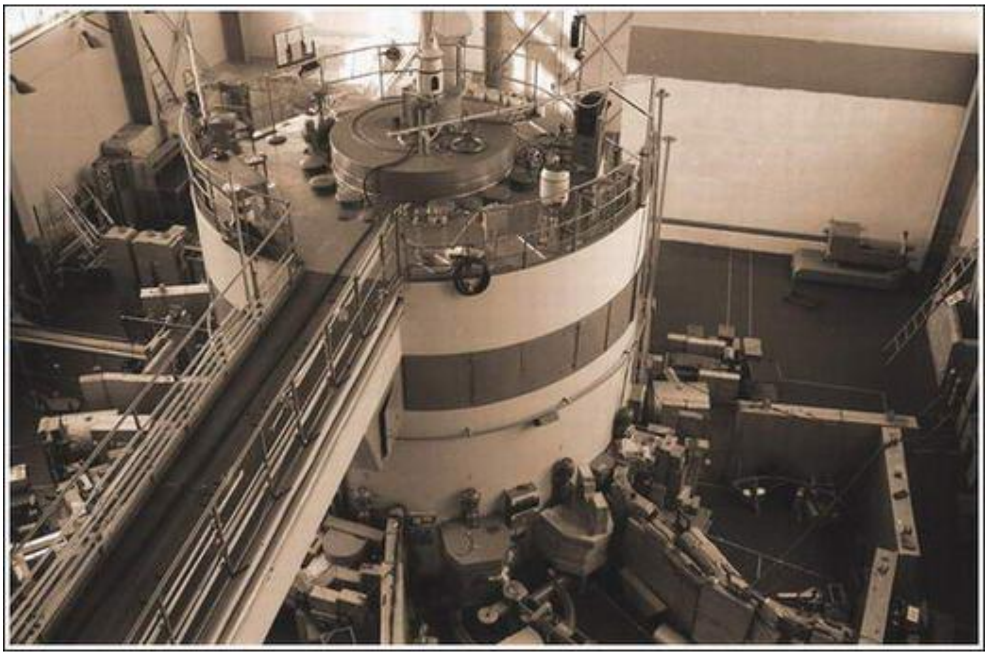

Figure 4. EWA reactor hall.

Source: National Atomic Energy Agency.

2.3. Spent fuel bunkers

Under the Nuclear Law Act, in addition to the MARIA and EWA research reactors, nuclear facilities also include a spent fuel storage bunkers. “Wet” spent fuel storage bunkers (with water) (facilities 19 and 19A) have been operated since January 2002 by the Radioactive Waste Disposal Site (ZUOP) located in Świerk.

Bunker 19 was used to store spent fuel of type EK-10 from the first operation period (1958-67) of the EWA reactor. It is currently used as a storage facility for selected solid waste from the decommissioning of the EWA reactor and for used high-energy gamma-ray sources. The bunker structure is based on a concrete body, in which four cylindrical chambers are located in a square grid. The chambers are lined with acid-resistant steel and there are storage tanks with separators for the appropriate distribution of spent fuel elements .

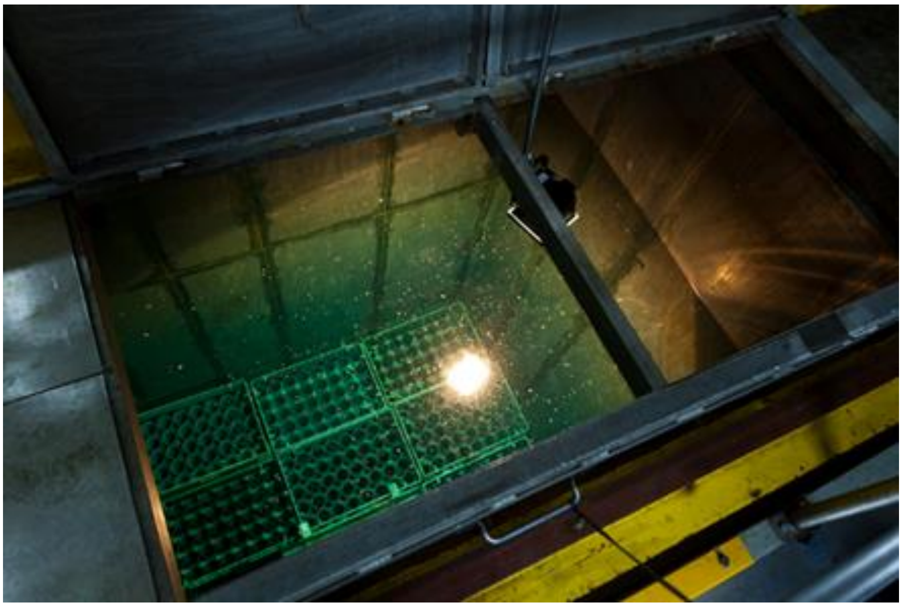

Figure 5. „Wet" spent fuel storage bunkers

Source: National Atomic Energy Agency

2.4. National Radioactive Waste Disposal Site

According to the MAEA classification, this is an over-ground waste disposal facility intended for the final disposal of short-lived, low- and medium-activity radioactive waste (with a half-life of ≤30 years) and spent sealed radioactive sources.

The National Radioactive Waste Disposal Site in Różan may store short-lived, low- and medium-activity radioactive waste and short-lived spent sealed radioactive sources. In addition, the plant may store long-lived radioactive waste awaiting disposal in a deep repository. Detailed information on the conditions that the repositories should meet is specified by the provisions of the Nuclear Law and the Regulation of the Council of Ministers of 14 December 2015 on radioactive waste and spent fuel (Journal of Laws of 2015, item 2267 and Journal of Laws of 2016, item 94). Detailed information on the quantities of radioactive waste transferred to the ZUOP and transferred to the disposal site can be found in the annual report of PAA President.

The Radioactive Waste Disposal Site (ZUOP) manages the collection, transport, treatment and storage of waste generated by all users of radioactive materials in Poland. ZUOP provides its services against payment, but the gains only cover a part of the costs incurred by the plant. ZUOP receives the missing funds in the form of subsidies from the Ministry of Energy.

2.5. Nuclear facilities near Polish borders

Poland does not have any nuclear power plant, but there are 8 active nuclear power plants (23 power reactors) within a distance of about 310 km from our borders.

These nuclear power plants include:

- 14 WWER-440 type reactors:
    - 2 blocks of the Rivne plant (Ukraine),
    - 4 blocks of Paks power plant (Hungary),
    - 2 blocks of Mochovce power plant (Slovakia),
    - 2 blocks of the Bohunice power plant (Slovakia),
    - 4 blocks of the Dukovany power plant (Czech Republic),
- 6 WWER-1000 type reactors:
    - 2 blocks of the Rivne plant (Ukraine),
    - 2 blocks of the Khmelnytskyi power plant (Ukraine),
    - 2 blocks of the Temelin power plant (Czech Republic),
- 3 BWRs:
    - 3 blocks of the Oskarshamn power plant (Sweden).

Figure 3. Nuclear facilities near Polish borders

Source: http://nuclear.pl/polska,wokol,elektrownie-jadrowe-wokol-polski,0,0.html

3. Nuclear security and radiological protection system in Poland

Close cooperation between the various types of services and offices relevant to that system is essential for ensuring a strong system of nuclear safety and radiological protection in Poland, That is why the President of PAA concluded formal agreements with the heads of services relevant to the fulfilment of his duties, as well as with the heads of entities responsible for the safety of Poland and its citizens.

These agreements define the forms and areas of cooperation within the scope of competences of individual entities and services. They concern issues such as the assessment of the radiation situation in Poland, protection of workers against ionising radiation, prevention of the consequences of illegal use or transport of radioactive sources and nuclear materials and the occurrence of a radiological threat to people and the environment *(Państowa Agencja Atomistyki*, 2020).

It is worth stressing that the PAA cooperates with the Border Guard and the Customs Service in the event of the detection of the illegal transport of radioactive sources and nuclear materials across the state border. The agreement within the framework of the National Contamination Detection and Alert System (KSWSiA) on cooperation in radiological protection and the elimination of the consequences of radiological events is also important. It makes enables making available the Central Unit for Contamination Analysis and its subordinate automated network for measuring radioactive contamination, a mobile radiometric laboratory and means of airborne contamination reconnaissance, as well as equipment intended for containing the contamination.

The cooperation between PAA and the State Fire Service and the Chief Sanitary Inspectorate covers, in particular, the participation of field Fire Service units and employees of Voivodship Sanitary and Epidemiological Stations in activities aimed at recognizing and removing the consequences of radiation events. Agreement of the President of PAA with the head of the Military Medical Institute in Warsaw enables diagnostics and the treatment of people with acute radiation syndrome *(Państowa Agencja Atomistyki,* 2020).

4. Assessment of radiation situation in Poland

In line with Article 72 of the Nuclear Law Act, the President of the Polish Atomic Energy Agency (PAA) makes a systematic assessment of the radiation situation in Poland. Data obtained from radiation monitoring, information on radiation events in Poland and information obtained from other countries and international organisations constitute the basis for such an assessment.

The Centre for Radiological Events (CEZAR) also presents a systematic assessment of the radiation situation in Poland. The tasks of the Centre for Radiological Events include:

- collection, verification and analysis of monitoring data,
- maintaining databases and operating IT systems essential for assessing the radiation situation in the country,
- verification and analysis of information on radiation events and reaction to radiation events (including operation of the National Contact Point and functioning of the PAA President's Emergency Service),
- cooperation in the field of radiation monitoring and crisis management with national institutions and emergency centres in other countries, as well as international organisations,
- forecasting the turn of radiation events and threats to the population and the environment in Poland.

Monitoring of radioactive contamination in Poland includes regular measurements of radioactive contamination, recording and analysis of the results of these measurements, enabling early detection of changes in alpha, beta and gamma radiation in the environment. Monitoring, carried out based on a regulation of the Council of Ministers, is coordinated by the President of the National Atomic Energy Agency.

The basis for these activities is the Regulation of the Council of Ministers on systems for detecting and notifying of contamination and the competence of authorities in these matters of 7 January 2013. The Regulation was issued based on the Act on the universal defence obligation in the Republic of Poland. It contains basic definitions and general principles for system organisation and an annex including a list of types of alarms, alarm signals and warning messages.

The national contamination detection system includes facilities responsible for detecting toxic chemical compounds, radioactive materials, infectious biological agents or infection focal spots.

They are organisationally and technically linked to each other and, in addition, to the entities that alert about contamination and counteract its consequences and to those that collect and process data and carry out preliminary analyses of the data collected.

The radiation monitoring system consists of stations for early detection of radioactive contamination and units measuring such contamination (§ 4(1)(c)). They make continuous or interval-based observations and measurements at geographically defined points or areas, both remotely and directly. It is the President of the National Atomic Energy Agency who is responsible for the operation of the national system for detecting radioactive contamination.

In the event of a radiological emergency, the public should listen to radio and television broadcasts from authorised services or public administrations. For example, it may be necessary to:

- Close windows and switch off the air conditioning;
- Check the sealing in windows, doors, ventilation grilles and any gaps.
  and crack, if there are no seals, create them with a wet cloth; inform the neighbours (they may not know about the threat);
- Store adequate supplies of drinking water, food and plastic bags for waste;
- Avoiding staying outdoors (in the open air), using filter masks when staying outdoors;
- Take a dose of stable iodine to block the thyroid gland (Lugol's iodine) under an organised nation-wide action;
- Reduce consumption of milk, fresh vegetables and mushrooms;
- Keep farm animals indoors and adapted them to stay there, including feeding;
- Engage in other actions recommended by medical or emergency services
  depending on the turn of events in a particular location.

Three factors minimize the impact of radiation on your body:

- distance – the larger the distance, the smaller the radiation dose;
- shielding – the denser and heavier the material, the better;
- time – in most cases, the radiation intensity decreases rapidly, thus limiting the time spent within the radiation area will limit the amount of absorbed radiation dose.

5. History of the development of the Polish radiation monitoring network

The beginning of the development of the Polish radiation monitoring network dates back to the works undertaken in the mid-1950s. by the employees of the Warsaw University of Technology, who as early as in 1957 established the Central Radiological Protection Laboratory in Warsaw (CLOR). The need to set up such a laboratory resulted from the then growing contamination threat associated with explosions trials of nuclear bombs and the increasingly frequent use of isotopes in technology and medicine (such as in non-destructive testing, radiology).

The Chernobyl disaster, which occurred on 26 April 1986, was a significant event in the history of the system. The government of the People's Republic of Poland got informed about the alarm situation thanks to the measurements made in the radiation monitoring station of the Radiation Detection Service in Mikołajki, managed by CLOR in Warsaw, by prof. Zbigniew Jaworowski. On the 28th of April, an increased amount of radionuclides in the air was recorded, when the cloud of radioactive dust reached the Polish territory. Even before any information of the Chernobyl disaster was received, an analysis of the radioactive air contamination had shown that it stemmed from a nuclear reactor accident. The identification of the risk has been facilitated by the experience that CLOR employees gained in controlling, among other things, the degree of exposure of medical staff and patients in hospitals, using a radioactive isotope of iodine 131I increasingly frequently since the mid-1960s.

With the early information on the nature of the threat, it was possible to quickly introduce civil protection measures. In accordance with the CLOR proposal, already submitted on the night of 28/29 April, large doses of stable iodine (Lugol’s iodine) (an aqueous solution of potassium iodide and elemental iodine) started being administered to children. This limited the absorption of radioactive iodine 131I, whose accumulation in the thyroid gland may lead to the formation of its neoplasms. Within a few dozens of hours, the stable iodine preparation was administered to 18.5 million people. Grazing of cattle on meadows was also stopped and it was recommended to limit the consumption of products that could get contaminated (milk, fresh fruit and vegetable, mushrooms, rainwater). A communication from the Government Commission and a contamination table were published in the press. CLOR started monitoring the level of 131I iodine in children's thyroid gland (at the end of May an order was received to stop this measure).

The COAS Centre, made of units of the Armed Forces' Infections Detection System, participated in monitoring radiation as well as in drafting and dispatching messages. The experience gained during that time facilitated the launch of the Military Automated Radioactive Contamination Measurement Network (SAPOS, since 1994 - an element of the State Environmental Monitoring, PMŚ) in 1991. Since 1993, the Centre has been operating the Control Point for the Contamination Detection System, whose staff stays on duty round the clock to monitor contamination levels in the whole Poland. In the 1990s, COAS began to adapt its operating principles to those in force in NATO.

6. The contemporary national radiation monitoring system

Currently, the national radiation monitoring system is supervised by the National Atomic Energy Agency in cooperation with the Central Radiological Protection Laboratory (CLOR), the National Contamination Detection and Alarming System (KSWSiA, operating since 2006), 6th Air Force Chemical Battalion and other units. The Central Unit for Contamination Analysis(COAS) plays the role of the KSWSiA's control centre. Polish experts also participate in works of international institutions, among others they are members of working groups of the European Atomic Energy Community (EURATOM), including groups for monitoring the level of radioactivity in the air, water and soil and groups for controlling the observance of the principles of transmitting results of radiation monitoring carried out in the Member States (including during radiation events) to the European Commission. Among other things, they draft reports on radiological safety in Poland for the International Atomic Energy Agency (a UN agency), as required by the Convention on Nuclear Safety.

6.1. Early contamination detection stations

There are the following types of early detection stations in Poland:

- base stations (round the clock), whose task is to make dose and spectrometric measurements of gamma radiation, enabling the detection of dose power increase by 25 nSv/h above the average value from the previous 24 hours; these stations are equipped in filters enabling the collection of atmospheric aerosols and detection of 131I and 137Cs (at the level of microbecquerels per cubic metre of air, $\mu Bq/m^3$) and total alpha and beta radiation (at the level down to Bq/m^3 after 1 hour of collection),
- auxiliary stations, whose task is to measure the power of the gamma radiation in their surroundings.

The basic station is the ASS-500 station, which is a field device for continuous sampling of atmospheric aerosols. Suspended particles are stopped by a Petrianov filter (FPP-15-1.5, active surface area 420×420 mm), through which a fan forces a stream of air sourced from 1.5 m above ground level. Pumping of about 10^3 m^3 enables qualitative and quantitative spectrometric analysis of natural and synthetic radionuclides from the level of 0.5 $\mu Bq/m^3$ (use of of a low-pressure gamma-ray spectrometer with an HPGe detector).

At all stations in Poland, samples are taken on a weekly basis. The Department of Dosimetry of the Central Radiological Protection Laboratory drafts collective monthly and quarterly reports and submits them to the National Atomic Energy Agency. The results from the station operating in the Central Radiological Protection Laboratory CLOR (Warsaw) are sent, based on the principle of reciprocity, to analogous units in other countries (Germany, Switzerland, Finland, Italy, Belarus, Hungary).

Some of the ASS-500 stations is equipped with three Geiger counters, which measure on-line the gamma and beta radiation levels in the collected dust (no possibility to distinguish between natural and synthetic radionuclides). Research is being carried out to improve detection methods so that they are better suited to the needs of the systems for early warning and alerting of the presence of synthetic radionuclides.

PMS stations constitute yet another type of stations. The PMS (Permanent Monitoring Stations) system enables continuous, unmanned monitoring of radiation. The station and the system were designed in Denmark in the early 1990s. In the years 2005-2006, a significant modernisation of the station's hardware and software took place in Poland:

- Scintillation counter of gamma radiation with NaI(Tl) sensor; power range: 100–2500 keV,
- Geiger-Müller sensor for measuring dose power equivalent (Sv/h)
- temperature sensor,
- rain gauge (mm/h).

Since 2016, new PMS stations have been installed to make the following measurements:

- Meteorology:
  - measurement of rainfall or water snowfall equivalent
  - measurement of wind strength and direction
  - measurement of humidity
  - temperature measurement
  - atmospheric pressure measurement
- Radiometry
  - Measurement of the spatial equivalent of the H*(10) [μSv/h] dose in the power range of 50 keV - 1300 keV (Geiger-Müller detector).

The stations run by the Institute of Meteorology and Water Management (IMiGW) and the Ministry of National Defence (MON) are complementary. The IMiGW stations make continuous measurements of the gamma radiation power dose, tests of atmospheric aerosols (total and synthetic alpha and beta activity) and tests of rainwater samples (137Cs content in weekly and monthly samples, total beta activity in daily and monthly samples, 137Cs and 90Sr content in combined monthly samples from all 9 stations).

The stations belonging to the Ministry of Defence referred to as “auxiliary” stations, are located within military units. They perform automatic measurements of the power of gamma radiation dose (the results are transferred to the Central Unit for Contamination Analysis - COAS).

The national radiation monitoring system includes

- 19 automatic PMS (Permanent Monitoring Station) stations belonging to PAA,

- 12 ASS-500 type stations (Aerosol Sampling Station), belonging to CLOR (except one - belonging to PAA),
- 9 IMiGW stations,
- 13 auxiliary stations belonging to the Ministry of Defence.

6.2. Measurement facilities of the National Radiation Monitoring System

Measurement facilities carry out laboratory analyses of radioactive contamination in environmental samples (air, water, soil), food and animal fodder. The facility network consists of:

1. primary facilities - 31 laboratories operated in the Unit of the State Sanitary Inspectorate (San-Epid),
2. specialist facilities - laboratories performing more detailed radioactivity analyses, operating in:
   - Central Radiological Protection Laboratory in Warsaw,
   - National Institute of Hygiene
   - National Centre for Nuclear Research in Otwock,
   - Institute of Nuclear Physics in Kraków,
   - Central Mining Institute in Katowice,
   - AGH University of Science and Technology in Kraków
   - Institute of Meteorology and Water Management in Warsaw,
   - Military Institute of Hygiene and Epidemiology in Warsaw,
   - Military Institute of Chemistry and Radiometry in Warsaw,

The tasks of specialist facilities include the measurement of the content of radioactive isotopes in samples of, for example:

- milk, potable water, and food - determining: - synthetic α-radioactive isotopes, especially 239Pu, 241Am above the level of 1 Bq/dm^3,
- synthetic γ-radioactive isotopes, especially 137Cs above the level of 0.1 Bq/dm^3 and 90Sr above the level of 0.06 Bq/dm^3,
- surface water – determining the level of 137Cs above 0.1 Bq/dm^3 and 90Sr above 0.06 Bq/dm^3,
- soil – determining 137Cs above the level of 0.1 kBq/m^2,
- bottoms – determining the level of 137Cs above 1 Bq/dm^3 and 239Pu above 0.1 Bq/dm^3,

- total atmospheric precipitation – determining the level of 137Cs above 0.05 Bq/m²·month, 90Sr above 0.05 Bq/m²·3 months.

In addition to analyses, specialist centres deal with keeping records of samples and analyses, participating in comparative measurements organised by the PAA (at least every two years) and developing new measurement techniques.

By the end of 2020, the National Atomic Energy Agency will expand its network of stations for early radioactive contamination detection. By the end of the year, a total of 15 new facilities will monitor the eastern border of Poland. The new stations will reinforce the system for detecting atmospheric radioactive contamination. The expansion of the network and its density will enable the National Atomic Energy Agency to earlier detect radioactive incidents across Poland's eastern border. This will enable the Agency to react faster in crisis situations and better inform the public about the possible necessary remedial actions.

Thanks to the expansion, the number of stations for early detection of radioactive contamination on the eastern wall will increase from 6 to 19. The exact locations of the 13 new stations will be given after an analysis of, among others, the relief, natural environment, urban planning aspects and availability of telecommunications infrastructure. The measure also provides for replacement of two old stations with new ones. It is expected that the development of the network of stations for detecting radioactive contamination will be completed by the end of 2020.

The measuring stations of the system for early detection of radioactive contamination are intended to enable an ongoing assessment of the radiation situation in Poland country, with particular regard to population safety. The system enables quick identification of radiation hazards.

6.3. Data exchange system in the European Union

The EURDEP (European Radiological Data Exchange Platform) operates continuously and covers the exchange of the following data from early contamination detection stations:

- power of gamma radiation dose (PMS and IMiGW stations),
- total alpha and beta activity derived from synthetic radionuclides in atmospheric aerosols (IMiGW stations).

Poland communicates its measurement results once an hour, regardless of the mode.

Besides, the European Union system for the exchange of measurement data from routine environmental radiation monitoring in EU member states includes data on dose power, air contamination, contamination of potable water, surface water, milk and food (diet). Once a year, the PAA Radiation Events Centre transmits the data to the Joint Research Centre (JRC) located in Ispra, Italy.

The scope and format of data transmitted by Poland within the framework of the exchange within the Council of the Baltic Sea States (CBSS), i.e. regional exchange, is identical to the EURDEP system in the European Union.

Final conclusions

Attempts to answer questions related to the issue under discussion has huge implications for both the natural and medical sciences, as well as for the psychological aspects.

Employees' compliance with and regulations is crucial for protecting workers' health and life and, in particular, the security of millions of citizens, as one of the biggest radiation disasters in the world history, the Chernobyl disaster in 1986, may prove.

It must be borne in mind that radioactive waste is very hazardous. Even small radioactive doses constitute a health hazard when taken over time. People who handle radioactive materials should be subject to a kind of self-control. Employers play a huge role, as they should often organise training on work safety with ionising radiation sources, and workers should know the three basic principles of radiological protection:

- the shorter the time spent near of a radiation source, the lower the dose,
- the further from the radiation source, the safer,
- shielding weakens the radiation.

Poland is now in a period of intensified discussion on the construction of a nuclear power plant within its territory. The public is very polarised with respect to this issue. Various voices are emerging from the discussion as to the legitimacy of the undertaking and its deployment when many countries are focusing on the development of other energy sources heading towards environmental safety. Both the countries close to us and neighbouring countries of Western Europe can serve as examples.

There are many doubts and many questions to be raised. However, with the need for a comprehensive approach to the reorganisation of our power sector in mind, its increasing orientation towards new energy sources and global trends related to broadly understood ecology, the energy obtained from the "'atom' becomes justified on condition that it is based on state-of-the-art technological solutions.

Rising some kind of public awareness and education in the area of radiation security is also extremely important. The society needs to understand the problem and then accept it as an inevitable process in building a new national power industry.

References

Państowa Agencja Atomistyki (2020). Available at: https://www.paa.gov.pl/.

Koziej, S. (2012) ‘Identyfikacja zagrożeń globalnych dla bezpieczeństwa międzynarodowego’ *Przyszłość. Świat - Europa – Polska* (No 2).

Kleszcz, S. (2017) ‘Rola Krajowego Systemu dostępu Skażeń i Alarmowania w systemie obronnym państwa’ *Przegląd Nauk o Obronności, 34*, 9 1-109. doi: https://doi.org/10.5604/01.3001.0013.0086

Kleszcz, S. (2018) Środowisko bezpieczeństwa RP dzisiaj i w perspektywie 15 lat. Terroryzm klasycznyoraz terroryzm z zagrozeniem od czynników CBRN. Warszawa: Wydawnictwo WAT.

Świerszcz, K. (2018) ‘Podmiotowość bezpieczeństwa energetycznego w wybranych regionach polski na przykładzie zasobów geotermalnych’, *Przegląd Nauk o Obronności*, (5), 93-105. doi: https://doi.org/10.5604/01.3001.0012.9742.