DOI: 10.29302/Pangeea 17.07

WE LIVE WITH RADIATION

Assoc.prof. PhD MONICA ANGELA BARA
Prof. PhD NICOLAE LUDUŞAN
"1 Decembrie 1918" University of Alba Iulia, Romania

ABSTRACT: *After the second war, at one time with the anticipation of nuclear fission importance, the radioactive elements were "rediscovered" and became very important energy sources. In this time was elaborated a lot of studies about the radiation properties, but this study are not accessible for commoners, therefore existing very much exaggerated information about the impact of radiations in to environment. These study presence, in a common language, the theoretical aspects of radiations and, in final, some dates about the Chernobyl accident and the possible sources of supplementary irradiation in the Alba district, Romania.*

Key words: *radiation; exposed; nuclear fission; ionization; damage;*

1. Radiation and radioactive elements

The most simplest definition that may be given to the radiation can be formulated as follows: *radiation are the emission of sound waves, electromagnetic waves etc., or particles which propagate in the form of rays in all directions* (according to the Explanatory Dictionary of Romanian Language, Academy Publishing House, Bucharest,1975).

Starting from this definition could easily deduce that the environment is constantly crossed by a wide range of radiation , first the sound and ending by the radiation emitted during radioactive decay processes (Fig. 1), but not all radiation has the same impact on the human body [1]. For example, electromagnetic waves, have no influence on the environment, but the sound waves, or certain portions of the light spectrum (infrared or ultraviolet spectrum), affects, a greater or lesser extent, certain components of the environment.

The most aggressive, in terms of impact, especially on the plants or animals, are produced during the radiation process of radioactive decay (fission reactions), which are the radiation, unlike other types of radiation, for which the term is waves, the terminology to be used in subsequent chapters of the work.

1.1. Natural radiations

Natural radiation is present everywhere in the environment. This radiation comes from outer space or from the Earth, because the Earth himself is radioactive, so that each body is exposed to natural radiation a greater or lesser extent.

According to some experts, the Cosmic radiations, would derive most of our galaxy and other experts claiming its origin in the extragalactic space. The fact is however that a significant amount of radiation comes from the Sun, because the undetermined radiations are practically constant in number and intensity, but those who come from the Sun are mainly emitted during solar eruptions. Once entering in the atmosphere, cosmic radiation is gradually absorbed by it, so that the dose decreases as altitude decreases. The number of cosmic particles entering the atmosphere is affected by Earth's magnetic field, leading to a decrease in the intensity of radiation from the poles to the equator.

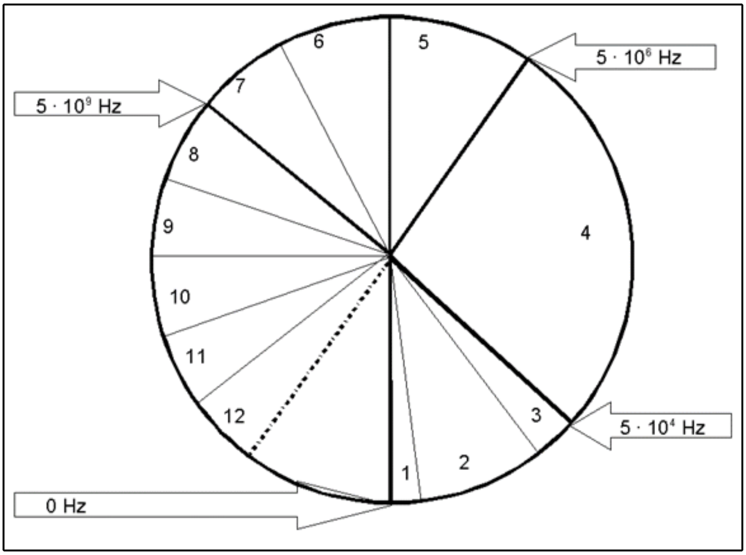

Fig. 1. Classification of radiation in the frequency of oscillation
1-infrasound, 2-sound waves, 3-ultrasound, 4-electromagnetic waves, 5-infrared radiation, 6-light radiation, 7-ultraviolet radiation, 8-X-rays, 9-neutron radiation, 10-γ radiation, 11-β radiation, 12-α radiation

Terrestrial radiation exists because all the components that make up Earth's crust (minerals, rocks) are radioactive, some experts arguing that the resulting energy from natural radioactivity from the Earth's core would help to the crust movements. The radioactive elements that contribute most to terrestrial radiation are represented by Uranium and Potassium. Uranium is dispersed in soil and rock at low concentrations, and where concentrations reach 1500 ppm. (parts per million), forming deposits that can be economically exploited. 238-Uranium is a first of radionuclides series of different elements that successively transforms to the final stable nuclide, 206-Lead. Among the early decay of disintegration is a radioactive gas, 222-Radon, some of which continue to diffuse into the atmosphere where it disintegrates. Thorium is also dispersed in the crust and during his disintegration giving a radioactive gas that diffuses into the atmosphere, 220-Radon, also known as the Thoronium [2].

1.2. Artificial radiation

Modern technology uses the disintegration in many areas, but use this property itself and the final products resulting from its use, will increase the radiation dose received by the human body.

Medical treatments use X-ray equipment , they are the most popular artificial sources of radiation being used in a variety of diagnostic procedures, from simple X-ray of the chest to the complicated dynamic studies on the heart. Patients may receive the radionuclide for investigative purposes, as 99-Tchnetium that is frequently used, which has a short half-life and is used in examinations of CT scans of the brain and bones. Radiation is used for therapeutic purposes, known as method of treating cancer by strong irradiation of malignant tissue to prevent the functioning of tumor cells. Also are used the radionuclide which are administered as drugs in order to treat cancer,for therapeutic purposes.

Radioactive deposits derived from

nuclear experiments, are spread all over the world, as a result of conducting these experiments in the atmosphere, which has led to deposits on Earth, nearly 3 tons of 239-Putonium and the emergence of a wide variety of radionuclide, such as: 16-Carbon, 90-Srontium and 137-Cesium. A significant part of the radioactivity is initially injected into the upper layers of the atmosphere, where it is slowly transferred into the lower strata and hence toward Earth, resulting in so-called radioactive deposition.

After the signing, in 1963, the Nuclear Test Ban Treaty in the atmosphere, radioactive activity of the upper atmosphere has considerably dropped, although the decrease is sometimes hampered by the experiences of countries not-signatories of the treaty.

Radioactive waste discharges into the environment come mainly from the nuclear energy industry and to a lesser extent, from research units and the hospitals. The Uranium for nuclear reactors is processed first as fuel, then used in the reactor and then reprocessed, in each of the three stages being "discharged" radioactivity in air and surface waters as a radioactive gases and aerosols.

Radiation dose received by the population depends on the nature and radioactivity of radionuclide released, how they are dispersed into the environment, residence, lifestyle and food habits of the peoples. Discharges of radioactive waste are subject to legal restrictions, being controlled and try to their continuous reduce, but this operation requiring additional expenses.

In the air and surface waters, the controlled discharge are present, caused by various institutes: for research, defense, industrial, medical, the radiation even if they caused an insignificant action but are also exposed to the same legal restrictions like the discharges from nuclear energy program.

Occupational exposure to radiation is on the use of radiation in industry, for process control and product quality, in medical diagnostic purposes and for study in universities and research institutes. As a result, there are a large number of processes that expose people to certain additional radiation beyond those arising from the environment or the nuclear industry. In addition, there are people, especially those working in the mines and air crew personnel, who are exposed to high levels of natural radiation.

Accidental exposures are present in people who come into contact with the radiation from natural or artificial sources, such as: luminescent watches with radioactive substances, television receivers, gained cosmic radiation during air travel and exposure to radioactivity dispersed into the atmosphere during coal combustion.

Carriers accumulated radiation doses from the luminescent watches are declining, as they use less hazardous radionuclide, as well as those due to television, because the kinescope tubes are well shielded. Excess of radiation coming from space, that people receive it in the plane, increases with increasing travel [3].

2. Impact of radiation on tissues

Radiation effects of energy loss by electric and ionization interactions is easy to guess where the water molecule, which has 10 protons and 10 electrons and after the passage of charged particles, an electron is ejected, leaving the molecule with an electrical charge in excess. These molecules may be transformed into other entities, such as free radicals, highly chemical reactive and which may modify important molecules of a tissue.

For a very special importance is deoxyribonucleic acid (DNA), located in the cell nucleus, its role is to control cell structure and function and to produce replicas of himself. Although the ways in which radiation affects the cells are not fully clarified, they could still show two types of action of radiation on DNA: a direct chemical change by ionization, or indirectly, through a free radical existing in the liquid cell. In both cases, chemical modification can be the basis of a harmful biological effect due to a strongly localized defect or a global defect, both of which are involved in cancer and genetic flaws.

As penetration power, α particle having a low speed, can barely penetrate the outer surface of the skin, thus emitting radionuclide that are not dangerous, unless you would be conscripted into the body. B articles can penetrate the body about 1 cm, thus radionuclide are hazardous to the superficial tissues but no to the internal organs, except they are incorporated in the body. Γ, x and η radiation pass the entire body and the radionuclide can be dangerous, both outside and inside the body [3].

3. Impact of radiation on the human body

The whole environment is constantly traversed by rays of various origins, all of which influence the body, set up in living tissues.

3.1. Natural radiation and human body

The amount of radiation accumulated by the human body can be determined as a physical quantity called equivalent annual dose, the unit of measure called seevert, the symbol Sv. Since 1 seevert equivalent dose of a year (1 Sv/year) is a large amount of energy, current measurements using a subunits, respectively microseevert, the symbol μSv, which is 1/1 million from a Sv. Annual dose equivalent value is influenced mostly by radiation intensity and exposure time, the unit size of this complex, currently being used, is called microröentgen per hour, the symbol μR/h. Each man, regardless of geographic area of residence, is subject to aggression of the two types of radiations, cosmic radiation and terrestrial radiation, plus the accidental exposure to artificial radiation.

Cosmic radiation. Since the vast majority of the world population lives at low altitudes, in terms of cosmic radiation dose is a small annual variation due to latitude, this varying from 320 μSv/year in northern Europe and 250 μSv/year in the Mediterranean area. Against this category of radiation can not do anything to minimize exposure, because it penetrates easily through walls of ordinary buildings.

The terrestrial radiation. A and β radiation with a very low penetration power, has very little influence on the population, the basic influence is given by γ and x radiation, and radioactive gases (Radon). Terrestrial γ radiation, irradiate the entire human body. Since building materials are extracted from the lithosphere, so they are radioactive, the population is irradiated both at home and outdoors, the doses being influenced by geological structure of the area and structure of buildings. Average dose equivalent derived from γ radiation is about 400 μSv /year, but there is considerable variation around this value, some people received doses several times higher than average.

Radioactive gases, Radon and Thoron, emitted into the atmosphere, are disperses in the air in relatively small concentrations, but they entered the house through the walls and floor and focus because of air stagnation. Of radon decay products attach to dust particles can be in the air, which when inhaled and produce lung irradiation. It is estimated that the annual dose equivalent due to radon products, on average, about 800 μSv/year, with pronounced changes, with private housing occupants received the dose is higher by two orders of magnitude. It is known, in this case, residential area of Avram Iancu-Băiţa (Apuseni Mountains), where the inside radiation intensity is about 200 μR/h, unlike the natural background intensity which falls in the range of 28 to 30 μR/h, leading to an equivalent dose of 4000 μSv / year. The case is the building material, consisting of schist and sandstones with impregnations of radioactive elements minerals.

To reduce the dose in a room can act by removing the decay products of the building, by increasing ventilation and use of air purification installations or prevent Radon entering the home, sealing floors or improving ventilation

The food radioactivity is due to the presence in the air, food and water of radionuclide, particularly 40-Potassium, 210-Lead, 210-Polonium and 14-Carbon, which are ingested daily in the body. It is estimated that the dose given to these sources of internal radiation is about 370 μSv / year, of which 40-Potassium contribute about 170 μSv / year. There are few possibilities to amend the internal exposure due to these radionuclide, except for avoiding any food or water with high content of radioactive elements.

The total dose of radiation accumulated by the human body due to radiation of natural origin is, on average, about 1870 μSv / year (Table 1).

is estimated that the average effective dose equivalent due to medical procedures is 250 μSv / year.

Radiation medical treatments can cause direct harm to the descendants patients, individual dose can be reduced by reducing the number treatments without it being put on treatment harm the patient.

Radioactive deposits on the nuclear experiences have an important contribution to increasing the dose of radiation, since from these experiments were deposited on the surface crust about 3 tons of 239-Plutonium. Much of the initial radiation is injected into the upper layers of the atmosphere, where it is transferred gradually to the lower strata, and from there, through rain, much faster toward Earth. The radionuclide from radioactive deposits are inhaled directly or included in the food, giving an internal radiation dose equivalent is about 10 μSv/year from a peak of 80 μSv / year to start the sixth decade of 20th century, when these experiences have been stopped.

Table 1. Average annual effective dose equivalent given by the natural radiation [3]

SOURCE	μSv
Cosmic radiations	300
Terrestrial radiation	400
Radon	800
Other internal radiation	370
TOTAL	1870

3.2. Artificial radiation and human body

Medical treatments, especially due to X-ray facilities (Roentgen) used in hospitals, given the higher dose of artificial radiation, whereas a simple scan may transfer in lung equivalent dose of 20 μSv / year.

In medicine the radionuclide are also used for investigative purposes or are used for radiation therapy, for cancer treatment. It

Occupational exposures contribute to the dose equivalent to persons working with radiation sources, but it is limited by law and in practice can not exceed 5000 μSv/year. Many people come to receive doses close to this limit (the medical staff 70 μSv / year , the nuclear industry 250 μSv / year, industry radiologists 170 μSv / year) the general trend of these doses are constantly decreasing. Besides those mentioned, there are people, particularly miners and air crew who are exposed to high levels of natural radiation, coal miners receiving an average dose of 2600 μSv / year.

Average annual dose received by the population from artificial radiation fall within the 250 μSv / year, of which medical procedures are, the most important sources of exposure of the population.

4. The Chernobyl accident

The Electric Factory in Chernobyl (Ukraine) is equipped with first-generation reactors, such that those based on graphite moderator.

In any type of reactor, enriched uranium is placed in bars, until the amount reaches critical mass, fission reaction is initiated spontaneously. To be controlled, between the bars of uranium are inserted the bars made from different types of moderators (in this case, graphite) which take the neutrons energy emitted during the fission reaction, which then yields a cooling circuit in that the agent is heavy water. In addition to taking energy, they also act as moderators to control the speed of the fission reactions, they are extracted automatically in calculated rhythm, from uranium fuel rods. Since the reaction is not perfectly linear, there may be situations where speed of fission reaction to increase or decrease, a phenomenon immediately reported by the coolant temperature, in which case it occurs by faster inserting or removing bars moderator.

The Chernobyl accident was to increase the speed of reaction, and temperature in the reactor so. When intervention for moderator reintroduction, who have slower reaction, installation has been blocked and the temperature increasing to the point of ignition of the graphite moderator. The explosion that followed was not a nuclear explosion, but the explosion of the graphite moderator.

The blast threw a radioactive dust cloud into the atmosphere, which contained a number of isotopes from the different stages of decay of uranium.

The material remained after the explosion, given the uranium mixture with the moderator, will continue to function as a reactor until all the uranium will be finished, and if the remains of reactor are well isolated, the environmental impact will be felt only in the surrounding areas.

Radioactive cloud was formed after the explosion had serious effects on the whole of Europe.

The effect was “favored” by the meteorological situation of the moment. If it had been normal, the general movement of air masses over Europe, the west-east direction, would have led to the displacement of the cloud Ural Mountains, but the existence in this time of a cyclone centered over Poland, trained cloud over central Europe. Effect on Romania was entering the radioactive cloud from the Pannonian Plain in Transylvania, through the Somes canyon.

Among the radioactive isotopes signaled in the area, in large quantities was detected 134- Iodine. To reduce the effects were given of population iodine tablets for thyroid saturation and not to not accumulated the radioactive isotope. Iodine, with very low half-life (about 4 days), has diminished very quickly the effect. Other radioactive isotopes such as: 89-Strontium, 91-Yttrium or 140-barium, with higher half-lives, have been trained by precipitation water in soil and their effect is felt even at present (see table 2) .

In the Alba Iulia area, measurements made at that time showed an equivalent level of absorbed dose to each person about 3000 μSv, accumulated within about a week, after that the activity decreased, so that against a period of one year ,absorbed dose does not exceed the maximum permissible dose for occupational exposure.

The annual average accumulated dose values for the Romanian population in XXth century, from various sources, are given in Table. 2.

Table 2. Body irradiation in Romania assessed effective equivalent dose [3]

Years	Irradiation **(µSv/year)**			
	Natural	Additional	Medical	Professional
1900	2000	-	-	-
1940	2000	-	100	-
1963	2000	430	300	10
1964	2000	120	300	10
1965	2000	80	300	10
1975	2000	20	300	20
1985	2000	10	500	25
1986	2000	1250	600	25
1987	2000	360	700	30
1988	2000	300	700	30
1989	2000	100	700	30
1990	2000	75	700	30

Data in the table involves some explanation of the additional radiation. It began to be determined from the 1963, year ban of nuclear experiments in the atmosphere, it is gradually decreasing to a value of 10 µSv in 1985, after the jump occurring in 1250 µSv in 1986, caused by the Chernobyl accident . For the next three years, values are gradually decreased, as in 1990 to 75 µSv, but much more than the value before the accident.

The increase of medical radiation is due to the use increasingly frequent medical examinations with x-ray, equipped with radiation sources (especially when treating malignant tumors) and medical treatment with radioactive isotope [4].

5. Possible additional sources of irradiation in alba county

As noted above, additional sources of radiation consist of natural sources (mineralization, accumulations or deposits of mineral contenting radioactive elements) and artificial sources.

Regarding natural resources, they are localized only in mountain areas, Apuseni and Sebes Mountains. The Apuseni Mountains are a few reservoirs, some of the industry, in the upper basin of Aries valley, such as those localized in the Arieşeni village (Galbena, Vârciorog, Scorţăriţa valleys) or the formation of a kind of perimeter Avram Iancu and Lupşa-Bistra [6].

Regarding deposit of Rosia Poieni worth mentioning that the deposit mass was reported presence of several small lenses of Pechblenda (uranium mineral) and natural gamma radiation slightly higher intensity (around 40-45 µR / h), but this is specific to all deposits of Copper, Uranium due to special chemical affinity for Copper. Reported to the fool deposit, these accumulations are completely insignificant and does not constitute an additional source of radiation than for staff directly involved in the operation.

In Şureanu Massif (Sebes Mountains) have been reported several areas with radioactives anomalous minerals of Thorium and TR, mainly in the upper basin of the Sebes river (Dobra valley).

All these lead to an increase in natural radioactive activity in those areas, surface water, groundwater and vegetation, which, adding the radon emanations, resulting an increase of dose values that can reach up to 3000 µSv/year, presence of this additional natural radiation can not feasibly be eliminated or weakened [2, 5].

Regarding additional artificial irradiation, the county there is no nuclear-profile target, so that from this point of view, additional radiation is nonexistent.

As a **final conclusion on** this, we can say that life on Earth appeared and evolved in the radiation environment, so that the presence of radiation is beneficial in certain doses, the total lack of it can lead to unpredictable disruptions of physiological processes, chain trophic or life forms.

Referring to the equivalent dose of natural radiation, this is around 2000 μSv / year and the maximum permissible dose for occupational exposure is 5000 μSv / year, dose that can be overcome if a brief exposure provided later person is released from the additional radiation for a period of time equivalent additional dose received. These values were taken to be compared with the equivalent dose to the first signs of radiation disease, which amounts to 20 Sv/year (20 million μSv/year).

REFERENCES:

[1]. Nederkorn, I., Lemnaru, G. (1980), *Combustibili nucleari*, Ed. Ştiinţifică şi Enciclopedică, Bucureşti, 1980
[2]. Stoici, S.D., Tătaru, S. (1988), *Uraniul şi thoriul*, Ed. Tehnică, Bucureşti.
[3]. National Radiological Protection Board, (1989), *Living with radiation*, Ed. Tehnic, Bucuresti.
[4]. Le Parlament de la Roumanie, The Parlament of Romania (2006), Législation roumanine, Romanian Legislation: *Déroulement des activités nucléaires en sûreté - The safe deployment of nuclear activities*, Monitorul Oficial, Bucureşti.
[5]. Murariu, T. (2005), *Geochimia si metalogenia Uraniului*, Ed. Univ. Al.I. Cuza, Iasi.
[6]. Bardan, Teodora (2008), *Scurt istoric al evoluţiei industriei uranifere în România*, in PANGEEA, no. 8, Ed. Aeternirtas, Alba Iulia.