Safety Rules Against Hazards of Nuclear Radiation

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Contents

1 Introduction to Nuclear safety

The International Atomic Energy Agency (IAEA) is an intergovernmental organization that has its objective to use nuclear energy in a peacefull manner and to inhibit its use for anymilitary purposose. IAEA was cretaed in response to growing international concern toward nuclear weapons, specifically the tension between the US and the Soviet Union.

The IAEA serves as an intergovernmental forum for scientific and technical cooperation on the peaceful use of nuclear technology and nuclear power worldwide. It maintains several programs that encourage the development of peaceful applications of nuclear energy, science, and technology; provide international safeguards against misuse of nuclear technology and nuclear materials; and promote and implement nuclear safety (including radiation protection) and nuclear security standards.

Nuclear safety is defined by the international atomic energy agency(IAEA) as " the achievement of proper operating conditions , prevention of accidents or mitigation of accidental consequences, resulting in protection of workers, the public and the environment from undue radiation hazards". In short, their definition is about operation, prevention and protection.

The IAEA defines nuclear security as the prevention and detection of and response to theft, sabotage , unauthorized access, illegal transfer or other malicious acts involving nuclear materials, other radioactive substances or their associated facilities. this covers nuclear power plants and all other nuclear facilities , the transportation of nuclear materials, and the use and storage of nuclear materials form medical power ,industry and military. So, the nuclear security is defined prevention and detection of unwanted actions that could harm the operating materials of nuclear facility.

1.1 The reasons for nuclear accidents

The reasons for nuclear accidents are multifaceted. Mechanical failures and human errors play role in nuclear accidents, deeper issues such as poor safety management and organizational structures with in nuclear idustries and governmental agencies are fundamental causes.

Nuclear accidents are often rooted in serious deficiencies in design, safety management. In adequate safety culture, insufficient safety information exchange, and weak regulatory regimes have been identified as significant contributors to accidents.

The chernobyl disaster in 1986 was one of the greatest disasters that resulted in significant human and monetary cost, with long-lasting effects on the environment and public health.The Chernobyl disaster began on 26 April 1986 with the explosion of the No. 4 reactor of the Chernobyl Nuclear Power Plant near the city of Pripyat in the north of the Ukrainian SSR, close to the border with the Byelorussian SSR, in the Soviet Union. It is one of only two nuclear energy accidents rated at seven—the maximum severity—on the International Nuclear Event Scale, the other being the 2011 Fukushima nuclear accident. The initial emergency response and subsequent mitigation efforts involved more than 500,000 personnel and cost an estimated 18 billion roubles—roughly 68 billion USD in 2019, adjusted for inflation. It was the worst nuclear disaster in history, and the costliest disaster in human history, costing an estimated 700 billion USD.

1.2 Nuclear safety regulation

Nuclear safety can be understood as accident prevention in nuclear installations, through its systems and its human resources, and the mitigation of risks and consequences if an accident should occur. The main goal is that the radiological impact on people and the environment from nuclear installations remains as small as possible for both normal operation and potential accidents.

To achieve this, technical and organizational measures are put in place at all stages of a nuclear facility's lifetime starting with its siting and design, manufacturing, construction and commissioning, operation, and finally, during its decommissioning. At every step, adherence to certain principles and practices which define what is known as safety culture is essential to ensure the safe operation of nuclear facilities. Some safety cultures include:

- Boiling Water Reactors(BWRs)
- Codes and standards
- Digital Instrumentation
- Inspection Practices
- Operating Experience
- Regulations of new and advanced reactors

Minimum requirements for nuclear saftey:

- Extraction, transportation, storage, processing, and disposal of fissionable materials
- Safety of nuclear power generators
- Control and safe management of nuclear weapons, nuclear material capable of use as a weapon, and other radioactive materials
- Safe handling, accountability and use in industrial, medical and research contexts

- Disposal of nuclear waste
- Limitations on exposure to radiation

2 Protecting yourself from radiation

Radiation is part of our life. Background radiation , coming primarily from natural minerals,is around as all the time.Fortunately, there are very few situations where an average person is exposed to uncontrolled sources of radiation above background. Nevertheless, it is wise to be prepared and know what to do if such situation arises.

2.1 What do we mean by Radition ?

In physics, radiation is the emission or transmission of energy in the form of waves or particles through space or a material medium. This includes:

- electromagnetic radiation consists of photons, such as radio waves, microwaves, infrared, visible light, ultraviolet, x-rays, and gamma radiation (γ)
- particle radiation consists of particles of non-zero rest energy, such as alpha radiation (α), $betaradiation(\beta)$, $protonradiation\ and\ neutronradiation$
- acoustic radiation, such as ultrasound, sound, and seismic waves, dependent on a physical transmission medium
- gravitational radiation, in the form of gravitational waves, ripples in spacetime

Depending on the type of radiation, different measures must be taken to protect our bodies and the environment from its effects, while allowing us to benefit from its many applications.

- **Health:** thanks to radiation, we can benefit from medical procedures, such as many cancer treatments, and diagnostic imaging methods.
- **Energy:** radiation allows us to produce electricity via, for example, solar energy and nuclear energy.
- **Environment and climate change:** radiation can be used to treat wastewater or to create new plant varieties that are resistant to climate change.
- **Industry and science:** with nuclear techniques based on radiation, scientists can examine objects from the past or produce materials with superior characteristics in, for instance, the car industry.

2.1.1 Types of radiation

1.Non-ionizing radiation

Non-ionizing radiation is lower energy radiation that is not energetic enough to detach electrons from atoms or molecules, whether in matter or living organisms. However, its energy can make those molecules vibrate and so produce heat. This is, for instance, how microwave ovens work.

For most people, non-ionizing radiation does not pose a risk to their health. However, workers that are in regular contact with some sources of non-ionizing radiation may need special measures to protect themselves from, for example, the heat produced.

Some other examples of non-ionizing radiation include the radio waves and visible light. The visible light is a type of non-ionizing radiation that the human eye can perceive. And the radio waves are a type of non-ionizing radiation that is invisible to our eyes and other senses, but that can be decoded by traditional radios.

2.Ionizing radiation

Ionizing radiation is a type of radiation of such energy that it can detach electrons from atoms or molecules, which causes changes at the atomic level when interacting with matter including living organisms. Such changes usually involve the production of ions (electrically charged atoms or molecules) – hence the term "ionizing radiation.

In high doses, ionizing radiation can damage cells or organs in our bodies or even cause death. In the correct uses and doses and with the necessary protective measures, this kind of radiation has many beneficial uses, such as in energy production, in industry, in research and in medical diagnostics and treatment of various diseases, such as cancer. While regulation of use of sources of radiation and radiation protection are national responsibility, the IAEA provides support to lawmakers and regulators through a comprehensive system of international safety standards aiming to protect workers and patients as well as members of the public and the environment from the potential harmful effects of ionizing radiation.

2.2 Radiation protection pricnciples of time, distance and shielding

- **Time:** For people who are exposed to radiation in addition to natural background radiation, limiting or minimizing the exposure time reduces the dose from the radiation source.

- **Distance:** Just as the heat from a fire reduces as you move further away, the dose of radiation decreases dramatically as you increase your distance from the source.
- **Shielding:** Barriers of lead, concrete, or water provide protection from penetrating gamma rays and X-rays. This is why certain radioactive materials are stored under water or in concrete or lead-lined rooms, and why dentists place a lead blanket on patients receiving X-rays of their teeth. Therefore, inserting the proper shield between you and a radiation source will greatly reduce or eliminate the dose you receive.

3 Safety precautions when using radioactive sources in schools

Radioactive sources which are used in school are usually very weak. They can only be used in the presence of an authorized teacher. They are kept in sealed container except when they are being used in an experiment or demonstration. The container can be designed based on appropriate shields. They are immediately returned to the container when the experiment or demonstration is finished. when using a radioactive source it should be:

- handled with tongs or forceps, never with bare hands. Moreover, hands must be washed after the experiment and definitely before eating.
- kept at arm's length, pointing away from the body.
- always kept as far as possible from the eyes

3.1 Precautions Should be taken when using radioactive materials

- Handling radioactive materials, always wear the relevant protective clothing, wear a lab coat, and always wear gloves when handling radioactive sources.
- Regularly examine the radiation level of these gloves. For handling the radioactive elements use proper radioactive shields.
- To avoid internal contamination, hygiene is essential when handling radioactive materials, like eating, smoking etc.
- To use and store radioactive materials safely in the classroom, containers must be correctly labeled and sealed.Descriptive labels will let teachers and students know which materials are radioactive. The storage containers should be made of material that will keep the radiation inside the container
- Keep radioactive sources like technetium-99 shielded (preferably in a lead-lined box) when not in use.

- Wear protective clothing to prevent the body becoming contaminated should radioactive isotopes leak out.
- Avoid contact with bare skin and do not attempt to taste the sources.

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