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# Comprehensive Administrative and Engineering Strategies for Radiation Protection and Occupational Health Safety

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## Abstract

*The risks of occupational exposure to radiation may lead to changes in the chemical balance of the body's cells. Some of these changes may lead to a defect in human DNA and thus lead to dangerous genetic mutations that may also be transmitted to children after their birth and other diseases. It affects the blood-forming system and may cause deformities, infections, or some types of cancer. Skin redness, inflammation, and hair loss. Continuous exposure to radiation leads to damage to tissues and muscles. Sexual infertility, Therefore, this will be addressed, and then administrative and engineering prevention strategies for exposure to radiation and occupational health safety.*

**Keywords:** Radiation, Occupational Exposure, Engineering and Administrative Procedures

## 1. Introduction

Radiation it is a type of energy and the release of energy (thermal, light, electrical, or atomic) in the form of waves or particles from natural or artificial sources [1]. Radiation risk, Ionizing radiation (introducing energy into the body's cells) can lead to changes in the chemical balance to the body's cells [2]. Some of these changes may lead to a defect in the human DNA (DNA) and thus lead to Serious genetic mutations may also be transmitted to children after their birth exposure to large quantities of radiation may lead to diseases within hours or days [3,4]. It may lead to death within 60 days of exposure and in cases of exposure to very large quantities, the death can occur within a few hours [5].

The symptoms of ionizing radiation may occur during a long period, for example in leukemia within two years [6]. A result for the accumulation of radioactive materials in the body and most of the information about the effect of radiation on the human being is obtained from studies conducted on the survivors of the atomic bombs that were thrown on Nagazaki and Hiroshima [7,8]. The health damage of the radiation depends on the level of radiation to which a person is exposed [9]. Radiation affects the cells of the body and increases the possibilities of cancer and other genetic transformations that may be transmitted to children and in the event that a person is exposed to a large amount of radiation that may lead to death and If a person received a radiation dose of 10 rem to the entire body above background, his or her risk of dying from cancer would increase by one percent [10,11].

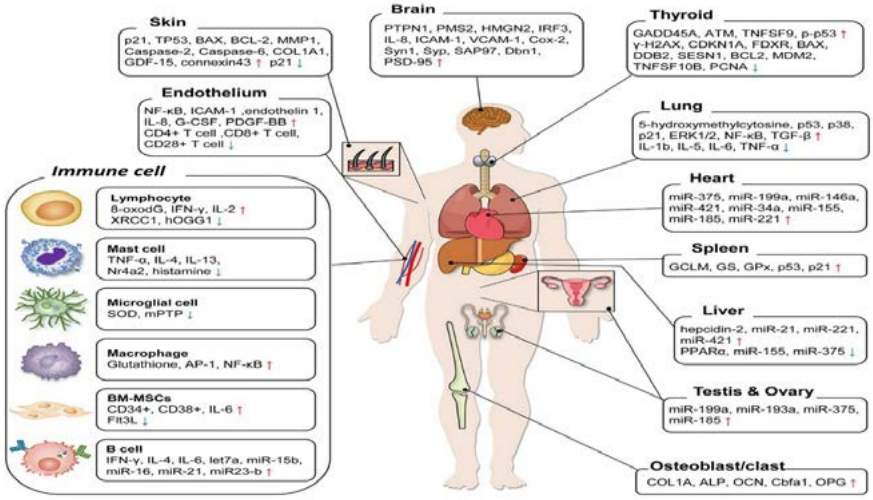


**Figure 1**

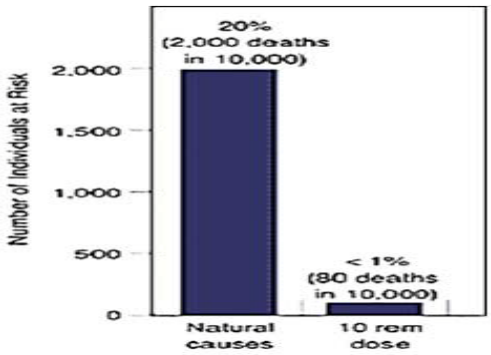


**Figure 2**


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## 2. The Effect of Radiation on Humans

It affects the blood-forming system and may cause deformities, infections, or some types of cancer [12]. Skin redness, inflammation, and hair loss [13]. Continuous exposure to radiation leads to damage to tissues and muscles [14]. Genetic risk and its impact on congenital malformations in newborns [15]. Sexual infertility death if the body is exposed to an amount of radiation amounting to (500) rads [16,17].

## 3. Occupations Involving Risk of Exposure to Ionizing Radiation

Uranium miners and mill workers [18]. Workers in atomic reactors and nuclear energy facilities air crews and astronauts [19,20]. Industrial radiography workers (including those performing field work including pipe welding operations) [21]. Some health workers (radiographers, nuclear medicine, dealing with medical waste radioactive) [22]. Radionuclide production workers [23]. Scientists who use radioactive materials for research purposes [24]. Luminous paint workers in serious accidents, workers in nuclear facilities, rescue workers, and the general population living in the vicinity may be exposed to excessive radiation exposure [25,26].

## 4. Types of Radiation

### 4.1. Ionizing Radiation

Such as X-rays, gamma rays, cosmic rays, and beta and alpha particles [27]. Ionizing Radiation there are three main types of ionizing radiation that may be found in man-made radiation as well as in natural radiation, which are alpha particles, beta particles, and gamma rays [28].

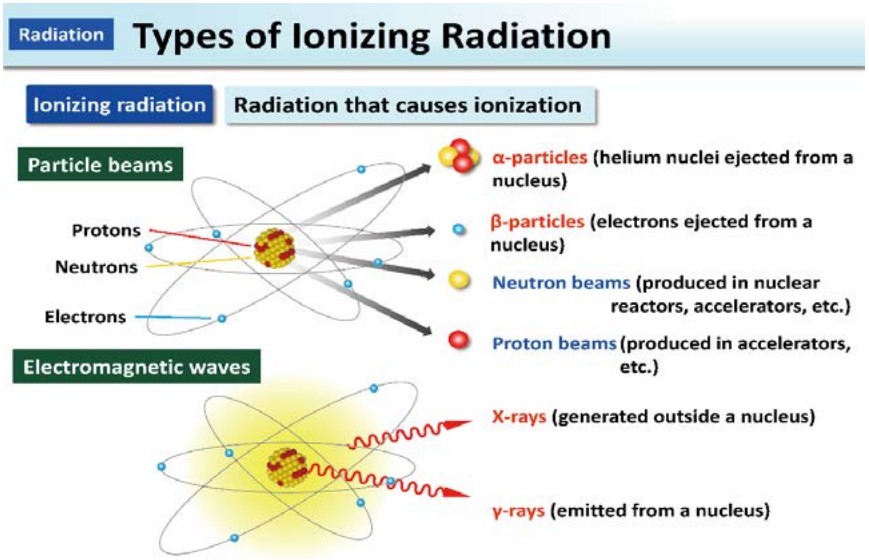


**Figure 3**

### 4.2. Alpha Particles

The penetrating power of alpha particles is very weak as they lose their energy as soon as they leave the radioactive element [29]. It is possible to cause harm and health damage to tissues through the simple path, and these rays are absorbed by the outer part of the human skin [30]. Therefore, alpha particles are not considered harmful outside the body, but they can cause significant harm if they are inhaled or swallowed (swallowing the radioactive material from which rays emerge) [31]. The path of alpha rays can be stopped by a piece of paper or by the human body, but if inhaled [32]. Vapors of the substance from which alpha particles radiate, or if they are swallowed and enter the body as a result of a wound in it, are harmful very [33].

### 4.3. Beta Particles

The penetration and penetration power of beta particles is greater than the penetration power of alpha rays [34]. Some beta particles can penetrate the skin and cause irritation [35]. It is extremely dangerous if the vapors are inhaled or the substance that emits beta rays is swallowed and can be stopped [36]. Emitted by simple chips of aluminum or wood beta particles cannot be stopped with a piece of paper, and the flow of these rays cannot be stopped with a piece of Wood, and may cause serious harm if it penetrates the body [37,38].

### 4.4. Gamma Rays

It is one of the most dangerous types of radiation and has a very high penetrating power, much greater than alpha and beta rays [39]. It can easily penetrate the human body or be absorbed by tissues and therefore pose a high radiation risk to humans [40]. Its emission can be stopped by concrete or lead. Its flow can be stopped by a concrete barrier. X-rays fall within the division of gamma rays, but they are less penetrative than gamma rays [41].

### 4.5. X-Rays

Their properties are similar to those of gamma rays, but differ in source, as X-rays are emitted from processes outside the nucleus While gamma rays are emitted from within the nucleus of the atom, the penetrating power and permeability of X-rays is less than that of gamma rays X-rays are considered one of the most common sources of human exposure to

radiation, as they are used in many operations Industrial - medical, and its ability to penetrate can be stopped by a slice of lead that is several millimeters thick few [42].

### 4.6. Ionizing Radiation

Which is characterized by low frequency and long wavelength, and the eye is considered the organ most affected by it:

- Ultraviolet rays.
- Infrared rays.
- Electromagnetic waves.
- Microwaves.
- Laser.
- Visible light [43].

### 4.7. Non-Ionizing Radiation

such as electromagnetic radiation, including waves Radio, television, radar waves, and short-wavelength heat waves (microwaves) Infrared, ultraviolet, and ordinary light [44].

## 5. Radiation Sources

### 5.1. Natural Source

- **Cosmic Rays:** which originate between stars and in outer space and from solar explosions.
- **Earth Rays:** emitted from the interior and surface of the Earth due to the presence of some radioactive materials in rocks such as potassium, uranium, and radioactive radon gas, which leaks from the ground all over the world due to the disintegration of some radioactive metals such as uranium [45].

### 5.2. Industrial Sources

- X-ray generating devices.
- In the field of education and scientific research: nuclear physics laboratories, radiopharmaceutical research, agricultural applications [46].

### 5.3. Medical Sources

- Diagnostic and interventional radiological applications.
- Radiation treatment.
- Nuclear medicine.
- Nuclear reactors and explosions.
- Accelerators.
- Radiation practices in the industrial and agricultural fields.
- Industrial radiography.
- Well sounding.
- Nuclear standards.
- Humidity and density meters [47].

## 6. Radiation Measurement Units

- **Rad:** The unit of measurement of the amount of absorbed radiation energy (absorption dose).
- **Roentgen:** The unit of measurement for outgoing radiation and is used mainly for X-rays.
- **Curie (Ci):** It is considered a measurement of the outgoing rays, and one curie = 3.7 x 1010 decays per second.
- **REM:** A unit of measurement of the biological effect of absorbed radiation.
- **Sievert (Sv.) SIEVERT:** One of the latest units for measuring the effect resulting from absorption, One Seivert = 100 REM [48].

### 6.1. Radiation Doses

- **Absorbed Dose:** the radiation energy given per gram of living tissue
- **Dose Equivalent:** the absorbed dose weighted according to the ability of different types of rays to cause harm.
- **Effective Dose Equivalent:** The dose equivalent is weighted according to the susceptibility to tissue harm.
- **Mass Effective Dose Equivalent:** the effective dose equivalent for a population of a radiation source.
- **Deposited Effective Dose Equivalent:** the collective equivalent dose transmitted after a period of time to future generations [49].

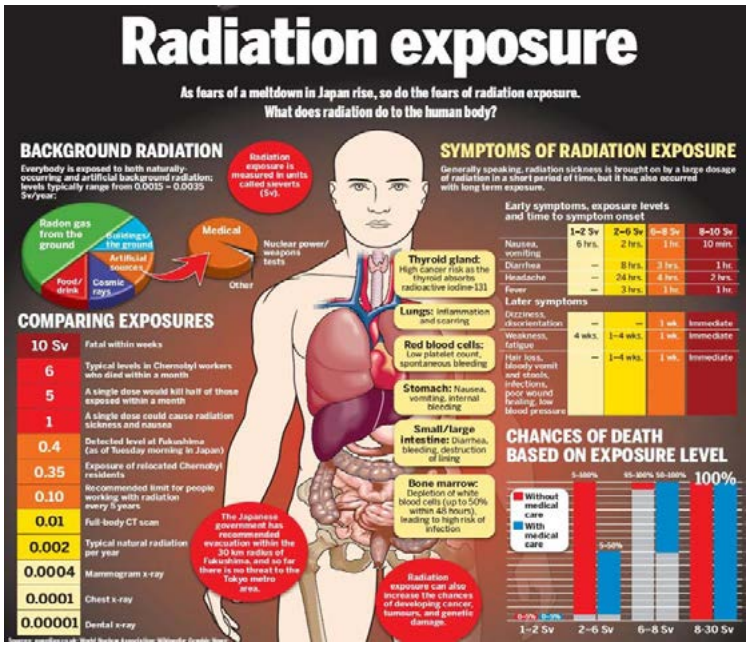


**Figure 4**



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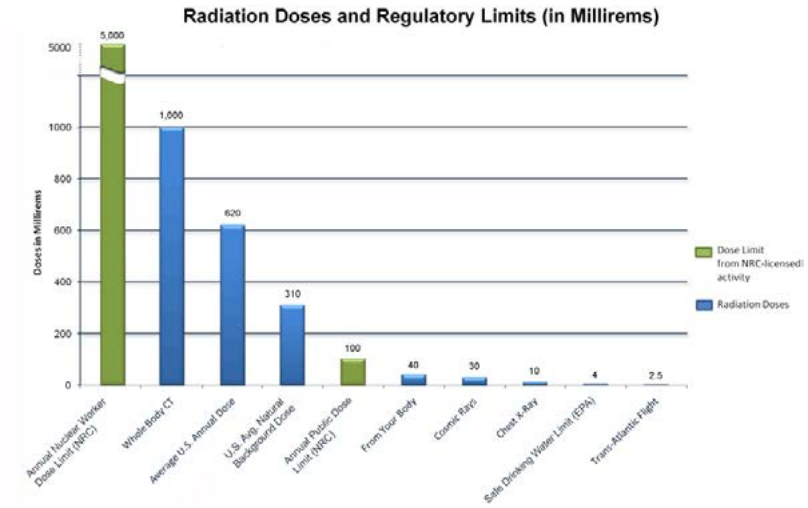


**Figure 5**

## 7. Engineering and Administrative Procedures for Public Safety in Radiation Protection

Determine the type and quantity of radiation present in the work environment, and the extent of workers' exposure to it (periodic inspection of the atmosphere of the facility or place from which radiation may be emitted and measuring it.) [50].

• Reducing the level of exposure to radiation to the lowest possible level (the limit that does not pose a danger to the body), that is, reducing the exposure time (the time the person spends next to the radiation source), and thus the amounts of radiation to which the person is exposed will decrease [51].

• Increasing the distance between the radiation source and the human body, to reduce the body's effect on it if it reaches it. As the distance between the person and the radioactive source increases, the exposure rate decreases (according to the inverse square law). Therefore, it is necessary [52].

• Wearing protective clothing that contains lead, which does not resist radiation penetration, and providing chemical cleaners and personal protective equipment [53].

• Isolate workplaces from eating places, and prevent storing food near workplaces. Avoid eating foods suspected of being contaminated with radioactive materials [54].

• Conduct periodic examination of workers exposed to the risk of radiation, to discover damage, if any, before it turns into danger stages [55].

• Educating workers and informing them of the dangers resulting from radiation, and the importance of preventing them [56].

• Barriers: Increasing barriers around the radioactive source will reduce exposure. And every type [57].

• Radiation: Appropriate barriers are placed to isolate it according to its ability to penetrate: (Isolating the production process from which radiation is issued from the rest of the production processes) [58].

• Good ventilation of sites that emit radioactive fumes [59].

• Preventive maintenance of machines and devices that emit radiation [59].

• Radioactive materials are transferred between different laboratories inside their designated containers [59].

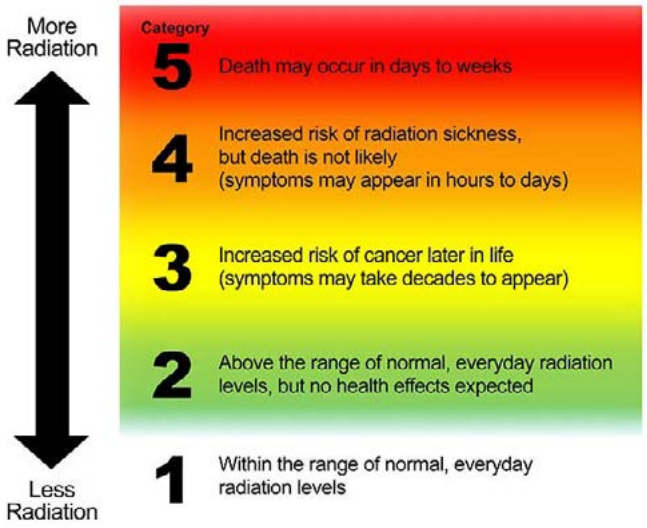


**Figure 6**

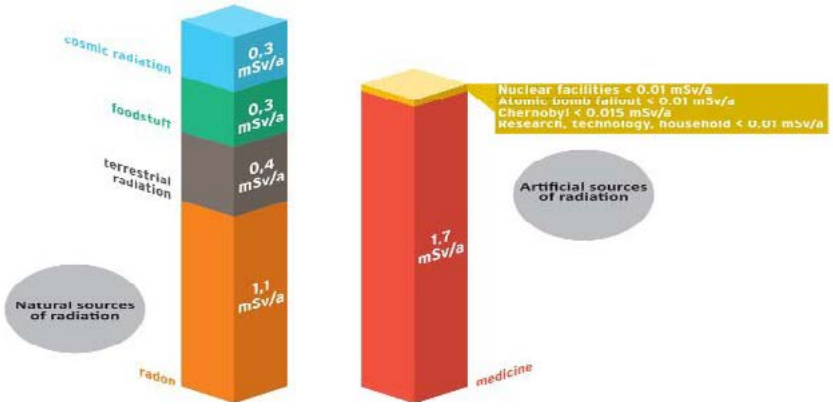


**Figure 7: Everyone is Exposed to Radiation from Natural and Man-Made Radiation Sources**

## 8. Conclusion

• Effectively managing radiation exposure in occupational settings requires a multifaceted approach that combines both administrative and engineering preventive strategies.

• Administrative measures, such as strong training programs, strict regulatory compliance, and continuous monitoring of workplace practices, play a crucial role in fostering a culture of safety.

• Engineering controls, including advanced shielding technologies, remote handling systems, and the implementation of safety protocols, significantly mitigate radiation risks.

• The integration of administrative and engineering strategies improves worker protection and supports public health goals. As radiation safety evolves with technological advancements and better health insights, continuous research and adaptation are crucial. By focusing on these solutions, organizations can create safer work environments, minimize occupational hazards, and enhance employee well-being in radiation-related fields.

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