Inhalation. Radioactive gases, liquids or solids may enter the body by inhalation water soluble gases, are rapidly absorbed from inhaled air and thus appear in extracellular fluid within a few seconds. A part of that inhaled will be deposited in the respiratory trace and the remaining exhaled. The deposited radionuclide forms a toxic radionuclide as a result radicals produced by the radiation.

Ingestion. It is a contamination due to internally ingesting a radionuclide or due to non-ventilation and unsafe working conditions in the radiation area or if a person breaths by mouth and not by nose. Indirect way of contamination is through food.

We are continually bombarded by radiation from both natural and artificial sources. We are exposed to radioactivity from the soil and other natural materials.

When matter absorbs radiation, the energy of the radiation can cause excitation or ionization of the matter. Ionization occurs when the radiation removes an electron from an atom or molecule. In general, radiation that causes ionization, called **ionizing radiation**, is more harmful to biological systems than radiation that does not cause ionization, called non-ionizing radiation.

Most living tissue contains at least 70% water by mass. When living tissue is irradiated, most of the energy of the radiation is absorbed by water molecules. Alpha, beta, and gamma rays (as well as X-rays and higher energy ultraviolet radiation) are forms of ionizing radiation.

When ionizing radiation passes through living tissue, electrons are removed from water, forming highly reactive H_2O^+ ion, which can react with another molecule to form H_3O^+ and a neutral molecule, with one unpaired electron.

$$H_2O^+ + H_2O \longrightarrow H_3O^+ + \bullet OH$$

The unstable and highly reactive •OH molecule is an example of a **free radical.** In cells and tissues, such particles can attack a host of surrounding biomolecules to produe new free radicals, which in turn, attack yet other molecules. Thus, the formation of a single free radical can initiate a large number of chemical reactions that are ultimately able to disrupt the normal operations of cells. The damage produced by radiation depends on the activity and energy of the radiation, the length of exposure, and whether the source is inside or outside the body. Outside the body, gamma rays are particularly harmful because they penetrate human tissue very effectively, just as X-rays do. Consequently, their demage is not limited to skin. In contrast, most alpha rays are stopped by the skin, and beta rays are able to penetrate only 1 cm beyond the surface of the skin. Hence, neither is as dangerous as gamma rays are, unless the radiation source somehow enters the body. Within the body, α-rays are particularly dangerous because they transfer their energy quickly to the surrounding tissue, indicating considerable damage.

In general, the tissues that show the greatest damage from radiation are those that produce at a rapid rate, such as bone marrow, blood-forming tissue and lymph nodes. The principal effect of extended exposure to low doses of radiation is to induce cancer. Cancer is caused by damage to the growth-regulation mechanism of cells, inducing cells to reproduce in an uncontrolled manner. Leukemia, which is characterized by excessive growth of white blood cells is probably the major cancer problem associated with radiation.

High energy radiation poses a health hazard because of the damage it does to cells. Healthy cells are either destroyed or damaged by radiation, leading to physiological disorders.

Safety measures

According to the International commission on Radiological protection (ICRP) and Australia's National Health and Medical Research Council (NH & MRC) the exposure to ionizing radiation must be kept as low as possible and the maximum permissible dose for a worker in the nuclear industry is 20 mSv per year.

Since it is now clearly recognised that nuclear wars cannot be won and therefore should not be fought, each nuclear-armed adversary must develop confidence in the sincerity of the other to ensure that the unthinkable will not be attempted or allowed to occur due to laxity in safety and security measures and procedures. Nuclear weapons states (NWS) must clearly spells out their nuclear doctrine and strategy, inspire confidence in their adversaries that they will abide by their declared stance and should give credible evidence that adequate checks and balance have been built into their nuclear decision-making process and nuclear weapons handling procedures. It is also necessary to convince the adversary that nuclear weapons are firmly under civilian control and that such control will not be delegated to military authorities except under the most extreme conditions.

All safety standards series documents are kept under continuous review and updated in response to developments in nuclear and radiation safety.

There must be no release of radioactive material in dangerous quantities from a nuclear facility to the general public.

The likelihood of a serious accident which would result in severe damage to the nuclear facility should be kept as small as possible.

System malfunctions and deviation from normal behaviour should be reduced to a minimum.

Governments have been primarily concerned with public and personnel safety; hence, nuclear safety research sponsored by Government agencies is more likely to address these issues.

External hazards can be minimized by reducing all external levels to value low as possible. This can be accomplished by a number of methods, including the following.

(i) Ensuring that the minimum quantity of radioisotope of the lowest possible toxicity is used for the specific operation.

(ii) Maintaining the maximum possible distance compatible with effective working method between the source and the worker.

(iii) Limiting the time spent in the vicinity of the source to the minimum necessary.

(iv) Using proper shielding between the source and the worker and, where necessary, using additional shielding to ensure that other person in the vicinity or in the adjoining room are not exposed.

(v) Conducting regular area and personal monitoring checks with a view to ensuring minimal radiation exposure.