Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 2, Issue 21; October-December, 2015, pp. 1833-1837

http://www.krishisanskriti.org/Publication.html

An Assessment of Radiation Effects on Health and Protection of the Environment

Saroj Kumar Singh

Deptt. Of Rural Economics, S. N. S. R. K. S. College, Saharsa,
(A Constituent Unit of B. N. Mandal University, Madhepura, Bihar)
E-mail: drsaroj999@gmail.com

Abstract—*The development of science and technology leads to environmental problems in both developed and developing countries. Different organisms show different sensitivity to ionizing radiations. The radioactive materials are transformed into gases and fine particles, which are carried to distant places by wind. When raindrops, the radioactive particles fall on the ground, it is called nuclear fallout. From the soil radioactive plants take substances, thence they reach humans and animals through food chains. Iodine 131 damages white blood corpuscles, bone marrow, spleen, lymph nodes, skin cancer, sterility, and defective eyesight and may cause lung tumors. Strontium 90 accumulates in the bones and may cause bone cancer and tissue degeneration in most animals and man. This paper therefore proposed preventive measures and sustainable solutions The objectives of this paper is to find out the sources, effects and protecting measures of the environment. Data for the study was generated through secondary sources. The impact of radioactive pollutants on human health has become a major issue in India. Therefore it is important to investigate the effects and the controlling measures of radioactive pollution.*

1. INTRODUCTION

Stockholm has an impressive history as the venue for meetings on radiation and environmental protection. In 1928, the International Commission on Radiological Protection (ICRP) was established in Stockholm. In 1972, the first United Nations Conference on the Human Environment was held there, and in 1996 the first international symposium on ionizing radiation and protection of the natural environment took place in Stockholm. The conference continued this tradition. The IAEA and the cooperating organizations have interrelated responsibilities with regard to environmental radiation protection.

2. OBJECTIVE

i. To conduct suitable programmers to make public aware.

ii. To investigate the impact of Radiation Hazards on human health.

iii. To find out preventive measures and sustainable solutions the sources and causes of Radiation Hazards..

3. SOURCES OF ENVIRONMENTAL RADIATION

3.1 Natural Radiation

This includes cosmic rays that reach the surface of the earth from space and terrestrial radiations from radioactive elements present in the earth's crust. Many radioactive elements such as radium 224, uranium 235, uranium 238, thorium 232, radon 222, potassium 40 and carbon 14 occur in rocks, soil and water.

3.2 Man-made Radiation

This includes mining and refining of plutonium and thorium production and explosion of nuclear weapons, nuclear power plants, nuclear fuels and preparation of radioactive isotopes.

Production of nuclear weapons involves the tests of nuclear arms. These tests produce large amount of radioactive elements into the environment and make other materials radioactive. They include strontium 90, cesium 137, iodine 131 and some others.

The radioactive materials are transformed into gases and fine particles, which are carried to distant places by wind. When raindrops, the radioactive particles fall on the ground, it is called nuclear fallout. From the soil radioactive substances are taken by plants, thence they reach humans and animals through food chains. Iodine 131 damages white blood corpuscles, bone marrow, spleen, lymph nodes, skin cancer, sterility and defective eye sight and may cause lung tumours. Strontium 90 accumulates in the bones and may cause bone cancer and tissue degeneration in most animals and man.

The radioactive materials are washed from land to water bodies where the aquatic organisms absorb them. From these organisms, radioactive materials may reach man through food chains.

3.2.1 Atomic Reactors and Nuclear Fuels

The operation of a nuclear power plant releases large amounts of energy. This energy is used in large turbines, which produce electricity. Both the fuel elements and coolants contribute to radiation pollution. Wastes from atomic reactors

also contain radioactive materials. The biggest problem is the disposal of these radioactive wastes. If these wastes are not properly disposed off, can harm the living organisms wherever they may be dumped. Inert gases and halogens escape as vapors and cause pollution as they settle on land or reach surface waters with rain.

3.2.2 Radio Isotopes

Many radioactive isotopes such as ^{14}C. ^{125}I, ^{32}P and their compounds are used in scientific research. Wastewaters containing these radioactive materials reach water sources like rivers through the sewers. From water they enter human body through food chains.

4. NUCLEAR HAZARDS AND SAFETY ISSUES

Recently there has been much apprehension about the dangers inherent in nuclear plants—fears of radiation hazard, waste disposal, disastrous accidents. While some of the hazards are real, nuclear scientists point out that many of them are not based on scientific facts and unbiased observation.

4.1 Radiation Hazard

There is no doubt that radiation causes damage to living cells—but this depends on the intensity of radiation and the time of exposure. When an atom of a complex organic cell is exposed to radiation, ionization takes place and molecules disintegrate, adversely affecting the biological system, sometimes even destroying the cell.

While high doses are fatal, low doses may have cumulative effect and cause cancers, especially of the skin, and leukemia. It may affect lymphatic tissues, the nervous system, and the reproductive organs. However, die adverse effects take place after considerably high and constant doses of radiation.

The release of radioactivity into air and water from reactors does take place, but it is kept well within the limits prescribed by the AERB. The earth is being constantly bombarded by cosmic ray nuclear particles (65 per cent of natural radiation experienced by a human being is due to this).

Background radiation from terrestrial and extra-terrestrial sources is much higher than radiation from nuclear plants. In the circumstances, the radiation exposures from nuclear plants are of a negligible quantity. The fear of radiation arises because most people are unwilling to believe in any “safe level” for radiation exposure.

5. HOW RADIOACTIVE POLLUTION EFFECTS HUMAN HEALTH?

Ever since the invention of the atomic bomb mankind is facing with the threat of atomic warfare. Therefore, it is important to know the extent of harm that penetrating high-energy radiations can cause to living organisms.

When a high energy nuclear particle or a gamma ray passes through any material, it ionizes the atoms it encounters en route by knocking electrons from them. In a complex organic molecule, when an atom is ionized, then the molecule may break up, which could further lead to the disruption of the functioning of the biological system. This might eventually result in the death of the organism.

5.1 The damage caused to the human body by such penetrating radiations depends upon

(a) The dose (b) The dose rate and (c) The part of the body exposed.

In high doses radiation can cause instant death whereas in lower doses it can impair the functioning of the body organs. Without getting permanently injured, hands and feet can tolerate a much larger dose of radiation as compared to other parts of the human body.

When nuclear radiations and X-rays pass through genetic cells, they affect the chromosomes. When the genetic cells are affected then the consequences are serious because the genes are affected i.e. mutation occurs.

Mutations are generally transmitted from generation to generation and so the damage is inherited by progenies of the affected generation. Tumours, cancer and developmental changes are other long-range effects of radiation pollution.

5.2 Some cells are more vulnerable to injury by radiations for instance

(a) Actively growing cells (b) Actively dividing cells (This is why cancer cells can be destroyed by radiations as they also belong to the actively growing category) (c) Bone marrow cells which produce blood corpuscles (d) Cells of the skin (e) Cells lining the intestine (f) Reproductive cells (g) Foetus or Embryo.

5.3 Other cells which are comparatively less vulnerable to injury by radiations are

(a) Muscles; (b) Bones and (c) Nervous tissues.

The atomic blasts of Japan (1945) resulted in innumerable deaths due to malignant growth, leukemia and cancer. Many children became mentally retarded and developed congenital malformations.

The pollutants, which happen to fall in the fields, find their way into cattle grazing on the plants growing in these fields. Children who drink the milk of such cattle get leukemia because the radioactive pollutants like strontium 90 gets deposited in the bones in the same manner as calcium does and causes bone cancer.

Iodine damages the white blood cells, bone marrow, lymph nodes and spleen and causes tumours, skin cancer, sterility and defective eyesight. The radioactive pollutants affect even the plants and animals. Some animals accumulate specific

nuclides, for instance, oyster's deposits ^{55}Zn, fish accumulate ^{65}Fe and marine animals selectively take up ^{90}Sr. Table 1.1 shows the per-capita radiation exposure in U.S.A.

Table 1: Per Capita Radiation Exposure in U.S.A:

Sources	Dose (Millirem 1 year)
Natural Background	130
Medical Diagnostic X-rays	90
Weapons Test Fall-out	5.1
Nuclear Power	0.01

Table 2 : Shows the effects of total body radiation:

Table 2: Effect of Total Body Radiation:

Dose (Roentgens)	Probable Effect
0 to 50	No obvious effect except possible minor blood changes.
150 to 250	Vomiting and nausea for about 1 day, followed by other symptoms of radiation sickness in about 50 percent of personnel. No deaths expected.
200 to 400	Vomiting and nausea for about 1 day, followed by other symptoms of radiation sickness in about 50 percent of personnel. About 10 percent deaths expected.
350 to 550	Vomiting and nausea in nearly all personnel on first day, followed by other symptoms of radiation sickness. About 25 percent deaths expected.
550 to 750	Vomiting and nausea in all personnel on first day, followed by other symptoms of radiation sickness. About 50 percent deaths, within one month.
1000	Vomiting and nausea in all personnel within 1 to 2 hours. Probably no survivors.
5000	Almost immediate incapacitation. All personnel will be fatalities within one week.

Table 3 depicts the maximum permissible dose equivalent values (MPD):

Table 3: Maximum Permissible Dose Equivalent Values (MPD):

	Maximum 13-Week dose (rems)	Maximum Yearly dose (rems)	Maximum accumulated dose (rems)
Controlled areas of body, gonads, lenses of eye,, red bone marrrow,	3	5	5 (N—18)
Skin (other than hands and fore arms)		15	
Hands	25	75	
Forearms	10	30	
Other organs, tissues and other organ system	5	15	
Non-controlled areas ocassional exposure populations dose limit		0.05 0.17 average	

To keep the risk minimal and within reasonable limit, maximum permissible doses have been proposed by International Commission on Radiological protection and other agencies. Table 4 shows the above maximum permissible doses:

Table 4: Maximum Permissible Doses set by International Commission on Radiological Protection, 1966:

Organs of Tissue	Adult Radiation staff (rems per year)	Members of the public (rems per year)
Gonads, red bone marrow	5	0.5
Skin, bone	30	3.0
Thyroid	30	3.0
Extremities	75	7.5
Other single organs	15	1.5

6. THE EFFECT OF RADIOACTIVE POLLUTANTS DEPENDS ON

a) The strength of the radiation, which in turn is determined by the degree of ionization, produced on passing through matter.

b) The duration of time for which radiation exposure has taken place.

c) The rate of diffusion of the radioactive pollutant.

d) Half-life period of the radioactive pollutant and

e) Environmental conditions.

7. SOME OF THE MAJOR EFFECTS OF RADIATION ARE AS FOLLOWS

1. The losing of hair quickly and in clumps occurs with radiation exposure at 200 rems or higher.
2. Since brain cells do not reproduce, they won't be damaged directly unless the exposure is 5,000 rems or greater. Like the heart, radiation kills nerve cells and small blood vessels, and can cause seizures and immediate death.
3. The certain body parts are more specifically affected by exposure to different types of radiation sources. The thyroid gland is susceptible to radioactive iodine. In sufficient amounts, radioactive iodine can destroy all or part of the thyroid. By taking potassium iodide, one can reduce the effects of exposure.
4. When a person is exposed to around 100 rems, the blood's lymphocyte cell count will be reduced, leaving the victim more susceptible to infection. This is often referred to as mild radiation sickness.
5. Intense exposure to radioactive material at 1,000 to 5,000 rems would do immediate damage to small blood vessels and probably cause heart failure and death directly.

6. Radiation damage to the intestinal tract lining will cause nausea, bloody vomiting and diarrhea. This is occurs when the victim's exposure is 200 rems or more. The radiation will begin to destroy the cells in the body that divide rapidly. These including blood, Gl tract, reproductive, and hair cells, and harms their DNA and RNA of surviving cells.
7. Because reproductive tract cells divide rapidly, these areas of the body can be damaged at rem levels as low as 200. Long-term, some radiation sickness victims will become sterile.

7.1 Effects of Radioactive Pollution: Harmful Effects

The effects of radiation were first noted in 1909 when it was found that uranium miners suffer from skin burn and cancer due to radiations from the radio-active mineral. Different organisms show different sensitivity to ionising radiations. For example, tests have shown that pine trees are killed by radiations in which oak trees continue to thrive comfortably.

It has also been reported that high altitude plants have developed polyploidy as a protective mechanism against radiations. Parts of coastal areas in South India have a high degree of background radiation which was formerly considered to be quite harmful to human beings.

The cells, which actively grow and divide are quickly damaged. This category includes the cells of skin, intestinal lining, bone marrow, gonads and embryo. Radiations have both immediate or short-range and delayed or long-ranged effects.

(i) Short Range (Immediate) Effects

They appear within days or a few weeks after exposure. The effects included loss of hair, nails, subcutaneous bleeding, change in number and proportion of blood cells, changed metabolism, and proportion of blood cells, etc.

(ii) Long Range (Delayed) Effects

They appear several months or even years after the exposure. The effects are caused by development of genetic changes, mutations, shortening of life span, formation of tumour, cancers, etc. The effect of mutations can persist in the human race.

8. MAJOR CONTROL MEASURES OF RADIATION POLLUTION

8.1 Radiation Exposure Protection

The three principles of radiation protection are distance, time to exposure and shielding. The exposure decreases with the square of distance from the source. The time of exposure should be kept as low as possible to accomplish a particular task.

In case of occupational requirements, the total exposure should be kept below maximum dose. Shielding is the interposition of a dense attenuating material between a source of radiation and the surroundings so as to adequately reduce or practically stop the travel of radiation. For neutrons a simple hydrogenous material like paraffin is used.

During medical examinations following measures need to be enforced:

(a) Prescription of X-ray slides should be to obtain diagnostic information and should be based on clinical evaluation.

(b) Avoid routine X-rays such as

i. Chest and lower back X-ray examinations in routine physical examinations.

ii. Chest radiography in routine prenatal case.

iii. Tuberculosis screening by chest radiography.

(c) X-ray equipment of highest quality operated and maintained by qualified and trained technicians.

(d) Photofluorography X-ray equipment should not be used for chest radiography.

(e) Adequate protection to limit exposure to desired part of the bodies.

8.2 Radiation Contamination Protection

Radioactive particles are particularly hazardous if inhaled. They irradiate in body continuously until eliminated. This can be minimised by using laboratory hoods, air filters and exhaust systems, eliminating dry sweeping, wearing protective clothing and radiation indicators (to see the total amount of radiation to which one has been exposed), using respirators where indicated and prohibiting smoking and eating where radioactive material is used. The radiation protection guides for water, food and air are given below:

Table 5: Maximum Limit of Radiation in Drinking Water

Contaminant	Max. level pico curie/It.
Combined radium 226 and radium 228	5
Gross alpha particle activity	15
Tritium	20,000
Strontium-90	8
Gross Beta particle activity	50

The main sources of radiation in the diet are manmade fall out on agricultural land. Material like strontium, cesium, iodine 131, may enter plants through roots and find its way to diet. Milk from dairy cattle is contaminated if the pasture grass eaten is contaminated. Such milk can be used for production of butter, powdered milk, or cheese.

Contamination of air by radioactive materials can come from nuclear explosions, nuclear reactors, nuclear fuel processing,

accidental releases and natural source. Maximum permissible level is 100-150 mR/year. Atomic explosions and use of atomic weapons should be totally banned. Leakage of radioactive elements from nuclear reactors and nuclear plants need to be checked from time to time.

8.3 Controlled Area

Areas, which cause or permit exposure to radiation are required to have controlled accessibility and should be marked 'Restricted Area! or 'Radiation Zone' etc. Level of radiation pollutant should be regularly checked in the high risk areas. Radiation resistant cases or walls should be constructed for screening workers from radioactive materials.

8.4. Collection, Storage and Disposal

Radioactive wastes should be changed into harmless form or stored in deep layers of the lithosphere where their gradual harmless decay can take place. Liquid and solid wastes may originate in radioscopic laboratories, chemical processing plants, nuclear reactors etc.

Solid wastes of low activity are collected in paper or plastic lined containers and disposed in approved manner (incineration or land disposal). High activity solid wastes are placed in shielded containers. Low level liquid and gaseous wastes are usually diluted or dispersed to maximum allowable limits before disposal.

High level wastes, both solid and liquid, are concentrated and stored. High-level wastes are mostly liquid wastes from nuclear power plants and still remain a major unresolved problem because of long-lived radioactivity present.

High-level radioactive wastes may be fixed in an inert solid material for disposal in an area or special glass container may be used to store them. These glass containers are maintained at 100-150°C and are believed to stand up for millions of years. The attempt is to convert these wastes into glassy material.

Ground disposal of low or intermediate level wastes may be permitted under approved soil, rock and ground water conditions. Other disposal methods considered include dry natural caverns, deep mine, salts cavities, deep well disposal and ocean disposal; but each of these require careful evaluation before being permitted.

Radiation pollution is a very dangerous threat to life because the people exposed to radiation hazards are unaware of the invisible but deadly consequences. The deleterious effects of radiations will be felt for years.

In view of the large scale destruction of human, plant and animal life, the tragic after effects of radiation pollution, the fact that there is no safe dose and no cure for the damage caused by radiations, man should keep out of the race for nuclear weapons.

(c) X-rays and Radiation Therapy:

Human beings also voluntarily receive radiation from diagnostic X-rays and radiation therapy for cancer.

(d) People working in power plants, nuclear reactors, fuel processors or living nearby are vulnerable to radiation exposure.

REFERENCES

[1] International Atomic Energy Agency, *Diagnosis And Treatment Of Radiation Injuries*, *Safety Reports* Series No. 2, IAEA, Vienna (1998).

[2] International Atomic Energy Agency, *The Radiological Accident In Lilo*, *IAEA*, Vienna (2000).

[3] International Atomic Energy Agency, *Draft Revised Code Of Conduct On The Safety And Security Of Radioactive Sources.* GOV/2002/35/Add.1- GC(46)/11/Add.1 (2002).

[4] International Atomic Energy Agency, *Intervention Criteria In A Nuclear Or Radiation Emergency, Safety Series No. 109*, IAEA, Vienna (1994).