very common in homes. They have now been replaced by battery driven electric clocks. We have considered here a few examples where gravity is seen to operate. As a matter of fact, life in the universe exists because of this or more generally the sun and the stars and the planets are there because of this universal property of all matter.

NUCLEAR TECHNOLOGY AND PUBLIC HEALTH

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The words "nuclear technology" registers in many people's mind an atomic and a nuclear bomb hence nothing more than destruction. This impression is not always correct since nuclear technology is also used for peaceful purposes. Isotopes of some elements emit radiation as their nuclear decay and they are called radioactive isotopes, radioisotopes or radionuclides. Some of these radionuclides occur naturally while others are artificial and the study of these radionuclides is called nuclear science. Nuclear technology is therefore the various nuclear techniques developed from nuclear science which make use of mainly radioisotopes or radiation procedures in response to the challenges imposed by the nuclear age. Their range of application is extremely broad which may be both constructive and destructive.

The application of these nuclear techniques will therefore have some advantages and disadvantages on public health; since these radionuclides will be used in the environment. The inhabitants of the environment such as man, animals and plants may benefit from the detrimental effects of the nuclear accidents and radiations.

Advantages of Nuclear Technology

The socio-economic development of many great nations have been achieved through the help of nuclear technology. Some of the areas in which nuclear technology have been applied are power generation, medicine, industry, agriculture, research and environmental management.

The generation of electricity from nuclear power plants have now been practiced in many countries of the world. This source of energy has been recognised as an economic and a clean source of energy as compared to the other sources of energy. According to Atseyinlu (1992), the nuclear energy is a viable energy source, and is beneficial in many respects, but it involves great risks and environmental problems.

The determination of metabolic pathways, visualisation of organs, localisation of tumors, detection of abnormalities in diagnosis, use of radiation sources for therapy, sterilisation of medical instruments are some of the major goals of nuclear medicine. Nuclear medical equipment, including scintillation gamma

chambers, High Energy Gamma (HEG) scanner and two channel profile scanners have been manufactured and are being used for detection of internal diseases. Wide use is made of radioisotope tracer techniques in this area, such as in the preparation of radiopharmaceuticals for clinical diagnosis of various abnormalities. In Nigeria, for example, where there are no definite nuclear programmes, some form of secondary applications of nuclear techniques in medicine have been done. These are found in areas of diagnosis or diseases prevalent in developing countries such as tuberculosis, viral hepatitis and malaria.

Nuclear techniques are used in the Industry in various ways. Some of these Include, the measure and control of fluid flow, wear and tear of engine parts, production of concrete polymer materials, optical glass colouring, plaster composition, hardening in large size electro technical products. Thermo-settling pipes, bands and other insulating and construction products have been produced with polyethylene which are treated with accelerated atomic particles. Radioisotope methods and equipment have been used in production of a non-stop analysis of the composition of substances for determining ash content of brown coal and coke and for measuring the depth of charge in blast furnaces; Radiation technologies have been used for leather conservation, rubber vulcanisation, textile fabrics, hardening of paints and varnishes, timber and abrasive materials and in disinfestation and conservation of works of art. In the beer industry, isotopic techniques are used in detecting the levels of beer in the bottles.

In agriculture, there are various uses of radioisotope tracers to monitor plant growth development and plant diseases. Radiation sources have been used to solve some agricultural problems — some of which include the elimination of insect pests by mass release of insects made sterile by irradiation, the radiation disinfestation of grain and the use of radiation to produce useful plant mutations. Nuclear techniques have been employed to preserve food and agricultural products. Radioisotopes have also been used as tracers in many research studies. In studies involving the rates of chemical reactions, structural determination mechanism of reactions and some physico-chemical properties of substances, radioisotopes and nuclear radiations are widely used.

Nuclear techniques are increasingly gaining grounds in environmental management. The use of isotopes and the development of analytical tools including tracer methods, Neutron Activation Analysis (NAA), X-ray fluorescence and atomic absorption spectrometry have added to the techniques available for the study and detection of environmental pollutants such as pesticides and toxic metals. The use of nuclear technique in ground water pollution research is an example of the value of nuclear techniques in water pollution studies. Sewage water purification is now done with radiation technologies and isotope techniques have greatly assisted in the studies of our ecosystem.

Health and Environmental Risks

Health and environmental risks are very vital issues when dealing with nuclear energy. Generation of nuclear energy as well as use of

radioisotopes in research, medicine, agriculture, and industry produce radioactive wastes which add to the naturally occurring radioactive substances found in our environment. This addition of artificial radioactive substances causes concern, since they are more concentrated and contain substances of high level activity as well as substances of lower level activity but with very long life time. Studies show that the soil samples of Hiroshima bomb incident contains high levels of radioactivity up to date, (Sakanoue and Tsieji, 1971). If these substances are not properly handled, they can contaminate the environment and present serious health hazards to man, animals and plant lives. At present, studies have shown that most of our earth's surface is contaminated by radioactive fallouts (Essien, 1991).

The release of radioactive materials and radiations are the subsequent results of nuclear energy and most of the instances radioactivity released into the environment come from the misuse of nuclear energy by man as in nuclear weapon manufacturer, testing and use, and from improper handling methods and disposal of the radioactive materials. It is expected that careful handling, controlled and peaceful applications of nuclear technology will continue to have little or no serious adverse effect on the environment.

Nuclear Accidents and Nuclear Waste Disposal

All forms of engineering technology and mechanical machinery have some type of accident risk to their operators, owners and to the public at large. Nuclear technology and installations are no exception. There is always the great fear of nuclear radiation on the part of the public based on the memory of the effects of the nuclear weapons of the Second World War and the Nagasaki incident of 1945. Although the risk of a radioactive release accident is quite small, it is by no means negligible, and the fact that when one occurs, it can have horrifying consequences is what frightens people and generates opposition to development of nuclear energy (Aina. 1992). The SNAP - 9A incident and the recent Chernobyl nuclear disaster of 1986 have again showed that despite the elaborate safety measures in the nuclear industry, accidents could still occur. There is great need to constantly review the safety measures in the nuclear industry.

Management and disposal of radioactive waste is an important issue in the development of nuclear industry. This problem is viewed by the public as being so serious, and hence the agitation for the closure of the nuclear industry. The debate on the issue is very understandable as the public is confronted with the fact that some nuclear wastes release radioactivity of almost instant mortal level if no protection is provided and others maintain their radio toxic character over a period which are many times exceeding the history of man. It is worthy to mention here that the main objective of management and disposal of radioactive waste is control, containment and isolation from the biosphere so as to protect the environment and avoid health hazards. According to Aina, (1992), scientists and engineers meeting under the auspices of International Atomic Energy Agency (IAEA) have for a number of years held that no additional breakthrough in technology is needed for the safe disposal of any radioactive waste

including high level such as spent fuel. Studies are continuing to further improve the already significant level of knowledge about long term behaviour of geologic repositories to facilitate selection of suitable locations.

Environmental Effects of Nuclear Waste

The application of nuclear sciences in industry, medicine, agriculture, research, environmental management and power generation produce radioactive waste which release radioactivity into the environment. These wastes may contain very high level of activities as well as low level activities. As discussed above, if the wastes are handled and disposed properly they pose negligible danger to the public but when improperly handled can lead to serious environmental hazards and loss of lives. The waste can lead to radioactive contamination of vegetable crops, vegetation grazing animals such as cows, sheep, horses and goats making them unfit for consumption. They can also contaminate our surface soils, water bodies, making our crops and marine foods also unfit for consumption. Groundwater may also be affected and the entire food chain connecting man to plant can be seriously affected. Generally, the radioactivity released could also have serious adverse effect on health man, such as cancer and could even lead to fatalities depending on the dose received.

The occurrence of a nuclear accident is another way nuclear technology might pose a significant danger to the public. The recent experience of Chernobyl accident in the USSR in 1986, led to environmental radioactive contamination of a very wide area. High levels of radioactivity were recorded in the air around the neighbouring countries. Apart from the fatalities in the immediate vicinity of the area, there were noticed contamination of food, water, milk and meat products which were declared unfit for consumption.

It is worth to note here that any form of nuclear radiation directly or indirectly produces ionisation and chemical change in its passage through matter. Therefore, intense irradiation of surface tissues are known to cause loss of hair and skin burns, blood producing cells in the spleen and bone marrow are particularly sensitive and there are high probability of contracting leukemia and cancer. Genetic mutation can be caused by radiation damage to the chromosomes and death can be caused by an acute over-exposure to radiation. Since damage or destruction to a cell requires a direct hit by only a single particle of radiation, it is wise to take precaution to avoid even the slightest exposure to any form of radiation from the nuclear waste.

Radiation Protection and Safety

There are very useful benefits derived from nuclear technology and we will continue to have workers in the nuclear industries, hence there is the need to establish radiation protections standards. The second international conference of radiology in 1928 established the International Commission on Radiation Protection (ICRP) to set the required standards of permissible exposure to radiation. A summary of these standards are presented in the table below for two categories of individuals namely (i)

Occupational, and (ii) the Ordinary Public.

In the S.I. Unit, the unit of radiation dose equivalent is the sievert (SV) which is defined as the dose in gray (GY) multiplies by the Quality Factor, (QF). Gray is defined as 1 joule per kilogram (1Kg) where 1Gy is equivalent to 100 rads. The rad is a quantitative measure of radiation energy absorption usually called the dose.

Organ/Body Tissue	Occupational Max. Permissible dose per year (mSv)	Ordinary Public Max. Permissible dose per year (mSv)
1. Gonads/Red bone marrow	50	7
2. Skin/Bone/Thyroid	300	30
3. Head/Forearms/ Feet/Ankles	750	75
4. Other Single organs	150	15

The commission recommended the following to be observed:

(i) The annual dose for occupational workers (those with routine exposure during their professional work) should not exceed 50mSv to the whole body.

(ii) Women of reproductive capacity should not receive more than 13 mSv on the abdomen for a quarter year.

(iii) Pregnant women should not receive more than 10 mSv throughout a quarter.

(iv) Radiation workers should avoid any unnecessary exposures.

We are all exposed to low level radiations every year. Studies have shown that an average American receives an average dose of about 1.3 mSv /year (Foster and Wright Jr. 1983).

Most of our low level radiations come from the following sources; cosmic radiations, ground radiation, internal sources, nuclear weapon testings, X-ray, medical checkups, wearing of luminous wristwatch, from watching coloured TV, nuclear power plants, etc. It is therefore very necessary that we stay away from any form of nuclear radiation as much as possible.

Conclusion

In conclusion, I seem to support the views of Awonaike (1992), who noted that there is no gain saying that application of nuclear technique would entail the consumption of radioactive food by the populace. We should know that we are all radioactive. There is no place on earth or in the universe, where one can hide from radiation. We all have some form of radioactive radium and carbon in our muscles and radioactive noble gases and tritium in our lungs. Studies have shown that radiation kills just as motor accidents and plane crash which are forms of engineering technology.

The potential benefits of nuclear technology for the development of our country can, therefore, not be over-emphasised, provided the safety requirements for the peaceful use of the nuclear technology are strictly observed. It is also viewed that the successful introduction of this technology requires interdisciplinary collaboration between relevant scientist, various government regulatory and financial agencies and industries. The health of the public will not be affected when all the arms associated with

the operation, handling and supervision of the nuclear industry are all in place as in other developed countries.

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