EG0800224

Radiation Monitoring – A Key Element in a Nuclear Power Program

A.S.Hussein and T.A.El-dally
Nuclear Power Plants Authority, Cairo, Egypt
nppa2@ides.net.eg

ABSTRACT

For a nuclear power plant, radiation is especially of great concern to the public and the environment. Therefore, a radiation monitoring program is becoming a critical importance. This program covers all phases of the nuclear plant including preoperational, normal operation, accident and decommissioning. The fundamental objective of radiation monitoring program is to ensure that the health and safety of public inside and around the plant and to confirm the radiation doses are below the dose limits for workers and the public. This paper summarizes the environmental radiation monitoring program for a nuclear power plant.

***Key Words*:** *Radiation Monitoring, Nuclear power plants, Doses, Health effects.*

INTRODUCTION

For Nuclear activates, radiation is especially of great concern to the public and to the environment. So that nuclear safety and radiation protection consequently have the same objective i.e. the protection of man and the environment against the harmful of ionizing radiation [1,2]. Therefore, environmental radiation monitoring program in the vicinity of the nuclear installations is becoming vital. The objectives of this program are [3] :

- To monitor the presence of radionuclides in the environment;
- To detect diffuse releases of radioactivity
- To test the data in mathematical models used to estimate the radiation doses to humans;
- To demonstrate that levels of radiation exposure within the limits stipulated by the Regulatory Agency , these limits are based on international guidelines ;
- To verify that nuclear power plants have less radiation effects and to gain its public acceptance.

Environmental monitoring is conducted both on and outside the nuclear power plant site giving rise to exposure of the public and radionuclides in the environment. The environmental monitoring programmes include measurements of radiation fields and radionuclide activity concentrations in environmental samples relevant to human exposure pathway shown in Figure 1, primarily in air, drinking water, agricultural produce and natural foodstuffs, as well as in bioindicators that concentrate radionuclides and provide a measure of trends in activity levels [4].

The environmental monitoring programmes should be comprehensive and appropriate for the local area, rapid in response and capable of sampling and measuring dose rates or activity levels in emergencies [4].

This paper focuses on the environmental radiation monitoring program in the vicinity of a nuclear power plant.

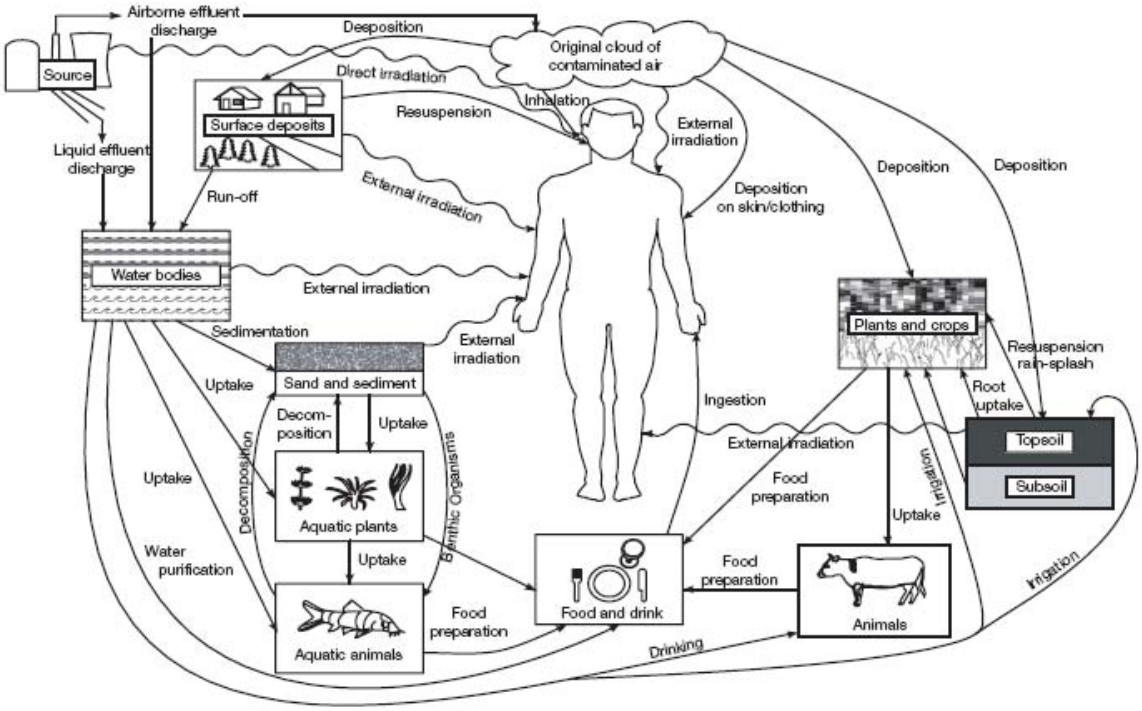

Figure 1: The possible pathways of exposure for the public as a result of discharges of radioactive material to the environment [(4)].

.

ENVIRONMENTAL RADIATION MONITORING PROGRAMS AT NUCLEAR POWER PLANTS

Pr-Operational Monitoring

Prior to any radioactive release from a nuclear power plant, a pr-operational radiation monitoring program for the selected site should be conducted to act as a reference for the future measurements. A well equipped Environmental Survey Laboratory (ESL) must be established at any nuclear power plant site. ELS's generate generate baseline data on the levels of external radiation dose and concentration of natural radioactivity (Uranium and Thorium and their progeny, Potasium-40, etc.) and radionuclides due to global weapon fallout (Strantium-90, cesium-137, etc).

During the pre-operational period, another important activity of the ESL is the collection of meteorological data, like wind speed and wind direction. These data are collected continuously and wind roses are drawn. The dispersion factors for gaseous effluents are derived on the basis of these data. These data are continuously collected during operational period also.

The preoperational programme can also serve to train staff and to test the equipment, instruments and organization of the operational monitoring programmes. The pre-operational programme should be

initiated in good time (2–3 years) before the commencement of operation so as to be able to study the annual variability in the local environment [4].

During the pre-operational period, arrangements for emergency preparedness should be considered. The basic intervention levels should be understood by all responsible persons and organizations, and operational intervention [4].

The environmental media that should be considered in the pre-operational radiation monitoring program, the recommended frequency and type of measurements are summarized in Table 1 [5].

Table 1 : Environmental media, frequency and type of measurements for a pre-operational radiation monitoring program [5] .

Media	Frequency	Type of Measurements
Air	Monthly	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta • Ambient Gamma Dose
Water - drinking water - ground Water - Rain Water - Sea Water	 Monthly Monthly Seasonally Twice a year	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta
Vegetables and Fruits Milk Meat and Fish Grass	Monthly Monthly Twice a year Monthly	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta
Soil and Sediment	Twice a year	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta

Normal Operation Monitoring

The operational level of the environmental radiation monitoring fulfills the following objectives [4]:

- Provides an early indication of the appearance or accumulation of any radioactive materials in the environment caused by operation of NPP.
- Verifies the adequacy and proper functioning of NPP effluent controls and monitoring systems.
- Provides an estimate of actual radiation exposure to the surrounding population
- Provides assurance to regulatory agencies and the public that the NPP's environmental impact is known within anticipated limits.
- Provides standby monitoring capability for rapid assessment of risk to the general public in the event of unanticipated or accidental release of radioactive materials (Source Term)

In normal operation radiation monitoring program, the recommended frequency and type of measurements are summarized in Table 2 [4].

Table 2 : Environmental media, frequency and type of measurements for normal operation radiation monitoring program [4,5].

Media	Frequency	Type of Measurements
Air	Weekly to Monthly	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta • Ambient Gamma Dose
Water - drinking water - ground Water - Rain Water - Sea Water	 Monthly Monthly Monthly Monthly	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta
Vegetables and Fruits Milk Meat Fish and shellfish Seaweeds and marine sponges Grass	Monthly Monthly Twice a year Twice a year Twice a year Monthly	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta
Soil and Sediment	Twice a year	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta

From literature it was reported the the environmental monitoring around nuclear power plants show relatively low activity concentrations of radionuclides in environmental samples [3,4,6].

Emergency Monitoring

NPP's are built very carefully to prevent accidental releases of radioactive materials. Many systems must fail before a large release can occur outside the NPP. So that, the probability of accidental releases of radioactivity substance into the environment is low, but does exist [4].

ESL plays a very important role during unlikely nuclear emergency situations in the NPP site.
During off-site emergency condition where the areas outside the site boundary are affected. ESL assesses the affected sector with the help of observed wind direction and wind speed.

In the emergency radiation monitoring program, the recommended frequency and type of measurements are summarized in Table 3 [4,5].

In a nuclear accident the prompt monitoring of a large area may be needed. For this reason, automatic measuring stations that will continuously measure and transmit to an emergency centre the dose rate in the environment should generally be installed around major facilities for the purposes of early monitoring and plume tracking. It is advantageous if the measuring stations are also capable of measuring concentrations of airborne particles, gaseous iodine and any other radionuclide of particular concern. For example, if a

facility may contain large amounts of tritium, some special device to measure tritium may well be installed [4,7,8] .

Table 3 : Environmental media, frequency and type of measurements for the emergency radiation monitoring program [4,5].

Media	Frequency	Type of Measurements
Air	Continuously Measurements every 2h	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta • Ambient Gamma Dose
Water - drinking water - ground Water - Rain Water - Sea Water	 Daily Daily Continuously Daily	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta
Vegetables and Fruits Milk Meat Fish and shellfish Seaweeds and marine sponges Grass	Daily Daily Representative samples Selected samples Selected samples Daily	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta
Soil and Sediment	Weekly	• Gamma Spectrometry • Alpha Spectrometry • Gross Beta

* Contamination map is very important for the emergency radiation monitoring program.

A map with preselected sampling locations should be prepared. Computer modelling of the dispersion of the radioactive plume with the source term, meteorological conditions and other factors taken into account can help to clarify monitoring priorities. The populated areas projected to be the most contaminated should have priority in the monitoring. Those responsible for assessments and management should be aware, however, that dose projections are uncertain. They should expect differences between the results obtained with different computer models and should not use these projections as the sole basis for protective actions [4,7,8].

An appropriately equipped mobile radiation laboratory can be advantage. Common equipment placed inside these laboratories includes gamma spectrometers, gross alpha/beta counter and liquid scintillation systems, among other equipment. To be effective, the mobile laboratory must be well maintained and available for immediate use when an accident occurs [7].

POPULATION EXPOSURE DOSES

One of the environmental radioprotection requirements for a nuclear facility licensing is the compliance of the dose limit (1 mSv/year) to the most exposured members of the public (critical group) . The US Environmental Protection Agency (EPA) estimates that someone living within 50 miles of a coal fired power plant receives an average dose of 0.3 μSv; someone living within 50 miles of a nuclear power plant receives 0.09 μSv [9].

Table 4 presents a worldwide comparison, based on data from the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), showing that the average radiation dose from nuclear power production is one ten-thousandth of the dose from natural background sources [(1)].

Table 4 Average annual doses to the world population from all sources of radiation (1).

Source	Dose (mSv)
Natural	
Cosmic	0.4
Gamma rays	0.5
Internal	0.3
Radon	1.2
Artificial	
Medical	0.4
Atmospheric nuclear testing	0.005
Chernobyl	0.002
Nuclear Power	0.0002
Total (rounded) mSv	**2.8**

QUALITY ASSURANCE PROGRAM

A good quality assurance (QA) program for environmental radiation monitoring around NPP's is essential to provide accurate information for the regulatory body and environmentalists. In this monitoring program , natural samples collected near a NPP are analyzed for their radioactivities in order to determine impacts from radioactive discharges of the NPP.Radioactivities in these natural samples are usually low and difficult to measure. The slightly increased activities in these samples from radioactive discharges are usually inseparable from natural variations, and it is essential to have a good quality control(QC) system for each radio analytical laboratories to provide results on these samples [(10,11)].

Generally, the quality assurance programme should be designed to ensure that [(4)]:

- The organizational structure, functional responsibilities, levels of authority and interfaces for those managing, performing and assessing the adequacy of work are defined;

- All management measures, including planning, scheduling and resource considerations, are addressed;
- Work processes and procedures are established and understood;
- The regulatory requirements relating to source monitoring, environmental monitoring and individual monitoring are met;
- Appropriate methods of sampling and measurement are used;
- The choices of environmental media, the locations for sampling and measurement and the associated sampling frequency are appropriate;
- Interlaboratory comparisons at the national or international level for methods and instruments are in place.

CONCLUSION

The primary consideration in the safety of nuclear power plants is the protection of the worker , public and the environment from effects of ionizing radiation both during normal operation and in the nuclear accident. So that, the environmental radiation monitoring program is an important part of the so-called " Nuclear Safety".

Good managed Quality Assurance program for the environmental radiation monitoring and a well equipped Environmental Survey Laboratory (ESL) play a crucial role to ensure that the environmental impact of nuclear power plants is minimized to extent possible.

Most of regulations and environmental radiation monitoring program should be followed the guide of international authorities such as the International Commission of Radiation Protection (ICRP) and the International Atomic Energy Agency (IAEA).

REFERENCES

(1) Radiation, People and the Environment, International Atomic Energy Agency (IAEA) (2004).
(2) Nuclear Energy Today, Nuclear Energy Agency (NEA) (2005).
(3) P.Wallberg and L.Moberg, Evaluation of 20 years of environmental monitoring data around Swedish nuclear installations, J.Envir.Rad. 63,pp1117-133(2002).
(4) Environmental and source monitoring for purposes of radiation protection , IAEA Safety Guide ,No.Rs-G-1.8(2000)
(5) Personal Communication with IAEA Expert.
(6) S.Roussel-Debet, G.Gontier, F.Siclet and M.Fournier, Distribution of carbon 14 in the terrestrial environment close to French nuclear power plants,J.Env.Rad. 87 pp.246-259(2006).
(7) Generic procedures for monitoring in a nuclear or radiological emergency, IAEA-TECDOC-1092 (2000).
(8) Dispersion of radioactive material in air and water and consideration of population distribution in site evaluation for nuclear power plants, Safety Guide No. NS-G-302(2002).
(9) Nuclkear Power and sustainable Development ,IAEA (2006).
(10) M.Betti and L. Aldave de las Heras, Quality assurance for the measurements and monitoring of radioactivity in the environment , J.Inv.Rad. 72 pp.233-243 (2004).
(11) J.K.Gone and T.W.Wang , Quality assurance program for determining the radioactivity in environmental samples at the Institute of nuclear Energy Research in Taiwan. IRPA,p-40-205(www.irpa.org).