الأسبوع السابع و الثامن

Chapter Four (Prevention and Reduction)

4.1 Methods of Prevention

Radiation protection or prevention, sometimes known as radiological protection, is the science and practice of protecting people and the environment from the harmful effects of ionizing radiation.

Fundamental to radiation protection is the reduction of expected dose and the measurement of human dose uptake. For radiation, protection and dosimeter assessment the International Committee on Radiation Protection (ICRP) and International Commission on Radiation Units and Measurements (ICRU) have published recommendations and data that are using to calculate the biological effects on the human body, and set regulatory and guidance limits.

There are three factors are control the amount or dose of radiation received from a source. Radiation exposure can be manage by a combination of these factors:

1- Time: Reducing the time of an exposure reduces the effective dose proportionally. An example of reducing radiation doses by reducing the time of exposures might be improving operator training to reduce the time they take to handle a source.

2- Distance: Increasing distance reduces dose due to the inverse square law. Distance can be as simple as handling a source with forceps rather than fingers.

3- Shielding: The term 'biological shield' refers to a mass of absorbing material placed around a reactor, or other radioactive source, to reduce the radiation to a level safe for humans. The effectiveness of a material as a biological shield is relating to its cross-section for scattering and absorption, and to a first approximation is proportional to the total mass of material per unit area interposed along the line of sight between the radiation source and the region to be protected. Hence, shielding strength or "thickness" is conventionally measure in units of g/cm^2. The radiation that manages to get through falls exponentially with the thickness of the shield. In x-ray facilities, walls surrounding the room with the x-ray generator may contain lead sheets, or the plaster may contain barium sulfate. Operators view the target through a leaded glass screen, or if they must remain in the same room as the target, wear lead aprons. Almost any material can act as a shield from gamma or x-rays if used in sufficient amounts. The effectiveness of shielding is dependent on the Stopping power of radiation particles, which varies with the type and energy of radiation and the shielding material used. Different shielding techniques are therefore use dependent on the application and the type and energy of the radiation.

Shielding reduces the intensity of radiation depending on the thickness. This is an exponential relationship with gradually diminishing effect as equal slices of shielding material are add. A quantity known as the halving-thicknesses is use to calculate this. The effectiveness of a shielding material in general increases with its atomic number, called Z, except for neutron shielding which is more readily shielded by the likes of Neutron absorbers and moderators such as compounds of Boron e.g. boric acid, cadmium and Carbon & Hydrogen respectively.

Graded-Z shielding is a laminate of several materials with different Z values (atomic numbers) designed to protect against ionizing radiation. Compared to single-material shielding, the same mass of graded-Z shielding has been shown to reduce electron penetration over 60%. It is commonly used in satellite-based particle detectors, offering several benefits:

1- protection from radiation damage
2- reduction of background noise for detectors
3- lower mass compared to single-material shielding

In most countries, a national regulatory authority works towards ensuring a secure radiation environment in society by setting dose limitation requirements that are generally based on the recommendations of the International Commission on Radiological Protection (ICRP). These use the following overall principles:

*Justification: No unnecessary use of radiation is permitted, which means that the advantages must outweigh the disadvantages.

*Limitation: Each individual must be protected against risks that are far too large through individual radiation dose limits.

*Optimization: Radiation doses should all be kept as low as reasonably achievable. This means that it is not enough to remain under the radiation dose limits. As permit holder, you are responsible for ensuring that radiation doses are as low as reasonably achievable, which means that the actual radiation doses are often much lower than the permitted limit.

This policy of prevention is based on the principle that any amount of radiation exposure, no matter how small, can increase the chance of negative biological effects such as cancer. It is also based on the principle that the probability of the occurrence of negative effects of radiation exposure increases with cumulative lifetime dose. Different types of ionizing radiation interact in different ways with shielding material.

Radiation protection instruments: - Practical radiation measurement using calibrated radiation protection instruments is essential in evaluating the effectiveness of protection measures, and in assessing the radiation dose likely to be received by individuals. The measuring instruments for radiation protection are both "installed" (in a fixed position) and portable (hand-held or transportable).

Installed instruments: - Installed instruments are fixed in positions which are known to be important in assessing the general radiation hazard in an area. Examples are installed "area" radiation monitors, Gamma interlock monitors, personnel exit monitors, and airborne particulate monitors.

The area radiation monitor will measure the ambient radiation, usually X-Ray, Gamma or neutrons; these are radiations which can have significant radiation levels over a range in excess of tens of meters from their source, and thereby cover a wide area.

Gamma radiation "interlock monitors" are used in applications to prevent inadvertent exposure of workers to an excess dose by preventing personnel access to an area when a high radiation level is present. These interlock the process access directly.

Airborne contamination monitors measure the concentration of radioactive particles in the ambient air to guard against radioactive particles being ingested, or deposited in the lungs of personnel. These instruments will normally give a local alarm, but are often connected to an integrated safety system so that areas of plant can be evacuated and personnel are prevented from entering an air of high airborne contamination.

Personnel exit monitors (PEM):- are use to monitor workers who are exiting a "contamination controlled" or potentially contaminated area.

These can be in the form of hand monitors, clothing frisk probes, or whole body monitors. These monitor the surface of the workers body and clothing to check if any radioactive contamination has been deposited. These generally measure alpha or beta or gamma, or combinations of these.

The UK National Physical Laboratory publishes a good practice guide through its Ionizing Radiation Metrology Forum concerning the provision of such equipment and the methodology of calculating the alarm levels to be used.

Portable instruments:- Hand-held ion chamber survey meter in use. Portable instruments are hand-held or transportable. The hand-held instrument is generally used as a survey meter to check an object or person in detail, or assess an area where no installed instrumentation exists. They can also be used for personnel exit monitoring or personnel contamination checks in the field. These generally measure alpha, beta or gamma, or combinations of these.

4.2. Reduction of Radioactive Contaminants

Radiation Pollution reduction can be doing at various levels, including the handling and treatment of radiation waste, the control and reducing of nuclear accidents, as well as the control and minimization of personal exposure to radiation at an individual level.

Treatment or reduction of radiation waste cannot be doing through degradation by chemical or biological processes. Additionally, many radioactive materials have very long half-life (time necessary for half of the material to degrade or transform into non-radioactive materials) and thus radiation waste may pose a risk for many years after it produced. There are only few options for radiation waste treatment involving:

1- Containment of the waste in radiation-shielded containers usually buried under ground
2- Isolation of radiation waste in remote locations such as remote caves or abandoned mines - which may also involve the use of some kind of barriers (shields),
3- When the first two alternatives are not possible, the waste may be diluted till background values are achieved.
4- Keep the radiation waste in cold places, away from any heating source, because the heat increases the amount of radiation and thus may increase the health risk.

At individual levels, there are measures you may take to prevent and/or reduce radiation pollution that may affect you and your family. Here are some examples:

First, testing of your home for radon may be doing by each person using inexpensive testing kits or by specialized consulting services. If radiation seems to be an issue (a higher than background value of radon in home is found), a preferred radon reduction technique is the installation of a special system called active soil depressurization (ASD). This system contains a vent pipe with an inline centrifugal fan that operates continuously to vent radon and other intruding gases from beneath the house. Thus, the system may be efficient to block the intrusion into homes not only of radon, but also of other toxic chemicals (non-radioactive) that may get from the subsurface into indoor breathing air.