DOE/SR-8006, Vol I

General Employee Orientation Training Course - Radiation Safety Student Handbook

Rev. 1
August 1989

Prepared by
NUS Corporation

A.D. Holmes, DOE-SR Task Leader
P.O. Matthews, DOE-SR Task Manager

Prepared for
U.S. Department of Energy

Facility Safety Division
Radiation Protection Branch
Savannah River Operations Office
Aiken, South Carolina

Under Contract No. DE-AC09-87SR15107

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STUDENT HANDBOOK
DOE-SR GENERAL EMPLOYEE ORIENTATION TRAINING

Federal statutes and regulations and Executive Order 12196 require that all federal agencies establish occupational safety and health programs for their employees. The Department of Energy (DOE) occupational safety and health program requires that all employees be informed of hazards in their workplace and how to minimize the risk to themselves, their fellow workers and members of the general public from exposure to those hazards. One of the objectives of this training course is to meet these information requirements as they pertain to radiological hazards. A second objective of this course is to provide you with sufficient information concerning the rules related to radiation safety to permit you to fulfil your individual responsibilities.

1.0 RADIATION

Although the term "radiation" is used very broadly to include such forms of energy as light, radio waves and microwaves, it is commonly used to mean "ionizing" radiation. Ionizing radiation has the ability to transfer energy to produce charged particles (known as ions) in materials that it strikes. The ions in turn may cause chemical changes and damage. Radiation is in the form of energy such as gamma or X-rays or in the form of energetic particles such as alpha, beta or neutron. Each type of radiation has a different hazard due to its characteristics. The Health Protection Department often identifies, on both signs and surveys, the various types of radiation that may be present to help you recognize the different hazards that may exist in an area.

1.1 Unit of Measurement

The rem is the basic unit for measuring radiation exposure, and the basic unit for exposure rate is rem/hour. Although other units are used when measuring the exposure or exposure rate from specific types of radiation, the rem is a unit that can be used to express exposure to any type of radiation. The rem, which is an acronym for "Roentgen Equivalent in Man", is a measure of the biological damage produced in human beings when radiation energy is absorbed in tissue. The rem takes into account the differing effects produced by different types and energies of radiation. Because a rem is a relatively large unit, the metric prefix "milli" is generally used for measuring both exposures and exposure rates. The prefix "milli" means 1/1,000 (one rem equals 1,000 millirem, and 1 millirem/hour equals 0.001 rem/hour).

1.2 Sources of Radiation

- Some radiation is produced in outer space. This cosmic radiation is one of the sources of natural background radiation.

- Unstable atoms can emit radiation by undergoing nuclear fission, radioactive decay or both. Unstable atoms that emit radiation are called radioactive material. Radioactive material that is in an undesirable location is commonly called contamination. Radioactive decay is a process during which an atomic nucleus emits radiation in the form of particles or energy in an attempt to become more stable.

Radioactive material that is capable of fissioning is additionally known as fissionable material. Fission is a process during which an atomic nucleus splits into two or more smaller nuclei along with the emission of neutrons and energy. The new atoms are more stable than the original but usually are also radioactive.

- The deceleration of charged particles produces radiation. This principle is used in x-ray machines, where a beam of electrons is used to create the x-rays.

Sources of radiation occur in nature and have also been made by man. Every individual, regardless of occupation, residence or protective measures, is exposed to sources of radiation.

1.2.1 Natural Background Radiation

Natural background radiation has always been present and was in man's environment long before the invention of the atomic bomb, nuclear reactors and other man-made radiation sources. This radiation comes from outer space (cosmic radiation); radioactive material in the earth's surface, air and water; and radioactive material in the human body.

Cosmic radiation consists of energetic particles that originate either from the sun or deep in the galaxy. The earth's atmosphere protects us from most of this radiation, and thus the amount of radiation that an individual receives from this source depends in part on how much air there is above the person. The amount of cosmic radiation present in Denver, Colorado is about twice that at sea level; the amount present at the normal cruising altitude for transcontinental passenger jets is about 100 times that at sea level. Cosmic radiation accounts for about 9% of the average U.S. individual's exposure to natural background radiation.

Radioactive material in the soil is another naturally occurring source of radiation. These materials have been present since the earth was formed. Like many natural elements, the naturally occurring radioactive materials are more likely to be present in high concentrations in certain geologic formations and types of rock or soil. The amount of radiation present as a result of radioactive material in soil therefore varies widely. On an overall average the amount of radiation present from radioactive materials in the soil in the Southeastern United States is about half that present in the rest of the country and only about one fourth of that present in some mountainous Western states. External radiation from radioactive material in the soil accounts for about 9% of the average U.S. individual's exposure to natural background radiation.

Radioactive material in the air is primarily the result of the decay of radioactive material in the soil. Gases such as radon are members of decay "chains" in which one radioactive element decays to another element that is also radioactive. Radiation is emitted each time a decay occurs. Elements such as uranium and radium that are normally solids usually remain in the soil unless disturbed. Elements such as radon that are normally gases will readily diffuse through soil and enter the air. When the radon decays the new element will be a microscopic solid particle that will remain suspended in air.

The amount of radioactive material present in air in a given location at any given time is influenced by many factors, including:

- the amount of radioactive material in the underlying soil, which determines the rate at which radon gas is produced.
- factors such as soil moisture content and permeability, which determine how rapidly the radon gas will diffuse through the soil into the air.
- meteorological conditions and ventilation of enclosed areas, which determine how rapidly radon and its particulate daughters will be removed or dispersed.

The concentration of radon and its radioactive particulate daughters in air is usually much higher inside buildings than outdoors. In the U.S., radiation from radioactive material in the air accounts for about 68% of the average individual's exposure to natural background radiation.

Radioactive material accumulates in the human body as a result of the transfer of radioactive materials from soil, water and the air through the food chain. There is some variation in the amount of radioactive material present in a given individual's body due to differences in the food and water consumed. However, the amount of radioactive potassium and carbon present in an individual, which is responsible for most of the radiation exposure that an individual receives from radioactive materials in the body, is controlled by body metabolism and does not vary significantly among individuals. In the U.S., radiation from radioactive material in the human body accounts for about 14% of the average individual's exposure to natural background radiation.

1.2.2 Manmade Radiation

Man has learned to control the natural fission process and has also developed processes and devices that artificially produce radiation and radioactive materials.

Nuclear Weapons Testing prior to the discontinuance of atmospheric testing produced fallout that has resulted in radioactive materials being dispersed throughout the world. Some of these materials have settled into the soil and water. Radiation from radioactive materials produced by weapons testing results in an additional exposure to radiation that is less than 0.5% of that received from natural background radiation by an average individual in the U.S.

Production and Utilization of Fissionable Material involves processes that result in direct radiation, excavation of large quantities of naturally occurring radioactive material that would otherwise remain deeply buried in the earth and production of radioactive materials that do not occur in nature. Controlled nuclear fission, which is a direct source of radiation, is used in nuclear weapons and reactors. Fissionable materials for use in these processes originate as naturally occurring material, which must be mined, separated, concentrated and fabricated before it can be used. The fission process produces radioactive "fission products", and also "activation products" that result from the absorption in nearby materials of some of the neutrons that are released during fission. Some activation products are fissionable, thus a reactor can both use and produce fissionable materials.

All of the activities associated with production and utilization of fissionable materials are closely regulated and controlled so that the resulting radiation exposure to members of the general public is very small. For the average individual living in the Central Savannah River Area the additional radiation exposure received as a result of these activities (primarily from the release of radioactive material from the Savannah River Plant and the Vogtle commercial nuclear power plant) is less than 0.1% of that received from natural background radiation.

Manmade sources of radiation are routinely used in the practice of medicine. X-rays are used for diagnosing or treating patients, and radioactive materials are administered to patients for the same purposes. Radiation from medical diagnosis and treatment procedures results in an average additional exposure to radiation that is approximately 18% of that received from natural background radiation by an average individual who lives in the U.S.

Miscellaneous sources of manmade radiation include common consumer products containing radioactive material, such as luminous dials, gemstones, smoke detectors, static eliminators, porcelain dentures and pacemakers. An additional source of radiation is fly ash from coal fired electric generating stations, which contains small amounts of naturally occurring radioactive material. Radiation from these miscellaneous sources results in an additional average exposure to radiation that is approximately 3% of that received from natural background radiation by an average individual who lives in the U.S.

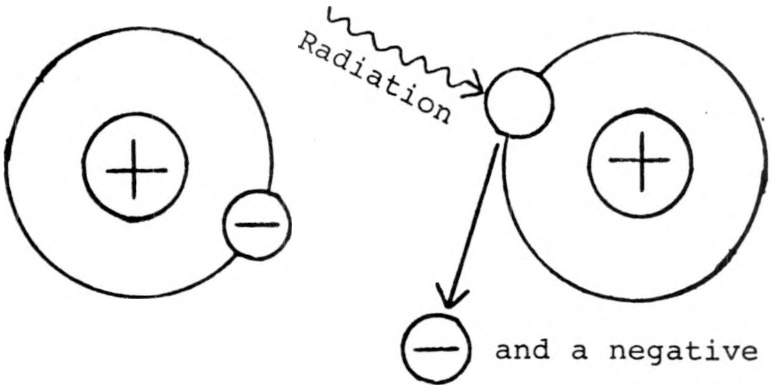
1.3 How Radiation Interacts with Matter

Rays or particles of ionizing radiation are different from other forms of energy such as light or heat in that each individual ray or particle contains sufficient energy to cause chemical changes in the material in which they are absorbed. Ionizing radiation interacts with matter by transferring some of its energy to atoms in the material in its path. If the energy transferred is greater than the energy that bonds an orbiting electron to the nucleus of the atom then the electron may be ejected from its orbit as shown in Figure 1. This process is known as "ionization" since it results in a negative ion (the negatively charged electron) being separated from an atom, leaving behind a positive ion (the remaining electrons and nucleus with a positive charge). Atoms chemically bond to form molecules by sharing electrons. If an electron is ejected from an atom through ionization a chemical bond may be split or the atom may

Figure 1

Ionizatior

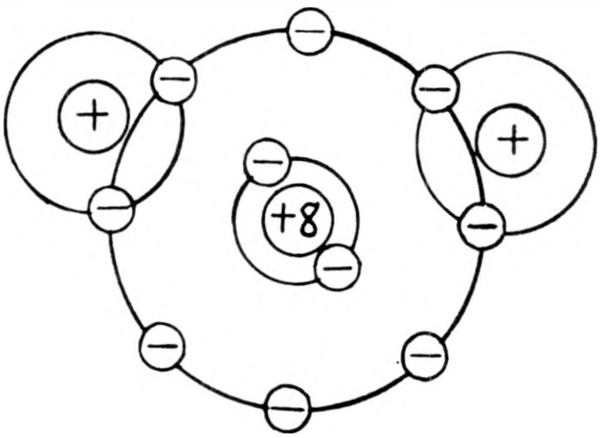
Ionization of an atom...



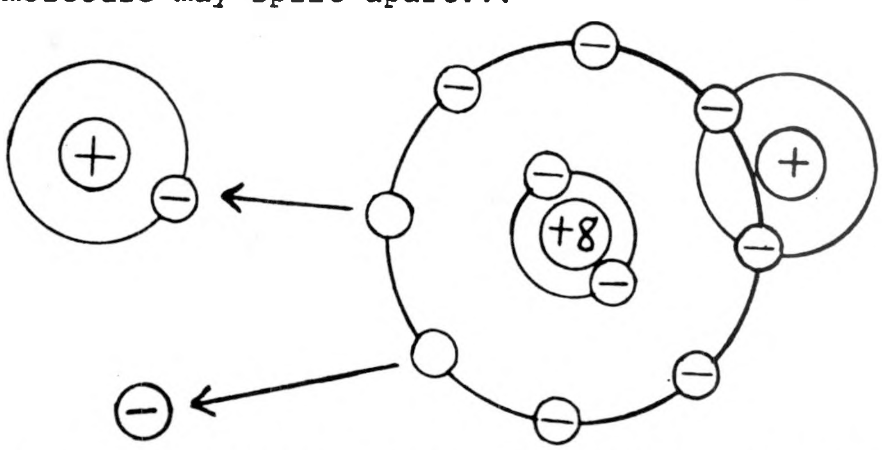
results in a positive ion...

and a negative ion.

Atoms share electrons to form molecules.



If an ejected electron was shared by two atoms, the molecule may split apart...



or may recombine with another atom or molecule.

combine with another atom or molecule. Thus ionizing radiation directly and indirectly results in disruptions and interferences to normal chemical activity.

1.4 How Radiation Damages Body Tissue

As illustrated in Figure 2, the body is made up of organs consisting of tissues, comprised of cells, which are in turn made up of various types of molecules. Each molecule in a cell is important to one or more cell functions. When a molecule is altered by ionization it may not be able to perform its normal function within a cell. Ions are chemically unstable and will attempt to bond with each other to again form chemically stable molecules. But, the new molecules may be different from the original ones. Thus, radiation creates ions which can disrupt and change the normal chemical activity in a cell. Most ionizing radiation has enough energy for each ray or particle to produce many ions. The higher the energy of the radiation and the higher the number of radiation rays or particles striking a cell the more ions will be created, and more disruption to normal chemical activity will occur. Unless the damage is severe, cells that have been damaged by disruption of their normal chemical activity are capable of recognizing the presence of damaged or unusable molecules and, given time, of either replacing them or rearranging them back into the proper chemical form. Severely damaged cells usually die, but the body is also capable of replacing most types of cells.

Some of the basic cell functions are:

- Division for self reproduction
- Developing specialized functions (maturing)
- Division to produce specialized cells

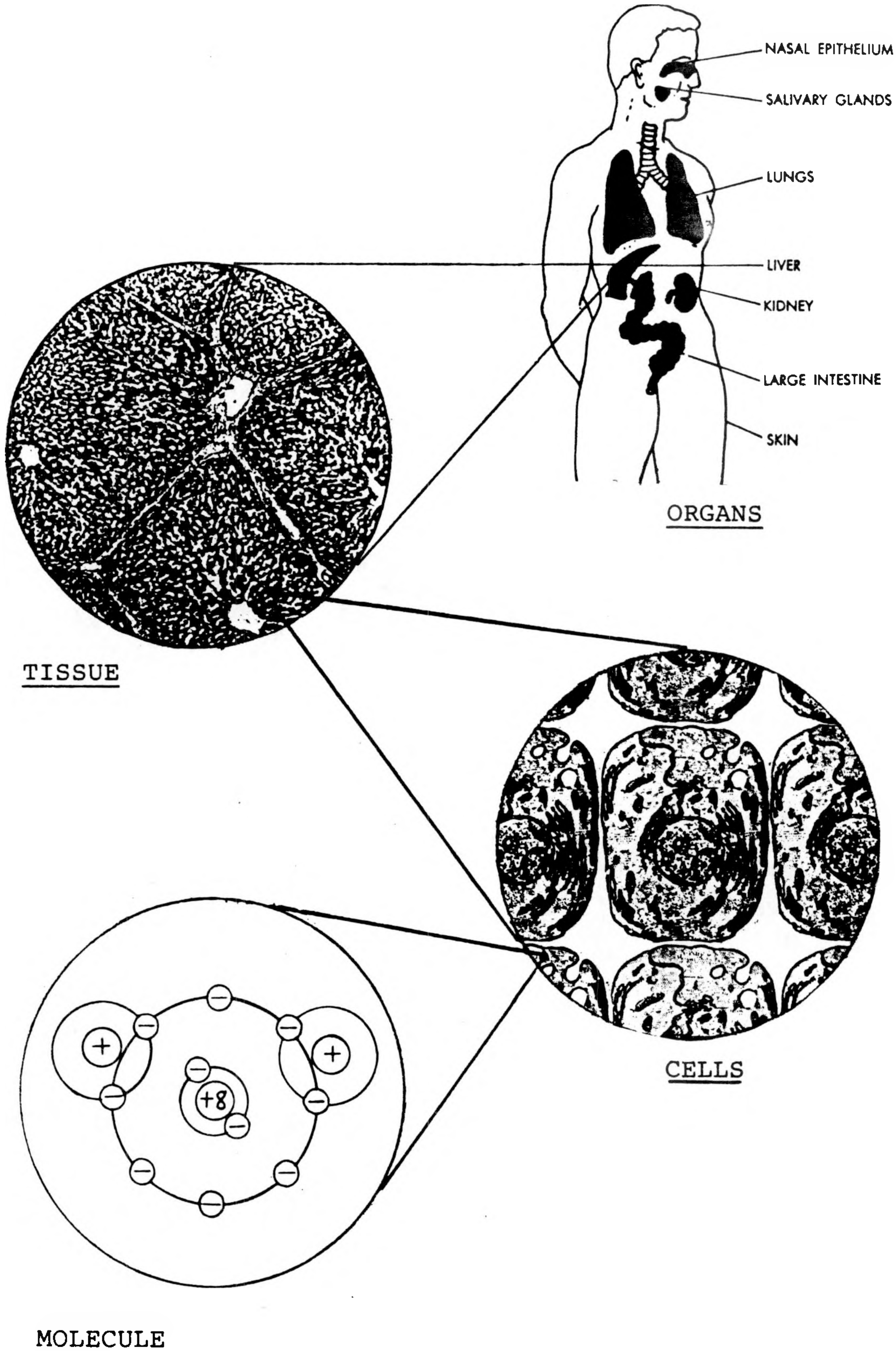
If a damaged cell needs to perform one of these functions before it has had time to repair itself it may either be unable to perform the function or perform it incorrectly or incompletely. The frequency with which a given type of cell is called upon to perform these functions therefore contributes to determining how sensitive that type of cell is to being injured by radiation.

In general, sensitivity to radiation varies directly with the rate of cell division and the number of future divisions that the cell will undergo, and inversely with the extent to which the cell's function is specialized. The single celled embryo is the most sensitive of all cells because it is dividing very rapidly, will undergo the maximum possible number of future cell divisions and is the least specialized in function.

As long as the rate at which cells are damaged is less than the rate at which cells can repair themselves or be replaced then the total population of cells of a given type will not decline. Unless the total population of cells of the type needed to perform a necessary body function decreases to the point that the required bodily function is impaired then there will be no observable injury to the body. Therefore, large exposures received in a short period of time result in clinically observable biological effects due to the damage rate exceeding the repair and replacement rate. Small

Figure 2

Biological Structure of the Human Body



exposures over long periods of time do not result in clinically observable biological effects since the repair and replacement rate far exceeds the damage rate.

Some damage to cells is never repaired, either because the repair function itself has been damaged or because the ability of the cell to recognize that it is damaged has been impaired. Over a period of many years of exposure to radiation at levels well below those necessary to produce immediately observable effects, the cumulative, unrepaired damage to some types of body tissue may result in an increased probability of certain abnormalities.

2.0 BIOLOGICAL EFFECTS FROM EXPOSURE TO RADIATION

The possible biological effects from exposure to radiation can be grouped into two major categories, threshold effects and non-threshold effects.

2.1 Threshold Effects

Threshold effects are those that do not occur unless a certain minimum dose is received causing damage to occur in a shorter period of time than it can be repaired. Threshold effects can be prevented by ensuring that an individual's exposure to radiation does not exceed the threshold exposure limit. Threshold effects include radiation sickness and death, sterility, loss of hair, reddening of the skin, benign tumors and cataracts. DOE limits exposure to radiation at a sufficiently low level to positively prevent any of these effects from occurring during normal operations at all facilities. However, exposures can occur that could result in these effects due to accidents or personnel disobeying rules, procedures and warning signs.

2.2 Non-Threshold Effects

Non-threshold effects are those where there is no minimum dose below which it is known that the effects will not occur. Non-threshold effects can be reduced but cannot be totally prevented because it is not possible to completely eliminate radiation exposure. The probability that they will occur is assumed to be directly related to dose, and can be reduced by maintaining exposure to radiation as low as reasonably achievable. Non-threshold effects include cancer, genetic defects in offspring and birth defects. DOE limits exposure to radiation and encourages that exposures be kept as low as is reasonably achievable in order to minimize the probability of these effects occurring to a level that is equivalent to working in any other safe industry.

2.3 Risk to Unborn Child

The embryo/fetus is more sensitive to radiation than adults, especially during the first four months of development. Radiation exposure to a fetus may increase the risk that the child will develop childhood cancer, have a small head size, or exhibit mental retardation. These effects are caused by many hazards in our environment. DOE limits radiation exposure to declared pregnant female workers to minimize the probability of any adverse effects to the unborn child.

3.0 RADIATION PROTECTION POLICIES AND PROCEDURES

The Environmental Protection Agency (EPA) is responsible for providing guidance to all federal agencies for protecting both workers and members of the public from hazards associated with exposure to radiation. In developing this guidance the EPA considers recommendations made by national and international scientists and experts in the field of radiation protection. In its most recent guidance, the EPA recommends that:

- There should not be any occupational exposure of workers to ionizing radiation without the expectation of an overall benefit from the activity causing the exposure.
- No exposure is acceptable without regard to the reason for permitting it.
- It should be general practice to maintain exposures to radiation as low as reasonably achievable below limiting values.

DOE has developed policies and procedures to implement the EPA recommendations. It is the policy of DOE to keep all radiation exposures within limits and as low as reasonably achievable.

3.1 Radiation Exposure Limits

DOE has established a limiting value for radiation exposure to members of the public as a result of DOE activities of 100 millirem per year. Limiting radiation exposure to no more than 100 millirem in a year prevents clinically observable biological effects from short term radiation exposure and limits the probability of occurrence of biological effects from long term radiation exposure to levels equivalent to risks that are normally accepted in everyday life as producing no undue concern.

Because individuals who work in DOE facilities receive more direct benefits from DOE's activities (i.e., employment) than members of the public, a higher limiting value for radiation exposure of 5,000 millirem per year has been established for persons whose job assignment requires working on, with, or in the proximity of radiation producing machines or radioactive materials; or if the potential exists for the person to be routinely exposed to radiation above the limit for a member of the public. This higher radiation exposure limit is based on controlling risk to levels comparable to those encountered on the job when working in other industries that are generally considered to be relatively safe. Such individuals are classified as "radiation workers." Prior to or concurrent with being assigned duties or responsibilities that would classify you as a radiation worker you are required to attend additional training to learn safety rules, procedures and techniques for minimizing your radiation exposure.

Risks from various activities can be expressed in terms of the estimated average days of lost life expectancy. These estimates account for treatability of effects and when in the average lifespan the effects are expected to occur. Tables 1 and 2 compare the risks from radiation exposure to risks associated with day to day activities and lifestyle choices and with risks associated with working in various industries.

Table 1

Estimated Loss of Life Expectancy from Health Risks

Health Risk	Estimates of Days of Life Expectancy Lost, Average
Smoking 20 cigarettes/day	2370 (6.5 years)
Overweight by 20%	985 (2.7 years)
All accidents combined	435 (1.2 years)
Auto accidents	200
Alcohol consumption (U.S. average)	130
Home accidents	95
Drowning	41
Natural background radiation, calculated	8
Medical diagnostic x-rays (U.S. average), calculated	6
All catastrophes (earthquake, etc.)	3.5
One rem of radiation exposure, calculated	1
100 millirem each year for 50 years, calculated	5

Table 2

Estimated Loss of Life Expectancy from Industrial Hazards

Industry Type	Estimates of Days of Life Expectancy Lost, Average
All industry	74
Trade	30
Manufacturing	43
Service	47
Government	55
Transportation and utilities	164
Agriculture	277
Construction	302
Mining and quarrying	328
Radiation accidents, death from exposure	<1
Radiation exposure of 0.65 rem per year (industry average for radiation workers) for 30 years	20
Radiation exposure of five rem per year for 50 years	250
Industrial accidents at nuclear facilities (nonradiation)	58

3.2 ALARA

Estimates of the probability of occurrence of long term effects from exposure to radiation are based on the assumption that there is no threshold, that is, any level of exposure may potentially result in an increased risk of cancer or genetic defects in offspring. It is therefore the policy of DOE to maintain all radiation exposures, both to its employees and contractors as well as members of the public, **as low as reasonably achievable (ALARA)** below limits. This policy is based on the assumptions that:

- Minimizing individual exposure minimizes the risk of long term effects to individuals, primarily the incidence of radiation induced cancers.

- Minimizing collective exposure (the total exposure received by all exposed persons) minimizes the risk of long term effects to the collective population, primarily the overall incidence of genetic defects in offspring.

As low as is reasonably achievable means as far below limits as technical, economic and practical considerations permit.

3.3 Radiation Exposure Control

Radiation exposure can be minimized by reducing the **time** people spend near radiation sources, by increasing the **distance** between people and radiation sources and by increasing the amount of **shielding** between people and radiation sources. There are many methods and practices for implementing these basic exposure reduction techniques. Many of the available practices for minimizing radiation exposure have been implemented by DOE management, but others can only be implemented by individual employees. The responsibilities of the Department and those of individual employees are specified in federal law.

The Occupational Safety and Health Act of 1970 requires DOE to provide conditions and places of employment that are free of recognized hazards. It is DOE policy that the primary means for maintaining radiation exposures as low as reasonably achievable be through physical controls incorporated into the design of its facilities. These physical controls are supplemented by administrative and procedural controls to ensure that design features will be effectively utilized. Most day to day responsibilities for implementing administrative controls as well as the responsibility to develop and implement more detailed safety rules and procedures governing specific hazards in specific process areas have been delegated by DOE-SR to the operating contractor. Operating contractor Health Protection Department personnel are responsible for assisting all personnel who enter process areas in complying with safety requirements.

3.3.1 Facility Design and Administrative Practices

Processes and facilities at Savannah River Plant have been designed for efficient operation so that workers spend a minimum amount of **time** near sources of radiation. In addition, major sources of radiation are provided with **shielding** that reduces radiation exposure rates in nearby occupied areas. Administrative and procedural controls relevant to ensuring that time and shielding are effectively used to reduce radiation exposures are primarily applicable to radiation workers.

The **distance** between radiation sources and personnel has also been maximized by design. Since distance is the primary means used to control radiation exposures to general employees it is important for you to understand how the combination of physical and administrative controls work together to minimize your exposure.

Processes and facilities at Savannah River Plant are designed to contain sources of radiation. Radioactive materials are processed in enclosed piping, tanks, glove boxes and similar systems and components. When it is necessary to move radioactive materials from one area to another they are packaged in containers that are designed to ensure that there is no leakage of radioactive material from the container. Process buildings are equipped with special ventilation systems that minimize the amount of radioactive material that is released into the air, and all personnel, equipment and other items are monitored for contamination before leaving process areas. These controls are important because loose radioactive contamination on surfaces or in the air could enter the human body through open wounds or sores, by being inhaled or swallowed, or even by absorption through unbroken skin.

Access to all facilities and areas at Savannah River Plant where it would be possible for an individual to receive radiation exposure in excess of the limit of 100 millirem in a year is controlled by fences, barricades, building walls or other physical means and are posted with signs warning that there is a radiological hazard in the area. These areas are designated as **Regulated or Controlled Areas**. Figure 3 illustrates two types of radiological warning signs that may be used to post these areas. Additional, similar, signs are used within regulated or controlled areas to warn radiation workers of more severe radiological hazards. All radiological warning signs have black or magenta letters and the trifoil symbol on a yellow background. **You are not permitted to enter an area that is posted with one of these signs unless you have completed radiation worker training or are escorted by an individual who has completed the training.**

Containers of radioactive material being transported from one area to another are identified in a variety of ways. The vehicle will have a yellow and magenta/black sign or label with the trifoil symbol on the driver's door or on the dashboard identifying it as regulated use or regulated service equipment. Some vehicles have signs on all sides. In some cases the actual "package" containing the radioactive material is part of the vehicle, such as a tank truck. The most common package used to transport radioactive materials from one area to another at Savannah River Plant are large yellow metal boxes containing low level radioactive waste destined for the burial ground.

Figure 3

Radiological Warning Signs

3.3.2 Personnel Monitoring for External Exposure

To ensure that controls within regulated or controlled areas are effective in limiting radiation exposures, the exposure of personnel who enter these areas is monitored.

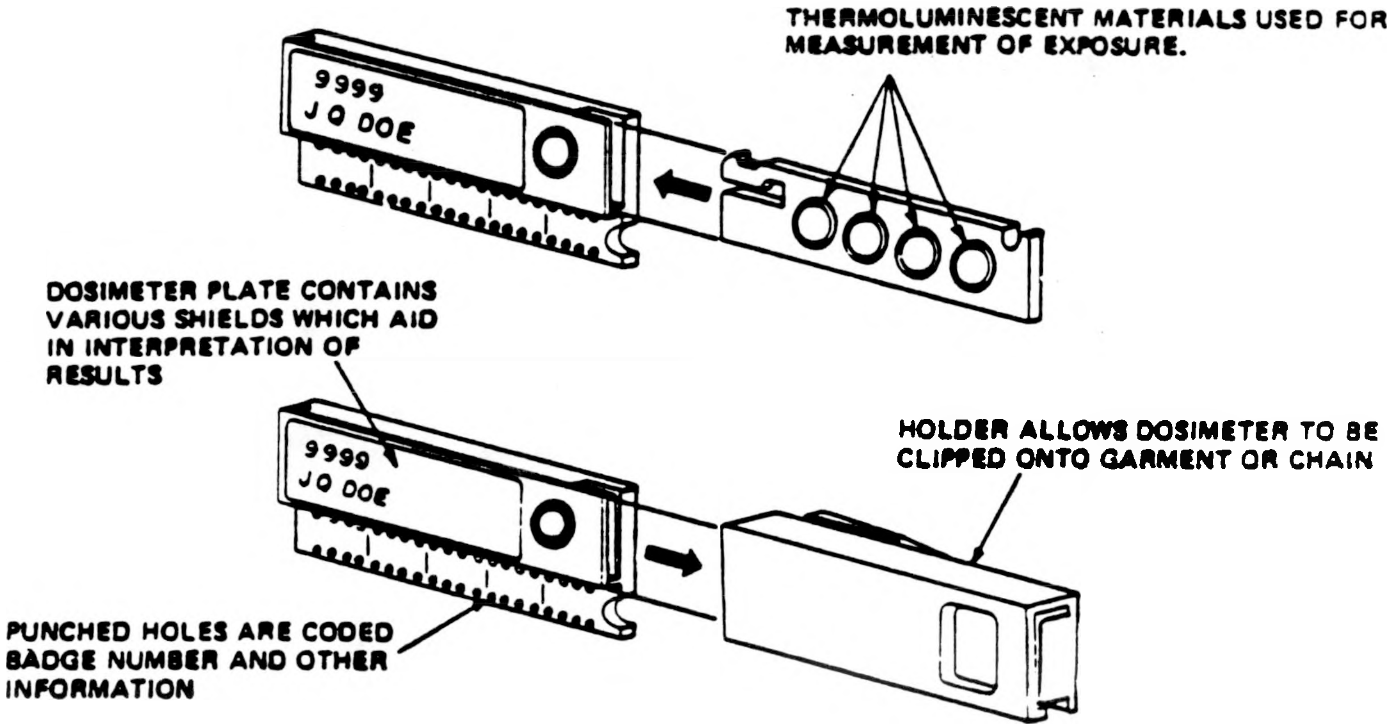
A variety of devices that are collectively known as 'dosimeters' are used to measure an individual's radiation exposure or 'dose'. Dosimeters are usually permanently assigned only to radiation workers. If it should occasionally be necessary for you to enter a regulated or controlled area you will be assigned temporary (visitor) dosimetry.

Thermoluminescent Dosimeters (TLD's) are the primary dosimetry device used at Savannah River Plant. These devices contain crystals of a material that absorbs and retains some of the energy from the radiation to which it is exposed. To "read" the TLD, the crystal is heated to an elevated temperature and the absorbed energy is released as light. The amount of light emitted is measured by a separate instrument and equated to your radiation exposure.

Figure 4 illustrates the type of TLD most commonly used at Savannah River Plant. **All personnel are required to wear one of these TLD's between the waist and shoulders on the outside of their personal clothing whenever they enter a regulated or controlled area.** The SRP TLD badge consists of three major assemblies. The outer assembly is a plastic holder with a clip or other means for attaching the badge to your clothing. The second assembly contains the shields. The inner assembly contains the TLD crystals and is removed from the other assemblies when the TLD is read. Although the badges are reasonably rugged, **TLD's can be damaged if improperly worn or handled.** The badge should not be subjected to moisture or high heat. Care should be taken to ensure that pointed objects do not enter the open window that is over one of the crystals. Do not attempt to separate the assemblies. The plastic catches that hold the assemblies together can be broken by attempting to disassemble the badge without a special tool, which could result in the inner assembly subsequently slipping out and becoming lost.

Temporary TLD's have orange labels and are available for issue in the lobby of building 703-46A. Both you and your escort must complete and sign a Visitor TLD Badge Request form when obtaining a temporary TLD.

TLD's should be returned to the location where obtained prior to departing the site for the day. Additional TLD's (with green labels) are stored in the same location to monitor natural background radiation at the TLD storage location. The exposure recorded by these extra TLD's is subtracted from the exposure recorded on each individual's TLD. If you were to take your TLD home at night and the natural background radiation at your home is lower than it is at the TLD storage rack location, your exposure while at work would be underestimated.



THE BADGE SHOULD NOT BE DISASSEMBLED
ANY TAMPERING IS PROHIBITED

Figure 4
Thermoluminescent Dosimeter (TLD)

3.3.3 Personnel Monitoring for Internal Exposure

Special instruments, a chest counter and a whole body counter, are used for externally measuring the amount of radioactive material present inside the body. These measurements are used to calculate the amount of radiation exposure received as a result of internally deposited radioactive material. In order to differentiate between internal contamination that may have occurred in previous employments at other facilities and contamination that may occur at Savannah River Plant a "baseline" count is performed on all employees who have worked at such facilities before they first enter regulated or controlled areas at Savannah River Plant. Depending on what areas you enter and the nature of your work these counts may also be performed on a periodic basis while employed at Savannah River Plant. The chest and whole body counters are very sensitive instruments and are capable of measuring very small quantities of radioactive material. They can detect minute accumulations of radioactive material in your body that might otherwise go undetected.

Laboratory analysis of urine, feces or blood can be used to detect and measure the quantity of certain types of radioactive material present in your body that are difficult to measure with the chest counter or whole body counter. Urine analysis is routinely performed for personnel who work where tritium is present. Since the external TLD does not respond to the low energy radiation type emitted by tritium, urine analysis is the only form of dosimetry available for tritium. All personnel who have previously worked at facilities where they might have been exposed to radioactive materials are required to submit a baseline urine sample. All personnel who routinely enter regulated or controlled areas at Savannah River Plant are also required to submit periodic urine samples for analysis for radioactive materials. If urine or feces samples are required you will be instructed on how to properly collect the sample and label the sample containers. Samples may consist of a single elimination or a 24 hour composite. If it is necessary for you to collect samples at home you will be provided with additional containers, labels, and carrying cases.

3.4 Emergency Planning

Even though DOE facilities are designed and operated safely it is always possible for an accident to occur. It is the policy of DOE to prepare for emergencies and pre-plan the necessary actions to control, mitigate and manage credible emergencies even though it is highly unlikely that one will occur.

Operational emergencies are generally defined as situations or conditions that endanger personnel, facilities and/or the environment. Emergencies that could occur include both nuclear and non-nuclear situations. Nuclear emergencies involve unanticipated exposures to radiation or releases of radioactive materials from failed equipment, reactor accidents, or following improper procedures during experimentation. Non-nuclear emergencies could arise from fires, explosions, natural events such as earthquakes or tornadoes, civil disturbances, hazardous materials or personnel illness or injuries. Operational emergencies are classified according to the general level of risk to the offsite population:

- An **Unusual Event** is an event in progress, or having occurred, which normally would not constitute an emergency but which indicates a potential reduction of safety of an SRP facility. No potential exists for significant offsite release of radioactive or other hazardous material.

- An **Alert** is an event in progress, or having occurred, which involves an actual or potential substantial reduction of the level of safety of an SRP facility. Limited offsite releases of radioactive or other hazardous material may occur, but are not expected to exceed amounts for which protective actions for members of the offsite population are recommended.

- A **Site Emergency** is an event in progress, or having occurred, which involves actual or likely major failures of facility functions which are needed for the protection of onsite personnel, the public health and safety, and the environment. Offsite releases of radioactive or other hazardous material not exceeding amounts for which protective actions for the offsite population are recommended are likely or are occurring.

- A **General Emergency** is an event in progress, or having occurred, which involves actual or imminent substantial reduction of facility safety systems. Offsite releases of radioactive or other hazardous material are occurring or are expected to occur in amounts for which protective actions for the offsite population are recommended.

If an emergency is declared you will be informed of the required response by verbal announcements over the public address system. In addition, you may be alerted to incidents by warning alarms in some SRP areas.

All of the nuclear emergencies that have been postulated for Savannah River Plant facilities that have the potential for causing significant radiation exposures outside of the affected process area involve the release of large amounts of radioactive material to the environment, usually as an airborne "plume." Emergency plans provide for two major protective action options for protecting personnel from exposure to radiation from a passing plume:

- **Evacuation** reduces radiation exposure by putting distance between people and the radiation source. It provides the most effective protection in situations where there is sufficient time to complete an evacuation before large amounts of radioactive material are released.

- **Sheltering** reduces radiation exposure by utilizing the shielding provided by buildings, and by isolating people from airborne radioactivity so that it won't be inhaled. It is the most effective protective action in situations where radioactive material is already being released or is expected to be released before evacuation could be completed, or when the risk from evacuation is greater than the projected risk from a limited exposure to radiation from a plume passing over a shelter. An example of such a situation is when severe weather is occurring.

4.0 INDIVIDUAL RESPONSIBILITIES

The Occupational Safety and Health Act of 1970 also assigns responsibilities to individual employees. It requires each employee to comply with occupational safety and health standards and all rules, regulations and orders issued to protect worker health and safety that are applicable to his or her own actions and conduct. This includes safety rules and procedures developed by the operating contractor for facilities for which they are the custodian.

As an individual federal employee it is your responsibility to:

- Stay out of areas that are posted as a Regulated or Controlled Area unless you are trained or escorted by someone who has been trained as a radiation worker.

- Familiarize yourself with emergency procedures. This includes knowing the required response to each alarm and the designated shelter area and evacuation route for your assigned work location. You should ask your supervisor about the designated shelter and evacuation route for the area in which you work.

  In the event of an incident requiring sheltering, a "slow warble" alarm will be sounded. DOE employees in the 700-A area, including those working in trailers, should move to the first floor interior hallway in building 703-A or 703-41A and await further instructions. You should stay away from windows and outside doors and follow the division/office Emergency Preparedness Coordinator's instructions and directions given over the public address system.

  In the event of an incident requiring evacuation, a "fast warble" alarm will be sounded. Unless instructed differently by your division/office Emergency Preparedness Coordinator or over the public address system, you should evacuate your work area using normal exit routes to your vehicle or car-pool location in the 3/700 area parking lots. Unless you have been instructed differently, you should leave and proceed home using normal routes. If you do not have transportation you should notify your division/office Emergency Preparedness Coordinator and wait in front of the building 703-A entrance for further instructions.

- Be alert for and respond to unusual radiological situations. Identification of and response to radiological incidents that are likely to occur in regulated or controlled areas are taught in radiation worker training. If you are visiting a regulated or controlled area and a radiological incident occurs you should follow the instructions of your escort.

  The only type of radiological incident that is likely to occur outside of regulated or controlled areas would involve transportation of radioactive material. If you should observe a container of radioactive material spilling or leaking its contents, falling from a vehicle or left unattended outside of regulated or controlled areas you should notify or have someone else notify Health Protection, stay clear from the immediate area and warn others in the area.

- If visiting a regulated or controlled area with an escort:

  → Obtain and wear dosimetry as instructed in procedures, by area Health Protection or by your escort.

  → Minimize your own exposure to radiation by spending the minimum time that is actually necessary in the area and by maximizing the distance between yourself and sources of radiation.

  → Obey the instructions from your escort.

  → To ensure that your exposure limit is not exceeded, do not enter areas posted as a "Radiation Area", "High Radiation Area", "Very High Radiation Area", "Contamination Area", or "Airborne Radioactivity Area" unless you have received specific permission from the area Health Protection Supervision.