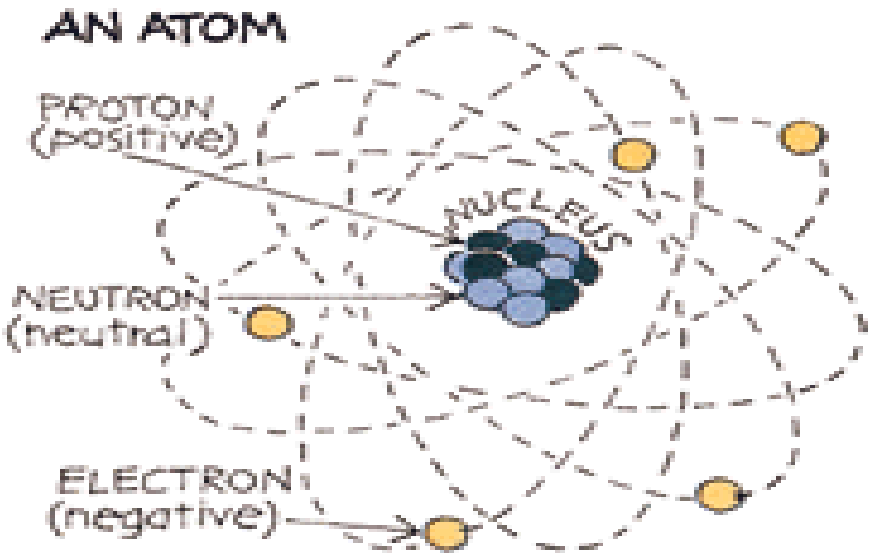
General Employee Radiation Training (GERT)

Denise Durham
Judy Thompson
Jerry Martin



Rev 10/2009

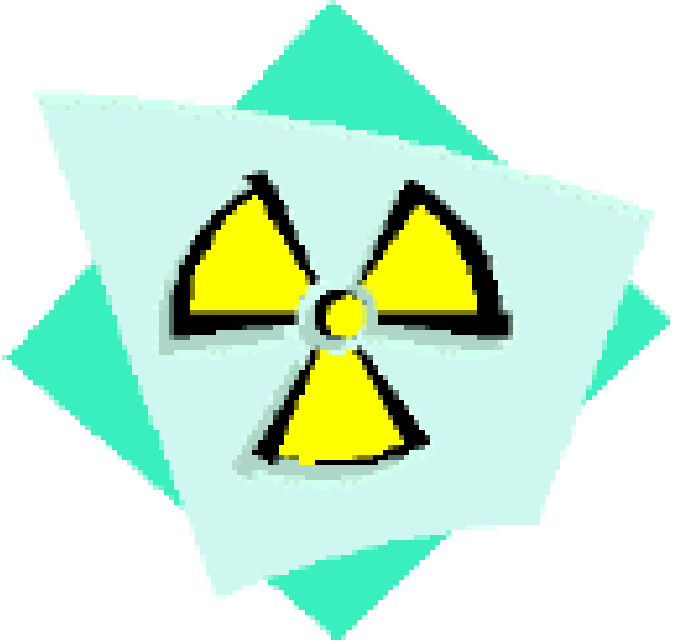
General Employee Radiation Training

Terminal Objective

Upon completion of this training, the participant will be able to DISCUSS (1) the hazards associated with radiological areas and radioactive material, (2) his/her limitations as a trained general employee during access to or work in the controlled areas, and (3) his/her responsibilities for complying with radiological requirements, including his/her expected response to abnormal radiological events or emergencies..

Enabling Objectives

- **EO1 IDENTIFY basic radiological fundamentals and radiation protection concepts**
- **EO2. IDENTIFY the four basic types of Ionizing Radiation**
- **EO3 EXPLAIN the difference between natural and man-made radiation**
- **EO4 DEFINE terms associated with Radiation and Radioactive Contamination.**
- **EO5 DEFINE the terms associated with Exposure and Dose**
- **EO6 STATE the Pantex Administrative Control (ACL) for whole body radiation exposure for General employees.**
- **EO7 IDENTIFY the relative risks of exposure to radiation and radioactive materials, including prenatal radiation exposure.**
- **EO8 IDENTIFY the ALARA concepts, practices and employee responsibilities**
- **EO9 STATE methods used to control radiological material.**
- **EO10 STATE which posted areas GERT personnel are allowed to enter unescorted.**
- **EO11 STATE the responsibilities for being a GERT escort.**
- **EO12 STATE the purpose for the Pantex dosimetry program.**
- **EO13 IDENTIFY the correct responses to radiological emergencies and/or alarms at Pantex.**



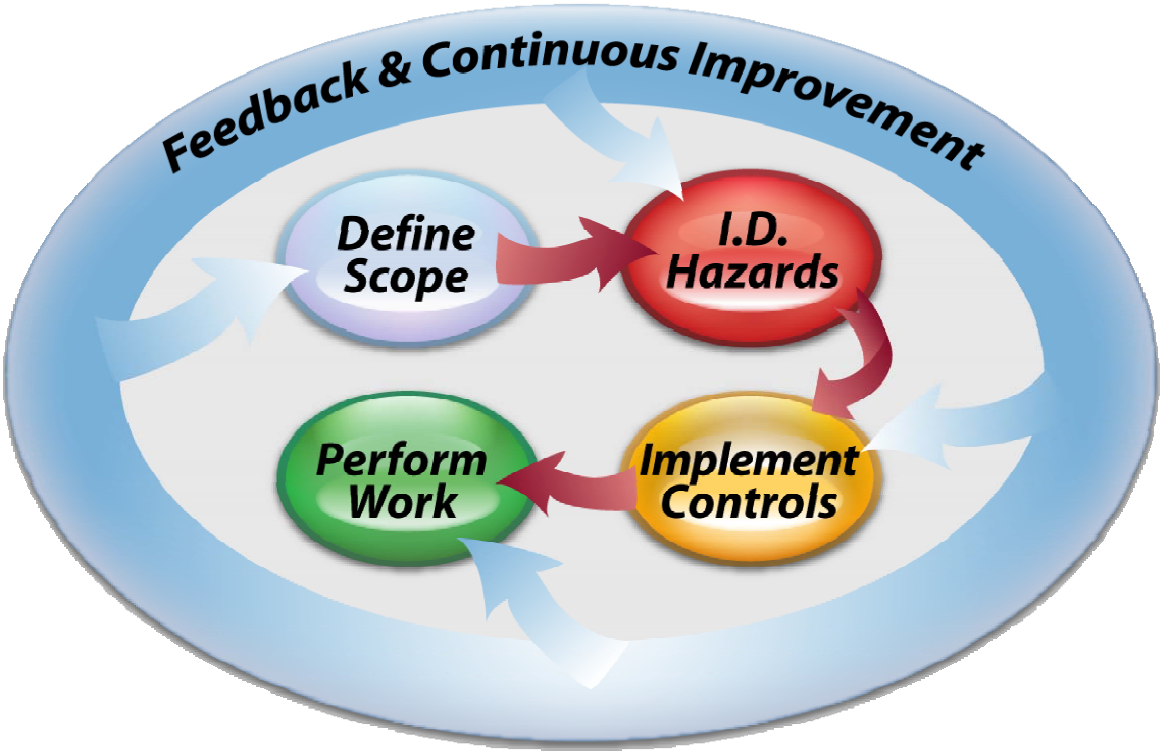
Introduction

General Employee Radiological Training (GERT) is provided to all site employees/contractors/visitors who may receive occupational exposure during access to controlled areas at a DOE site or facility or who are permitted unescorted access to controlled areas. These individuals may routinely enter the controlled area and encounter radiological barriers, postings, radiation producing devices or radioactive materials. Individual responsibilities for observing and obeying radiological postings and procedures are emphasized throughout this training.

- **Additional training beyond GERT is required for the employees/contractors/visitors who are identified as radiological workers.**

Every employee/contractor/visitor, both radiation and non-radiation worker, must play an active part in maintaining exposures to radiation and radioactive materials to As Low As Reasonably Achievable (ALARA). In order to do this, we need to develop a sense of pride and ownership toward our daily activities and have a healthy respect -- not fear -- for the type of work performed on site.

In other words, GERT qualified individuals should be able to place the risks associated with working at a nuclear facility in perspective with other risks that we take in our everyday life.



Define the Scope of Work

Identify and Analyze the Hazards

Develop and Implement Hazard Controls

Perform Work within Controls

Provide Feedback and Continuous Improvement

Notes:

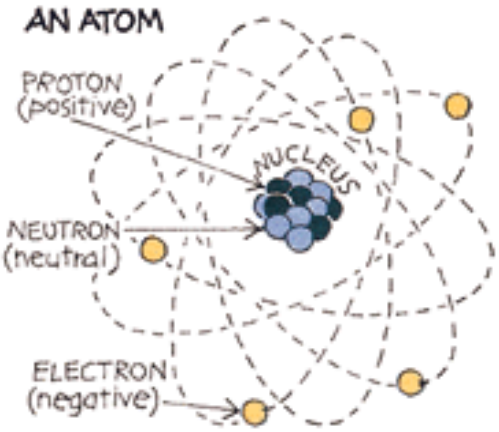
_____

_____

Ionizing and Non-Ionizing Radiation E01

Radiation is energy emitted through space and matter.

This energy release is in the form of rays or particles and is emitted from unstable atoms.



Atoms

The elements that make up all matter are composed of atoms. Atoms have three basic particles: protons, neutrons, and electrons.

- **Stable Atoms** — **Most atoms contain the proper ratio of neutrons and protons and are stable. They do not need to rid themselves of excess energy.**

- **Unstable Atoms** — **Some atoms are not stable. Unstable atoms contain too much energy and therefore try to become stable by releasing their excess energy in the form of rays/waves or particles (radiation).**

Notes:

_____

_____

_____

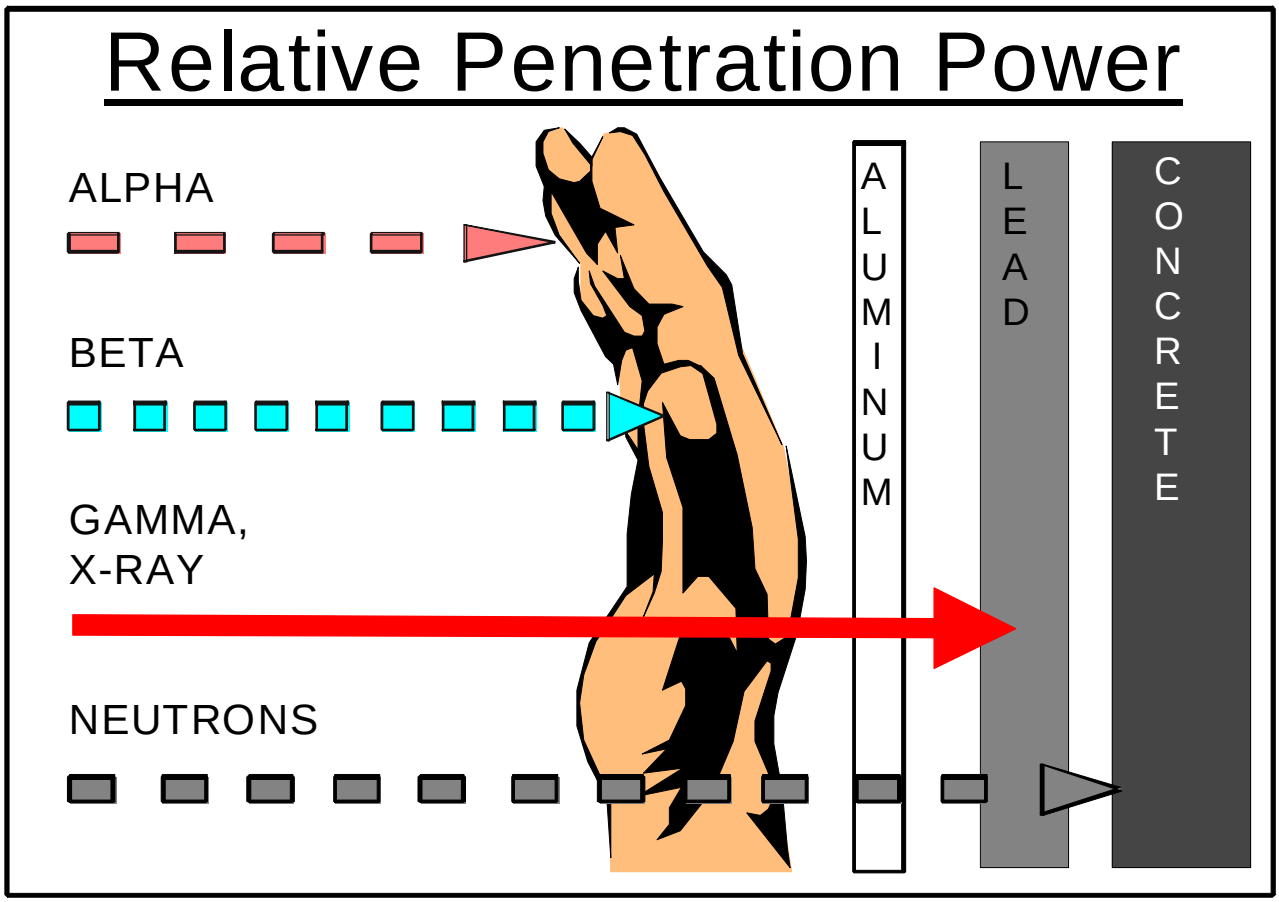
Ionizing Radiation EO2

Ionizing radiation has enough energy to remove electrons from electrically neutral atoms. This is the type of radiation of most concern.

There are four basic types of ionizing radiation:

α	**alpha particles**
β	**beta particles**
η	**neutron particles**
γ	**gamma rays or waves**

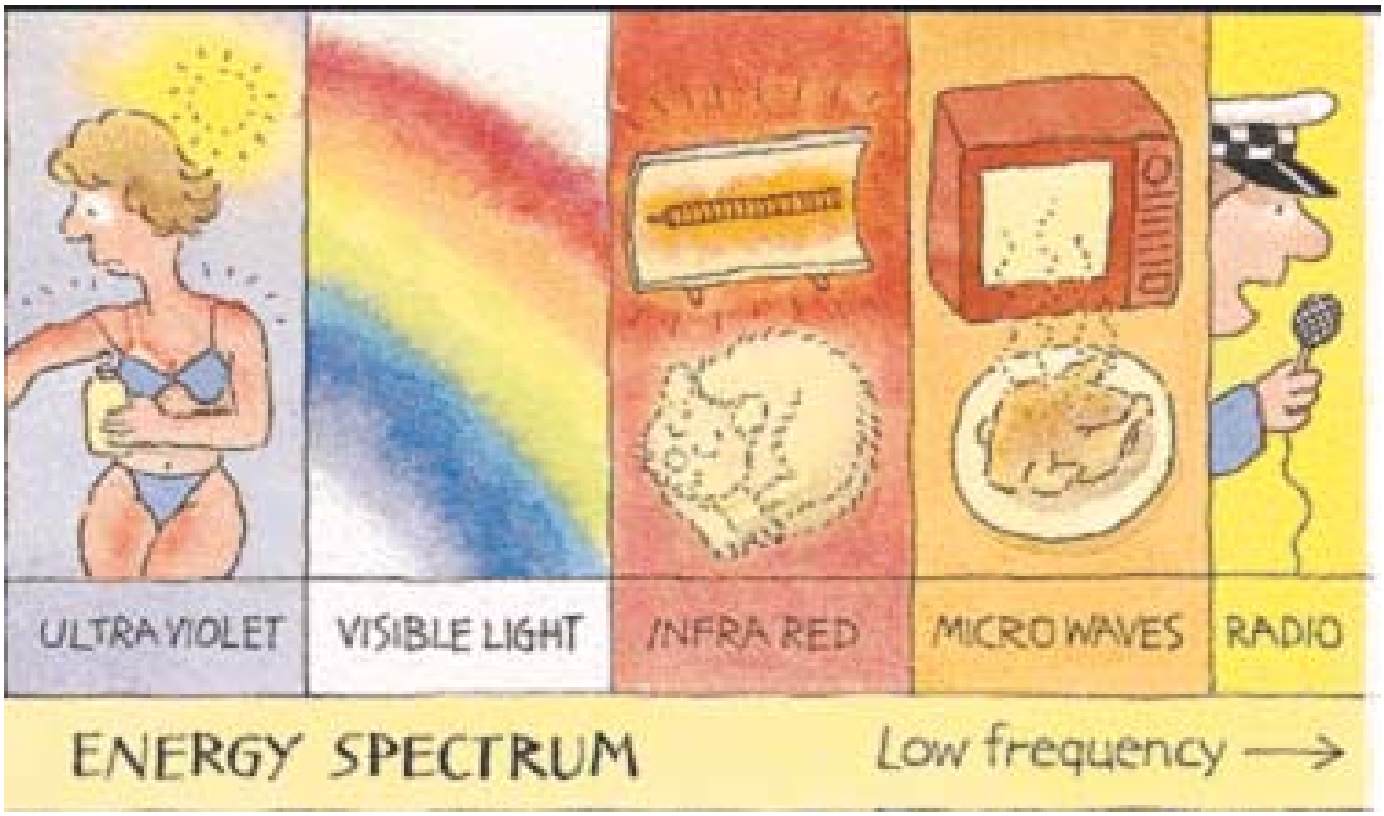
***Note: X-rays are identical to gamma rays except for their place of origin.**



Non-Ionizing Radiation

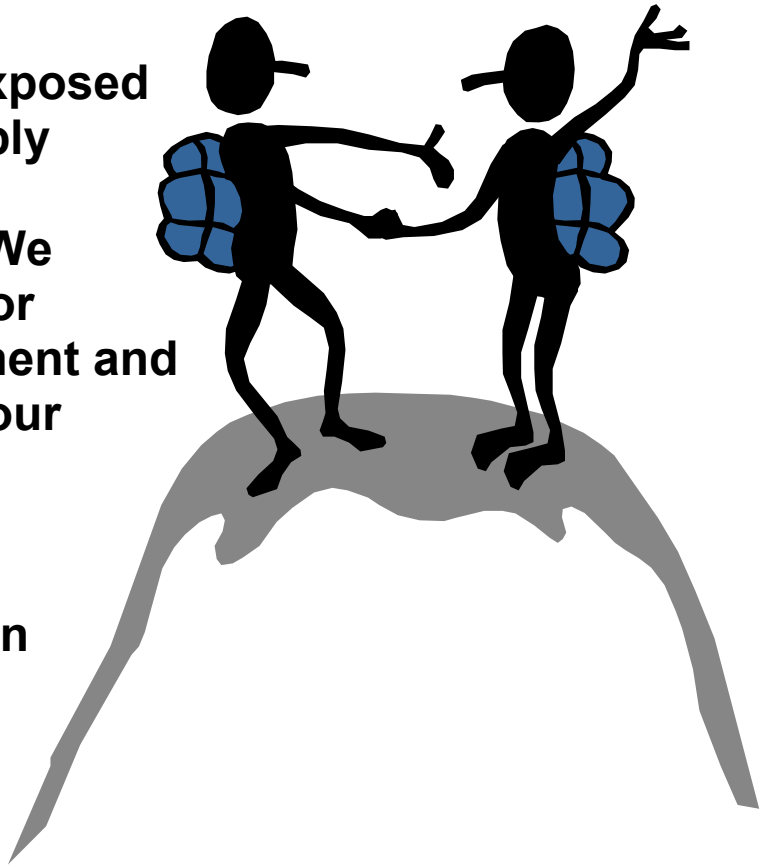
Non-ionizing radiation does not have enough energy to remove an electron from an electrically neutral atom. Even though non-ionizing radiation is capable of causing biological damage, it is not a major radiological concern.

Types of non-ionizing radiation include:



Visible light, Heat, Radio waves, Microwaves, Infrared, Ultra Violet

Sources of Radiation EO3



People have always been exposed to radiation. Radiation, simply defined, is energy emitted through space and matter. We are exposed to this energy or radiation from our environment and even from materials inside our bodies.

The average annual radiation dose to a member of the general population is about 620 mrem/year.

The unit "mrem" is the basic unit of measurement used to equate the amount of biological damage done to the cells in our bodies by radiation.

1 rem = 1000 mrem

This amount is a combination of both natural background and man-made sources of radiation.

Natural Background Sources of Radiation

Natural background radiation contributes about 310 mrem/year to radiation doses.

The main sources of natural background radiation are:

- **Cosmic radiation - from the sun and outer space**
- **Radon (200 mrem)**
- **Terrestrial radiation - materials in the earth's crust such as rocks and soil**

- **Materials present in our bodies such as Potassium-40**

Notes:

_____

_____

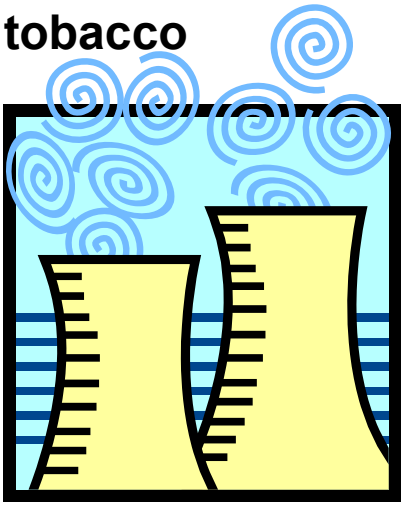
_____

Man-Made Sources of Radiation

Man-made sources of radiation contribute to the remainder of the annual average radiation dose.

Man-made sources include the following:

- **Medical uses such as x-rays and nuclear medicine. (300 mrem/yr)**
- **Consumer products such as smoke detectors, lantern mantels, and tobacco products.**
- **Nuclear weapons testing and Reactor fallout.**
- **Domestic Water Supply.**



Pantex Sources of Radiation

- **Tritium**
- **Plutonium**
- **Radiation Generating Devices (RGD)**
- **Sealed Sources**
- **Uranium**
- **Thorium**

Comparison of Annual Radiation Doses from Selected Sources

As stated earlier, natural background radiation is by far the largest contributor to radiation doses. To illustrate this, let's take selected sources that we have discussed and link the annual radiation dose to that source (expressed in mrem/year).

Cigarette Smoking	1300
Radon in Homes	200
Medical exposures	300
Terrestrial radiation	28
Cosmic radiation	28
Round-trip U.S. by air	5
Domestic Water Supply	5
World-wide fallout	< 1
Natural gas range	0.2
Smoke detector	0.0001

Definitions associated with Radiation and Radioactive Contamination EO4

A basic misconception is that exposure to radiation will result in contamination of the person. Exposure to radiation does NOT result in contamination of the worker.

Radiation is a type of energy and contamination is a material.

Radioactive material is any material that emits radiation as it decays.

Contamination is radioactive material in an unwanted location.

E05

Dose is the amount of radiation absorbed by the body or a particular organ.

Exposure is the amount of radiation measured in the air.

Risks in Perspective

Radiation comes from background and manmade sources. We receive approximately 620 mrem/yr. This is separate from occupational exposures. In addition, radiation dose may also be received on the job. The potential risks from this exposure can be compared to other risks we accept everyday.

Occupational Exposure

The risks associated with occupational exposures are very small and considered acceptable when compared to health risks of other occupations (i.e. being a coal miner or a construction worker).

Pantex Administrative Control Level (ACL) EO6

The Pantex ACL for the *general employees* to the site from occupational exposures is:

200 mrem/year

General Employee **– an individual who is either DOE/NNSA or DOE contractor employee who performs work for or in conjunction with DOE or utilizes DOE facilities.**

Different ACL's are applicable for weapons work

Comparison between DOE limits and Pantex Administrative Control Levels:

	DOE Limits	Pantex ACL
Whole Body	5000 mrem/yr	200 mrem/yr
Skin/Extremities	50,000 mrem/yr	10,000 mrem/yr
Fetal	500 mrem/9 months	100 mrem/9 months
Lens of the Eye	15,000 mrem/yr	3,000 mrem/yr

Responsibilities

It is each employee's responsibility to comply with DOE dose limits and Pantex ACL. If you suspect that dose limits or administrative control levels are being approached or exceeded, you should notify your supervisor or Radiation Safety immediately x5110.

Chronic Radiation Dose EO7

A chronic radiation dose refers to small amounts of ionizing radiation received over a long period of time. Examples of chronic radiation doses are those from natural background, routine medical, and occupational radiation.

Potential Biological Effects from Chronic Doses

Biological effects from chronic doses of radiation may occur in the exposed individual or in the future children of the exposed individual.

Exposed individual

There is scientific evidence for health effects (cancer) from radiation doses well above the annual limit for occupational exposures (>10,000 mrem).

Future children of the exposed individual

Heritable effects, genetic changes, to the parent's sperm and/or eggs that results in an observed effect in their offspring from ionizing radiation have been found in plants and animals, but have not been observed in the human population.

Prenatal Exposure

A developing embryo/fetus is especially sensitive to ionizing radiation.

Possible Effects

Radiation dose to the embryo/fetus may increase the chances that the child will develop conditions such as lower birth weight and/or slower mental growth or childhood cancer. These effects can also be caused by many other hazards in our environment.

DOE Policy:

The risk of these effects is minimized by having special protective measures for the embryo/fetus and by keeping all exposures As Low As Reasonably Achievable (ALARA).

A female radiation worker is encouraged to voluntarily notify her employer, Radiation Safety Department (RSD), and Occupational Medical Department (OMD), IN WRITING by using the PX-2820, when she is pregnant. (MNL- RS0001).

The employer shall provide the option for a mutually agreeable reassignment of work tasks, without loss of pay or promotional opportunity, such that further occupational radiation exposure is unlikely.

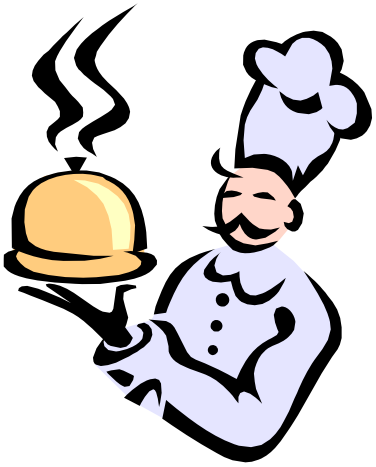
Comparison of Risks of Occupational Radiation Doses with Other Health Risks

Let's now compare the risk of working with or around sources of ionizing radiation versus the risks we accept as part of everyday life.

Loss of life expectancy due to various causes

(expressed in days):

Being unmarried male	3500
Smoking (1 pack/day)	2250
Being unmarried female	1600
Being a coal miner	1100
20 % overweight	900
Being a construction worker	227
Driving a motor vehicle	207
Alcohol (U.S. Average)	130
Average Job	74
Radiation Workers (500mrem/yr)	40
Coffee	6



Relative Risk of 1 in a 1,000,000 Chances of Dying:

Smoking 1.4 cigarettes (lung cancer)

Eating 40 tablespoons of peanut butter

Eating 100 charcoal broiled steaks

Spending 2 days in New York City (air pollution)

Driving 40 miles in a car (accident)

Flying 2500 miles in a jet (accident)

Canoeing for 6 minutes

Receiving 2.5 mrem of radiation (cancer)

Benefit Versus Risk

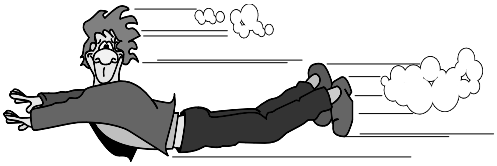
Accepting a risk is a personal matter and each individual must weigh the benefits against the potential risk. We know that there are many benefits from ionizing radiation. However, because it may harm us if we receive too much, just like too many aspirin can kill you, we must learn to respect it and learn to work safely with and around radioactive materials.

ALARA Concept EO8

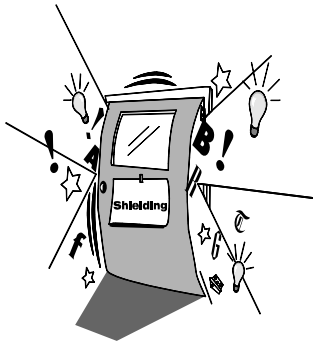
The "As Low As Reasonably Achievable" (ALARA) process of managing radiation exposure is a fundamental requirement of the Pantex Radiological Control Program. DOE and Pantex develop plans and measures to maintain occupational exposures ALARA. An effective ALARA process includes consideration, planning, implementation of both physical design features (including engineering controls) and administrative controls to balance the risks of occupational radiation exposure against the benefits arising out of the authorized activity. ALARA is not a dose limit but a process that has the objective of attaining (and maintaining, if achieved) doses as far below the applicable limits as is reasonably achievable, taking into account social, technical, economic, practical, and public policy considerations.

There are three basic practices personnel may use to minimize exposures

Time: Reduce the amount of time spent near a source of radiation.



Distance: Stay as far away from the source as possible.



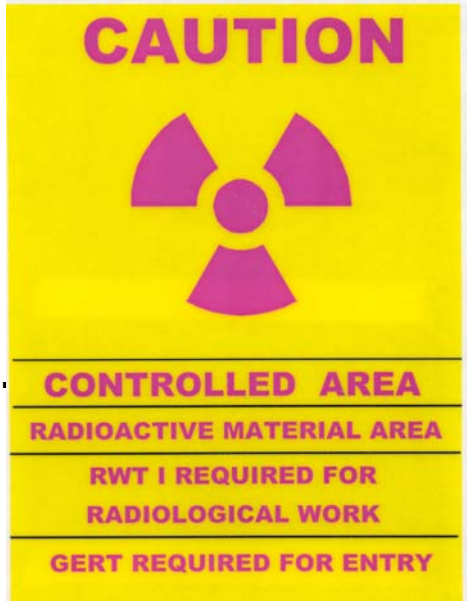
Shielding: Shielding is placed between workers and the source.

Radiological Controls EO9

In support of the ALARA concept, radiological controls are established in order to protect individuals from exposure to radiation and radioactive material. These controls include a unique identification system using certain colors and/or symbols and radiological postings.

Radiological Identification Systems

Only specially trained/qualified workers are permitted to enter areas controlled for radiological purposes or to handle radioactive material. All areas or material controlled for radiological purposes are identified by one or more of the following:



Signs that have the standard radiation symbol colored magenta or black on a yellow background.

Yellow and magenta rope, tape, chains, or other barriers are used to designate boundaries of posted areas.

Tags and labels with a yellow background and either a magenta or black standard radiation symbol are used to identify radioactive material.

Radioactive material MUST be stored in a posted Radioactive Material Area (RMA), at a minimum.

Protective clothing and equipment are used to prevent personnel contamination.

Potentially contaminated tools and portable equipment used for radiological work are marked.

Postings EO10

Postings are used to alert personnel of potential or known radiological conditions, and to aid them in minimizing exposures and preventing the spread of contamination. Let's discuss the different areas on site and whether this training will permit you to enter those areas.

Controlled Area **has been established to protect individuals from exposure to radiation and radioactive contamination.** ***This training WILL permit you to enter the Controlled Area Unescorted.***

A Radiological Material Area (RMA) **is an area where radioactive materials are handled or stored.** ***This training WILL permit you to enter the Radioactive Material Area Unescorted.***

A ***Radiological Material Management Area (RMMA)*** **is an area where the potential exists for contamination due to the presence of unencapsulated or unconfined radioactive material or activation products.** ***This training WILL permit you to enter the Radioactive Material Management Area Unescorted.***

A <u>Fixed Contamination Area (FCA)</u>* is an area or equipment that contains radioactive materials that are not easily removed. Y*ou may enter the FCA Unescorted as long as the material is not being disturbed.

A <u>Soil Contamination Area (SCA)</u>* is an area with contaminated soil that is not releasable in accordance with 10CFR834. Y*ou may enter the SCA Unescorted as long as the soil is not being disturbed.

GERT Trained personnel are allowed to enter these areas as long as they DO NOT perform radiological work!! Radiological Work is: moving, handling, storing radioactive material, operating an X-ray machine or generating radioactive waste

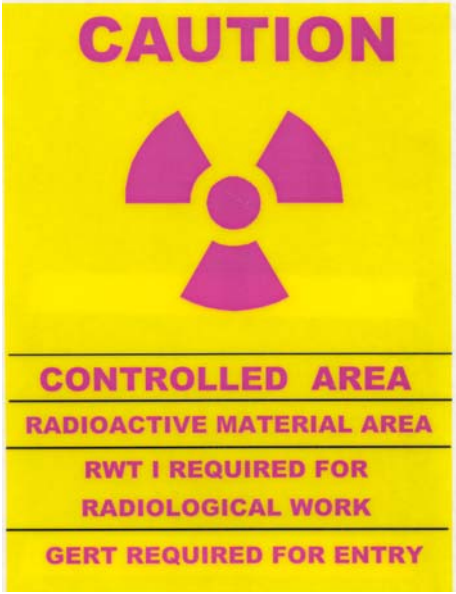
There are other radiological areas established within the Controlled Area. Some examples include:

Radiation Areas (High and Very High) (HRA & VHRA)

Contamination Areas (High)

Airborne Radioactivity Areas

Radiological Buffer Areas



This training WILL NOT permit you to enter these areas. Personnel are NOT permitted to enter these areas unless escorted and/or trained.

When in doubt, following the postings!!

GERT Escort EO11

A GERT trained individual may escort another (untrained) individual into areas that require GERT training for entry. Normally this provision is used with visitors to the site, and only for a short period of time (1 day).

Escort duties must be performed as follows:

- **You may escort a maximum of 4 people at one time.**
- **You may not work and escort at the same time. You must observe the activities of those you are escorting.**
- **You may escort to the level you are trained. GERT trained individuals may not escort into an area requiring Rad Worker I/II or for an individual to perform radiological work.**
- **You are responsible for ensuring that the escorted individual(s) comply with the documented Radiation Safety Program.**
- **In the event of a radiological alarm or event, you are responsible to see that your escorted individuals respond to the alarm or event appropriately.**

IMPORTANT: **If you are GERT trained and are being escorted in a radiological area, you may be required to sign a Radiation Work Permit (RWP). Be sure you read the information and understand the requirements. Only then should you sign. Your signature indicates that you understand the information and will comply with all the requirements. If you have questions, ask your escort or radiation safety department personnel.**

Monitoring (Dosimetry) EO12

Since radiation cannot be detected with any of the human senses, special detection devices must be used. Workers should become familiar with the equipment and devices used to measure and detect radiation.

Thermoluminescent Dosimeters (TLDs)

Thermoluminescent dosimeters (TLDs) are used to measure radiation from neutrons, gamma and x-rays, and all but very low energy beta particles. Each dosimeter contains elements of lithium borate and calcium sulfate in crystalline form. Exposure to radiation causes electrons in the atoms of the elements to move into higher orbits (energy levels) where they remain until heated. When heated, the electrons drop back to their lower orbit and emit tiny amounts of light in the process. The amount of light given off is proportional to the amount of radiation to which the TLD was exposed. Very sensitive instruments measure this light. Purpose: The TLD measures external occupational radiation doses and is not a shield.

Wearing Your Dosimeter

Wear your whole-body dosimeter clipped to clothing on the upper part of the body (on the torso, between the neck and the waist). *Do not hang your dosimeter on a chain.*

Obtaining a Dosimeter

Persons who need access to an area posted "TLD Required" must obtain a dosimeter prior to entry into these areas. If you are issued a wrist dosimeters, please wear it on the wrist identified on the label.

Traveling to Another Facility

If you visit another facility where you are issued a dosimeter, it is important that Pantex Plant receive radiation exposure information from the facility so that we can maintain a complete radiation dose history for you.

If you work at a second where you are measured for occupational radiation dose you must bring that dose report to Pantex to be included with your dose records.

Dose Reports

You will be mailed a radiation dose report through the plant mailing system each time your dosimeter is processed. This report will detail radiation doses for the current calendar year and contains year to date (annual), and lifetime doses.

Return dosimeters for processing periodically. Personnel failing to return dosimeters for processing *WILL BE RESTRICTED FROM RADIOLOGICAL WORK AND ACCESS TO MAA (Zone 12-South/Zone 4) WILL BE DENIED.*

Leaving Work

Dosimeters should be left at Pantex on an official issue station board when not being worn.

Medical Applications

Workers who have been administered radio-nuclides for diagnostic or therapeutic medical purposes should report their medical procedure to the OMD and get a radiation pass before returning to work. Radionuclide injections or ingestion for medical purposes may sound the alarm on portal monitors at the security stations.

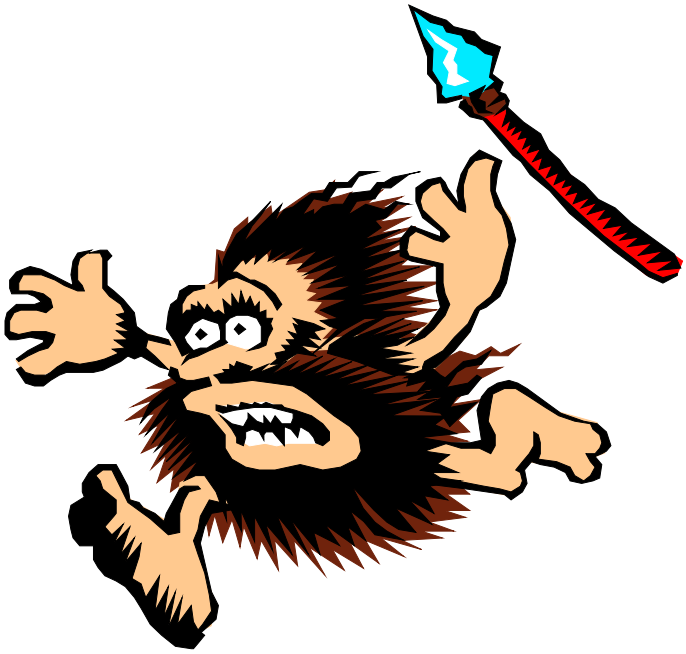
Lost or Damaged Dosimeters

Should you lose or damage your dosimeter, exit the controlled area and contact External Dosimetry at Extension 5110 for a replacement.

Bottom line: Your dosimeter should be either on you or on the issue station board

EMERGENCY PROCEDURES EO13

In the unlikely event that a radiological incident occurs, it is important for each employee to know the emergency procedures.



Know the location of your muster station, and be familiar with the Radiation Alarm Monitoring System (RAMS) Procedures.

RAMS - is the whole system; continuous air monitors, data, and the lights.

CAMS (Continuous Air Monitors) - alpha and tritium monitors.

Four (4) Light RAMS

Green Light

The green light indicates *Normal Operations*. There is no sound associated with the green light. There are no emergency procedures.

Amber Light

The amber light indicates a *System Malfunction.* A loud buzzer sound is associated with the amber light.

***Emergency procedure for Amber*:**
1) Stop work; 2) Call Radiation Safety (Ext. 5555) and the Operations Center (Ext. 5000). 3) Personnel do not have to evacuate.

Red Light - Tritium Alarm

The red light indicates *Airborne Tritium*. A loud continuous bell is associated with the red light.

Emergency procedure for Red light:
1) STOP Work, Do not ARGUS out, **2) EVACUATE the work area 3) If wearing additional PPE (such as labcoat, Tyvek coveralls), REMOVE the PPE immediately outside the facility entrance, 4) REPORT to the mustering station, announce to the individuals inside you are responding to a Tritium alarm and wait there until released by RSD**, **refrain from touching anything and stay in one area 5) NOTIFY RSD (Ext. 5555) and the Operations Center (Ext.5000). Provide the information requested.**

Blue Light - Alpha Alarm

The blue light indicates *Airborne Alpha Contamination*. A high-pitched steady tone is associated with the blue light.

Emergency procedures for Blue light:

1) STOP Work, Do not ARGUS out, **2) If not in full protective clothing and respirator, EVACUATE the work area, 3) STAY outside the bay/cell, refrain from touching anything and stay in one area. 4) If wearing additional PPE (such as labcoat, Tyvek coveralls), REMOVE the PPE in the personnel interlock area before exiting the last door, 5) WARN others, refrain from touching anything and stay in one area until released by RSD, 6)One person go the nearest phone and NOTIFY RSD (Ext. 5555) and the Operations Center (Ext.5000). (If there is not a phone outside the bay/cell, one person may leave to make the necessary phone calls) Provide the information requested.**

Simultaneous Alpha and Tritium Alarm

Follow emergency procedures for the Tritium Alarm.

In the event of an abnormal event that could cause a radiological release with no CAM alarm, including areas that do not have a CAM monitor, all personnel must evacuate the facility in a minimum of 5 minutes in order to maintain doses ALARA. Personnel controlling the material will inform you to evacuate and you must exit the facility at that time.

Summary

A positive radiological attitude is not limited to those who perform radiological work. All employees have an impact on maintaining exposures to radiation and radioactive material ALARA.

Employee responsibilities are:

Obey all signs/postings.

During a RAMS alarm, personnel outside of the affected area, *Do Not* walk in front the area where a Tritium/Alpha CAM is alarming.

Comply with all radiological and safety rules.

Do not enter any area controlled for radiological purposes unless escorted or trained.

If visiting a radiological area with an escort:

- **obey the instructions of the escort.**
- **obtain and properly wear dosimetry as instructed by procedure, Radiation Safety personnel, or your escort.**
- **utilize ALARA techniques to minimize your exposure.**

Unusual Situations

If you discover radioactive material that appears to be unattended, (i.e. discarded in trash receptacle or loose outside or in a building corridor) you should take the following actions:

- ► **DO NOT touch or handle the material.**
- ► **Warn other personnel not to approach the area.**
- ► **Guard the area and have someone immediately notify Radiation Safety personnel. (Ext. 5555)**
- ► **Await Radiation Safety personnel.**

Other unusual situations in which you will need to notify Radiation Safety:

- **Rad Material Spilled**
- **Rad Posting Down**
- **Rad Rope Down**

Only Radiation Safety personnel are authorized to remove and/or post radiological area signs . Personnel who encounter posting(s) that have been compromised (torn or fallen) must contact Radiation Safety.

Know where and/or how to contact Radiation Safety personnel in your work area.

Comply with emergency procedures for your work area.

Keep exposures to radiation and radioactive material ALARA.

As an employee, it is important to be aware of potential risks and to take appropriate protective measures to minimize the risks. Through an enhanced awareness and a sense of personnel responsibility and ownership, each employee can contribute to safe ALARA practices.