FORD 2

REGULATO INFORMATION DISTRIBUTION STEM (RIDS)

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SUBJECT: Informs that author received encl employee training manual for plan filled w/grammar errors & scientific flaws.Info on plant requested.

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R I D S / F O R D 2 D O C U M E N T

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Ms. Elizabeth Burgess
2206 N. Richland St.
Phoenix, AZ 85006

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
August 6, 1993

Sir or Madam

Recently, I have been in correspondence with the owners of Palo Verde Nuclear Generating Station concerning information given to me during a tour. Linda Zinn-Badsgard, the Energy Affairs Representative who gave me the information, sent me literature, as did Laurel Stone of the US Council on Energy Awareness. Included in the information provided by Ms. Zinn-Badsgard was the general employee training manual for PVNGS. Reading through it, I noticed many spelling errors, as well as grammar errors and scientific flaws. These problems concern me deeply; if a company cannot provide correct training (although spelling and grammar errors do not effect performance) to the employees who *handle hazardous materials*, then I fear that their credibility is damaged. Training employees is a vital necessity in the nuclear industry; at least they could take the time to proofread their manuals. Trainees should receive at least the slight consideration of using a manual written in correct English.

If you could possibly send me any information regarding the proposed nuclear station in Northern Arizona, I would truly appreciate it. If that area is out of your jurisdiction, please direct me to the organization responsible. Enclosed is a copy of the pages of the manual that contain errors, which are identified. Thank you for your time.

Sincerely

Elizabeth Burgess

Elizabeth Burgess

enclosures

Rec: Linh Tran

DF01
1/1

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[illegible] Brady was [illegible]
[illegible] Mr. Tim-Hackett was the [illegible] coaching [illegible] and [illegible] deeply [illegible] film and glass [illegible] the employees who create [illegible] carefully [illegible] medical [illegible] enclosed their [illegible]

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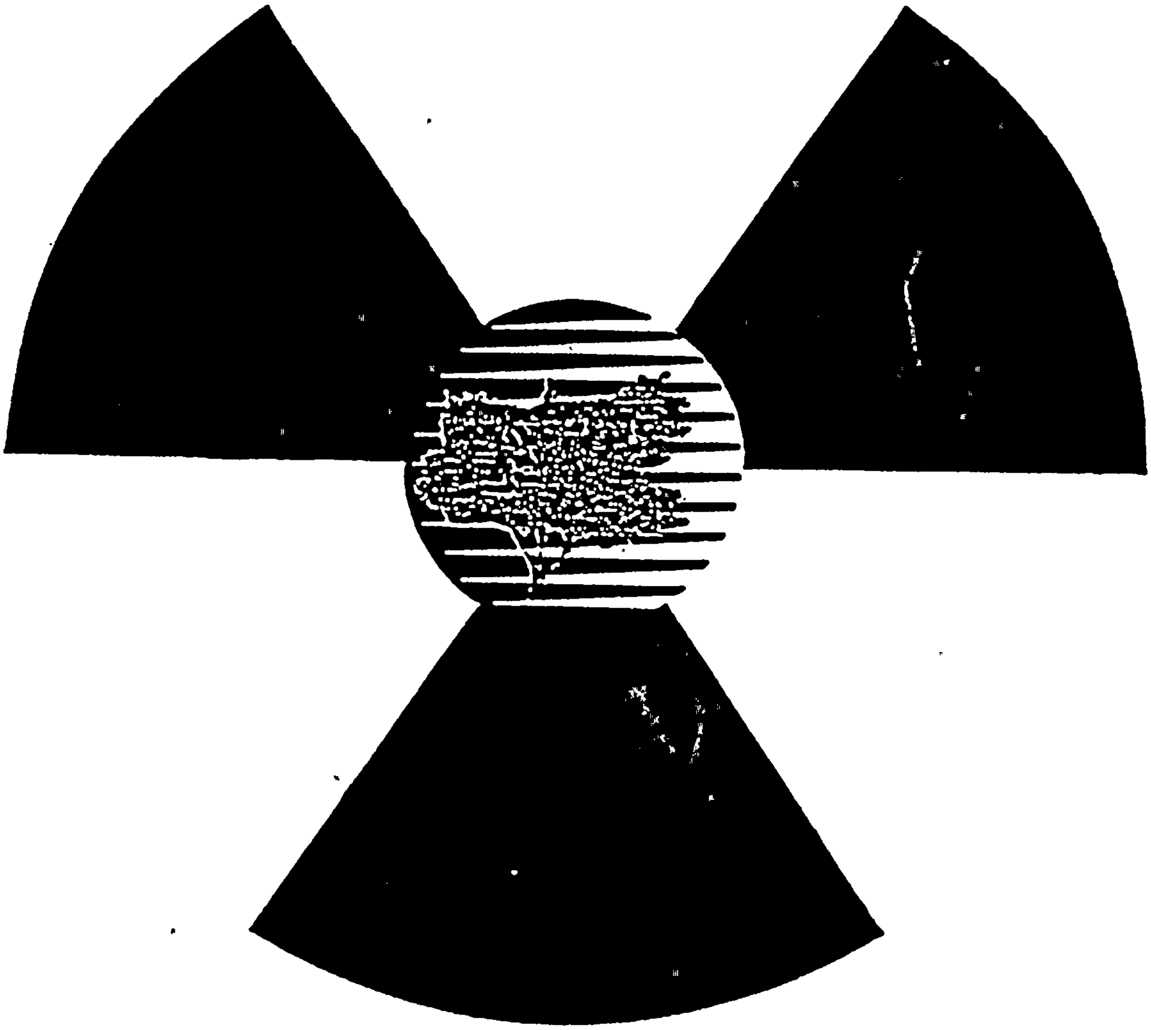
S: scientific error or
discrepancy
P: punctuation
SP: spelling
G: grammar
*: other

(on top right corner of each page)

Palo Verde Nuclear Generating Station

General Employee Training



RADIOLOGICAL WORK PRACTICES TRAINING

The Characteristics of the Atom

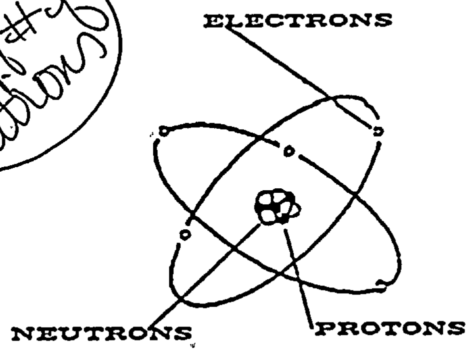
About one hundred basic substances make up all the materials in the world. These substances are called elements. An atom is the smallest bit of an element that can exist and still have the properties of that element. An atom of one element is different from an atom of another element, while atoms of the same element are identical. isotopes → (U-238 vs. U-235) isotopes (protium, deuterium, tritium) U235 fissions while U238 doesn't.

Structure of the Atom

isotopes have diff at. mass.

diff # neutrons

Atoms are composed of smaller particles called protons, neutrons and electrons.



The nucleus of the Atom is composed of neutrons, which have no charge; and protons, which have a positive charge.

Electrons orbit the nucleus of an atom and have a negative charge.

Atoms are composed primarily of space (between the electrons and the nucleus). If the nucleus was the size of a baseball, the nearest orbiting electron would be 1/2 mile away.

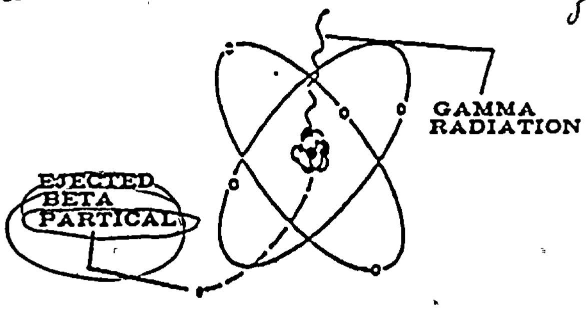
SP /S

Stable Atoms - atoms consisting of a certain number of protons, neutrons and electrons arranged such that the atom is happy with this arrangement. good scientific description?

Unstable Atoms (Radioactive) - atoms which are unhappy with their arrangement of protons, neutrons, and electrons. They try to rearrange themselves to become stable atoms. In doing this, it ejects energy in the form of radiation.

unstable nucleus → p+/n0 not e-

e- only in ionization (ionic bond) or changing energy lvls rel. energy



Unstable Radioactive Atom

We can compare this to having too many people in a phone booth at one time. It isn't comfortable in the booth until a few people have been ejected or the occupants have rearranged themselves. The unstable atom becomes a stable atom emitting radiation.

Definitions of nuclear terms

Radiation: Any type of energy emitted from a source. Common types of radiation we deal with everyday are heat from a fire or light emitted from a light bulb.

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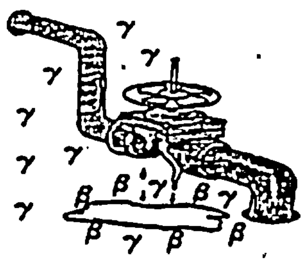
Nuclear Radiation: The type of radiation we are specifically concerned with in the nuclear industry. Nuclear radiation is energy emitted from unstable atoms. The energy is released in the form of rays (waves of energy) or particles.

Radioactive Material: Material made up of unstable atoms (which emit radiation). Here at Palo Verde, the radioactive material is normally contained within the piping systems or within storage or shipping containers.

When radioactive material is within piping and other forms of containment, it is controlled. If this radioactive material escapes the piping, it is then what we call *contamination*: radioactive material where we do not want it. Good radiological work practices can help maintain control of contamination and thus reduce the hazards they present.



It is important for students to realize the difference between radiation and radioactive material. Radiation is energy! It cannot be touched, seen or heard. Radioactive material can be touched and moved from place to place. This can be compared to a fire in a fireplace. Heat is radiation. You cannot grab a handful of heat and carry it elsewhere. The burning logs, like radioactive material (contamination), can be moved purposely or accidentally, from one location to another.

Ionization: This process changes atoms (and molecules) by altering their electrically neutral charge. The atom acquires a positive or negative charge and becomes an ion.

acquires or loses e^-

Terms used to measure the amount and effects of radiation

The *Roentgen* is a term used to measure X and gamma radiation in air. Since we may be involved with other types of radiation, the Roentgen has limited use.

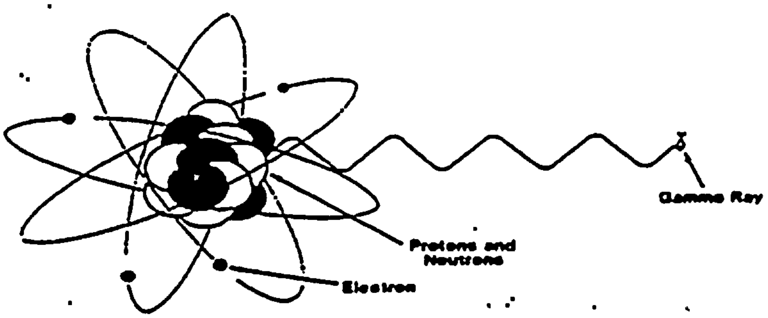
The *RAD* is used to measure any type of radiation, though it is often used when discussing Beta radiation in the plant.

The *Rem* is a measure of the biological damage caused by ionizing radiation. The Rem takes into account the biological effects of radiation and is referred to as the biological dose equivalent unit.

> The Rem is a relatively large unit for our work, so we will frequently use the millirem (mR or mRem). One mRem is one-thousandth of a Rem or .001 Rem; and 1000 mRem equal one Rem.

The units of Rem and mRem are for measuring dose. Dose is the amount of radiation exposure received by an individual. The units of Rem/hr and mRem/hr are used for measuring dose rate, the amount of exposure over a period of time.

P/ Sexplain



The four types of ionizing radiation of concern at PVNGS are alpha, beta and neutron (particle) radiations and gamma (wave) radiation. Let us now examine each in detail.

Alpha Radiation

Alpha radiation is a particle type radiation which consists of 2 protons and 2 neutrons so it has a double positive charge. Because of its double positive charge, alpha radiation will cause more ionization than the other types of radiation. Alpha cannot travel very far, (2"-4" in air) therefore, it has very little penetrating ability.

($^{4}_{2}He$)? (Helium nucleus)

Externally, alpha radiation is not a hazard since it cannot penetrate the dead outer layers of a person's skin.

Internally, if material which emits alpha radiation gets into the body, it is the most damaging because of its high ionizing ability.

The *source of alpha radiation* in a commercial nuclear power plant is the *fuel*. Consequently, unless a plant has a damaged fuel assembly, alpha radiation will not be a problem.

Some sources of alpha radiation other than in commercial power plants are:

- Black Silica sand used for sand-blasting
- Some of the glazes used on glass-ware
- Radium watch dials
- Some types of smoke detectors
- Burning of coal (radon 222-radium 226)
- Fly ash.

Alpha radiation is easily shielded. A piece of paper would stop alpha radiation.

Beta Radiation

A beta particle is an energetic electron and is the smallest form of particle radiation with a single negative charge.

Beta radiation is normally considered to be skin exposure. It only travels 10'-12' in air. Although more penetrating than alpha radiation, it cannot penetrate beyond the living layers of skin to damage vital organs.

Beta radiation is primarily a skin hazard but exposure to the lens of the eye is considered to be whole body exposure. To protect the lens of the eye, safety glasses or plastic goggles (beta glasses) may be worn.

P/S

The *source of beta radiation* at PVNGS is normally considered to be *contamination*. Radioactive material is contained in either piping or storage/shipping containers which beta radiation cannot penetrate, so unless an individual comes in contact with the internals of a radioactive system, (e.g., jumping generators), the only way beta exposure would occur is from being in contact with contamination.

Neutron Radiation

Neutrons are not normally emitted by atoms going through radioactive decay. They only come from atoms during fission and are normally only *found in the Containment Building, in the vicinity of the reactor when the reactor is operating*. Neutron radiation travels long distances (130' to 150' in air) and is very penetrating.

Neutron exposure is considered to be whole body exposure, since neutron radiation has the ability to penetrate to the vital organs, (i.e., blood forming cells).

It takes material high in hydrogen, such as water or polyethelene, to shield neutrons.

Gamma Radiation

Gamma radiation is a wave type radiation of high energy and is capable of traveling long distances (140' to 160'). It is similar to X-rays the difference being only in the way in which they are produced.

Gamma radiation is considered to be whole body exposure because, like neutrons, it can penetrate to any organ in the body.

Gamma radiation is similar to some types of radiation which we are already familiar with, such as:

Protective Clothing And Eye Protection Can Minimize Skin And Eye Exposure to BETA Radiation

Radar waves
Electricity
Infra-red
Heat
Ultra-violet radiation.

Gamma rays and X-rays are very similar. The difference being only in the way in which they are produced.

Gamma radiation is the most common type of ionizing radiation at PVNGS. It is emitted by the radioactive materials which circulate within the plant's piping systems.

Gamma radiation is one type of wave energy called electromagnetic radiation.

Decay Fundamentals

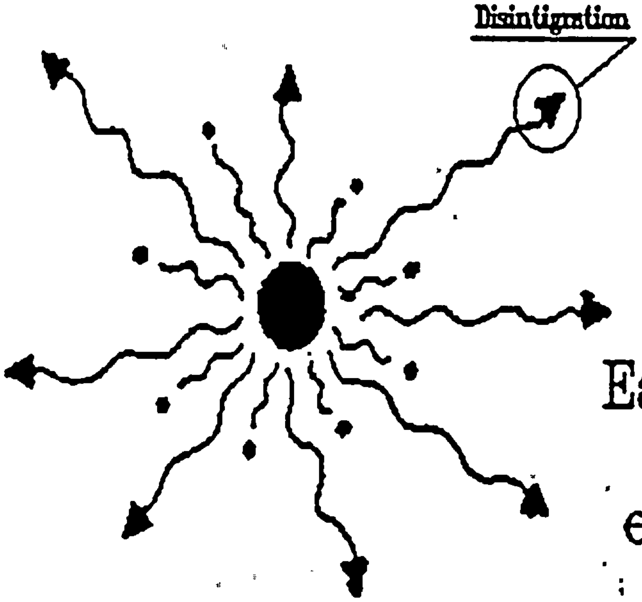
The unit used to measure the radioactive decay is *dpm*. DPM stands for Disintegrations Per Minute.

Curie - a term which is used to measure an amount of radioactivity by the rate at which the material decays. If there are 2.22 million-million disintegrations occuring each minute, there is one curie.

Half-life - the time required for a radioactive material to lose 50% of its activity by decay. Each radionuclide has a unique half-life. Most of the activity is gone after 7 half-lives.

The longer the half-life of a radioactive material, the slower its radioactive decay.

Types Of Radiation That Can Be Detected At PVNGS

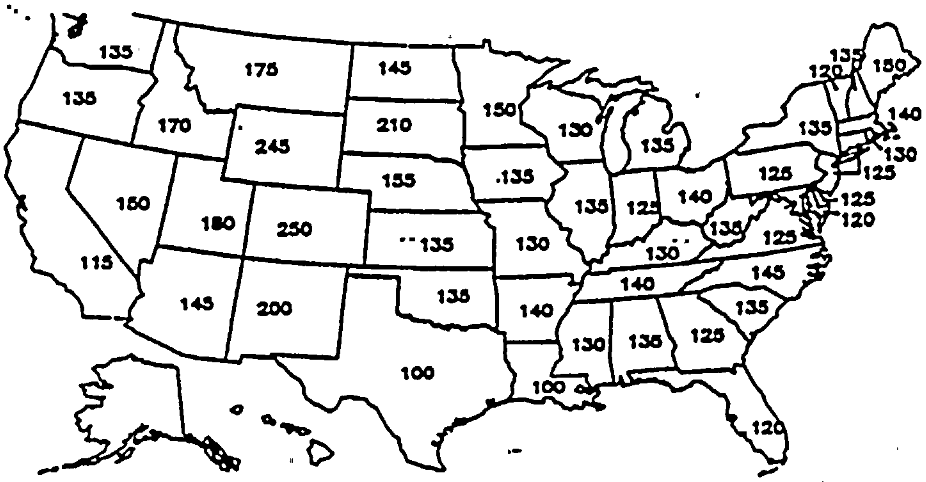


Each disintigration emits Radiation

1 Curie = 2.22×10^{12} dpm
(2,220,000,000,000)

S

Average Natural Background Radiation By State
***Radon Contributions are not Included**



Natural Background Radiation Exposure

Cosmic Radiation gives us a dose of about *30 mRem/year* at sea level. The components of cosmic radiation reaching the earth's surface are primarily high energy gamma rays formed by interactions between cosmic radiation and our atmosphere. These gamma rays are then shielded by the atmosphere. Hence, the higher the altitude, the greater the dose rate. At Denver, (1 mile elevation) - about 70 mRem/year.

48 according to pA10

Terrestrial Radiation is natural radioactivity found in the rocks, soil, building materials, etc. and gives us a dose of about *30 mRem/year*. Recently, public attention has focused on radon, a naturally occurring radioactive gas produced as uranium and radium decay. These elements are widely distributed in trace amounts in the earth's crust. Estimates of the average exposure from radon in the U.S. contributes approximately an additional *200 mRem/year.*

Natural Radiation Sources inside our bodies (primarily Potassium 40) give us a dose of *40 mRem/year*. As you can see, we are exposed to about 300 mRem/year from natural background radiation.

Total exposures from naturally occurring background radiation in the U.S. vary from 300 to 450 mRem/year mainly due to altitude and the type of rock and soil.

Sources of Man-Made Radiation

There are three categories of man-made radiation sources: consumer products, medical diagnosis and treatment, and nuclear reactors.

Consumer products such as watches, televisions, and smoke detectors contribute an average of 7 mRem/year.

Medical exposures are the greatest contributor to man-made non-occupational radiation exposures: about 53 mRem/year.

25-55
pA10

Commercial Nuclear Power Plants
The average individual living just off site will receive less than 1 mRem/year during normal operation. Even at

GIPS

Biological Effects of Radiation

The cell is the basic structural and functional unit of all living matter.

Cells of living organisms can be attacked and/or damaged by a variety of agents.

Agents such as the following:

- Viruses - enter the body and attacks surrounding cells.

- Chemicals - may enter the body through inhalation, ingestion and/or absorption which may damage the cells of major systems.

- heat/cold - a flame burns the cells of the skin and cold may cause frost bite.

How the damage to the cells is caused is different in each case; however, the effects on the cells involved and the overall effect on the body would result in one or more of the following effects:

- not enough of the damaging agent to cause any damage to the cells.

- some damage to the cells may occur, but the cell has the ability to repair itself.

- damage may occur to the DNA and cause a change in the cell or future cells,

- enough damage may occur to cause cellular death.

The response of the body to cell damage (no matter what caused the damage) usually includes symptoms such as fatigue, nausea and loss of appetite.

Let's take a look at the way radiation interacts with matter and living organisms.

Remember discussing the process called "ionization" earlier in the class? We said ionization is the process by which an electron is removed or stripped from an atom leaving a pair of electrically charged ions.

e- can also be taken on to an atom giving it a - chg

How does this effect us?

Since the human body cell is approximately 80% water, a large amount of ionization takes place in the water molecules of the cell. The creation of ions in the water molecules of a cell causes the formation of certain chemical compounds (such as hydrogen peroxide, H_2O_2) which attack the various parts of the cell.

The chemical compounds may attack key parts of the cell, such as enzymes or proteins. If this happens, the cell may be incapable of performing its particular function or cell death may occur.

The loss of enough cells could cause tissue damage or failure. Enough tissue damage or failure could cause organ damage or failure.

In some cases the radiation may ionize the cell's structural material. The actual effect on the cell varies depending on which part of the cell is damaged and just how much ionization occurs. In most cases damaged cells can either repair or replace the damaged structure.

If the DNA is damaged, one of the following may happen:

The cell may undergo repair and when cell division takes place the cell divides normally, GP

The cell may not have repaired the damage by the time the cell division takes place and the daughter cells will contain genetic changes,

The cell may not have repaired the damage when the cell division takes place and the daughter cells will be born dead or die shortly after birth,

The cell may be killed outright and the cell division will not take place.

The overall effect of radiation on the body depends on several factors which include the rate of exposure, total amount of exposure, and radiosensitivity of the cells involved.

Rate of Exposure

The rate of exposure is a major factor in the effects of radiation on the body and in the body's ability to repair or replace damaged cells affected by radiation.

Two terms are used to describe this dependency. The terms related to the amounts and time of exposure are chronic and acute exposure.

Chronic Exposure

Exposure (low amount) over a long period of time. As radiation workers, we receive very low exposure in our careers in the nuclear industry.

Radiation exposure in a nuclear power plant is maintained chronic.

? Exposure limits are set to ensure that radiation workers experience chronic exposure.

exp. limits are set to ensure that wkrs receive only low amounts.

The effects of chronic radiation exposure are delayed effects, that is, the effects may show up many years after the exposure. The effects of chronic radiation exposure have been shown to be:

An increase in the risk of developing cancer,

A shortening of life span,

A possibility of genetic changes.

Occupational radiation exposure limits are set low enough that potential long term risks are minimized.

The risk of greatest concern with long term chronic radiation exposure is the slight increase in the risk of developing cancer later in life.

Acute Exposure

Exposure (large amount) over a short period of time. If the amount of radiation involved is high enough, the effects can manifest themselves within a period of hours or days.

The signs and symptoms which include these short term radiation effects are known as acute radiation syndrome.

The effects listed below do not include any possible benefits from medical treatment.

ACUTE DOSE of:	RESULTS in:
25 - 50 Rem (25,000 - 50,000 mRem)	Minor changes in blood
80 - 100 Rem (80,000 - 100,000 mRem)	Nausea and vomiting for about 1 day followed by flu-like symptoms) in about 10% of the exposed population

PG

ACUTE DOSE of:	RESULTS in:
180 - 200 Rem (180,000 - 200,000 mRem)	All exposed individuals exhibit some degree of flu-like symptoms. About 50% experience dehydration. Still no deaths expected. Symptoms occur 5 - 10 days after exposure
400 - 500 Rem (400,000 - 500,000 mRem)	All above mentioned symptoms. 450 Rem what we call lethal dose 50/30 ($LD_{50/30}$) - 50% of the population will die within 30 days without medical assistance. Recovery for the rest of the exposed population will take approximately 6 months
>1000 Rem (1,000,000 mRem)	All previously mentioned symptoms show up within hours of the exposure time. Death is almost certain.

Acute exposures are <u>not</u> the type of exposures workers encounter in the nuclear power plant.

Cell Sensitivity to Radiation

The cells which make up the tissues of the body differ both in appearance and function, therefore, their response to radiation would be different. This is known as the radiosensitivity of a cell.

Studies have shown that cells that have a rapid reproduction rate are the most radiosensitive. The following are examples of cells which are the most sensitive:

- White blood cells
- Red blood cells and the cells which produce red cells
- Gonads
- All of the cells of the unborn child.

The cells which are the least radiosensitive (due to a slower reproductive rate)are as follows:

- Muscle cells
- Bone cells
- Nerve cells,

Theoretically, the effects of radiation exposure could be passed on to future generations. These effects are called genetic effects. Genetic effects of radiation exposure have never been found to occur in humans.

The effects of radiation on the person who received the exposure are called somatic effects.

Somatic effects - I got the exposure, what does it do to me.

Genetic effects - I got the radiation, what does it do to my children and grandchildren

A third term used to describe radiation effects is teratogenic. This refers to the effects on a fetus or unborn child who is exposed to radiation. This is not the same as genetic. The unborn baby is present in the radiation area.

P

Radiation and the unborn child

In general, the older we get the less sensitive we are to radiation exposure. Adults are less sensitive overall than teenagers; teens are less sensitive than toddlers; toddlers are less sensitive than babies, and babies are less sensitive than the unborn child.

Scientific studies have shown that the embryo or fetus is quite sensitive to the effects of radiation.

It is important; therefore, that if a female employee becomes pregnant, the exposure to developing baby be kept ALARA.

The Federal government, through Reg. Guide 8.13, has recommended that the dose equivalent to the unborn child not exceed 500 mRem during the term of the pregnancy.

It is the responsibility of the mother to take the steps that she feels are necessary to protect her offspring.

When she determines that she is pregnant, she should notify her supervisor and Radiation Protection.

She has several options. She can

- ask for reassignment to areas of less or no radiation,

- request leave of absence until after the child is born,

- continue to work in present position.

When notified of the pregnancy, RP will limit exposure to 500 mRem for the term of the pregnancy. The rate of exposure will be controlled to no more than 150 mRem per quarter.

The effects of radiation on a developing fetus or unborn child can be compared to the effects of other hazards.

Reg. Guide 8.13

Reg. Guide 8.13 was published to explain the guidelines established by the NRC for exposure to the unborn child. You will find a copy of Reg. Guide 8.13 in Appendix A of this handout. You should pay particular attention to the comparison of the effects of radiation exposure on the unborn child versus the effects of other hazards.

Risk vs. Benefit

Some risk is associated with working at any occupation. Risks associated with working in a nuclear power plant and with radiation exposure are low compared with many other occupations

The American Cancer Society says that 25% of all adults 20 - 65 years of age will get cancer from some cause. Out of 10,000 workers, 2500 should be expected to get cancer.

If each of the 10,000 workers got 1 Rem of exposure, 3 additional cases of cancer would be expected. This increases the risk from a 25% chance to a 25.03% chance.

BEIR III, a nuclear industry report predicts 1 additional cancer death per 10,000 workers exposed to 1 Rem each, an increase of .01%.

Exposure to ionizing radiation is maintained at low levels in the plant so that risks are minimized. Workers must decide for themselves whether the benefits they receive from their jobs are worth the risks associated with those jobs.

6/8

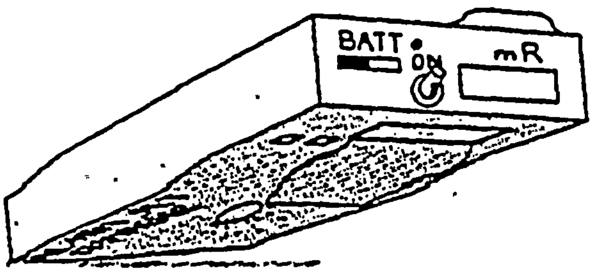
PERSONNEL DOSIMETRY

Anyone who receives occupational radiation exposure must be monitored with dosimetry. The Dosimetry Program is set up to maintain accurate records of this exposure, and help ensure that individuals remain aware of their exposure.

In order to be issued personnel dosimetry devices, you must meet three requirements. *First*, you must satisfactorily complete this Radiological Work Practices training. *Second*, you must receive a whole body count, which will be discussed later. The *third* requirement is a signed NRC Form.

The following

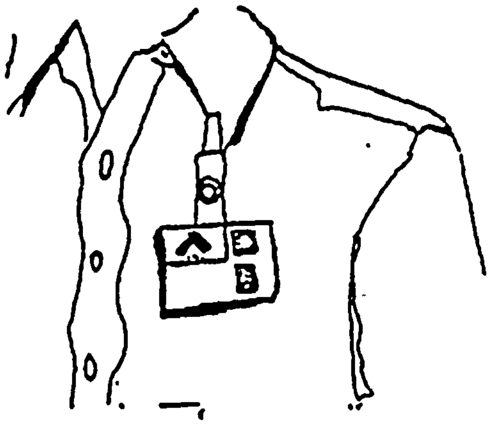
Two categories of dosimetry are used at PVNGS; Thermoluminescent Dosimetery (TLD) and Self-Indicating Dosimeters (SID).



Thermoluminescent Dosimeters (TLDs)

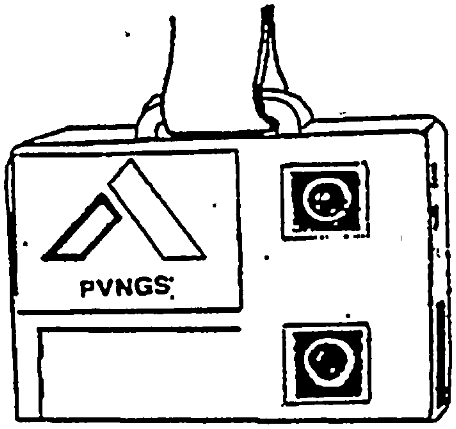
TLDs have crystals which store part of the energy of the radiation which passes through them. Later, these crystals are heated in the TLD Reader, causing them to release this stored energy as flashes of light. The amount of light released is directly related to the amount of radiation received. This measurement is accurate and is used as the legal record of dose received by radiation workers. TLDs are used at PVNGS for several purposes.

The *Record TLD* is issued with the ACAD. It should be worn on the front of the body between the thighs and the shoulders. The record TLD is issued in a plastic case with a small hole (beta window) which should always face away from the body. TLD chips in this case are located behind the window and behind the plastic. Gamma radiation will be recorded by all the chips. Beta radiation cannot penetrate the plastic case and will only be recorded on the chip in the window.



In addition to the Record TLD, you may be issued special TLDs. Special TLDs include:

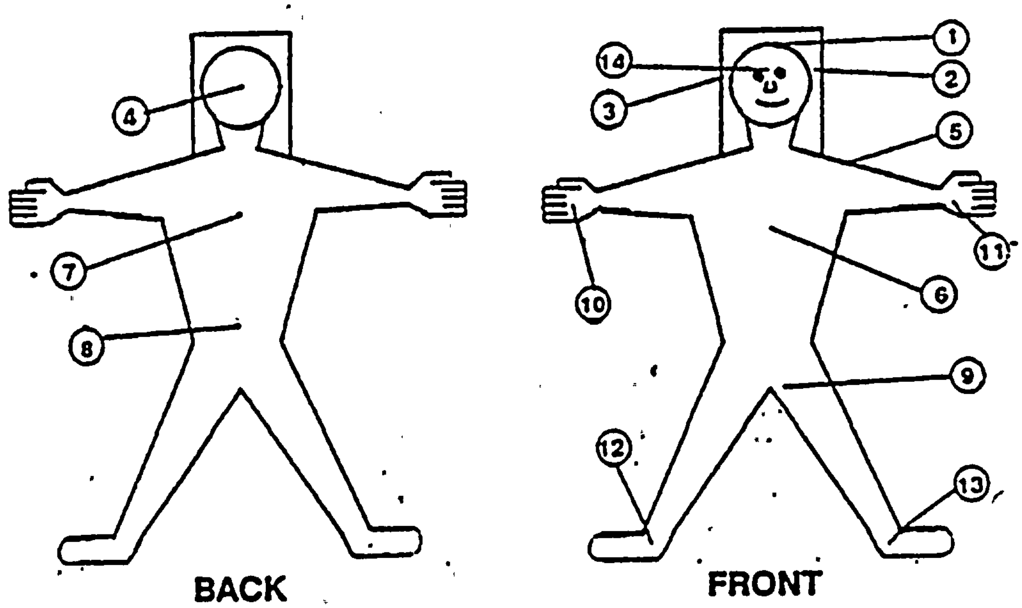
- Multiple TLDs
- Extremity TLDs.
- Neutron TLDs.



Extremety TLDs are used if the extremities could receive a dose significantly higher than the whole body dose. We could attach a TLD to the forearms and/or feet, or a special TLD called a Finger Ring may be worn on the finger(s).

Multiple TLDs are used if dose rates vary widely over the body. For example, an individual might work where doses come from behind and from overhead as well as from front chest level. In such a situation, it is necessary to have more than one TLD so that the highest dose received is recorded.

Neutron TLDs are used to record neutron radiation only. Since neutrons will be encountered in the vicinity of the reactor only while it is operating, entries into the Containment Building at power will require that personnel wear neutron TLDs. Neutron TLDs use a special process for monitoring and these TLDs will be worn on a belt around the waist. RP will provide the belt with the TLD.



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In review, the Record TLD is worn by all individuals who will receive Occupational Radiation Exposure, it measures whole body and skin dose. There are also special TLDs for multiple badging, for extremity monitoring, and for neutron exposure.

Personnel are responsible for their assigned dosimetry and **SHALL NOT** tamper with nor cause the dosimetry to be exposed to radiation except during the performance of work requirements at PVNGS.

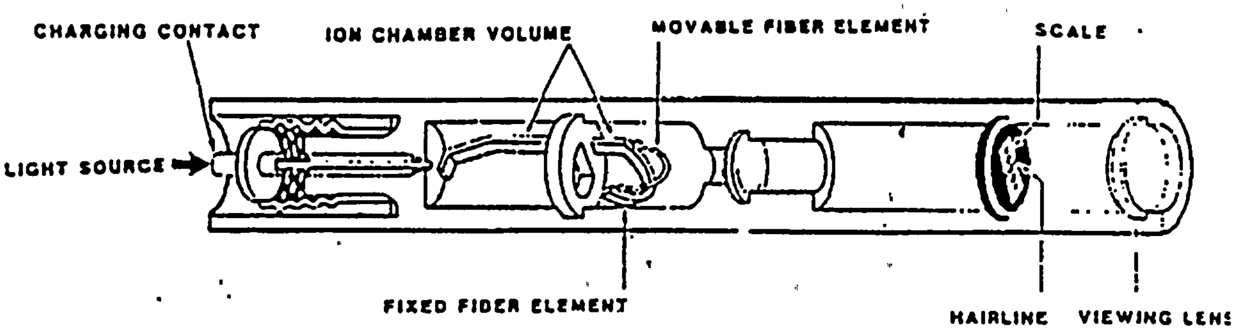
SIDs

The second category of dosimetry used at Palo Verde is Self-Indicating Dosimetry. They provide a worker with a direct read out of the amount of dose he or she has received. We commonly use three types of SIDs.

The *pocket dosimeter* (called a "SID") is the most common. It detects and measures the ions produced by radiation passing through it. There are 2 fibers inside the pocket dosimeter, one fixed and one movable. An electric charge is placed on the fibers, causing the movable fiber to separate from the fixed one. When you look through a pocket dosimeter that has just been charged, the movable fiber appears as a hairline set on the zero point of a scale. As dose is received, the movable fiber discharges and moves closer to the fixed one, causing the hairline to move up the scale. The range of dosimeter you will be issued depends on the radiation level in the area where you will be working. Every entry into the RCA requires at least a 0-200mr pocket dosimeter. *Pocket Dosimeters measure gamma radiation only.*

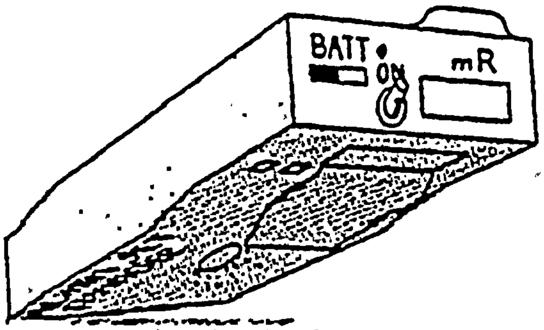
A pocket dosimeter is for your personal reference and is used for dose tracking between TLD readings. It is worn next to the TLD. You need to check it when you first receive it and periodically while working. If you are working in a low dose rate area, you may not need to check it as often as you would in a higher dose rate area. Never allow your pocket dosimeter to go beyond three quarter scale. For example, when your zero to 200 mR dosimeter reaches 150 mR, it is at three-quarter scale. At this point, you should exit the RCA and report to Dosimetry issue. The Tech will record your pocket dosimeter reading and rezero it.

Pocket dosimeters are fragile and if dropped or bumped, the hairline may jump up or down scale, or go off scale completely. Treat your pocket dosimeter with care. If you check your



pocket dosimeter and it is off-scale, you must notify other workers in the area, leave the RCA and notify RP. Since it is possible the off-scale reading is due to radiation, you can see it is important to tell your co-workers so that they check their pocket dosimeters immediately.

Alarming dosimeters are electronic self-indicating dosimeters which are set to alarm at a particular dose. They are issued for entries into High Radiation Areas with the setting indicated on your REP. The alarming dosimeter can register doses up to 9999 mRem and has a digital readout that will display each mRem as it is received. Alarming dosimeters are battery-powered so always check the battery before use. It has a chirping mode which can



Alarming Dosimeter

readout. Alarming dosimeters are set to alarm at a preset dose as a ~~signal to~~ leave the area and report to RP. time

For more accurate control of exposure, PVNGS uses a dosimetry device called a "*Teledose*." This device is like a walkie-talkie for dose. The worker wears a sending unit which sends a signal for each mRem received, to a receiving unit in a low dose rate area. This allows RP to keep track of exposures during high dose rate jobs.

If you ever lose your dosimetry you must report the loss to Radiation Protection immediately. If you are inside the RCA and lose any of your dosimetry, you *must* leave the RCA promptly and report to the RP office. Do not spend time inside the RCA trying to locate lost dosimetry because you will be receiving radiation exposure while not wearing the appropriate dosimetry device. Someone will be sent into the area to locate the lost dosimetry. If you lose your dosimetry inside the Protected Area but not in the RCA, you must still report the loss to Radiation Protection as soon as possible.

DETECTION INSTRUMENTS

Dose Rate Instruments

Since radiation can't be detected using our senses, we rely on various devices to detect and measure radiation, contamination, and radioactive material.

RP has portable instruments to detect and measure each type of radiation. They are called "Dose Rate" instruments because they read out in dose per hour(much like the speedometer on your car which reads out in miles per hour). If the "dose rate" in an area is 50 mrem/hr and you stay there for 30 minutes, you will receive 25 mrem. Radiation Protection routinely surveys all areas of the plant with dose rate instruments and records the results on survey maps. Dose rate instruments are used by RP Techs only, except in special situations.

Contamination Detectors

Since contamination is radioactive material, it emits radiation. We detect contamination by the gamma and beta radiation it gives off, using friskers and Personnel Contamina-

P/G

tion Monitors(PCM).

A frisker is used to monitor personnel and equipment for contamination. A frisker uses a hand held detector, which is passed over the area to be checked. It reads out in counts per minute(cpm), which is multiplied by 10 to determine dpm of which our limits are based. The frisker meter responds slowly, but the audible indication responds quickly. It takes about 18 seconds for a frisker to display 100 cpm(1000 dpm) which is the limit. It should take 3-4 minutes to "frisk" your entire body.

The other device we use to detect contamination is the Personnel Contamination Monitor(PCM). The PCM monitors 1/2 of the body at a time by using 15 large detectors starting with the right side. Monitoring is done by inserting your arm in a sleeve and placing your palm flat on a detector with the fingers spread. The PCM is very fast and accurate but has "dead zones". You must position your body 3" from the detectors for proper monitoring. The PCM alarms when contamination is detected.

Radioactive Material Detectors

The last devices we will discuss are the ones used to detect radioactive material. When exiting Security Headquarters you pass through a radiation monitor, shaped like a door frame, called a "Portal Monitor". This monitor detects the gamma radiation emitted by radioactive material and alarms. It is primarily used to prevent radioactive material from being removed from site but will detect large amounts of contamination (hot particles). If it alarms a second time, step back, do not leave Security Headquarters, and wait for RP to respond.

The whole body counter detects the gamma radiation emitted from radioactive material inside your body. It can determine the amount, type, and location of radioactive material. Whole body counts are used to evaluate internal contamination events known as "uptakes".

Permanently mounted radiation dectectors monitor general area radiation levels as part of reactor operation management and as an alarm system if area dose rates change significantly. There are three components to this detection network: The Radiation Monitoring System (RMS), Area Radiation Monitors (ARMs), and Continuous Air Monitors (CAMs) aid the Radiation Protection Group to measure radioactivity as an indication of reactor operations. Each reactor plant has a wide range of air, liquid and general area, radioactivity detectors. Each power block uses in excess of 50 radiation detectors attached to plant components and within the path of air and water supply and disposal systems. The detectors verify that radiation levels are within design specifications. If radiation levels reach preset alarm points, alarms will sound at the monitor, in the Control Room, and in the RP office.

If you are in the vicinity of an alarming RMS radiation monitor you should leave the area in a safe manner and report to the RP island.

In addition to the RMS system, portable detectors are used to monitor air and area radiation levels. Continuous Air Monitors sample the air in an area and alarm if preset alarm points are exceeded. Area Radiation Monitors monitor dose rates in the area and also alarm at preset levels. Again, your actions will be to leave the area and report to the RP office. These alarms are set just slightly over normal operating levels. You have plenty of time to place your work area

next page begins "In summary..."

Sp. +

Palo Verde uses the same exposure limits as the Federal Government for skin and extremities: 7.5 Rem/quarter limit for the skin and 18.75 Rem/quarter for extremities.

Palo Verde Administrative exposure limits may be exceeded up to the federal limits, if there is a justifiable need for it.

To be granted an extension, the ~~individuals's~~ individual's supervisor must submit a Request for Exceeding Administrative Exposure Limits form, which can be obtained from Dosimetry of the Unit RP office.

Extensions will only be allowed with prior *AUTHORIZATION*, proper *JUSTIFICATION* and a completed NRC Form 4 on file with Dosimetry.

Same paragraph

To be granted an extension, the individuals's supervisor must submit a Request for Exceeding Administrative Exposure Limits form, which can be obtained from Dosimetry or the Unit RP office.

The extension will be justified by supervision. Authorizations from management will vary according to the amount of extension requested. The larger the extension, the higher the level of authorization that is required.

Pre-Natal Exposure Guidelines

You will recall from Site Access Training that *special precautions* are in place for fertile and pregnant female workers. NRC Regulatory Guide 8.13 addresses this topic in great detail.

Recommendations in Reg. Guide 8.13 are made on the basis of *radiation effects on the fetus* carried in the womb of a pregnant woman. These effects have been observed most in children who were exposed to ionizing radiation during their first three months in the womb. It is during this interval that the cells of the fetus are most radiosensitive because of their rapid reproduction rate.

Fertile females are held to the PVNGS Administrative limits.

PVNGS requires that as soon as a female radiation worker becomes pregnant that she notifies her supervisor and Radiation Protection, and fill out and sign a Pre-natal Dose Limit Statement.

The pregnant female worker will be limited to 150 mRem/quarter whole body radiation exposure, not to exceed 0.5 Rem (500 mRem) for the entire duration of the pregnancy.

C9

Emergency Exposure Guidelines

PVNGS has an extensive plan of action to follow in the unlikely event of an emergency. You should remember the Emergency Plan classifications from Site Access Training: Notification of an Unusual Event, Alert, Site Area Emergency, and General Emergency.

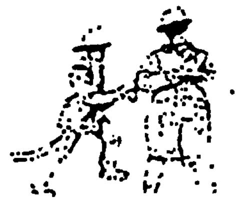
During a declared emergency, the Emergency Coordinator can verbally authorize workers to exceed administrative and federal exposure limits.

For samples that need to be taken, typically by Radiation Protection and Chemistry Technicians, the individual will be restricted to 5 Rem whole body exposure.

If actions are taken to correct a problem that threatens the plant's physical integrity, and reduces ~~thereby reducing~~ the protection of the public, these individuals involved will be limited to 25 Rem whole body exposure.

or which reduces

When activities are related to saving a life, those personnel involved in the life-saving activity will be limited to 75 Rem whole body exposure.



The following restrictions apply to these Emergency Exposure Guidelines:

The person who is going to receive the exposure:

SHALL

- be a volunteer.
- receive only one lifesaving exposure in his/her life.
- have been trained to understand the biological effects of ionizing radiation.

SHOULD

- be over the age of 45.
- NOT be a fertile female.
- have a completed NRC Form 4 on file.

Some radiological emergencies will involve the release of radioactive iodine gas. This type of emergency is particularly significant because our thyroid glands use iodine to function properly, and the thyroid could absorb radioactive iodine and receive doses of radiation. To prevent this from happening, potassium iodide(KI) tablets are administered during emergencies involving radioactive iodine gas. The thyroid will absorb the non-radioactive iodine from these tablets and not be able to absorb radioactive iodine later. This is called *"Thyroid Blocking"*.

> Due to reactions and side effects in some individuals, the use of potassium iodide is strictly voluntary, and only when *authorized* by the Emergency Coordinator.

Upon termination, request a report of your exposure while working here. This report is necessary when you report to another nuclear job. Palo Verde must furnish this report within 30 days of the request date or within 30 days after the exposure has been determined by PVNGS, whichever is later.

In addition, PVNGS will give employees estimates of their current quarter exposure when they terminate.

PVNGS is also required to give you a report of your exposure annually upon request and whenever notification to the NRC is required.

Dose Limit Responsibilities of the Individual

Know your current exposure. You can check with Dosimetry or refer to the list posted near the REP bulletin boards.

Know your current dose limit and how much remains. If you started with a 1000 mRem/quarter limit and currently have received 200 mRem your remaining allowable quarterly dose is 800 mRem.

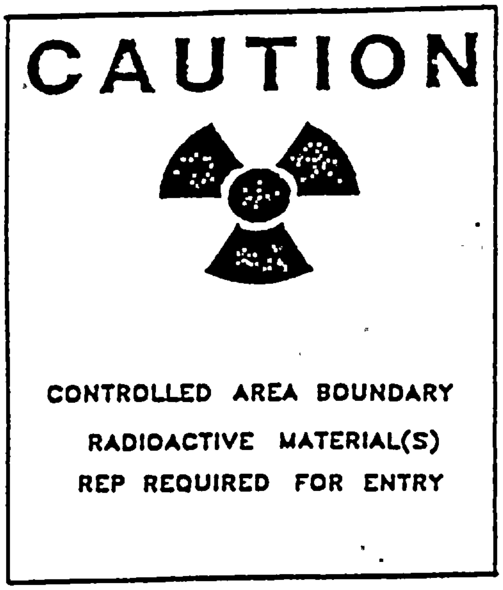
Stay within all radiation exposure limits. If you are approaching a limit, notify your supervisor and R.P. Give *adequate warning* so work schedules may be adjusted or extension paperwork can be submitted.

Keep your exposure As Low As Reasonably Achievable (ALARA). Know the location of low dose rate areas and use them whenever possible.

Consequences of Exceeding Exposure Limits

We never want to exceed radiation exposure limits, there are possible consequences which make it a situation to avoid.

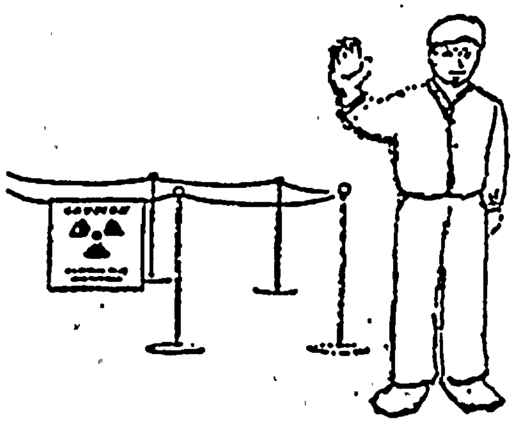
> Possible adverse health effects involved with radiation exposure.
>
> Exceeding dose limits may result in disciplinary action.
>
> If Federal exposure limits are exceeded, the Nuclear Regulatory Commission may assess fines against Palo Verde.



The RCA includes *any area at PVNGS which features positive controls for the purpose of protecting personnel from radiation exposure and radioactive material.* The RCA prevents *unnecessary radiation exposures* since personnel are not allowed in without a need to enter and the RCA helps prevent *the spread of radioactivity to clean areas of the plant or offsite.*

Any area on site designated as an RCA will be identified by physical barriers such as ropes, fences, doors and/or floor markings. In addition to barriers these areas will be *posted with yellow and magenta radiological warning signs with the word "Caution" or "Danger" and the international radiation symbol, the trefoil, printed on them.* Rope barriers, ribbon or tape will also be yellow and magenta.

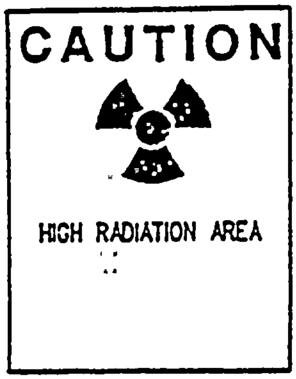
There is what is called the standard RCA. The standard RCA is a specific part of each power block with controlled entry and exit. Parts of the standard RCA have additional requirements for entry and will be distinctly identified.



SP

A High Radiation Area (HRA) is an accessible area where a major portion of the whole body could receive in excess of 100 mRem/hr.

Due to the significant risk of exceeding dose limits in High Radiation Areas there are very strict requirements for entry.



To enter a High Radiation Area, you must meet all the requirements for entry into the RCA and have one or more of the following:

Wear an alarming dosimeter.

Carry a dose rate instrument of an appropriate range.

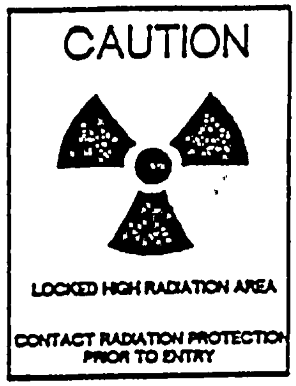
Be escorted by an RP Tech with a dose rate instrument.

A Locked High Radiation Area (LHRA) has dose rates GREATER than 1000 mRem/hr. LHRAs will have additional controls.

Shall remain locked except when access is required. The keys controlled by unit Radiation Protection Supervision and issued to RP personnel only.
Personnel access shall be under a specific REP which shall specify the dose rates in the immediate work area and the maximum stay time for individuals in the area.

In lieu of the stay time being specified on the REP, direct or remote continuous surveillance may be provided by Radiation Protection personnel to provide positive exposure control over activities in the area.

If it is not practical to enclose and lock the area, it shall be roped-off, posted, *and a flashing light* shall be installed as a warning device.



A Hot Spot (HS) is a small localized area where ~~the dose~~ rate is significantly higher than gerneral area dose rates.

Hot Spots generally are caused by "crud traps". Crud traps are places in the plant piping system where radioactive materials get trapped or settle out. Typical crud traps are drains, elbows in pipes, valve and detector piping-junction surfaces, weld seams, and the bottom of tanks and vessels.

Hot Spots will be labeled with yellow and magenta stickers with the words "Hot Spot" printed on it. It is definitely a good ALARA practice to avoid Hot Spots.

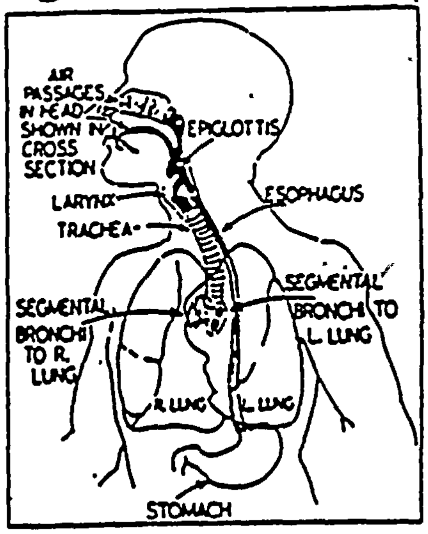
products. These particles consist of relatively large quantities of radioactive materials which can produce very large doses, both to the skin and the whole body, in relatively short periods of time. They are also very difficult to detect because of their size and the fact that the radiation levels "die off" in a short distance. Frisking with the probe too far away can cause you to miss a highly radioactive hot particle.

Hot particles are very easily transferred from one location to another, behaving much like grains of sand. Although hot particles typically do not stick to dry surfaces, they may easily be dislodged and become physically trapped on oily or greasy surfaces. Equipment shared by the units allow particles to be moved great distances.

Contamination may also become an internal hazard. It might be swallowed because of hand to mouth activities. It is also possible that work activities may cause contamination to become airborne and then be inhaled.

When contamination does enter the body, it becomes a special problem. These contaminants remain inside the body, continuing to ionize the body tissues, until they are removed by natural body processes and/or radioactive decay. This elimination may take hours or even years depending on the elements involved.

Certain body parts can be more affected than others. This results in large doses to certain organs. Particulates like Cobalt, Manganese or Cesium may get trapped in the lungs or be transported to muscle or bone tissues. Radioiodine, a radioactive form of iodine gas, is readily absorbed by the thyroid gland.

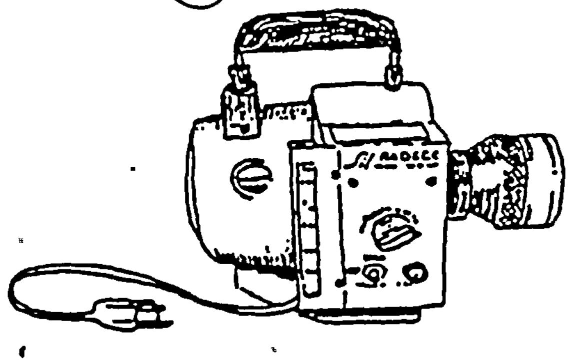


DETECTING CONTAMINATION

The Radiation Protection Department is constantly monitoring work areas, sampling the air, and surveying the plant systems for contamination.

Airborne radioactivity is sampled continuously in most plant areas as well as periodically during jobs or in work areas.

Portable air samplers are used to collect samples of air from workers' breathing zones. These portable samplers allow quick analysis of airborne radioactivity before, during, and after a particular task.



Continuous Air Monitors (CAMs) are stationary air sampling devices set up in various portions of the RCA. They constantly sample the air and will alarm when preset levels are reached. RP routinely

Now we will address the *methods used at PVNGS to detect internal and external contamination.*

> Internal contamination *is detected using bio-assays.* Bio-assays include: *Whole Body Counts, Urine and Fecal samples.*

Whole body counters use a detector which *measures gamma radiation emitted from the radioactive materials inside the body.* Other Bio-assays (urine and fecal samples) determine the amount of radioactive material inside our body by measuring the various types of radiation (alpha, beta and gamma) emitted from these specimens.

Whole body counts are *required* at the following times:

> *Initially*, prior to being issued dosimetry or being allowed inside an RCA. This establishes a baseline measurement to be compared to later measurements.
>
> *Annually*, to ensure that radioactive materials are not accumulating inside the body. This verifies the effectiveness of the Respiratory Protection Program.
>
> *Upon termination* of employment. To see if any radioactive material has collected inside the body during work at PVNGS.
>
> Anytime *internal contamination is known or suspected.*
>
> Prior to going to another plant where exposure may be received and when you return.

DETECTING EXTERNAL CONTAMINATION

We use friskers, and Personnel Contamination Monitors (PCMs) to detect external contamination.

Friskers are portable and have a hand held detector which can detect contamination.

A frisker detects radiation as counts per minute (CPM). A person is considered contaminated when the meter indecates 100 CPM over background. The background CPM is determined prior to handling the detector.

Personal Contamination Monitor (PCM) is a half-body monitor which requires the individual to step up into the monitor and place one arm into a detector-filled sleeve. If contamination is detected the monitor will alarm and indicate which part of the body is contaminated.

Contamination Control Methods

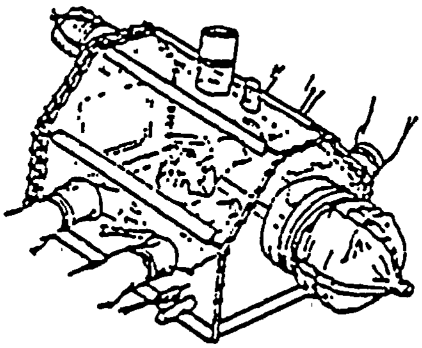
As mentioned earlier, contamination is a serious hazard because the radiation it emits may cause internal and external exposures. Besides trying to control the spread of contamination we must make every effort to minimize exposures while working with contaminated materials.

Along with identifying and avoiding possible contamination hazards, there are Work Practices and Engineering Controls which can be followed to help minimize the spread of radioactive contamination.

Engineering controls can also help in the fight to control contamination. Two principle controls are *containments and ventilation.*

Abbreviation

Containments include work tents, glove boxes, and drip catches. A work tent allows properly dressed workers to handle contaminated materials inside the tent while others outside can work without the restrictions of protective clothing because the hazards are contained within the tent. Glove boxes have gloved sleeves which allow workers to reach through the walls of the box to work on a contaminated item and not spread the contamination outside the glove box. Drip catches hang beneath contaminated work areas or leaking components to prevent falling debris or leaking fluids from spreading to clean areas. Do not handle drip catches or remove them without RP direction.



Glove Box

Ventilation systems can be both portable or built into the plant. They are filtered so that radioactive materials are captured in the filter media. They also work so that air is constantly exhausted out of areas, preventing the blowing and spreading of contamination. If a task requires local ventilation, portable units can be used. These filtered ventilation systems are High Efficiency Particulate Air (HEPA) filters and some are equipped with charcoal beds which can absorb certain radioactive gases.

Good Radiological Work Practices

Work Area Setup

1. Herculite on the floors or other components.

2. Drip catches, work tents, glove bags.

3. Lay down area for clean equipment/tools.

4. Tape tools, cover test equipment.

Housekeeping

1. Clean component prior to start of work.

2. Clean up as you go.

3. Keep work area neat and orderly.

Decontamination of areas or items

1. Wipe down tools as you go.

2. Change gloves often.

3. As surface contamination levels increase, decon-taminate. (abb)

4. When work is complete.

The best work practice is good **housekeeping.** If you keep your work area clean, less material will get contaminated. Always put radioactive materials in proper storage areas and double bag contaminated materials. Refrain from laying tools and equipment on the floor.

Decontamination is very helpful as well. A few minutes spent decontaminating items or jobsites may allow work without the use of protective clothing or equipment, save man-Rem and reduce radwaste.

SP/P

Controlling Personnel Contamination

Internal exposure occurs if radioactive materials are *inhaled, ingested, or absorbed.* Hand to mouth activities like *eating, drinking, smoking, or chewing are therefore prohibited in all parts of the RCA.* Open wounds present an absorption path, so they must be properly covered, and the covering approved by RP prior to RCA entry. Along with the work practices and engineering controls described earlier, minimizing time in contact with contamination and the proper use of respiratory protection equipment also help minimize the risk of internal exposures.

External exposures from contamination are best minimized by keeping contamination off your body and clothing. You should also avoid areas containing standing water and unnecessary contact with contaminated surfaces and equipment. Do not touch boron crystals, drip catches, floor drains, cable trays or overhead piping.

PROTECTIVE CLOTHING

Let's now discuss protective clothing, its purpose, proper donning and removal.

Protective clothing is designed to *help prevent personnel skin contamination.* There is no real set order for donning protective clothing, however, certain points must be stressed.

You will be informed of the required protective clothing for your job on the Radiation Exposure Permit. The REP is your ticket for work inside Radiological Controlled Areas. Not all work inside an RCA involves working with contamination, so not all REPs require PCs. A full set of PCs includes coveralls, rubber gloves with cotton liners, rubber overshoes with plastic shoe covers, and a cloth hood. There may be times when more or less may be required. For example, work with contaminated liquids may require plastics (waterproof pants and jacket) or working in an area that is lightly contaminated may only require shoe covers, gloves, and a lab coat.

Whatever the REP specifies however, is what must be worn. Only the RP Group can authorize substitutions.

Enter the RCA wearing your modesty clothing. It is suggested that gym shorts and a "T" shirt are worn.

When you pick your PCs at clothing issue, it is important to inspect them. Inspect the cloth coveralls and hood for tears. If damaged, place them in the repair barrel. Check the rubber gloves for holes by gripping the cuff and spinning the glove so that inflates with trapped air. Squeeze the glove tightly. If air escapes through holes in the rubber, discard the gloves in contaminated waste. The rubber and plastic shoe covers should also have complete integrity. Now that all materials are inspected satisfactorily, you are ready to don them.

Although an exact method for donning PCs has not been specified, the following sequence is recommended: Slip on the plastic shoe covers then the coveralls, tape the ankles and zipper. The rubber overshoes are next, followed by the cloth hood. The cotton glove liners are worn under the coverall wrist cuffs, the rubber gloves over the cuffs, tape the gloves. Your TLD and pocket dosimeter are placed in a plastic bag and attached to the outside of the coveralls over the left breast unless otherwise directed on your REP. The TLD must be placed such that the beta window faces outward, away from the body.

If your PCs become wet, leave the area, frisk

RADIATION EXPOSURE PERMITS

Just like a Homeowner wishing to put in a room addition and needing a permit to do so, the nuclear worker must have a Radiation Exposure Permit (REP) prior to work within the Radiological Controlled Area.

The Radiation Exposure Permit is a very valuable tool for work inside Radiological Controlled Areas. It can make a worker aware of actual conditions which exist in the work area without having to be exposed to Radiation or Contamination.

OBJECTIVES

At the end of this lesson you should be able to:

1. **Identify the primary purposes of REPs and when they are required.**
2. **Identify the locations where REPs will be posted or filed.**
3. **Recognize the Rad Worker's responsibilities concerning REPs.**

The Radiation Exposure Permit (REP) provides a complete description of the radiological conditions and requirements for each job to be performed within the RCA. The REP informs the worker about the job: it's description; location and estimated duration; about the radiological conditions to expect, dose rates, contamination levels and airborne activity and about the protective equipment required: dosimetry, dose rate instruments, protective clothing and respiratory protection. It is of extreme importance that you always know which REP you are working under and understand and obey all of the instructions listed on that REP.. At Palo Verde Nuclear Generating Station, your REP is as important as your work procedures, drawings, tools and common sense.

The REP serves two major purposes. It is an *accountability tool* and it *sets the radiological requirements* for each specific task.

As an accountability tool, the REP ensures that no one enters any radiological controlled area without having both a need to enter and all required materials. The REP also provides a means of tracking exposure by job.

In addition to establishing the radiological requirements for individual jobs, the REP. ?

Radiation Exposure Permits are required for:

Any job or task within the RCA. handles also?

Any handling of radioactive material (whether inside or outside the RCA).

There are three types of REP's in use in the plant. The Standing REP will be used for work which is expected to cause exposure less than 0.1 man-Rem. A Job REP will be used for specific jobs and the Emergency REP is used only in the event of a declared emergency.

No matter which type of REP you are using, it is important for you to be aware of the information which is provided on an REP. As we proceed, refer to the copy of the REP on page F6.

A REP can be originated by anyone. Let's look in detail at the REP and discuss what each listed item means.

The top of the form lists the REP number, work order and the expiration date. The REP number is broken down to Unit-year-sequential number and revision number.

Part I information is supplied by the originator. It includes the job description, location, estimated man-hours and estimated duration. In addition, the work group supervisor may be required to supply a list of personnel who will be authorized to work under the REP.

Part II lists the radiological survey results including dose rates, contamination levels and concentrations of airborne radioactivity. Survey results will be listed for the actual component to be worked on and the general area around the component. In addition, any dose rates from surrounding sources will be listed. These survey results will include, as appropriate:

Gamma dose rates in mR/hr.

Beta dose rates in mRad/hr. The exposure from these beta dose rates would affect unprotected skin and eyes.

GV/P

Neutron exposures in mRem/hr if the work is to take place in the Containment Building while the reactor is operating.

Loose surface beta-gamma and/or alpha contamination in dpm/100 cm^2.

Airborne concentrations in MPCs. (Maximum Permissible Concentration).

Based on the survey results and estimated man-hours, the RP Group will calculate man-Rem. This calculation is performed by multiplying the number of man-hours required to complete the job by the job site dose rate. For example, a job requiring 180 man-hours in a 500 mRem/hour area would expend 90 man-Rem (180 hrs. X 0.5 Rem-/hr = 90 man-Rem). If the man-Rem exposure estimate is 10 man-Rem or greater, the ALARA Committee will review the pre-job ALARA review.

Part III lists exactly what protective clothing and equipment is required for that REP. These requirements will vary greatly depending on the task to be performed. Whatever requirements are listed must be followed exactly. Unless the RP Group makes written substitutions, individual *workers may not deviate from these requirements.* Requirements may include gloves, shoe covers, cloth coveralls and/or plastics (a waterproof suit, pant or jacket top), or respiratory protection. Dosimetry is also listed ranging from your Record TLD and 0 to 200 mR pocket dosimeter; to extremity TLDs, multiple TLDs and Neutron TLDs.

Part IV indicates the frequency of Radiation Protection job surveillance. RP will inspect and survey the job location prior to your beginning the work. Intermittent job surveillance would require the RP staff to check in periodically to ensure that radiological conditions have not changed significantly. Continuous job surveillance will be required when strict dose control must be maintained and when the progress of work is expected to cause changes in radiological conditions. Continuous job surveillance will usually be required for work in airborne areas, high contamination and high radiation areas and the opening of radioactive systems.

Part V lists special instructions. Specific instructions might include such things as the installation of exposure reduction equipment (temporary shielding) or portable filtered ventilation; containment devices like drip catches or work tents; or disposition of contaminated components; instructions for area clean up; or any other amplifying instructions.

Part VI is for REP review and approval and assignment of a Reg. Guide 1.16 category. These categories are for the reporting of exposures by tasks to the Nuclear Regulatory Commission. The first review is by the RP Tech who wrote the REP. The Radiation Protection Manager and Operations Shift Supervisor must approve it.

Part VII is for REP termination. There are three reasons listed: expiration according to date, completion of the job or revision of the REP because radiological conditions have changed. An REP may also be terminated if the Unit RP Group determines that the REP is being used improperly, or to stop unsafe work practices. When the expiration date arrives, the RP Group will terminate the REP. After a job is complete, *the originator must* notify the RP Group to terminate the REP. Termination may be initiated by RP, the originator or the Operations Shift Supervisor.

Because REP revisions are possible at any time, the nuclear worker must be very attentive. Make sure you read your REP thoroughly every time you prepare to enter the RCA. A revised REP will have a different letter designation after numerical one.(i.e., 0005a becomes 0005b) or may just have pen-and-ink changes.

REPs are always available for you to read. After approvals by the *RP Manager and the Operations Shift Supervisor*, copies of the REP will be posted or filed at these locations:

The original will be filed at the *Radiation Protection office.*

A copy will be filed in the *Operations Shift Supervisor's office in the Control Room.*

A copy will be posted on the *REP Bulletin Board* in numerical order OR be *available at the RP island.* The REP Bulletin Board is just outside the RCA access point in each unit.

An additional copy of the REP may be available at the job site or at the job control point.

You have *several responsibilities* concerning REPs. You are required to:

Read the REP *every time* you enter the RCA. Be alert for revisions.

Sign the REP initially and after each revision. Signature sheets are maintained at the dosimetry issue point for this purpose. Signing for the REP indicates that you have read and *understood* your REP.

Comply with all requirements. Noncompliance may result in:

Increased risk in personal and co-worker safety.

Personnel contamination or increased radiation exposure.

Disciplinary actions including termination.

Stay within the scope of your REP. Discuss all job scope changes with RP prior to performing any actions.

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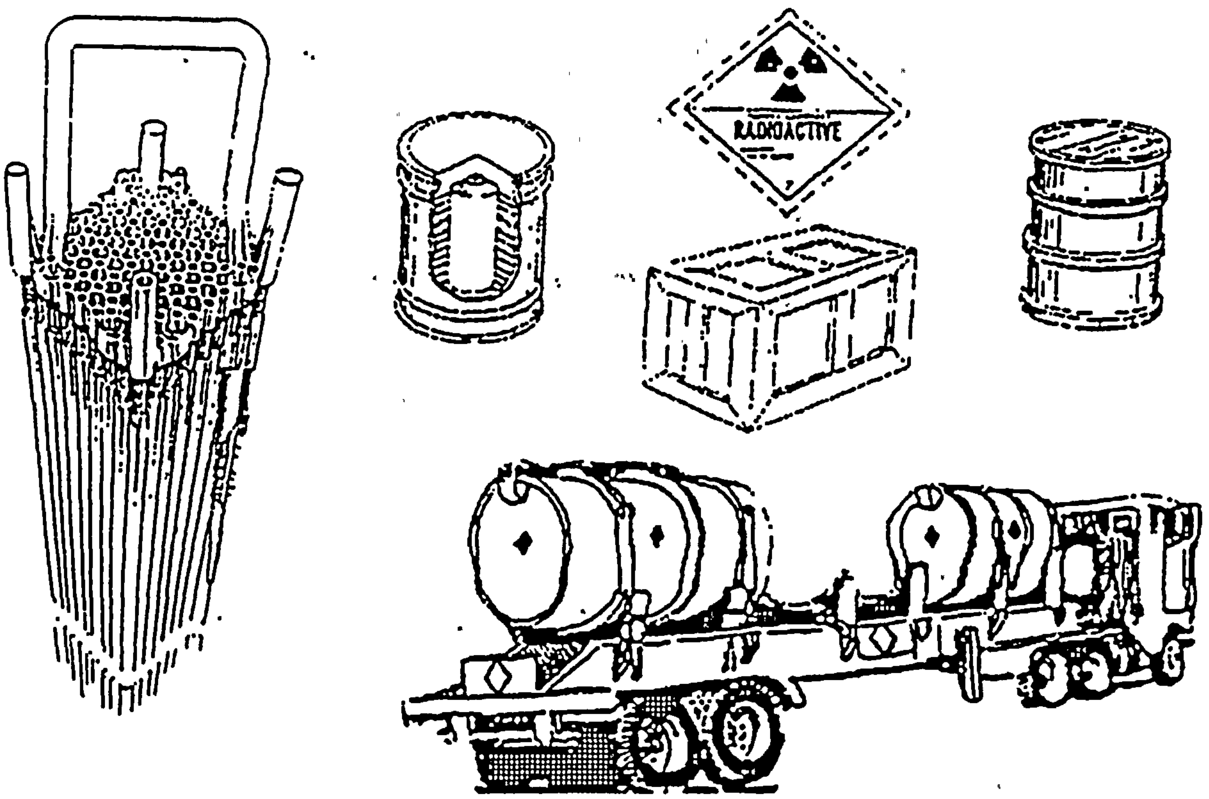

Radwaste is material that has become ıctivated or contaminated due to plant ›perations and activities. Examples of adwaste range from paper trash, rags, ıopheads, disposable protective cloth- ıg, small valves, pieces of piping and ıachinery, to spent fuel bundles. We lassify radwaste as either high level or ›w level.

← Missing word parts in original

ligh level waste is mostly spent fuel and ›ent fuel by-products. Spent fuel con- sts of fuel bundles which have been ›moved from the nuclear reactor once ıeir useful life is complete. These sp- ıt fuel rods contain thousands of curies f radioactivity and are extremely dange- ›us due to their ultra-high radiation vels. When discussing the amount of ıdioactivity involved, or in :her words, the number of curies, *99%* *all radwaste is high level waste.*

However, when we consider volume or amount of space required, *94% of all radwaste is low level waste.* Essentially, the greatest amount of radioactivity is high level waste and the greatest amount of bulk is low level waste.

Low level waste, which ranges from simple trash to used plant components, is further classified as either wet or dry waste. Wet waste is primarily generated from liquid processing systems of the plant. It includes oil, water, chemicals, ~~or~~ wet rags, resin and filters. Wet waste must be dried prior to shipping.

Dry waste is generally contaminated trash and/or scrap components. Examples are rags, bags, disposable PC's, scraps or parts from maintenance activities and broken tools/equipment.

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environmental impact of such sites. Each local and state government will make their regulations.

Another major concern is cost. Radwaste is very expensive trash. Utilities are not only charged by volume to dispose of waste, but every step of the process entails significant costs. Special handling tools and techniques, special packaging and containers, specific training and management programs and detailed regulations and shipping requirements all add to high costs. For shipping, handling and disposal the cost is currently $120/cubic foot, therefore, one 55 gallon drum of radioactive waste will cost approximately $850-$950. APS expects to dispose of wastes totaling 36,000 cubic feet in 1990. This equals $4.3 million. The volume figures are estimated to stabilize through 1993 but cost could increase to $200/cubic foot due to opening of new waste sites in California. Considering APS will ship drums by the tractor-trailer load about 250-300 times each year, final radwaste costs are in excess of 4.3 million dollars per year. It is obvious that volume reduction is cost reduction, and is therefore extremely important.

PVNGS also has a radwaste sorting program. This is a major part of our Radwaste Reduction Program. Most bags are taken to the sorting table and monitored for contamination. This is a final step to assure that no clean material is disposed of as radwaste. Obviously, sorting would be minimized if everybody was careful to properly dispose of their trash.

The compactors used at PVNGS can compress the volume of six barrels of trash into a single 55 gallon barrel.

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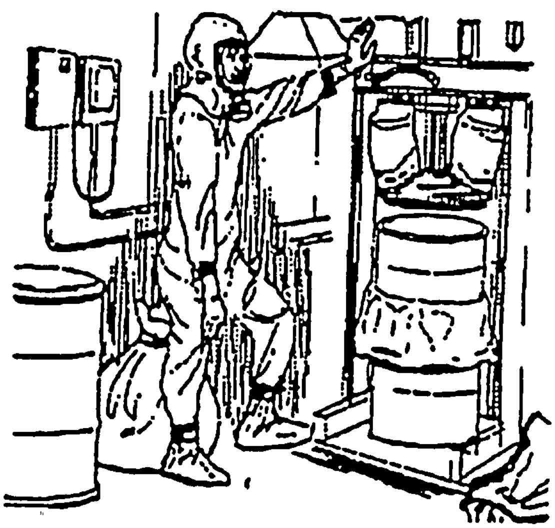
The RP group helps minimize radwaste by minimizing contaminated areas by using drip catches and decontamination. They can also provide you with suggestions for controllong contamination and other volume reduction methods.

As with all aspects of radiological work practices, the most important element in the radwaste reduction program is the individual worker. Each of us in the plant must be aggressive in reducing the amount of material which becomes radioactive waste. As an added incentive, workers should realize that the radwaste problem could affect them personally. If costs are not reduced, there may be an increase in the cost of electricity and greater dependence on foreign oil.

Let us now talk about *individual worker responsibilities*. They are: minimizing the amount of radwaste generated; and segregating items for disposal.



Compacting 55 gallon drums to reduce volume

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Minimizing Radwaste through Pre-job Planning

The easiest way to minimize the volume of radwaste generated is to *take only those items needed* for a job into the radiological controlled area. *Do not* take cardboard boxes and other packing materials into the RCA, only the item that came in the package. If materials are not job-related essentials, they should never be taken into the RCA.

Use tools that have *already* been *used in the contaminated area.* PVNGS has a "Hot Tool Crib" where contaminated tools may be obtained.

If a "clean" tool must be taken into a contaminated area, it can be kept clean by *wrapping* it with tape or sleeving. Items like electronic test equipment, etc., can be protected. Wooden handled tools can be kept contamination free by covering the handle with tape.

Segregation of Items

Tag items that are to be stored or deconned then transport them to the area designated by RP.

PVNGS has set up a simple means of segregating "clean" trash from "dirty" trash. White barrels with green bags are strictly for "clean" materials. Never throw anything away in "clean" trash if you are not certain it is clean.

RP Technicians can monitor materials for contamination. If you are exiting a contaminated area, put your materials in a yellow bag and ask RP to survey them.

Yellow barrels with yellow bags are for dry compactible, non-hazardous contaminated materials.

If you are exiting a contaminated area, put your materials in a yellow bag and ask RP to survey them.

Yellow barrels are specifically marked for PC's, respirators, hazardous waste such as batteries, aerosol cans, and non-compactible waste. Contact RP for the location of these barrels or bag the items separately.

Most protective clothing is washable and *must not* be thrown into radwaste unless directed by Radiation Protection. Sometimes plastic suits will be used to protect against wet contamination. These will be thrown away as waste.

Some radioactive materials such as scrap metals, replaced valves, piping or machinery cannot be compacted. These items also must be separated from compactible radioactive waste. Aerosol cans may become an explosive hazard when compacted, so *never* put them in with the normal compactible radwaste.

It is very important to segregate wet waste from dry waste. Disposal sites will not accept shipments of wet waste. Wet wastes *must* be solidified for disposal. Therefore, wet or damp materials and fluids need to be placed in different containers than dry materials and marked "wet waste".

Because oil, oily waste, organic or other solvents can damage liquid processing systems, they *must never* be poured down floor drains and *must always be segregated from other liquids. If you need to dispose of liquids or oily wastes, contact Radiation Protection.* RP will sample

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liquids. If clean, they will release the liquid to you for disposal outside the RCA. If contaminated, RP will direct you to the disposal location in the RCA. Oily waste such as rags must be placed in drums designated for oily waste.

RADIOACTIVE MATERIAL PACKAGING and CONTROL

Packaging

Radioactive mateial is routinely moved around inside the RCA's and from unit to unit. Much of this rad material is contaminated and requires special handling. When an item is removed from a contaminated area it must be packaged in order to prevent the spread of contaminaton.

At a minimum, the material must be placed in a yellow (some are clear) bag with radiological markings. In alot of cases, the material must use additional packaging methods. The material must be bagged well enough to prevent contamination from leaking out and keep the item inside from puncturing the bag.

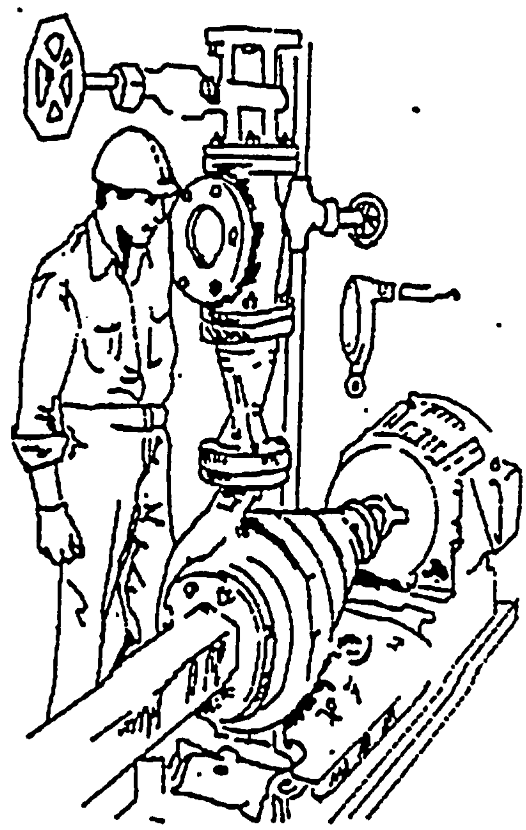
Wet material must be bagged separately. Double bag damp or wet items and place absorbent material (rags or papertowels) in the bags to prevent the liquid from leaking out. Label "WET". You may even want to consider using a bucket.

Internally contaminated hoses should be completely drained. Bag only the ends and place absorbent material in the bag and around the ends to absorb moisture and prevent the bag from being cut by the fitting.

Heavy or sharp objects should be padded (tape, towels, cardboard) and bagged securely. Herculite or multiple bags should be used. Contact RP for assistance in determining adequate packaging methods for the material you are bagging.

Labeling

Material that is bagged for removal from a contaminated area must be labeled. You can start by writing on the bag whether it is "wet", "non-compactible", "oily" or other descriptions. RP must place a tag on the bag that lists radiological information and work group info. If the item is to be stored or decontaminated, you must place a "Contaminated Material Transfer Tag" on the bag. You retain a copy and the tag stays with the item for tracking.



Only take in those items essential for the job

Once radioactive material is tagged, it must be moved to a designated storage location, as directed by RP. RP may accompany the movement. The material should be taken directly to the storage location.

Radwaste Problem Report

The R W P R is used to aid in reducing rad waste produced at PVNGS. The form is available in procedure 76AC-O-RW02. Any worker may fill one out to identify areas or work practices that generate excessive radwaste. Any suggestion you have for reduction methods will be evaluated. Radwaste reduction is everyone's goal.

A summation of rad worker responsibilities regarding radwaste volume reduction includes the following:

- Take *only the tools and materials needed* for the job into contaminated areas and keep these tools in a bag or tool box until needed. Laying tools on the floor can cause them to become unnecessarily contaminated.

- *Unpack equipment and tools in clean areas* so that the packing material will not enter contaminated areas.

- Radwaste receptacles *(yellow drums, yellow bags) are for Dry, Compactible, Non-hazardous contaminated trash* unless otherwise marked. *DO NOT throw clean trash into these containers.*

- *DO NOT dump organic or other solvents or oily waste down floor drains* since these materials can shorten the life-of-liquid radwaste treatment equipment and result in larger amounts of processed waste.

- *Notify the Control Room if excessive leakage is observed* from pumps or valves.

- *All tools and equipment removed from Contaminated Areas must be checked by RP personnel* to determine if they are contaminated. Contaminated tools and equipment should be stored for future use, and contaminated trash should be disposed of as radwaste. Tools, equipment, and trash that are frisked "clean" may be released.

- Whenever possible, *use tools and equipment that are already contaminated.* Re-use of contaminated tools and equipment will reduce the amount of radioactive material generated. If you do not know where to get contaminated tools and equipment, ask your supervisor or contact RP

- *DO NOT put protective clothing in waste receptacles.* If protective clothing is placed with radwaste, they will be disposed of as radwaste.

- *Be neat!* By using herculite and catch bags to prevent water from splashing, a worker can reduce the spread of contamination to personnel and to the surrounding area. This will also reduce the amount of material required for area decontamination. You will create less radwaste by covering an area or item than by having to decontaminate it later.

- *When decontaminating, use only the materials required to clean the area.* An excessive amount of bags, rags, and liquid adds to radwaste.

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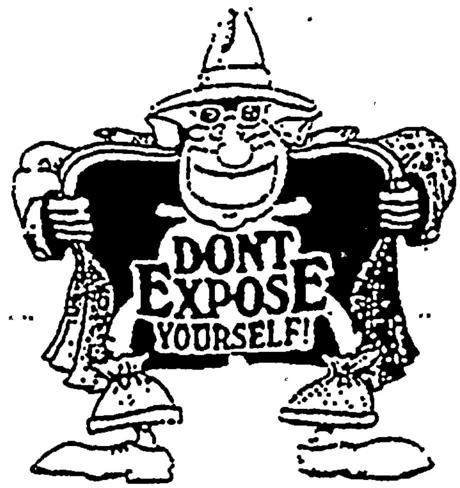

The Man-Rem Concept

Alara means maintaining exposures to :adiation, As Low As Reasonably Achiev- ible. Since even low exposures involve some isk, we control dose to each individual. ALARA also applies to the TOTAL ex- osure the site receives. This is called Man- Rem.

Man-Rem is calculated by multiplying the umber of workers involved in a task, times he radiation exposure rate, in Rem/hr, mes the amount of time it takes to com- lete the task.

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For example, 5 men are required to work hours in an area where the dose rate is 00 mRem/hour. The dose equals dose rate multiplied by the length of time or 7 hours mes 400 mRem/hr which equals 2800 Rem (2.8 Rem). If this exposure is then ultiplied by the number of men involved, we arrive at a total man-Rem of 14 an-Rem. It is our goal to find ways to duce this total.

:tual Man-rem is determined post job by ding up the exposures of all of the rkers involved.

Reducing External Radition Exposure

There are *three* principle means of man-Rem reduction. They are time, distance, and shielding.

When the amount of time spent near a radiation source is reduced, the amount of exposure is reduced.

When the distance between a radiation source and our bodies is increased, the amount of exposure will decrease.

When we place a material which shields radiation between the radiation source and our bodies, the radiation exposure is reduced.

Time

The total amount of radiation exposure received is directly proportional to the time spent in any external radiation field. This means less time, less dose. You should remember that dose equals the dose rate multiplied by the time. For example, if the dose rate in an area is 20 mRem/hr and the time spent there is 2 hours, the dose received will be 40 mRem (20

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mRem/hr X 2 hrs = 40 mRem). Obviously, if only one hour were spent in this area, the total dose received would be reduced to 20 mRem.

The time spent in a radiation field can be reduced in several ways:

Preplan the task. Ensure that everyone involved in the task knows exactly what is required of them, and is qualified to do the job.

Make sure all of the tools required are ready at the job site. Think about electrical outlets, water sources, drains, compressed air, communications, rigging, welding leads, and access to equipment.

Plan ahead for potential problems.

The use of mock-up training is another valuable time/dose saver which consists of practicing a task on a model. A full scale model is used in a location where dose is not a factor. Practice allows a task to be performed more efficiently.

It also helps identify problems prior to performing the job in the radiation area.

Distance

Distance from a radiation source can be used effectively to reduce dose. The further from a light, noise, or heat source you are, the smaller the effect. This works for radiation sources as well. The farther you are from a source, the lower the dose rate.

Doubling the distance from a source reduces the dose rate to just one-fourth its original intensity. For example, a source that is 1000 mRem/hr at one foot, reads just 250 mRem/hr at two feet and 62.5 mRem/hr at four feet.

Ways to take *advantage* of distance include:

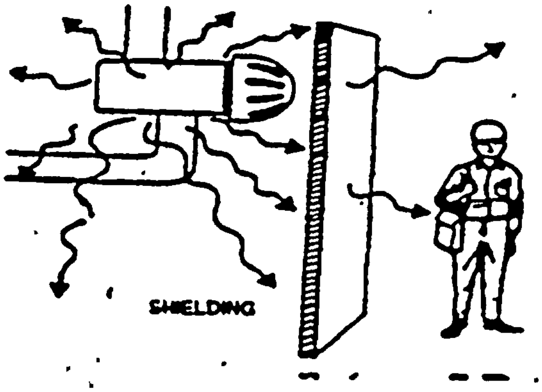
Using long handled tools

Remote operation

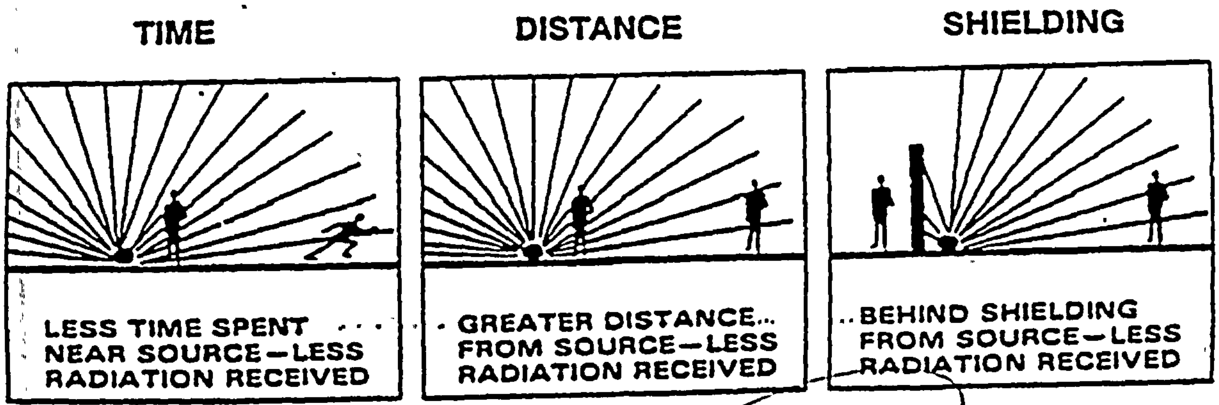
- Removal of the component to low dose rate area.

Shielding

The third principle of man-Rem reduction is shielding. Shielding is a material which, when set between the radiation source and our bodies, will absorb some or all of the energy from that radiation. This absorption does not mean that the radiation is soaked up by the shield as a sponge will soak up water. Instead, the absorption refers to the radiation (energy) being used up by the shield like light passing through a curtain. Naturally, it is better for a concrete wall to absorb energy from ionizing radiation than for your body to absorb it.



Radiation shielding is categorized as to how will it reduces the radiation



level in terms of tenth value layer. A tenth value layer is the amount of material which will reduce radiation to one tenth its original intensity.

The type of shielding that should be used depends upon the type of radiation you are trying to shield yourself against. Let's look at the kinds of shielding materials used for each type of radiation we may have to deal with.

A. Alpha radiation, although the most damaging type of radiation, is the least penetrating. It will not penetrate the dead layer of skin, therefore, is not externally hazardous. It is easily shielded by a sheet of *paper*.

B. Beta radiation is not very penetrating and is effectively shielded by *heavy plastic, rubber* and *sheet metal*. Therefore, sealing contaminated items in double plastic bags provides a good shield against most beta radiation emitted by the contamination.

C. Neutron radiation is shielded best by materials which are rich in hydrogen atoms. This material is called hydrogenous. Hydrogen atoms work well because hydrogen

all same type

is made up of one proton and one tiny electron. A proton is nearly the same size as a neutron so when a neutron collides with a hydrogen proton, it loses approximately half of its original energy. Materials which are rich in hydrogen include *water, paraffin, polyethylene* and *concrete*. Tenth thickness for neutrons: 10" water, 10" polyethelene.

D. Gamma radiation is best shielded by dense materials such as *iron* or *lead*. Lead, being denser than iron, is a better shield; the denser a material is the more gamma radiation energy is used up as it penetrates the material. *Concrete* and *water* can absorb or use up gamma radiation also. Tenth thickness for gamma rays: 2" lead, 4" steel, 10" concrete, 24" water.

E. Many shielding materials are used in construction and plant operations. Materials like concrete, iron, and stainless steel were used as plant construction materials and work as permanent shielding for gamma radiation. The water used for plant operations will shield

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neutron radiation and the plant piping systems shield beta radiation.

F. Lead will often be used as temporary shielding for gamma radiation during work. If you feel that temporary shielding could reduce dose without causing interference in your work area, you can go to Radiation Protection or your supervisor and fill out a Temporary Shielding Request Form. If approved, shielding will be installed. Lead in the form of bricks or blankets is the most common type of temporary shielding used. Workers are not allowed to remove or alter any shielding without RP approval.

ALARA and Internal Radiation Exposure

ALARA concerns apply to internal exposure as well. Methods of protecting ourselves from this hazard fall into three main categories.

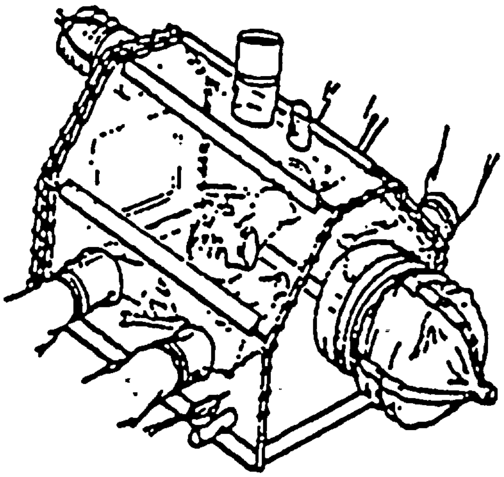
The first category is Engineering Controls and Good Work Practices.

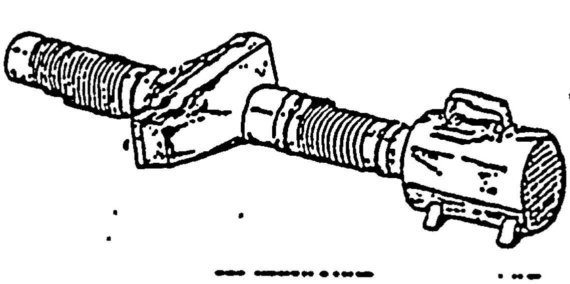
Engineering controls include installed and portable *filtered ventilation systems* and *containment devices* such as work tents and glove bags.

Good work practices include *not sweeping or grinding on contaminated surfaces* and *prohibiting eating, drinking, smoking and chewing inside the RCA.* Covering all wounds prior to entering the RCA and receive RP approval.

The second main category for protecting ourselves from the hazards of internal contamination is time. Just as with radiation exposure, internal exposures can be reduced by minimizing time spent in areas of airborne radioactivity.

Respiratory protection is our last resort if engineering controls and work practices are inadequate. Respirators may be required for personnel entering certain areas. Respiratory protection training is required before individuals are allowed to use respirators. If work in an area requires respiratory protection, it will be stated on the REP and on the area postings.





How ALARA Works at PVNGS

The ALARA Program has *three participants*: Management, the Radiation Protection Department, and the individual workers. Let's discuss the responsibilities of each participant.

Management has established administrative exposure limits lower than federal exposure limits. Management has provided ALARA training for all personnel as part of this RWP class. In addition, more detailed ALARA training is available for specific disciplines.

Radiation Protection has very strict control over the Radiological Controlled Areas of the plant, the conditions there, and the manner in which work is performed. All areas of the RCA are surveyed on a regular basis. Before any work begins, RP will evaluate the radiological conditions in the work area and establish the clothing and equipment requirements for the job. The results and radiological requirements will then be identified on the REP. Survey maps can be reviewed at the RP office and may be posted at job sites. Copies of maps will be posted outside most rooms in the RCA.

Radiation Protection will return to the jobsite while work proceeds to make sure radiological conditions have not changed and that workers are doing the job in a radiologically safe manner as per the REP.

When an REP is written for the performance of a task, RP will calculate a man-Rem estimate. They will then evaluate the task and make an engineering evaluation for this job. RP will make recommendations to the appropriate groups for engineering controls and work aids to reduce exposure such as: flushing systems; changing filters; decontamination; filling or draining tanks; temporary shielding; local ventilation.

Each year man-Rem is wasted industry-wide because personnel wander through radiation and high radiation areas looking for equipment. Here at PVNGS a valuable tool called the "Valve and Instrument Locator Map Book" was developed to save man-Rem. You can find this book at the RP island. It is available to all personnel to aid in trying to find a component within the complex layout of the plant. The "Valve and Instrument Locator" allows personnel to locate an item in the plant prior to entry into the RCA. The "Locator" has an index of areas and items which refers the user to a particular map in the book. As a further aid, the user can then cross-reference the "Valve and Instrument Locator Map" to the RP Survey maps of the area. A sample page from the "Locator" is provided on the next page.

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like before
(continuity)

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ALARA Pre-Job Planning

The level of RP and plant management involvement in pre-job planning and review is based on calculated man-rem for the complete job. The higher the expected exposure, the higher the level of involvement will be.

All jobs need some amount of planning even if you just run through the job in your head.

Work history files are helpful when determining tools and parts needed for staging.

Pre-job briefings are conducted by RP and include discussions on all applicable ALARA and Radiation Protection Techniques.

Worker participation and involvement in these briefings is essential to their success.

Each worker shall sign an attached attendance sheet signfying they have attended the pre-job briefing and that any questions were adequately answered.

Pre-job briefings include discussions of:

- Radiological conditions
- Special use or variations of protection clothing
- Dosimetry placement
- RP hold points
- REP limitations

Post Job Debriefing: Once the job has been completed, a debriefing or discussion follows with comments and recommendations for any future improvement. All information relating to the job is utilized as a basis for revisions, improving reliability and consequently reduce associated exposure.

The "*ALARA Suggestion Form*" can be initiated by *any worker* at PVNGS to identify to management situations which have caused unnecessary exposure or to offer exposure saving ideas.

It is the responsibility of each nuclear worker to report any ALARA related problems. This is an effective means of man-Rem reduction because the suggestions come from the workers that perform the job. *An "ALARA Suggestion Form" can be obtained from the RP island in your Unit.*

All reports will be answered by the Radiological Engineering Group or the ALARA Committee with an attached statement of actions being taken to correct the problem.

You, the individual worker, *have the greatest responsibility*. These responsibilities include:

- Know your *current quarterly whole-body dose and exposure limits.*
- Comply fully with the *instructions of Radiation Protection* personnel in all matters pertaining to radiation protection.
- Comply with *procedures, warning signs and barriers that concern radiation and contamination control.*

Know the principal *radiological conditions at your job site.* This information is to be provided by RP.

Properly use the *exposure reduction tools and methods available.*

Make plans to anticipate difficulties and take advantage of shielding.

Plan entry and exit routes through low dose rate areas and rehearse the job to expose any problems you might have.

Ensure all tools and materials are available and in good working condition.

Execute the job efficiently.

Discuss *exposure reduction ideas* with RP and Supervisory personnel, and submit *ALARA Problem Reports*, if appropriate.

Participate in *preplanning of work to be done in radiation areas and post-job reviews*, as required.

During the prejob briefing, inform cognizant RP tech if the *job scope has changed from what was initially planned.*

The ALARA Cycle

: ALARA cycle begins when a job gnment comes from management and kers are assigned to the task. The kers or their supervisor will file a re- st to RP to initiate an REP. The RP up will make its radiological surveys iat the REP can be written and a man- ı estimate calculated. RP will review REP and prepare engineering evaluations for the job and conduct prejob briefings. Following RP and the Shift Supervisor's approvals, work will start. During the job, RP will track worker exposure, inspect work activities and evaluate radiological controls. Upon completion of the job, RP will conduct a post-job de-briefing. This is one of the most important parts of the cycle.. It is during the post-job debriefing that any problems which occurred during the job can be identified and resolved before the job is done again. Also, things which caused the job to go smoothly or be completed ahead of schedule can be recognized. Finally, all information about the task, the exposures, controls used, and briefing documents are filed for future reference.

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GLOSSARY

Activation Products: Radioactive material formed when corrosion and wear products in the coolant pass through the reactor and absorb neutrons.

Airborne Radioactivity: Radioactive materials dispersed into the air in a particulate or gaseous form.

Alpha Radiation: Particle radiation with a charge of +2. Its source is the nuclear fuel and it is a biological hazard only when inside the body.

ARM: Area Radiation Monitor. Constantly monitors the radiation levels in its surrounding area. Alarm will sound when preset alarm point is reached.

Beta Radiation: Particle radiation with a charge of plus or minus one. Its primary source is contamination and it is a biological hazard to the skin and the unshielded lens of the eye. Measured in units of Rad or mRad per hour.

Bioassay: The collection and analysis of human urine or fecal samples to determine the amount of radioactive material within the body.

Buffer Zone: Designated area outside a Hot Particle Control Area to control the spread of hot particles.

CAM: Continuous Air Monitor. Constantly samples the air in its vicinity. Alarm will sound when preset alarm point is reached.

Cold Area: A low dose rate waiting area used when leaving the area is impractical.

Containments: Devices used to control the spread of contamination by surrounding the source (i.e., glove bags, tents or drip catches).

Contamination: Radioactive material where it is not wanted or where it does not belong. Loose surface contamination, measured in dpm/100 cm^2, can be transferred from one place to another; Fixed contamination, measured in CPM or mRem/hr is not smearable, but is controlled because of the dose rate.

CRUD: Acronym for Chalk River Unidentified Deposits. The term is now generally used for any radioactive particle within a contaminated system.

Crud Traps: Locations in plant systems where radioactive materials collect (i.e., drains, valves, elbows, tank bottoms and small diameter piping).

Curie: Unit used to describe a fixed rate of decay for radioactive materials, equal to 37 billion disintegrations per second. Named in honor of Marie Curie, French chemist and physicist who discovered Radium and Polonium in 1898.

DPM: Disintegrations Per Minute. A term used to describe a concentration of contamination.

Decontamination: Various processes used to reduce or remove radioactive material from where it is not wanted such as surfaces, tools, equipment or personnel.

Dose: The amount of radiation exposure received. Measured in mRem and Rem.