BASIC RADIATION TRAINING

Emergency Worker

Alabama Department of Public Health • Office of Radiation Control • 334.290.6244 • alabamapublichealth.gov/radiation

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SCAN ME

For a digital download of this book!

https://www.alabamapublichealth.gov/radiation/assets/basic-rad-ew-pem.PDF

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Basic Radiation Training

For Emergency Workers

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ALABAMA DEPARTMENT OF PUBLIC HEALTH EST. 1875

ALABAMA DEPARTMENT OF PUBLIC HEALTH OFFICE OF RADIATION CONTROL

Date	Change
3/1/2023	MORGAN: CRC is now Priceville High School & Hartselle Intermediate
	MORGAN: EWD is now Decatur Fire/Police Training Center

Change Log

Videos

- All videos are now housed on our YouTube channel:

https://bit.ly/ADPHORCyoutube

TABLE OF CONTENTS

The Federal Emergency Management Agency (FEMA), an agency of the Department of Homeland Security (DHS), is required to interview a certain number of emergency workers, personnel and equipment monitors to ensure that they are aware of their radiation dose limits, equipment, and the basics of radiation. The training manual has the following features:

•**Table of contents** for looking up the answers for exercises, evaluations, real-time emergency situations

•**Forms** located in the back of the book that can be used for reception centers, personal radiation exposure records, equipment setup, etc.

•**Maps** for the two nuclear power plants' 10-mile Emergency Planning Zones (EPZ) and the 50-mile Ingestion Pathway Zones (IPZ).

•**Glossary** in the back of the book with radiation terms not routinely used.

Formatting for this guide is as follows:

1. Information *on* the PowerPoint slide
2. Information *below* the PowerPoint slide in the Notes section
3. Information *discussed* in the Basic Radiation Training course by the instructor

TABLE OF CONTENTS

Everything you need to know about protecting yourself from radiation can be found in this manual. Therefore, please place this manual in a readily accessible location. For example, law enforcement might place it in a patrol car, or firemen might place a copy in each fire engine.

EWS = Emergency Worker Station (where you get your equipment)
EWD = Emergency Worker Decontamination
CRC = Community Reception Center
MCF = Mass Care Facility (where people are sheltered after going through the CRC, a.k.a. "shelter")
*****Potassium Iodide (KI) will be administered for Emergency Workers at each EWS and to the general public in affected areas at each CRC.*****

Henry:
EWS = Henry County EMA Parking Lot
EWD = Houston County Farm Center
CRC = Houston County Farm Center
MCF = Westgate Recreation Center

Houston:
EWS = Houston County Farm Center
EWD = Houston County Farm Center
CRC = Houston County Farm Center
MCF = Westgate Recreation Center

Lauderdale:
EWS = Lauderdale County High School
EWD = Lauderdale County High School
CRC = Brooks High School
MCF = Florence High School

Lawrence:
EWS = Lawrence County EMA
EWD = Moulton Recreation Center
CRC = Moulton Recreation Center
MCF = Moulton Church of Christ, Moulton Elementary School, Moulton Middle School

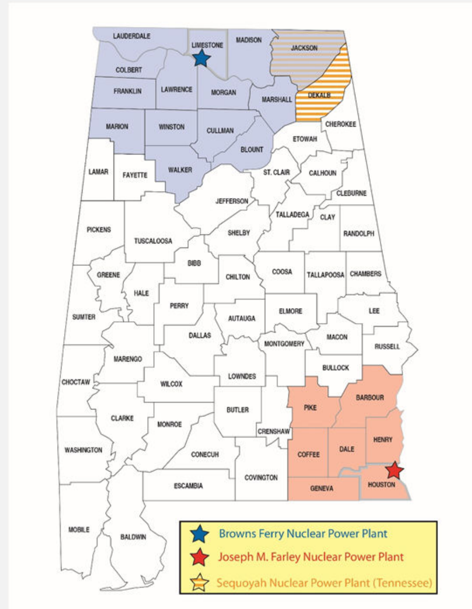
Limestone:
EWS = Athens/Limestone County Rescue Squad
EWD = all CRCs
CRC = Ardmore High School, Elkmont High School
MCF = all CRCs

Madison:
EWS = N/A
EWD = N/A
CRC = Dr. Richard Showers Recreation Center ; Dublin Park Recreation Center, Madison ; UAH, Spragins Hall
MCF = all CRCs that are activated.

Morgan:
EWS = Morgan County EMA (however, some equipment is prepositioned)
EWD = Decatur FD/PD Training Center
CRC = Priceville High School, Hartselle Intermediate School
MCF = Priceville High School, Hartselle Sparkman Civic Center

NUCLEAR POWER PLANTS

- Alabama
  - Two active nuclear power plants
    - Browns Ferry
    - Joseph M. Farley
- BFNP 10-mile EPZ
  - 4 risk counties
  - 1 host county
- FNP 10-mile EPZ
  - 2 risk counties
- 50-mile IPZ
- Universal Training and Equipment



In Alabama, there are two nuclear power plants: **Farley Nuclear Plant** in Houston County near Dothan, Alabama, and **Browns Ferry Nuclear Plant** in Limestone County near Athens, Alabama.

Browns Ferry has four risk counties (counties within the 10-mile EPZ) and one host county for the overflow of the evacuees. The risk counties are Limestone, Morgan, Lawrence, and Lauderdale. The host county is Madison.

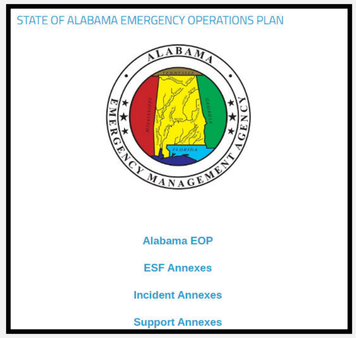
Farley has only two risk counties (Houston & Henry). Because of geographic ownership of the Chattahoochee River, we share responsibility with Georgia (via Early County).

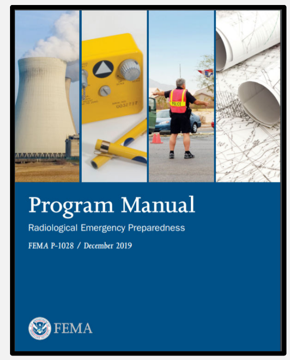
We train all emergency workers and personnel & equipment monitors in the 10-mile EPZ. We also have a different training program for the ingestion pathway counties (50-mile IPZ).

Training, equipment, and documentation are all standardized across the entire state of Alabama. Therefore, trained personnel can easily assist with a radiological event at either nuclear power plant, if requested.

RADIOLOGICAL EMERGENCY PREPAREDNESS (**REP**) PLANS

- Utility is responsible for **ON-SITE** emergency response & recovery
- Plans for **OFF-SITE** emergency response & recovery
  - **State** plan for radiological events or incidents with specific ADPH ORC Incident Annex
  - **County** plan is specific and identifies responsible organizations.
  - **Hospital** plan for radiological events or incidents





The Radiological Emergency Preparedness (REP) Incident Annex E of the State of Alabama Emergency Operations Plan (EOP) is the plan for dealing with radiological emergency response. The plan details the concept of radiological emergency planning and operation for off-site emergency response and recovery in the event of a radiological accident at a nuclear power plant. The plan is reviewed and updated annually.

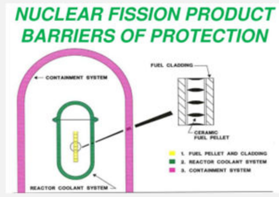
During an evaluated exercise, FEMA/DHS evaluates us according to our plan. As long as we follow our plan and procedures, we can't go wrong! The county EMAs take what is needed from the state plan and put it in their county plan. The county plan is tailored to a county's needs. If you are a county emergency responder, then follow your county plan.

No one agency can handle a radiological emergency alone. We must build and rely on partnerships from the States, Counties, Utilities and Federal agencies.

<u>Contract hospitals for Browns Ferry Off-Site Organization (ORO) Response:</u>
Decatur Morgan Hospital – Main Campus
Decatur Morgan Hospital – Parkway Campus
Huntsville Hospital
<u>Contract EMS Services for Browns Ferry ORO Response:</u>
Greg's Ambulance Service (Lawrence County EMS)
Lifeguard Ambulance Service
First Response Ambulance Service

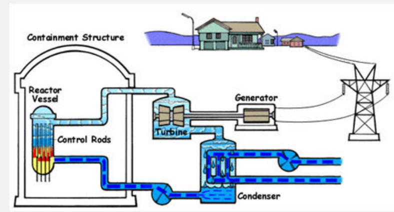
<u>Contract Hospitals for Farley ORO Response:</u>
Southeast Health Medical Center
Flowers Hospital
<u>Contact EMS for Farley ORO Response:</u>
Pilcher's Ambulance (Dothan Ambulance Service)

EMERGENCY CLASSIFICATION LEVELS

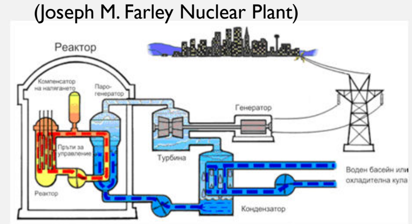


- General Emergency (GE)
- Site Area Emergency (SAE)
- Alert
- Notification of Unusual Event (NOUE)

BWR: Boiling Water Reactor
(Browns Ferry Nuclear Plant)



PWR: Pressurized Water Reactor
(Joseph M. Farley Nuclear Plant)



There are four Emergency Classification Levels (ECL) at all U.S. nuclear power plants. Nuclear power facilities use the ECLs as the method of communicating different types of incidents. Each ECL describes the specific actions that must be completed by both the licensee and the offsite emergency responders. Emergency classifications are declared for events that are occurring or have occurred affecting plant radiation safety or plant security. Each time an ECL is declared or changed, the State Emergency Operations Center (EOC) and/or the Utility (owner of plant) is required to make notifications to the responsible state agency: the Office of Radiation Control (ORC).

Notification of an Unusual Event – The least serious of the four classifications. Events in this class indicate:
•Potential degradation of plant safety
•Security threat to facility protection is initiated
•No release of radioactive material unless plant conditions degrade

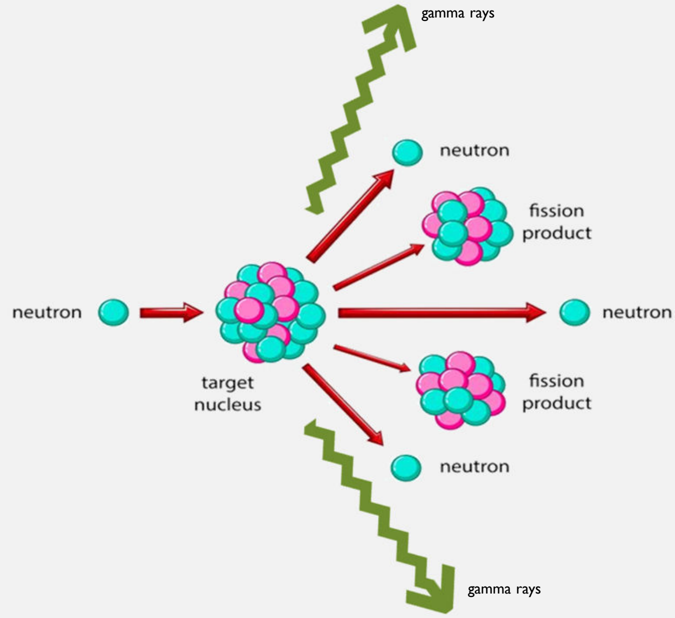
Alert – Events in this class indicate:
•Potential or actual degradation in plant safety
•Lives of onsite personnel may be threatened or site equipment may be damaged due to a hostile action
Prattville's State Radiological Monitoring & Assessment Center (SRMAC) will stand up and monitor the situation closely. This includes watching radiation levels for the pressurized ionization chambers (PICs) installed around both nuclear plants.

Site Area Emergency – Events in this class indicate:
•Actual or likely plant functions failure. Plant functions would be needed to protect the public's health and safety
•Hostile actions that result in an intentional damage to plant personnel or equipment used to protect the public
•Malicious acts that could lead to failure of equipment used to protect the public or could prevent effective access to said equipment used to protect the public
If not already accomplished, Radiation Control will issue two health orders: Public Warning and Restricted Access (of the 2-mile radius of the plant) and will send out radiological field monitoring teams to survey the area. We have state-trained and county-trained radiological field monitoring teams.
If not already accomplished, Radiation Control will move forward to the Decatur SRMAC (beside Morgan County EMA) or the Dothan SRMAC (beside Dothan/Houston County EMA).

General Emergency – Events in this class indicate:
• Actual or imminent significant core degradation or melting.
•There is a potential for loss of containment integrity which may result in radioactive material to the atmosphere.
• Hostile action that results in an actual loss of physical control of the facility
Based on the field measurements, wind speed, wind direction, and status of the plant, Radiation Control could issue evacuation health orders or other health orders that are applicable.

RADIATION

- Radiation
  - **Energy** that travels in the form of **waves** or high-speed **particles**
  - Occurs **naturally** in sunlight and sound waves
  - **Man-made** radiation
    - X-rays
    - Nuclear weapons
    - Nuclear power plants
    - Cancer treatment.



Radiation is a process where energy travels from one point to another by waves or particles, like the waves on the surface of the ocean. Radiation comes in various forms. A good example is the sun. Radiation is used everyday to improve our quality of life, from medical treatments to warming leftovers.

Atoms are the basis for all matter, consisting of a nucleus made up of neutrons, protons, and electrons. Naturally, only certain combinations of protons and neutrons occur. Some are stable and some unstable. Stable nuclei have no excess energy, but unstable nuclei become stable by releasing energy. This releasing energy is commonly called radioactivity. Radiation takes the form of either non-ionizing radiation or ionizing radiation.

REM
(ROENTGEN EQUIVALENT IN MAN)

- A unit of radiation dose equivalent used **to measure the amount of damage to human tissue** caused by all types of ionizing radiation.

1 R ≈ 1 Rad = 1 Rem

1000 mR = 1 R

The REM is the unit of dose equivalence and is the measure which accounts for the varying effects of different types of radiation on the human body. Two other units that are important in the scientific study of radiation are the ROENTGEN and RAD (radiation absorbed dose). But for our purposes, one roentgen equals one rad equals one rem.

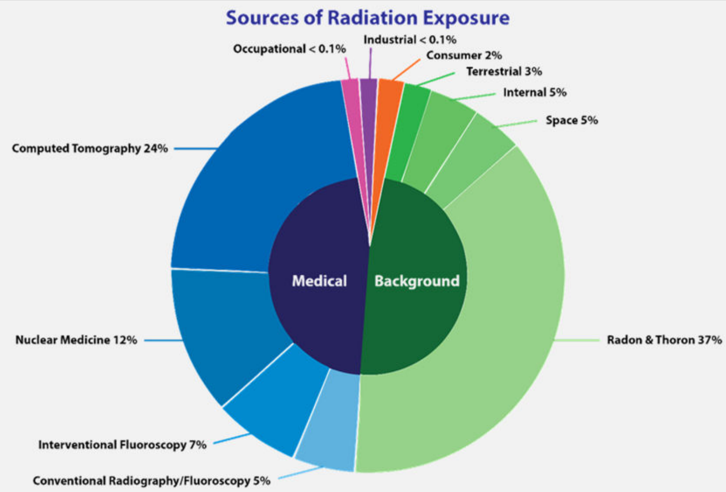
Roentgen **(R)** is a unit of measurement for radiation exposure in air from x-rays or gamma rays.

RAD is an acronym for **R**adiation **A**bsorbed **D**ose. It is a dose unit which is used to describe the amount of radiation absorbed by an object or person.

REM is an acronym for **R**oentgen **E**quivalent in **M**an. It is measurement of the effect of all types of radiation on the human body.

AVERAGE ANNUAL RADIATION EXPOSURE

- **~620 mR/yr**
  - **~310 mR from natural radiation**
  - ~310 mR from man-made radiation
  - <1 mR from nuclear power generation



Average Annual Radiation Dose

Sources	Radon & Thoron	Computed Tomography	Nuclear Medicine	Interventional Fluoroscopy	Space	Conventional Radiography/ Fluoroscopy	Internal	Terrestrial	Consumer	Occupational	Industrial
Units mrem (United States) mSv (International)	228 mrem 2.28 mSv	147 mrem 1.47 mSv	77 mrem 0.77 mSv	43 mrem 0.43 mSv	33 mrem 0.33 mSv	33 mrem 0.33mSv	29 mrem 0.29 mSv	21 mrem 0.21 mSv	13 mrem 0.13 mSv	0.5 mrem 0.005 mSv	0.3 mrem 0.003 mSv

(Source: National Council on Radiation Protection & Measurements, Report No. 160)

Virtually everything emits radiation. Radiation is a natural part of our environment. Radiation is in the air we breathe, the food we eat, the soil, our homes, sunshine, and even our bodies. Radiation is also present in consumer products such as tobacco products, smoke detectors, lantern mantels, and building supplies. The radiation naturally occurring or existing in our environment is called background radiation. The amount of background radiation varies from one location to another. People may also be exposed to radiation through medical procedures (diagnostic & therapy) and dental x-rays.

The health effects of radiation exposure to people are measured in units called millirem. A millirem is $1/1000^{th}$ of a rem. On average, Americans receive a radiation dose of about 620 millirem each year. Half of this dose comes form natural background radiation. Most of this background exposure comes from radon in the air, with smaller amounts from cosmic rays and the Earth itself. The other half (310 millirem) comes from man-made sources of radiation which includes medical, commercial and industrial sources. In general, a yearly dose of 620 millirem from all radiation sources has not been shown to cause humans any harm. Less than 1 millirem comes from nuclear power generation.

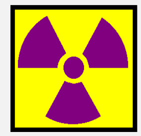
- PET CT = 4,500 millirem
- Cardiac Stress Test with Thallium-201 = 4,070 millirem
- PET Scan for Cancer Staging = 1,410 millirem
- **Protective Action Guide for Nuclear Power Plant Evacuations = 1,000 millirem**
- CT of Abdomen = 800 millirem
- Chest X-ray (posterior/anterior) = 10 millirem
- Abdominal X-ray = 7 millirem
- Panoramic Dental X-ray = 1 millirem

RADIOACTIVE MATERIAL IN ALABAMA

- Nuclear Power Plants

- Medical Uses
- Industrial Uses

- Research



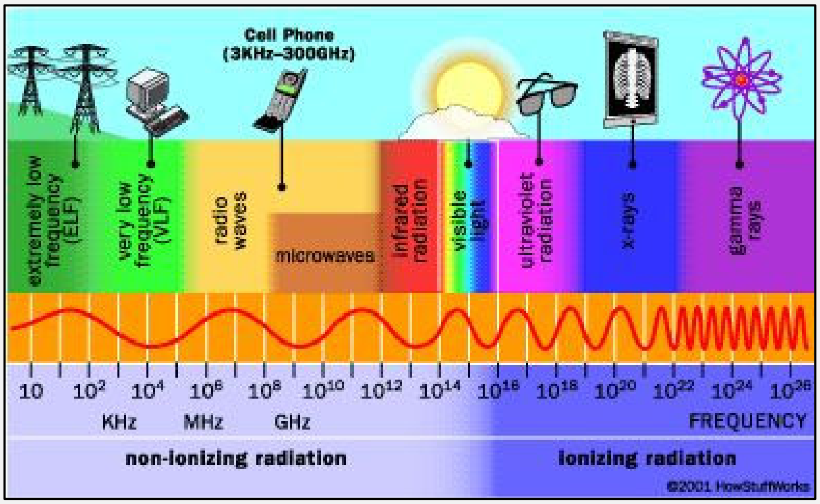
- Naturally Occurring Radioactive Material (NORM)
- Waste Isolation Pilot Plant (WIPP)

In Alabama, we have two nuclear power plants and approximately 400 licensees that are authorized to use radioactive material. The types of licensed uses include medical, industrial and research. We also have naturally occurring radioactive material or (NORM) in the state. In addition, the Department of Energy (DOE) has shipments of low level waste as part of the Waste Isolation Pilot Plant (WIPP) that come down I-59 and I-20.

<u>Nuclear Power Plants</u>: Browns Ferry and Joseph M. Farley
<u>Medical Uses</u>: Medical uses include hospitals, cancer centers, cardiology clinics and nuclear pharmacies.
<u>Industrial Uses</u>: Industrial radiography companies in Alabama use radioactive material to x-ray welds at temporary job sites including paper mills, chemical plants, shipyards, oil and gas pipelines, etc. Well logging companies use radioactive material to help study geological formations. Moisture density gauges are commonly used by highway construction crews at job sites to help determine moisture content and compaction of the soil.
<u>Research</u>: Most of the universities in Alabama have radioactive material licenses for research purposes.
<u>NORM:</u> Naturally Occurring Radioactive Material. In South Alabama around Citronelle or Gilbertown, you will find elevated levels of NORM due to the scale that has accumulated on the gas wells' piping and in the tanks. If it is greater than 50 microR/hr at the surface, we require them to dispose of it through a radioactive waste broker. We have also seen piping from paper mills that had elevated radiation levels caused by kaolin clay used in the process. Kaolin is a white clay found primarily in Alabama and Georgia containing elevated levels of uranium and thorium decay series. In the paper process, it is used to produce high gloss for magazines and beer packaging. Up in Muscle Shoals, there is a giant slag pile with elevated radiation levels that exceed 100 microR/hr due to the byproducts created as part of the National Fertilizer Company in the 1970's. This is under exclusive federal jurisdiction as part of TVA.
<u>WIPP</u>: The WIPP program started in 1999 and its purpose is to secure national defense related transuranic waste below ground in the remote desert of New Mexico. Shipments come through Alabama from Oak Ridge National Lab and Savannah River National Lab. We are notified of these shipments and have computer access to track these shipments via GPS while they travel through Alabama. Transuranic waste is man-made isotopes that are heavier than uranium.

TWO TYPES OF RADIATION

- NON-IONIZING: Radio and TV Waves, Infra-Red, Microwaves, UV-A & UV-B rays
- IONIZING: **Alpha & Beta Particles, Gamma Rays**, X-rays, UV-C rays

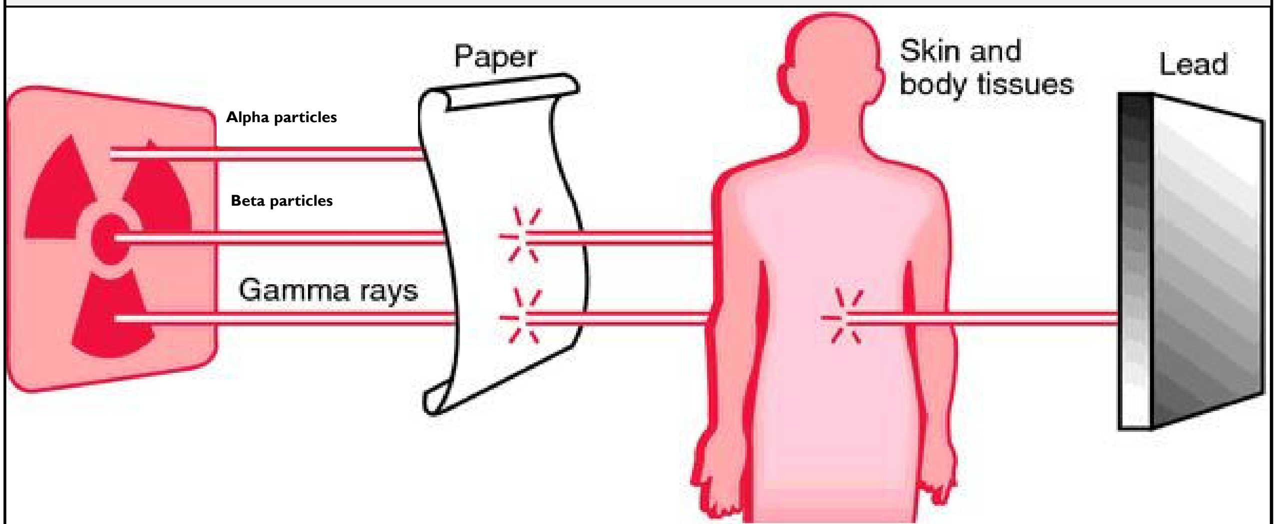


There are two types of radiation: non-ionizing and ionizing.

Non-ionizing radiation has enough energy to cause electrons within atoms to move and vibrate but not enough to remove them from the atom itself. For example, microwave ovens use microwaves to force the electrons in food to move around, thus producing heat and heating the food. However, these electrons do not break away from the atoms of the food. We also come in contact with many types of non-ionizing radiation daily, such as the sun that delivers light and heat. Other examples of non-ionizing radiation include visible light and radar waves.

Ionizing radiation comes in two forms: particulate and waves/rays. Ionizing radiation is more energetic than non-ionizing radiation. Ionizing radiation has enough energy to remove electrons from atoms, thus forming ions. When ionizing radiation passes through material, it deposits enough energy to break molecular bonds and displace (or remove) electrons from atoms, thus creating ions. Ions are electrically charged particles which may cause changes in living cells of plants, animals, and people. These types of radiation are associated with nuclear power plant generation. In nuclear power generation, fission (splitting an atom's nucleus) takes place which results in radiation being produced by splitting an atom's nucleus and may be emitted in three forms: alpha particles, beta particles, and gamma rays.

IONIZING RADIATION



Alpha particle – A positively charged particle emitted from the nucleus of an atom. Alpha particles are charged particles, which are emitted from naturally occurring materials (such as uranium, thorium, and radium) and man-made elements (such as plutonium and americium). Alpha emitters are primarily used (in very small amounts) in items such as smoke detectors.

In general, alpha particles have a very limited ability to penetrate other materials. In other words, these particles of ionizing radiation can be blocked by a sheet of paper, skin, or even a few inches of air. As a result, alpha particles do not usually make anything radioactive. Nonetheless, materials that emit alpha particles are potentially dangerous if they are inhaled or ingested, but external exposure generally does not pose a danger.

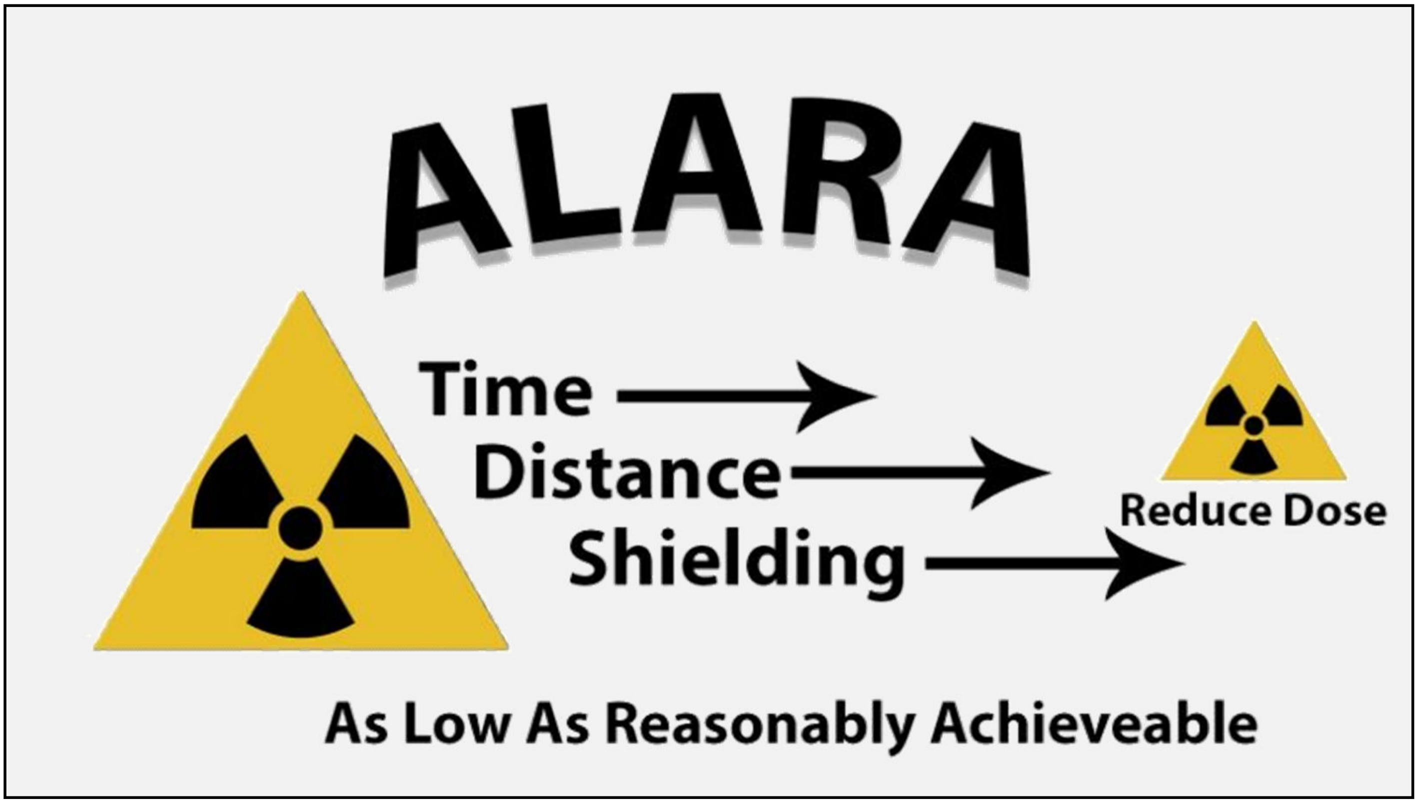
Beta particle – A negatively charged particle emitted from the nucleus of an atom.

In general, beta particles are lighter than alpha particles, and they generally have a greater ability to penetrate other materials. As a result, these particles can travel a few feet in the air, and can penetrate skin. Nonetheless, they can be stopped by several sheets of paper, a thick book, or even a sheet of aluminum or plastic. Beta particles are both an internal and external hazard which can damage the skin and cause second-degree burns and eye damage. Elements with beta emitters can be used for medical purposes, such as treating eye disease.

Gamma ray – A photon originating from the nucleus of an atom. Gamma rays and x-rays consist of high-energy waves that can travel great distances at the speed of light and generally have a great ability to penetrate other materials. For that reason, gamma rays (such as cobalt-60) are often used in medical applications to treat cancer and sterilize medical instruments. Similarly, x-rays are typically used to provide static images of body parts (such as teeth and bones), and are also used in industry to find defects in welds. X-rays and gamma rays have great penetrating power and can easily pass through the human body.

Thick, dense shielding, such as lead, is necessary to protect against gamma rays. The higher the energy of the gamma ray, the thicker the lead must be. X-rays pose a similar challenge, so x-ray technicians often give patients receiving medical or dental X-rays a lead apron to cover other parts of their body. Gamma rays are external and internal hazards.

Gamma rays are an external and internal hazardous.

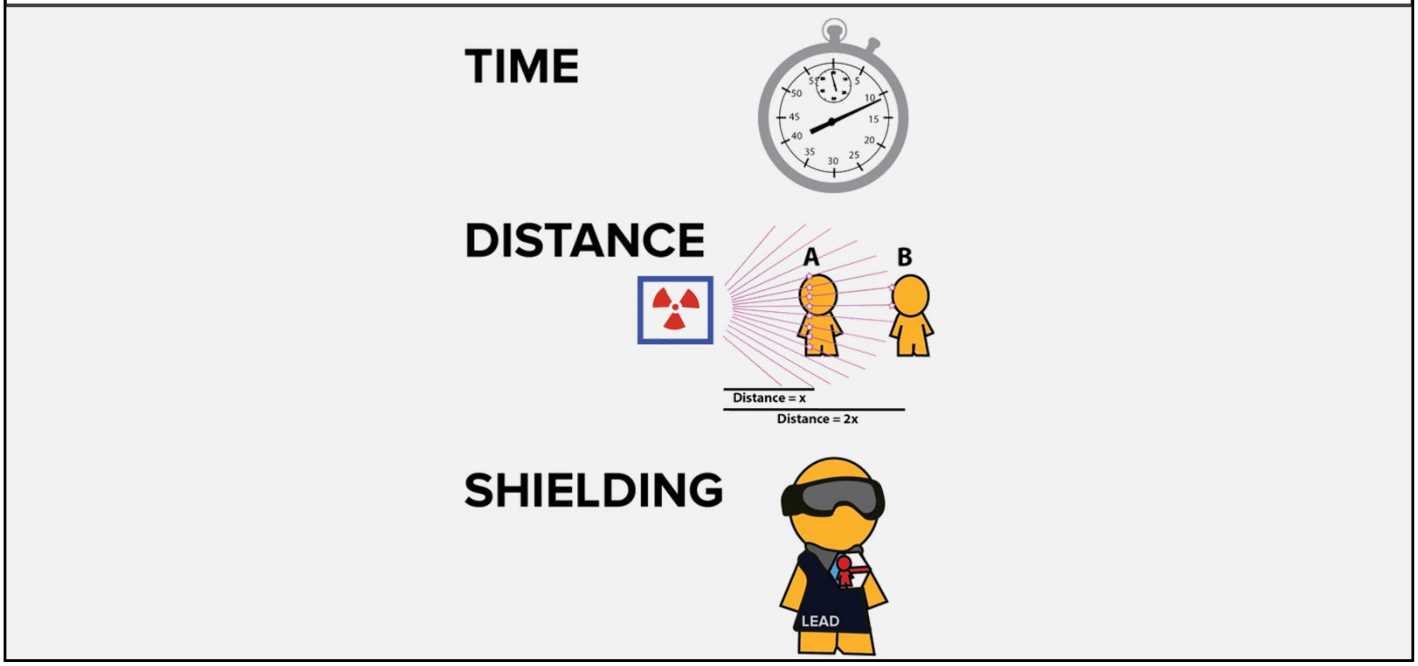


The ALARA philosophy is the foundation for all exposure (dose) limits. ALARA assumes that radiation exposure of any amount is a potential hazard. ALARA means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, thus **A**s **L**ow **A**s **R**easonably **A**chievable.

Do not spend more time than necessary near a radiation source. Stay as far away from a radiation source as you can. Place material between you and the source of radiation.

Use a commonsense approach when dealing with radiation!

CONTROLLING EXPOSURE



We cannot eliminate radiation from our environment. But we can, however, reduce our risk by controlling our exposure to it. Radiation is very easily detected. There are several simple, sensitive instruments capable of detecting minute amounts of radiation from natural and man-made sources. There are three ways in which people can protect themselves from ionizing radiation:

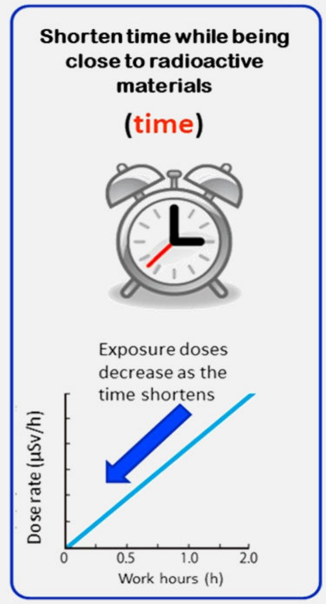
1. Time
2. Distance
3. Shielding

PROTECTION FROM RADIATION: TIME

Less time with ionizing radiation

=

Less radiation exposure



For people who are exposed to radiation, in addition to natural background radiation through their work, the dose is reduced and the risk of illness essentially eliminated by limiting exposure time.

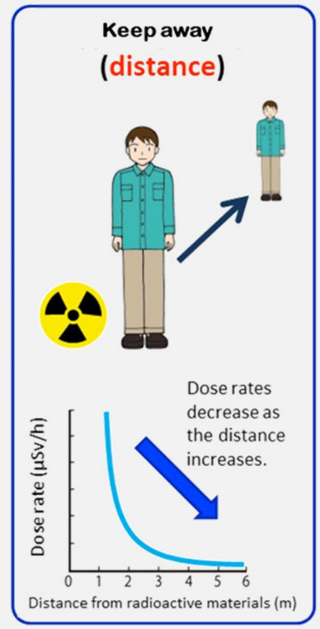
If you decrease the amount of time you spend near the source of radiation, you will decrease the amount of radiation exposure you receive. To imagine this, think of a trip to the beach as a comparison. For instance, if you spend a lot of time on the beach, you will be exposed to the sun, and, ultimately, get a sunburn. If you spend less time in the sun and more time in the shade, your sunburn will be much less severe. This is a comparison of how radiation exposure works.

The less time you spend in a radiation area, the less dose you will receive. Emergency workers will be assigned to work in a radiation area only for the amount of time required to accomplish their particular task.

For example, if you were working in an area where the exposure rate was 50mR/hr and you stayed there for one (1) hour, you would receive a dose of 50 millirem. But if you remained there for only a half an hour (30 minutes), you would receive half the dose or 25 millirem.

PROTECTION FROM RADIATION: DISTANCE

Greater the distance from ionizing radiation = Less radiation exposure



The farther away you are from a source of ionizing radiation, the less dose you will receive. In the same way that heat from a fire is less the farther away you are, the intensity of radiation decreases farther from its source.

Because of the inverse square law ($1/d^2$), each time you double your distance from a point source of radiation, you will receive one-fourth (1/4) of the dose. If you triple the distance from a point source of radiation, you will only receive one-ninth (1/9) of the dose.

Example: If your exposure rate at a distance of one (1) foot from a point source of radiation is 100 mR/hr, then if the distance is doubled to two (2) feet away, then the exposure rate will now only be 25 mR/hr.

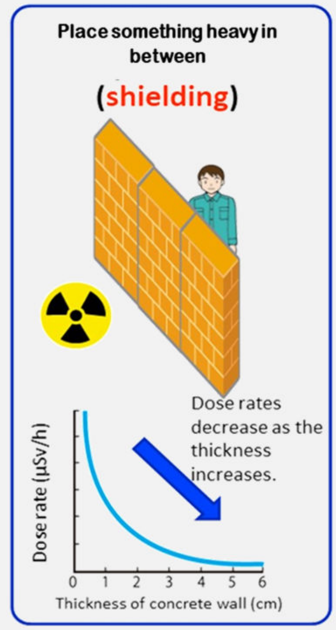
Example: The farther away you are from a radiation source, the less dose you will receive. Compare this to an outdoor concert. You can sit directly in front of a speaker, 50 yards from the stage, or on the grass in the park across the street. If you sit in front of the speaker, you will probably suffer some damage to your hearing. If you sit 50 yards from the stage, you will be exposed to an average amount of music. If you sit in the park across the street, the noise is even further reduced and you might not even hear the concert, or even know what song they are playing.

PROTECTION FROM RADIATION: SHIELDING

Thicker/denser material

=

Less radiation exposure

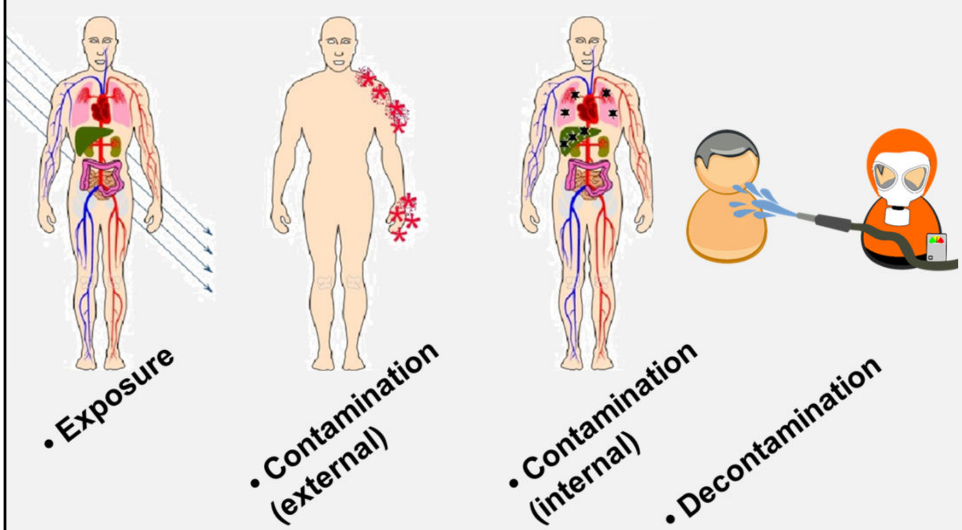


The use of shielding, such as lead, steel, concrete, or earth, between you and a source of radiation will also reduce your exposure. The amount of reduction depends on the type and thickness of the shielding material. Barriers of lead, concrete, or water give good protection from penetrating radiation such as gamma rays. Radioactive materials are therefore often stored or handled underwater, or by remote control in rooms constructed of thick concrete or lined with lead.

If you increase the shielding around a radiation source, it will decrease your exposure. For example, if you stand out in the rain without an umbrella, you will get wet. But, if you use an umbrella to shield you from the rain, you will remain dry and protected. This is similar to the idea of shielding in radiation protection.

So when possible, emergency workers in radiation areas should take advantage of shielding (standing behind buildings, cars, or some other means of shelter) to reduce their exposure. Keep something substantial between you and a point source of radiation. In the event of a radioactive plume, sheltering while the plume passes may be helpful.

EXPOSURE, CONTAMINATION & DECONTAMINATION



- **Radiation** is a type of **energy**
- **Contamination** is a **material**
  - Radioactive contamination emits radiation
- Exposure to radiation will not contaminate you

Radiation exposure is energy that passes through and may do damage but does not contaminate. So when a person is exposed to radiation it does not necessarily mean that the person is contaminated. In order to become contaminated, a person has to be physically in contact with the radioactive material. When radioactive material is where it is not wanted (e.g., on the ground, in water, or on you), we refer to it as "contamination". Contamination is measured in counts per minute (cpm) and disintegrations per minute (dpm).

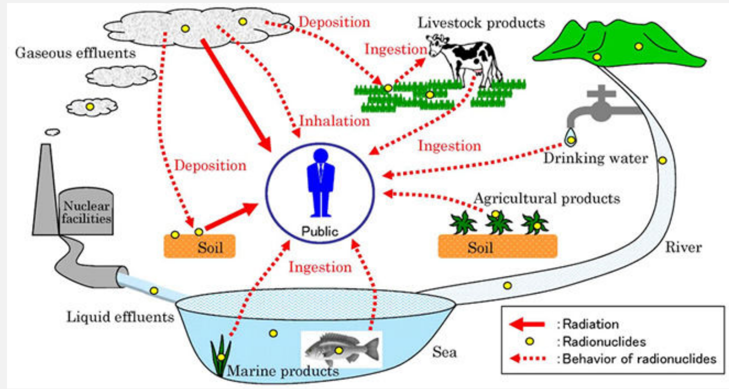
If someone is contaminated (externally), most of the material could be easily removed from the body by removing the clothing and washing with a mild soap and shampoo.

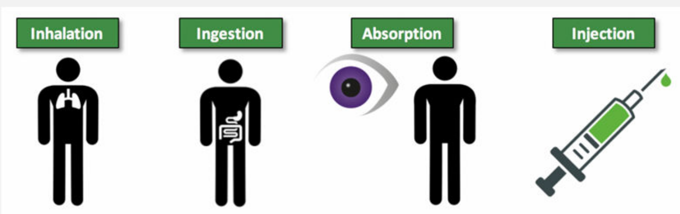
Example: We all go to the dentist and periodically receive an x-ray of our dental work. The energy of the x-ray travels through our tissue and teeth which develops the film to be read by the dentist. The x-ray passed through our teeth but did not physically touch our body in any way. Note: X-rays, CT scans, fluoroscopy, any machine producing radiation does not contaminate the patient.

If a radiological incident or accident occurs at a nuclear power plant in Alabama, the risk counties have procedures in place to open reception centers in order to monitor evacuees and emergency workers for radiation contamination and if needed, decontaminate. At reception centers, the evacuees and/or emergency workers can be decontaminated by gender, which typically takes place at school gymnasiums, recreation centers, or decontamination tents.

RADIATION PATHWAYS

- **Inhalation**
- **Ingestion**
- **Absorption**
- **Injection**





External hazards of radiation dose are beta particles and gamma rays. Beta particles can cause burns to the skin. Gamma rays are very energetic and can penetrate through internal organs.

Internal hazards of radiation dose are alpha particles, beta particles, gamma rays, and neutron particles. Once inside the body, they all become very harmful internal hazards. Radiological materials may enter the body by ingestion, by inhalation, by absorption through the skin, or by injection through a cut or break in the skin, such as a wound.

- Inhalation – a major route of entry; either exhaled or deposited in the respiratory tract. If deposited, damage can occur through direct contact with tissue or may diffuse into the blood through the lung-blood interface. Substances absorbed into the blood are circulated and distributed to organs that have an affinity for that radioactive element. Health effects can then occur in the organs.
- Ingestion –inadvertently gets into the mouth and is swallowed; can be absorbed through the lining of the gastrointestinal tract and then transported by the blood to internal organs.
    - DIRECT: in the plume drinking contaminated water
    - INDIRECT: eating meat from cattle that have fed on contaminated grass
- Injection: Substances may enter the body if
- Absorption – Skin (dermal) contact is the method of absorption into the body; can also cross the skin barrier and be absorbed into the blood system, producing systemic damage to internal organs; eyes are particularly sensitive to absorption.
- Injection – Substances may enter the body if the skin is penetrated or punctured by contaminated objects. Effects can then occur as the substance is circulated in the blood and deposited in the target organs. Open wounds can also be a sources for injection.

Examples:
inhalation of airborne contaminants such as radon
ingestion of contaminated food or liquids
absorption of vapors such as tritium oxide through the skin
injection of medical radioisotopes such as technetium-99m

AVOID RADIOACTIVE CONTAMINATION

Do not:

- Eat
- Drink
- Smoke
- Chew/Dip
- Apply lip balm
- Apply makeup

Use PPE while on the scene of an incident involving radioactive material.

Contamination occurs when an individual comes in contact with radioactive material. This may be external, internal, or a combination of the two.

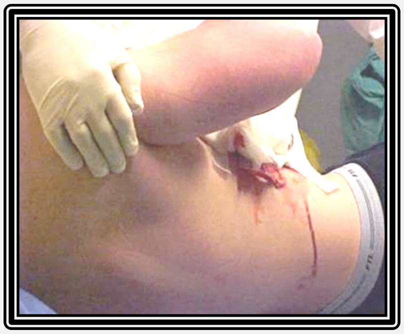
When people walk through, touch, or have radioactive material spill or fall upon them, they are **externally contaminated**. The contamination causes exposure because the radioactive material is deposited on the person's body and/or clothing. Removing the clothing and showering with a mild soap will probably remove the external contamination. In stubborn cases, a second shower may be required.

A trained person with a survey instrument will be able to detect contamination on an individual and will be able to decontaminate them externally.

CONTAMINATED INJURED

In all cases…

the treatment of an injury takes priority over decontamination!!!



Saving lives

>>>

Decontamination Protocols

A contaminated individual may have also sustained a physical injury. In all cases, the treatment of an injury takes priority over decontamination.

Contamination is nothing more than a nuisance. Injuries come first, and decontamination comes second.

RADIATION & OUR FIVE SENSES

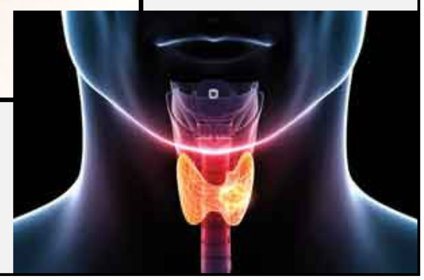
- We are aware of our environment through our five senses.
- You must rely on instruments to detect the presence of radiation.

Ionizing radiation cannot be detected by our five (5) senses. We **<u>cannot</u>** feel, taste, smell, see, or hear radiation. The safety of emergency responders is the most important consideration when responding to a radiological incident. Safety is accomplished by the use of radiological instruments which help the first responder detect, measure, and document the amount of radiation in a radiological response. Therefore, we must use radiation detection instruments such as pocket dosimeters and other equipment to know if, when, and how much radiation is present.

You must learn to read the instruments properly because the instruments will let you know if radiation is present. You have to rely on them.

KI (POTASSIUM IODIDE)

- Thyroid Blocking Agent
- Fills the thyroid gland with non-radioactive iodine
- Helps radioactive iodine from being absorbed into the thyroid
- Adult dosage: 130 mg/day
  - Effective for 24 hours
- Distributed at the Emergency Worker Station & the Community Reception Center by an ADPH nurse who is KI-trained

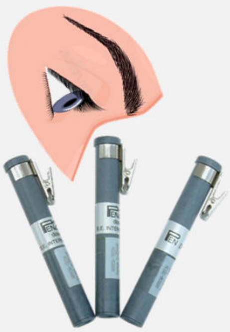


In a radiation emergency at a nuclear power plant, radioactive iodine in the form of I-131 may be released into the air. Potassium Iodide can help prevent radioactive iodine from being absorbed into your thyroid.

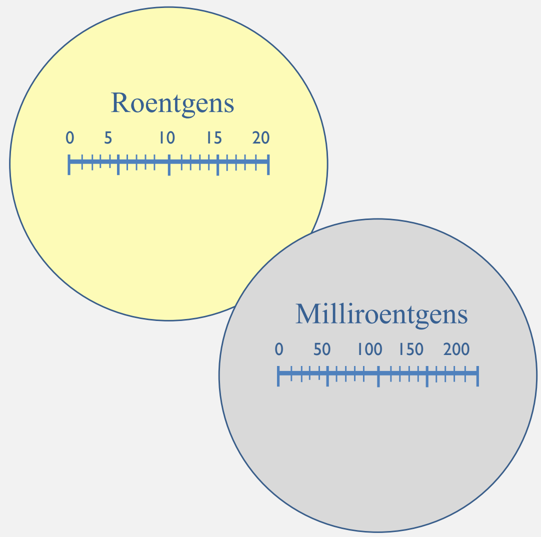
All radioactive material targets different parts of our bodies. Some are organ seekers, bone seekers, blood seekers, etc.. Radioactive iodine is a thyroid seeker. Our thyroid gland works like a sponge. We're going to fill the thyroid gland up with nonradioactive iodine in the form of KI (Potassium Iodide). So if radioactive iodine happens to be breathed in, the thyroid gland is already full and would not accept much more, if any. So the radioactive iodine would be excreted from your body with minimal damage.

When there is a need for Potassium Iodide, KI will be made available to you. Potassium Iodide is stockpiled at the county health departments (Houston, Henry, Morgan, Lawrence, Lauderdale, and Limestone) in the possession of the county health nurse. If you are told to take KI, take 1 dose for every 24 hours (Daily dose = (1) 130 mg tablet or (2) 65 mg tablets) you are exposed to radioactive iodine. Do not take more often and do not take this drug if you know you are allergic to iodine.

POCKET DOSIMETERS



- Look through the dosimeter toward a light source



The Direct-Read Dosimeters (DRD) are designed to measure gamma radiation and x-rays. The DRD is a pencil-shaped tube with an eyepiece at the clip end and an ion-chamber equipped with a charging pin at the opposite end. Dosimeters are fairly accurate, rugged, and can be read directly by the user. Direct-Read Dosimeters give the advantage of immediately knowing the amount of gamma radiation that the wearer has been exposed to. DRDs are not expensive and are fairly easy to use.

The pocket dosimeter is read by pointing it toward a good source of light and viewing the scale and hairline through the lens at the clip end of the dosimeter. When reading pocket dosimeters, always keep the scale in the horizontal position to ensure an accurate reading.

If the dosimeter is exposed to radiation, the hairline will move along the scale to indicate the amount of exposure.

While performing the tasks of an emergency worker, **read your dosimeter *at least* every 30 minutes.** Record the beginning and ending dosimeter readings on the Radiation Exposure Record. The difference between the beginning and the ending is your exposure.

RADIATION EXPOSURE

- Dosimeter = Odometer
  - It doesn't go back down once it goes up.
- *Can* be used by anyone else after it is zeroed.
- Accumulated Exposure

Emergency workers measure their radiation exposure with a pocket dosimeter/direct-read dosimeter (DRD). Pocket dosimeters are a piece of equipment which can be read immediately by the wearer. Radiation exposure is measured in Roentgen (R) and Milliroentgen (mR). The pocket dosimeter will let you read how much dose you have received.

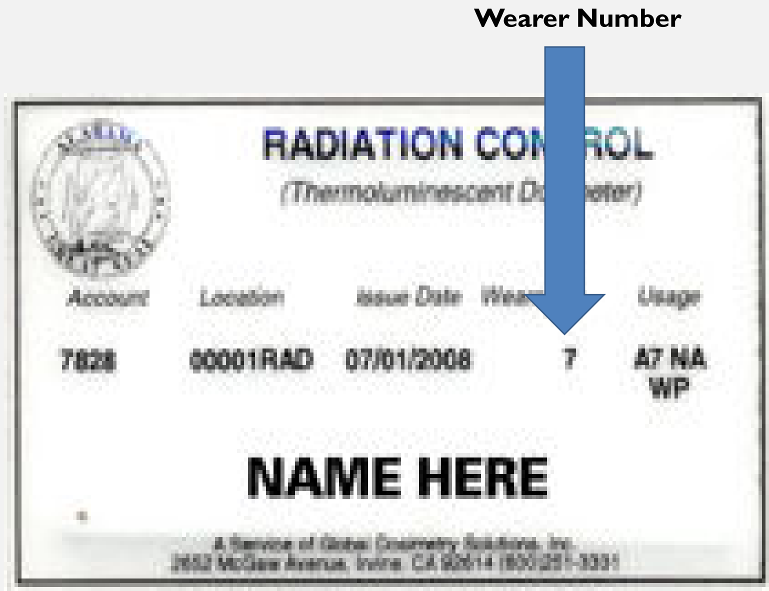
Pocket dosimeters are similar to odometers. The accumulated exposure recorded on a dosimeter can be compared to the accumulated distance on an odometer.

All emergency workers working in a radiation field will be issued two (2) pocket dosimeters. One (1) low-range dosimeter reading in 0-200 mR and one (1) high-range dosimeter reading in either 0-20 R or 0-5 R.

If your DRD is dropped (consider it contaminated) and the needle is no longer visible, then use the reporting levels from your team member. The use of another team member's DRD reading is considered Group Dosimetry.

THERMOLUMINESCENT DOSIMETER

- Records radiation dose for legal/permanent exposure records
- *<u>Can</u>* *<u>not</u>* be used by anyone else once issued
- Results not immediately available



The thermoluminescent dosimeter (TLD) is a laminated wallet-sized card which provides a permanent record of the wearer's dose. TLDs are extremely accurate and will give the exact amount of exposure. The TLD card serves as your legal/permanent record to radiation.

TLD cards are so precise, they will give the exact amount of dose from radiation. TLDs contain two (2) lithium fluoride chips which absorb and store the energy received from exposure to radiation. Unlike the pocket dosimeters, TLD cards **<u>cannot</u>** be read directly by the user. When you complete your emergency worker duties, you will turn the TLD card in, your TLD will be sent off to be read, and you will be notified of your dose.

<u>Remember:</u> the thermoluminescent dosimeter serves as your legal/permanent record.

PLACEMENT OF THE TLD & POCKET DOSIMETER

TLD

Pencil/Pocket

TLDs and pocket dosimeters should be placed between the shoulder and the waist (preferably on the chest area).

Since TLDs cannot be read by the wearer, TLDs should be placed on street clothes or under protective clothing.

Pocket dosimeters need to be placed on the outside of the clothing whether it’s street clothing or protective clothing so they can easily be accessible when reading and reporting at predetermined time intervals (i.e. at least every 30 minutes).

TEDE
(**T**OTAL **E**FFECTIVE **D**OSE **E**QUIVALENT)

- Total Dose = *External* + *Internal*
  - ***External*** = Pocket Dosimeter Reading
  - ***External*** = ***Internal***
  - Therefore…
- ***TEDE = 2 x Pocket Dosimeter Reading***

In Alabama, the administrative limit is stated in terms of the external dose, which is measured by a pocket dosimeter. To account for the internal dose, which cannot be measured prior to or during a mission, the internal dose is assumed to be equal to the external dose. The two doses (internal & external) added together is the Total Dose or TEDE. In Alabama, twice (2x) the pocket dosimeter reading is recorded as a person's TEDE.

RADIATION DOSAGE LIMITS FOR EMERGENCY WORKERS AND PERSONNEL & EQUIPMENT MONITORS

EMERGENCY WORKERS (EW)
PERSONNEL/EQUIPMENT MONITORS (PEM)

Radiation Dosage Limits

TEDE (Total Effective Dose Equivalent)

EW: Protecting Property, Patrolling Evacuated Areas, and Manning Check Points
PEM: Monitoring evacuees/EWs and equipment for radiation contamination.

	TEDE	Dosimeter
Seek Relief	200 mrem	100 mR
Daily Maximum	1 rem	500 mR
MAXIMUM for ACCIDENT	5 rem	2.5 R
Evacuating Known Residents	10 rem	5 R
Fighting Residence Fires	10 rem	5 R
Life Saving	25 rem	12.5 R

Alabama Radiation Control

https://bit.ly/ADPHgreencard

Although emergency workers are not expected to be exposed to significant levels of radiation, the dosimeter reading values are shown in the right hand column. The administrative limit for emergency workers in Alabama is set at one-half of the EPA-recommended limits. This table shows the dosimeter readings that will most likely keep the TEDE (Total Dose) from exceeding the EPA limit. Do not exceed the limits in the right hand column, and you will not exceed your TEDE (Total Dose).

The green wallet size card is for Emergency Workers (EWs) <u>and</u> Personnel & Equipment Monitors (PEMs). The 6 radiation dose limits apply to all EWs and PEMS.

EWs and PEMs are instructed to seek relief at 100 mR on their dosimeter. Do not wait until the dosimeter is on 100 mR before you request relief. Remember, you are recording your dosimeters at least every 30 minutes. Call to request relief when your dosimeter approaches 100 mR; this gives your replacement ample time to travel to your destination to relieve you.

- Remember 100 mR on dosimeter (external) + 100 millirem (internal) = 200 mrem TEDE.
- Which dosimeter would you be reading? Answer: Low-range (black or silver)

EWs and PEMs are allowed to receive 1 rem per day TEDE; your dosimeter would be reading 500 mR.

- 500 mR on dosimeter (external) + 500 millirem (internal) = 1000 mrem = 1 rem TEDE.
- Which dosimeter would you be reading? High-range (yellow)

EWs and PEMs are allowed to receive 5 rem maximum per accident TEDE; your dosimeter would be reading 2.5 R.

- 2.5 R on dosimeter (external) + 2.5 rem (internal) = 5 rem TEDE.
- Which dosimeter would you be reading? High Range (yellow)

The Annual Occupational Limit (AOL) for individuals who work in the radiation area are allowed to receive 5 rem per/year TEDE.

Additional radiation dosage limits for EWs and PEMs: one could receive up to 25 rem TEDE for life saving situations. At that point your dosimeter should be reading 12.5 R. 12.5 R on dosimeter (external) + 12.5 rem (internal) = 25 rem TEDE.

REMINDERS FOR EMERGENCY WORKERS AND PERSONNEL & EQUIPMENT MONITORS

FOR EWs and PEMs

-All emergency workers are advised to make a reasonable effort to limit their total dose, while at the same time accomplishing their emergency responsibilities.
-Read dosimeters and record at least every 30 minutes.
-Do not take Potassium Iodide (KI) until instructed by your county EMA.
-Control your exposure to radiation by your time, distance and shielding.

FOR PEMs ONLY

-Contamination level in Alabama is (2x) twice background (open window) and will warrant decontamination.
-Monitoring technique: 1 inch away and move 1-2 inches per second.
-On lowest scale (x0.1), the Ludlum 14C meter scale will read 0-600 cpm.
-Do a response check and calibration verification, cover probe, and obtain background.
-Use CPM scale when monitoring for contamination.

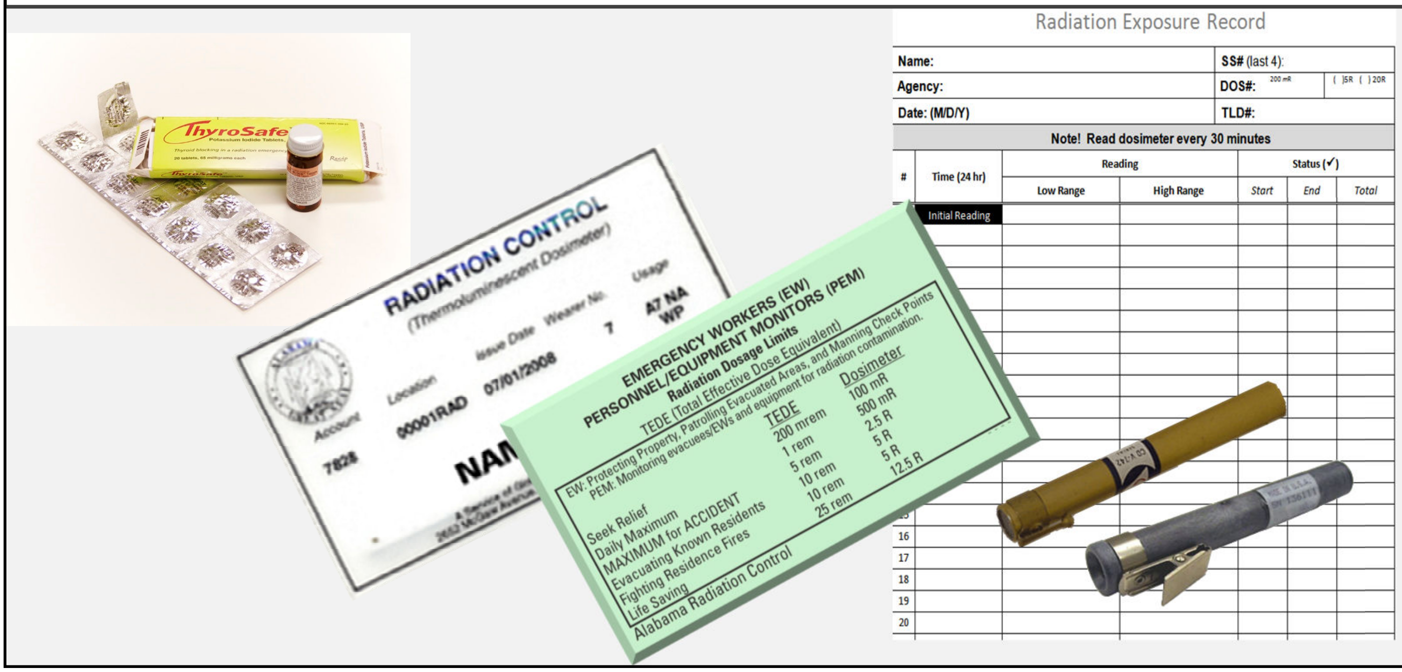
Alabama Radiation Control

https://bit.ly/ADPHgreencard

The back of the green wallet size card shows key reminders for both EWs and PEMs *as well as* key reminders for just PEMs.

Remember – You can carry/have the green wallet-sized card at all times. This green card lists all your limits and keynotes since you may not have access to the manual.

EMERGENCY WORKER EQUIPMENT



1. KI tablet
   a. When do you take the KI? (when your county EMA has instructed you to)
   b. How often and how many should you take? (one (1) 130 mg tablet or two (2) 65 mg tablets every 24 hours as needed)
   c. Who should not take KI? (a person who has a known medical history to iodine)
2. Thermoluminescent Dosimeter (TLD Card)
   a. Can you read a TLD card? (No)
   b. What does the TLD card serve as? (Your legal permanent record)
3. Two Pocket Dosimeters. One low-range and one high-range.
   a. By color, which is the high range? (Yellow)
   b. What units are used by the high range dosimeter? (0-20 Roentgen) or (0-5 Roentgen)
   c. How often would you check and record your dosimeters? (at least every 30 minutes; Read 15 minutes in > 1 mR/hr field or every 30 minutes < 1 mR/hr field)
   d. What is your seek relief limit measurement on your dosimeter? (100 milliroentgen)
   e. Which dosimeter would you be reading to begin with? (Black or Silver - Low range, 0-200 milliroentgen)
4. Record your pocket dosimeter readings on the Radiation Exposure Record.

Radiation Exposure Record

Name:	SS# (last 4):	
Agency:	DOS#: 200 mR	( )5R ( )20R
Date: (MM/DD/YY)	TLD#:	
Note! Read dosimeter at least every 30 minutes	06/2019	

#	Time (24 hr)	Reading		Status (✓)		
		Low Range (mR)	High Range (R)	*Start*	*End*	*Total*
1	Initial Reading					
2						
3						
4						
5						
6						
25						

Signature: ______________________ Date: ___/___/___

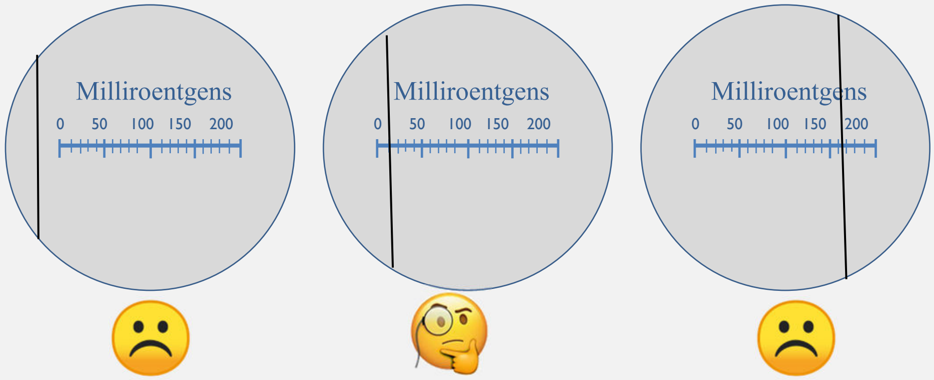
Last Revised: June 7, 2019

Radiation Equipment Distribution Log

#	Date (MM/DD/YY):	Name:
	SS# (last 4):	Agency:

Dosimeter(s)				TLD Card
Low (200 mR) #:		High ( )5R ( )20 R #:		#:
Initial Reading	End Reading	Initial Reading	End Reading	

Dosimeter(s)				TLD Card
Low (200 mR) #:		High ( )5R ( )20 R #:		
		Initial Reading	End Reading	



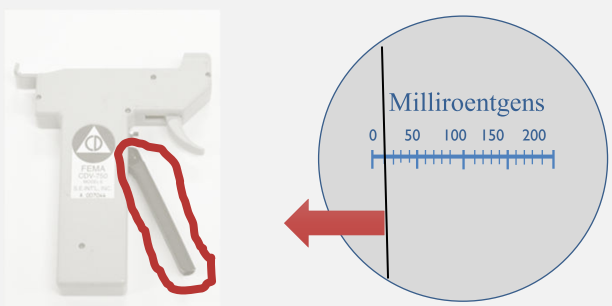
Reload dosimeter onto charger if:

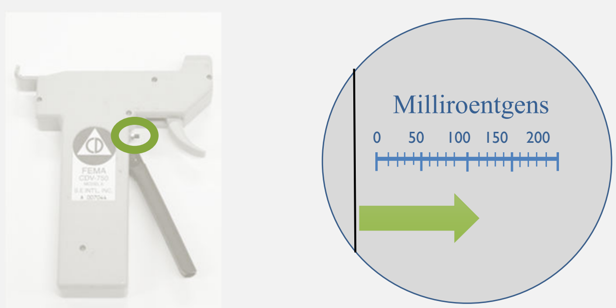
1. Filament won't move/appear
2. Filament "floats" (keeps on moving while on the charger

Get a new dosimeter (or charger) if above cannot be resolved

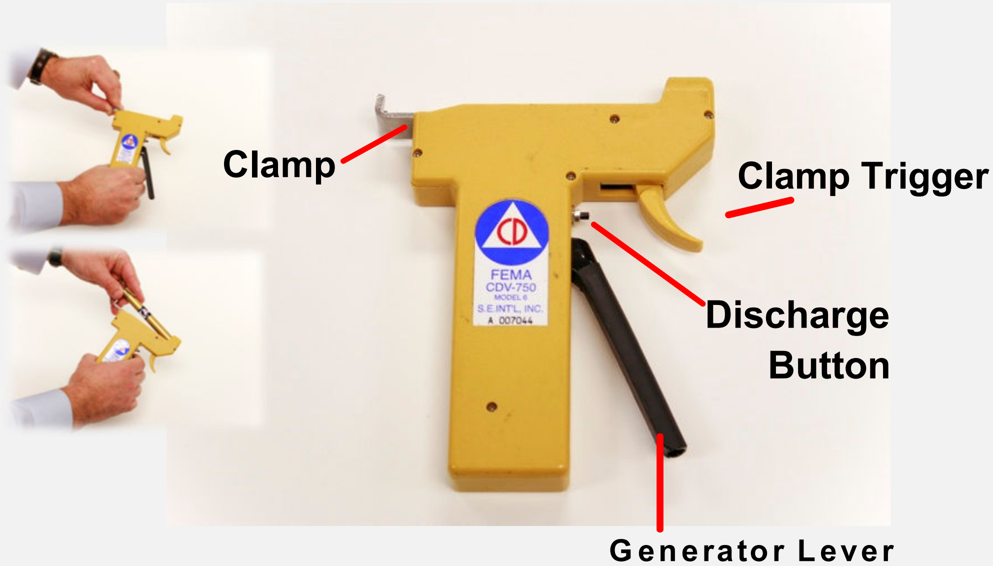
Get a new dosimeter if

1. The filament still moves when off of the charger





CDV-750 DOSIMETER CHARGER



The dosimeter charger is used to charge or zero the pocket dosimeters with different lengths and ranges. The charger provides 200 volts to the direct-read dosimeter that moves the hairline down to zero.

Instructions on using the CDV-750 dosimeter charger:

1. Adjust the clamp to fit the length of the dosimeter.
2. Pull the clamp trigger back and insert the dosimeter with the clip toward the back. The dosimeter must have a snug fit. Make sure the scale of the dosimeter is horizontal.
3. Look to see if there is a hairline. If there is a hairline, pump the black generator lever to "charge" or zero the dosimeter. If you don't have a hairline, then give the generator lever a few slow pumps, and the hairline will appear on the right hand side. Continue pumping the generator lever until the hairline is on zero.
4. If the hairline falls below zero, press the black discharge button to bring the hairline back to zero.
5. To remove the dosimeter from the charger, squeeze the clamp trigger and lift the dosimeter above the end of the clamp, pulling it straight back to disengage it from the charging contact.
6. Once removed from the charger, read the dosimeter to ensure that the hairline has remained on the zero reading. It may be necessary to re-zero the dosimeter.

EW FEEDBACK

https://bit.ly/orcewfeedback

1. KEEP book
2. KEEP green card
3. Turn in TLD
4. Turn in dosimeters
5. Turn in chargers

- END OF EMERGENCY WORKER TRAINING -

JUST IN TIME VIDEOS

- Pocket Dosimeter Zeroing: Using CDV-730 Charger (quick overview)
  - **https://youtu.be/0yxneFuqDQE**
- Pocket Dosimeter: Usage of Low & High Range Dosimeters
  - **https://youtu.be/Nez1_pi_8z4**
  - **Note:** Although many protocols in the video are in line with ADPH protocols, always follow ADPH protocols

GLOSSARY

- **ALPHA RADIATION** – A positively charged particle emitted from the nucleus of a radioactive element. It has a low penetrating power and has a short range - a few inches. Alpha particles are not an external hazard but are extremely hazardous when introduced into the body.
- **ALARA** – An acronym for As Low As Reasonably Achievable. An approach to radiation protection to control or manage exposures as low as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit but a process to keep dose levels as far below applicable limits as reasonably achievable.
- **BACKGROUND RADIATION** – The radiation in the natural environment, including cosmic rays and radiation from the naturally radioactive elements, both outside and inside the bodies of humans and animals. It is also called natural radiation. The average individual exposure from background radiation is 620 millirem per year.
- **BETA RADIATION** – A negatively charged particle emitted from the nucleus during radioactive decay. It has a medium penetrating power and a range of up to a few feet. Large amounts of beta radiation may cause skin reddening, and are harmful if they enter the body. Beta radiation is an external and internal hazard.
- **CONTAMINATION** – The deposition of unwanted radioactive material on the surface of structures, areas, objects, or personnel. Radioactive material in a location where it is unwanted.
- **CPM** – An acronym for counts per minute and is associated with contamination surveys. The pancake probe (44-9) with the Ludlum 14C is used when detecting for contamination.
- **DECONTAMINATION** – The reduction or removal of radioactive material from a location where it is unwanted.
- **DOSIMETER** – A portable instrument or device used for measuring and registering the total accumulated exposure to ionizing radiation. Examples are pocket dosimeter, TLD or film badge.
- **EMERGENCY CLASSIFICATION Levels** – 1. Notification of an Unusual Event (NOUE), 2. Alert, 3. Site Area Emergency, 4. General Emergency.

GLOSSARY

- **EMERGENCY WORKER** – An individual performing duties to protect the health and safety of the public during a radiological emergency (e.g., firemen, school bus driver, police, highway personnel, medical personnel, etc.)
- **EXPOSURE** – The absorption of radiation or ingestion of a radionuclide.
- **EXPOSURE RATE** – The measure of radiation by a device (survey meter) over some time period, usually an hour.
- **GAMMA RADIATION** – A high energy photon emitted from the nucleus of an atom. It has the most penetrating power and a range of up to hundreds of feet. Gamma rays will penetrate the internal organs; therefore, they are an internal and external hazard.
- **GEIGER-MUELLER COUNTER** – A radiation detection and measuring instrument. It consists of a gas-filled tube containing electrodes, between which there is an electrical voltage but no current flowing. When ionizing radiation passes through a tube, a short intense pulse of current passes from the negative electrode to the positive electrode and is measured or counted. The number of pulses per second measures the intensity of radiation.
- **ION** – An atom that has too many or too few electrons, causing it to be chemically active; an electron that is not associated (in orbit) with a nucleus.
- **IONIZING RADIATION** – Any radiation capable of displacing electrons from atoms, thereby producing ions. Examples: alpha, beta, gamma, x-rays, neutrons and ultraviolet light. High doses of ionizing radiation may produce severe skin or tissue damage.
- **INVERSE SQUARE LAW** – The law states the gamma rays intensity is inversely proportional to the square of the distance from a point source. Therefore, doubling the distance from a point source of gamma radiation decreases the exposure rate to one-fourth (1/4) the original exposure rate.

GLOSSARY

- **IONIZATION** – The process of adding one or more electrons to, or removing one or more electrons from, atoms or molecules, thereby creating ions. High temperatures, electrical discharges, or nuclear radiation can cause ionization.
- **LITHIUM FLUORIDE** – A chemical compound used in thermoluminescent dosimeters.
- **KCPM** – An acronym for kilo counts per minute (thousands of counts per minute).
- **MILLI** – A prefix meaning one-thousandth (1/1000) or divides a basic unit by 1000. For example, millirem is one-thousandth part of a rem)
- **PERSONNEL MONITORING EQUIPMENT**– Devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), and pocket dosimeters.
- **POTASSIUM IODIDE (KI)** – A chemical form of stable iodine that can be used by the body to block absorption of radioiodine by the thyroid gland.
- **RAD** – An acronym for Radiation Absorbed Dose . The special unit of absorbed dose. One (1) rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram (0.01 gray).
- **RADIATION** – Is energy in the form of rays or high-speed particles. Radiation occurs naturally as in sunlight. Radiation is also manmade in the form of x-rays, medical treatments, nuclear weapons, and commercial nuclear power facilities. All forms of electromagnetic radiation make up the electromagnetic spectrum.
- **RADIOACTIVE MATERIAL** – Any material which spontaneously emits particle or photon radiation in an effort to expend excess energy.
- **RADIOACTIVITY** – The spontaneous emission of radiation, generally alpha or beta particle often accompanied by gamma rays from the nucleus of an unstable isotope.

GLOSSARY

- **RCA** – An acronym for Radiation Control Agency.
- **REM** – Roentgen Equivalent in Man. The special unit of dose equivalent in man. It is measurement of the effect of all types of radiation on the human body.
- **ROENTGEN (R)**– A unit of exposure to ionizing radiation in air. It is radiation effect in air from x-rays or gamma rays.
- **SHIELDING** – Any material or obstruction that absorbs radiation and thus tends to protect personnel or material from the effects of ionizing radiation
- **SURVEY METER** – Any portable radiation detection instrument adapted for inspecting an area to establish the existence and amount of radioactive material present.
- **TEDE** – An acronym for Total Effective Dose Equivalent. Total Dose = External Dose + Internal Dose.
- **THERMOLUMINISCENT DOSIMETER (TLD)** – An extremely accurate device used to measure and provide a permanent record of exposure to radiation.
- **X-RAY** – A photon originating from the electron cloud rather that from the nucleus of an atom. One form of electromagnetic radiation. It has penetrating power like gamma radiation. X-rays will penetrate the internal organs; therefore, they are an internal and external hazard.

Appendix A: Abbreviations and Acronyms Used in the REP Program

A-Team Advisory Team for Environment, Food, and Health

AAM After-Action Meeting

AAR After-Action Report

ACP access control point

AHJ Authority Having Jurisdiction

ALARA as low as reasonably achievable

ALC Annual Letter of Certification

ANS alert and notification system

ANSI American National Standards Institute

ARC American Red Cross

CDC U.S. Centers for Disease Control and Prevention

C&O Concepts and Objectives (meeting)

C/E Controller and Evaluator

cfm cubic feet per minute

CFR Code of Federal Regulations

Ci curie

CNS central nervous system

COL combined license

CPG Comprehensive Preparedness Guide

cpm counts per minute

CRCPD Conference of Radiation Control Program Directors

Cs cesium

DHS U.S. Department of Homeland Security

DIL derived intervention level

DIR disaster-initiated review

DOC U.S. Department of Commerce

DOD U.S. Department of Defense

DOE U.S. Department of Energy

DOT U.S. Department of Transportation

DRD direct-reading dosimeter

DRL derived response level

EAL emergency action level

EAS Emergency Alert System [formerly Emergency Broadcast System (EBS)]

EBS Emergency Broadcast System [replaced by the Emergency Alert System (EAS)]

ECCS emergency core cooling system

ECL emergency classification level

ED exercise day

EEG Exercise Evaluation Guide

EMS emergency medical services

EOC emergency operations center (state, local, or tribal government)

EOF emergency operations facility (licensee)

EP emergency preparedness

EPA U.S. Environmental Protection Agency

EPZ emergency planning zone

ERDS Emergency Response Data System

ERO emergency response organization

ESP early site permit

ETE evacuation time estimate

ExPlan Exercise Plan

FBI Federal Bureau of Investigation

FCC U.S. Federal Communications Commission

FDA U.S. Food and Drug Administration

FEMA Federal Emergency Management Agency

FIOP Federal Interagency Operational Plan

FMT field monitoring team

FNSS functional needs support services

FPM Final Planning Meeting

FRMAC Federal Radiological Monitoring and Assessment Center

FRPCC Federal Radiological Preparedness Coordinating Committee

FSAR Final Safety Analysis Report

GE General Emergency

GIS	geographic information system
GM	Guidance Memorandum
G-M	Geiger-Mueller (detector)
GPS	global positioning system
Gy	gray
HAB	hostile action-based
HAZMAT	hazardous materials
HEPA	high-efficiency particulate air (filters)
HHS	U.S. Department of Health and Human Services
HP	health physicist
HPT	health physics technician
HSEEP	Homeland Security Exercise and Evaluation Program
HSPD	Homeland Security Presidential Directive
I	iodine
I&C	Instrumentation and Control
ICP	Incident Command Post
ICS	Incident Command System
IP	Improvement Plan
IPAWS	Integrated Public Alert and Warning System
IPM	Initial Planning Meeting
JIC	joint information center
JIS	joint information system
KI	potassium iodide
LOA	letter of agreement
MDL	minimum detection limits
MOU	memorandum of understanding
MPM	Midterm Planning Meeting
MSEL	Master Scenario Events List
μ	micro
μCi	microcuries
μR	microRoentgen
NAWAS	National Warning System
NEI	Nuclear Energy Institute
NEP	National Exercise Program
NGO	non-governmental organization
NIMS	National Incident Management System
NIST	National Institute of Standards and Technology
NNSA	National Nuclear Security Administration
NOAA	National Oceanic and Atmospheric Administration
NOUE	Notification of Unusual Event
NPD	National Preparedness Directorate
NPG	National Preparedness Goal
NPP	nuclear power plant
NPS	National Preparedness System
NRC	U.S. Nuclear Regulatory Commission
NRF	National Response Framework
NRIA	Nuclear/Radiological Incident Annex
NRT	National Response Team
NVLAP	National Voluntary Laboratory Accreditation Program
NWS	National Weather Service
OCC	Office of the Chief Counsel (FEMA)
OJT	on-the-job training
ORO	offsite response organization
OSC	Operational Support Center
OSHA	U.S. Occupational Safety and Health Administration
OSLD	optically stimulated luminescence dosimeter
PAD	protective action decision
PAG	protective action guide
PAR	protective action recommendation
PCA	Preliminary Capabilities Assessment
PII	personally identifiable information
PIO	Public Information Officer
PKEMRA	Post-Katrina Emergency Management Reform Act
PPD	Presidential Policy Directive
PPE	personal protective equipment
PRD	permanent record dosimeter
Pu	plutonium
R	roentgen
R/h	roentgen per hour
RA	Regional Administrator

RAC	Regional Assistance Committee
RACES	Radio Amateur Civil Emergency Services
rad	radiation absorbed dose
RAP	Radiological Assistance Program
REA	radiation emergency area
rem	roentgen equivalent man/mammal
REP	Radiological Emergency Preparedness
RLO	Regional Liaison Officer
RPM	REP Program Manual
RSO	Radiation Safety Officer
RTL	Regional Tribal Liaison
SAE	Site Area Emergency
SAV	staff assistance visit
SME	subject matter expert
SOG	standard operating guideline
SPR	Stakeholder Preparedness Review
Sr	strontium
SRPC	Site Radiation Protection Coordinator
Sv	sievert
TAC	traffic and access control
TCP	traffic control point
TED	total effective dose
TEP	Training and Exercise Plan
TEPW	Training and Exercise Planning Workshop
THD	Technological Hazards Division (FEMA)
THIRA	Threat and Hazard Identification and Risk Assessment
TLD	thermoluminescent dosimeter
TMI	Three Mile Island
TSC	Technical Support Center
TTD/TTY	Telecommunication Device for the Deaf/TeleType
TTX	tabletop exercise
UE	Unusual Event
USDA	U.S. Department of Agriculture
VOAD	Voluntary Organizations Active in Disaster
WEA	Wireless Emergency Alert (system)

NRC ABBREVIATIONS AND ACRONYMS

ADAMS	Agencywide Documents Access and Management System
ALARA	as low as reasonably achievable
ANS	Alert and Notification System
AOP	abnormal operating procedure
BWR	boiling-water reactor
COL	Combined License
CDE	committed dose equivalent
CEDE	committed effective dose equivalent
CFR	*Code of Federal Regulations*
CR	control room
DBA	design-basis accident
DBT	design-basis threat
DDE	Deep-Dose Equivalent
DHS	Department of Homeland Security
DIL	derived intervention-level
DOE	United States Department of Energy
DRD	direct-reading dosimeter
EAL	emergency action level
EAS	Emergency Alert System
ECL	Emergency Classification Level
EDE	Effective Dose Equivalent
ENS	emergency notification system
EOC	emergency operations center
EOF	Emergency Operations Facility
EOP	emergency operating procedure
EP	emergency preparedness
EPA	United States Environmental Protection Agency
EPIP	emergency plan implementing procedure
EPZ	emergency planning zone
ERC	emergency risk communication
ERDS	Emergency Response Data System
ERF	emergency response facility
ERO	Emergency Response Organization
ERPA	emergency response planning area
ETE	evacuation time estimate
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FMT	field monitoring team
FNSS	functional needs support services
FRMAC	Federal Radiological Monitoring and Assessment Center
FSAR	final safety analysis report
FTS	Federal Telecommunications System
GDC	general design criteria
GE	General Emergency

HAB	hostile action-based
HEPA	high-efficiency particulate air
HHS	United States Department of Health and Human Services
HP	health physics
HPN	health physics network
IC	Incident Commander
ICP	Incident command post
ICS	Incident Command System
IMAAC	Interagency Modeling and Atmospheric Assessment Center
INPO	Institute of Nuclear Power Operations
ISFSI	independent spent fuel storage installation
JIS	Joint Information System
JIC	Joint Information Center
KI	Potassium Iodide
LLEA	local law enforcement agency
LOA	letter of agreement
LOCA	loss-of-cooling accident
MACCS	MELCORE Accident Consequence Code System
NEI	Nuclear Energy Institute
NIMS	National Incident Management System
NOUE	Notification of Unusual Event
NPP	nuclear power plant
NRC	United States Nuclear Regulatory Commission
NREP	National Radiological Emergency Preparedness
NRF	National Response Framework
NVLAP	National Voluntary Laboratory Accreditation Program
NWS	National Weather Service
OCA	owner controlled area
ODCM	offsite dose calculation manual
ORO	offsite response organization
OSC	Operations Support Center
OSHA	Occupational Safety and Health Administration
OSLD	optically stimulated luminescence dosimeter
PAD	protective action decision
PAG	Protective Action Guide
PAR	protective action recommendation
PASS	post-accident sampling system
PI	performance indicator
PIO	Public Information Officer
POC	point of contact
PRD	permanent record dosimeter
PSE	planned special exposure
PWR	pressurized-water reactor
RADTRAD	RADionuclide Transport and Removal and Dose Estimation
RAP	Radiological Assistance Program

RASCAL	Radiological Assessment System for Consequence Analysis
RCS	reactor coolant system
REMP	radiological environmental monitoring program
SAE	Site Area Emergency
SAMG	Severe Accident Management Guideline
SARA	Superfund Amendments and Reauthorization Act
SAT	systematic approach to training
SGI	Safeguards Information
SGTR	steam generator tube rupture
SIP	shelter in place
SPDS	safety parameter display system
SQA	Software Quality Assurance
TAR	tone alert radio
TEDE	total effective dose equivalent
TLD	thermoluminescent dosimeter
TSC	Technical Support Center
USCG	United States Coast Guard
V-JIC	Virtual Joint Information Center

Name:	**SS#** (last 4):	
Agency:	**DOS#:** 200 *m*R	( )5R ( ) 20R
Date: (MM/DD/YY)	**TLD#:**	
Note! Read dosimeter at least every 30 minutes		**06/2019**

#	Time (24 hr)	Reading		Status (✓)		
		Low Range (mR)	High Range (R)	*Start*	*End*	*Total*
1	Initial Reading					
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

#	**Date** (MM/DD/YY):	**Name:**	**Dosimeter(s)**				**TLD Card**
	SS# (last 4):	**Agency:**	**Low** (200 mR) **#:**		**High ( )5R ( )20 R #:**		#:
			Initial Reading	End Reading	Initial Reading	End Reading	
#	**Date** (MM/DD/YY):	**Name:**	**Dosimeter(s)**				**TLD Card**
	SS# (last 4):	**Agency:**	**Low** (200 mR) **#:**		**High ( )5R ( )20 R #:**		#:
			Initial Reading	End Reading	Initial Reading	End Reading	
#	**Date** (MM/DD/YY):	**Name:**	**Dosimeter(s)**				**TLD Card**
	SS# (last 4):	**Agency:**	**Low** (200 mR) **#:**		**High ( )5R ( )20 R #:**		#:
			Initial Reading	End Reading	Initial Reading	End Reading	
#	**Date** (MM/DD/YY):	**Name:**	**Dosimeter(s)**				**TLD Card**
	SS# (last 4):	**Agency:**	**Low** (200 mR) **#:**		**High ( )5R ( )20 R #:**		#:
			Initial Reading	End Reading	Initial Reading	End Reading	
#	**Date** (MM/DD/YY):	**Name:**	**Dosimeter(s)**				**TLD Card**
	SS# (last 4):	**Agency:**	**Low** (200 mR) **#:**		**High ( )5R ( )20 R #:**		#:
			Initial Reading	End Reading	Initial Reading	End Reading	
#	**Date** (MM/DD/YY):	**Name:**	**Dosimeter(s)**				**TLD Card**
	SS# (last 4):	**Agency:**	**Low** (200 mR) **#:**		**High ( )5R ( )20 R #:**		#:
			Initial Reading	End Reading	Initial Reading	End Reading	
#	**Date** (MM/DD/YY):	**Name:**	**Dosimeter(s)**				**TLD Card**
	SS# (last 4):	**Agency:**	**Low** (200 mR) **#:**		**High ( )5R ( )20 R #:**		#:
			Initial Reading	End Reading	Initial Reading	End Reading	
#	**Date** (MM/DD/YY):	**Name:**	**Dosimeter(s)**				**TLD Card**
	SS# (last 4):	**Agency:**	**Low** (200 mR) **#:**		**High ( )5R ( )20 R #:**		#:
			Initial Reading	End Reading	Initial Reading	End Reading	

RADIATION ACCIDENT TEAM
DRESS-OUT PACKAGE

ITEM	QUANTITY
Disposable Booties	1 (pair)
Yellow Plastic Waterproof Shoe Covers	1 (pair)
Disposable Coveralls	1 (suit)
Disposable "**Orange**" Nitrile Gloves	1 (pair)
Disposable Non-latex Gloves	1 (pair)
Protective Mask w/Splash Visor Eye Shield	1
Disposable Hood	1

Note: You will need a roll of masking tape.

DRESS-OUT INSTRUCTIONS

1. Record TLD number, personal dosimeter serial numbers, and initial dosimeter readings on Radiation Exposure Record before entering controlled area.

2. Attach TLD to clothes (*upper body*).

3. Put on disposable booties.

4. Put on (yellow) plastic waterproof shoe covers over disposable booties.

5. Put on disposable coveralls.
   a. *Tape zipper – leave a tab for easy removal of tape*.
   b. *Tape to booties – leave a tab for easy removal of tape*.

6. Put on inner pair of "**orange**" nitrile gloves.
   a. *Tape to sleeve – leave a tab for easy removal of tape*.

7. Put on outer pair of non-latex gloves (***do not tape!***).

8. Label your position "title" on masking tape.
   a. *Place on front <u>and</u> back of coveralls*.

9. Attach pocket dosimeters to upper body (*outside coveralls*).

10. Put on mask w/splash visor eye shield.

11. Put on disposable hood.

Last Revised: January 2021

RADIATION ACCIDENT PROTOCOL
EXIT OF THE DECONTAMINATION TEAM

<u>HOSPITAL</u>: Post in sight of step-off pad
<u>AMBULANCE</u>: Post in back window of ambulance

1. Have Inside Radiation Safety Officer (RSO) frisk hands before beginning Exit Process.
   If contamination is found, remove and replace outer pair of non-latex gloves and continue instructions.

2. Give pocket dosimeter to RSO.
   Be sure that reading is recorded upon exit.

3. Remove disposable hood.
   Put in a waste container.

4. Remove (yellow) plastic waterproof shoe covers.
   Put in a waste container.

5. Remove tape from wrists, coveralls, and booties.
   Put in a waste container.

6. Remove coveralls (***slowly*** *pull downward to ankles*).
   Step out of coveralls.
   Put in a waste container.

7. Remove disposable booties (one at time).
   Put in a waste container **<u>while stepping over the control line.</u>**
   a. RSO should monitor bottom of shoes at this time.

8. Remove outer pair of non-latex gloves.
   Put in a waste container.

9. Remove TLD and give to RSO.

10. Remove mask w/splash visor eye shield.
    Put in waste container

11. Remove inner pair of "**Orange**" nitrile gloves.
    Put them in a waste container.

12. Receive a complete whole-body survey with a Geiger-Mueller survey meter from the hospital personnel (*should take several minutes*).
    a. If survey indicates the presence of contamination, DO NOT leave the area until assisted by the RSO.

Last Revised: January 2021

EMERGENCY WORKERS (EWs) and PERSONNEL & EQUIPMENT MONITORS (PEMs)

DOSIMETRY EQUIPMENT "JUST IN TIME" TRAINING

Equipment/supplies needed for "Just in Time Training":

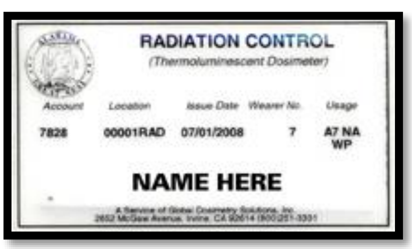
- ☐ Thermoluminescent Dosimeters (TLD cards)
- ☐ Clips for TLD Cards
- ☐ Low Range Pocket Dosimeters (0-200 mR)
- ☐ High Range Pocket Dosimeter (0-5 R or 0-20 R)
- ☐ CDV-750 Dosimeter Charger(s)
- ☐ Radiation Dosage Limits Cards for Emergency Workers and Personnel & Equipment Monitors
- ☐ Radiation Equipment Distribution Log(s)
  NOTE: Record all EWs and PEMs with the appropriate issued equipment.
- ☐ Radiation Exposure Record(s)
- ☐ Pen(s) and/or Pencil(s)

All EWs and PEMs will be issued the following equipment (pouches):

1. Thermoluminescent Dosimeter (TLD Card)
2. Low Range Pocket Dosimeter (0-200 mR)
3. High Range Pocket Dosimeter (0-5 R or 0-20 R)
4. Radiation Exposure Record
5. Radiation Dosage Limit Card
6. Potassium Iodide (KI) will be made available, if needed **(EWs only)**

Follow the steps below to conduct "Just in Time" Training:

- ☐ Zero pocket dosimeters (instructions on back)
- ☐ Track each EW and PEM issued dosimetry on the Radiation Equipment Distribution Log
- ☐ Prepare a Radiation Exposure Record for each EW and PEM
- ☐ Instruct each EW and PEM on the use and specific details of dosimetry (see below)
- ☐ Inform each EW that Potassium Iodide (KI) will be made available, if needed **(EWs only)**
- ☐ Issue each EW and PEM a Radiation Dosage Limit Card and discuss the allowable limits
- ☐ *Remember: TIME, DISTANCE and SHIELDING!*
- ☐ At the end of mission, return dosimetry, etc. to the Command Post and/or EW station. Dosimetry will be recorded. **(EWs only)**
- ☐ If contamination is present, EWs will be directed to a local community reception center for decontamination. **(EWs only)**



- TLD card(s) serve as a permanent/legal record. (user specific; not interchangeable)
- Place clip on TLD card
- Clip TLD card to street clothes or under protective clothing between the neck and waist (preferably chest area)
- Can NOT be read in the field; will be read at the completion of the emergency

- Pocket dosimeters can be read directly by the user
- Place pocket dosimeters on the outside of the top layer of clothing between the neck and waist (preferably chest area)
- Read both (low and high) pocket dosimeters at least every 30 minutes (clip end/good source of light)
- Record readings on the Radiation Exposure Record
- Seek relief at 100 mR on the low dosimeter

Instructions on how to zero a pocket dosimeter

1. Adjust the clamp to fit the length of the dosimeter.
2. Pull the clamp trigger back and insert the dosimeter with the clip toward the back. The dosimeter must have a snug fit. Make sure the scale of the dosimeter is horizontal.
3. Look to see if there is a hairline. If there is a hairline, pump the black generator lever to "charge" or zero the dosimeter. If you don't have a hairline, then give the generator lever a few slow pumps, and the hairline will appear on the right hand side. Continue pumping the generator lever until the hairline is on zero.
4. If the hairline falls below zero, press the black discharge button to bring the hairline back to zero.
5. To remove the dosimeter from the charger, squeeze the clamp trigger and lift the dosimeter above the end of the clamp, pulling it straight back to disengage it from the charging contact.

Radiation Dosage Limits: Emergency Workers Personnel & Equipment Monitors

EMERGENCY WORKERS (EW)
PERSONNEL/EQUIPMENT MONITORS (PEM)
Radiation Dosage Limits
TEDE (Total Effective Dose Equivalent)

EW: Protecting Property, Patrolling Evacuated Areas, and Manning Check Points
PEM: Monitoring evacuees/EWs and equipment for radiation contamination.

	TEDE	Dosimeter
Seek Relief	200 mrem	100 mR
Daily Maximum	1 rem	500 mR
MAXIMUM for ACCIDENT	5 rem	2.5 R
Evacuating Known Residents	10 rem	5 R
Fighting Residence Fires	10 rem	5 R
Life Saving	25 rem	12.5 R

Alabama Radiation Control

FOR EWs and PEMs

-All emergency workers are advised to make a reasonable effort to limit their total dose, while at the same time accomplishing their emergency responsibilities.
-Read dosimeters and record at least every 30 minutes.
-Do not take Potassium Iodide (KI) until instructed by your county EMA.
-Control your exposure to radiation by your time, distance and shielding.

FOR PEMs ONLY

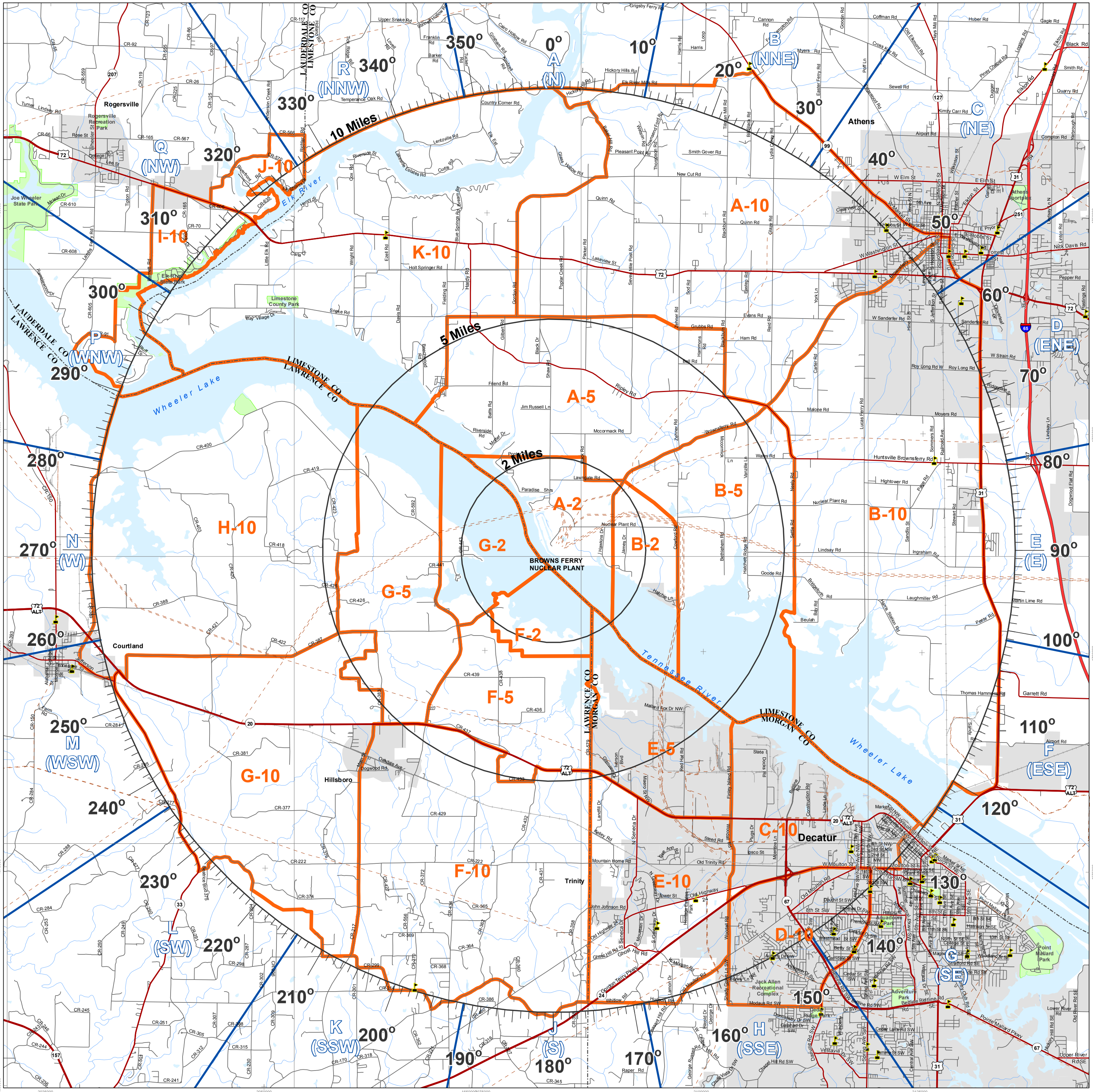
-Contamination level in Alabama is (2x) twice background (open window) and will warrant decontamination.
-Monitoring technique: 1 inch away and move 1-2 inches per second.
-On lowest scale (x0.1), the Ludlum 14C meter scale will read 0-600 cpm.
-Do a response check and calibration verification, cover probe, and obtain background.
-Use CPM scale when monitoring for contamination.

Alabama Radiation Control

BROWNS FERRY 10 MILE

EVACUATION SECTORS

REP REVISION 8
JULY 2015



LEGEND

- Evacuation Sectors
- PAR Beyond 10 Miles Sectors
- Interstate
- State or US Highway
- Major Roads
- Other Road or Street
- Railroad
- Transmission Line
- County Boundary
- School
- Urban Area
- Recreation Area
- Water
- Stream

N

SCALE 1:64,000

Projection and 10,000-meter grid,
Zone 16: Universal Transverse Mercator
25,000-foot grid ticks based on
Alabama (West) coordinate system
1983 North American Datum

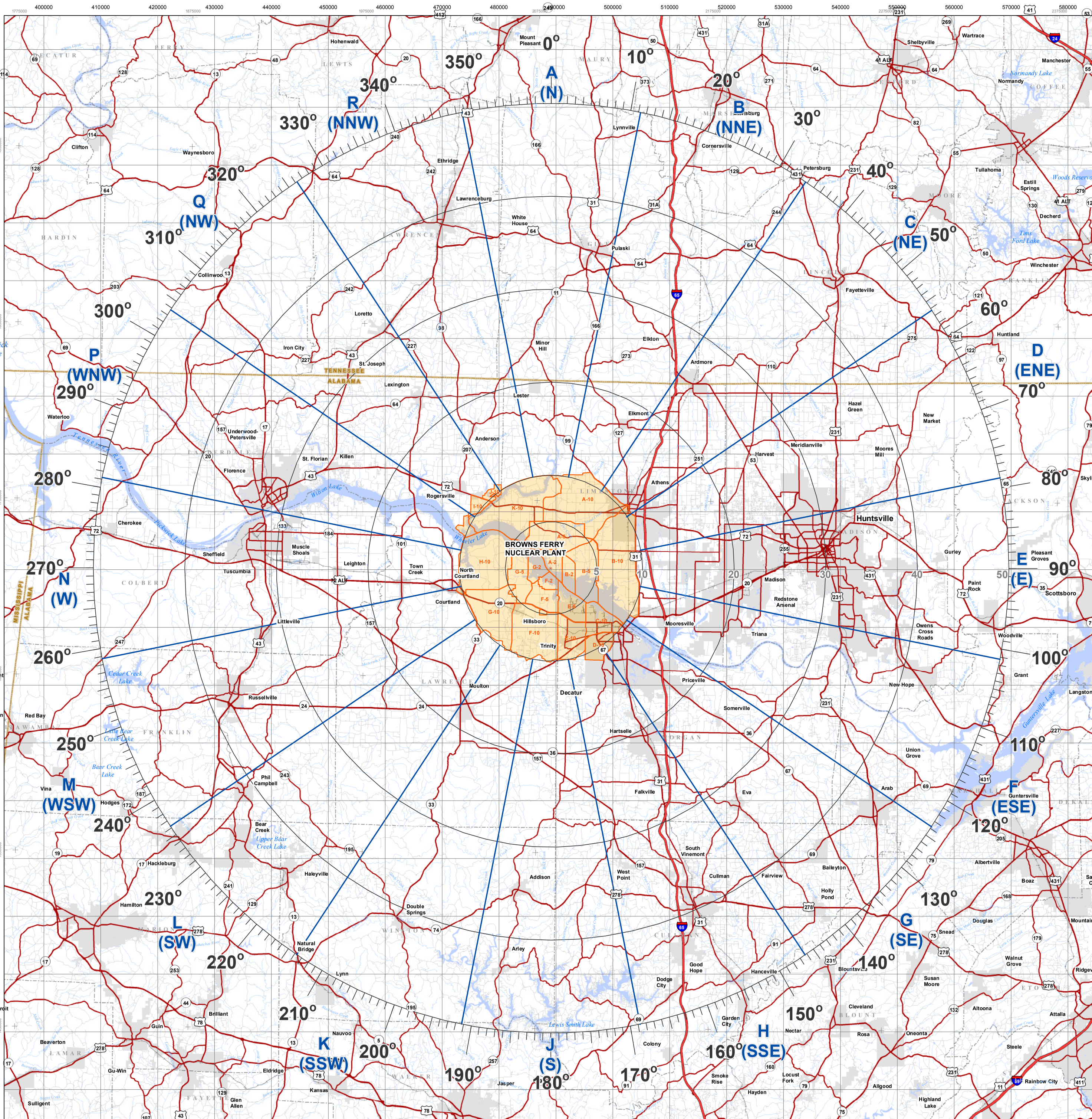
Produced by Tennessee Valley Authority
in cooperation with
Alabama Emergency Management Agency

BASE REVISION 2015

BROWNS FERRY 50 MILE

INGESTION PATHWAY ZONE (IPZ)
ALA - TENN RADIOLOGICAL
EMERGENCY PLAN

REP REVISION 6
JULY 2015



LEGEND

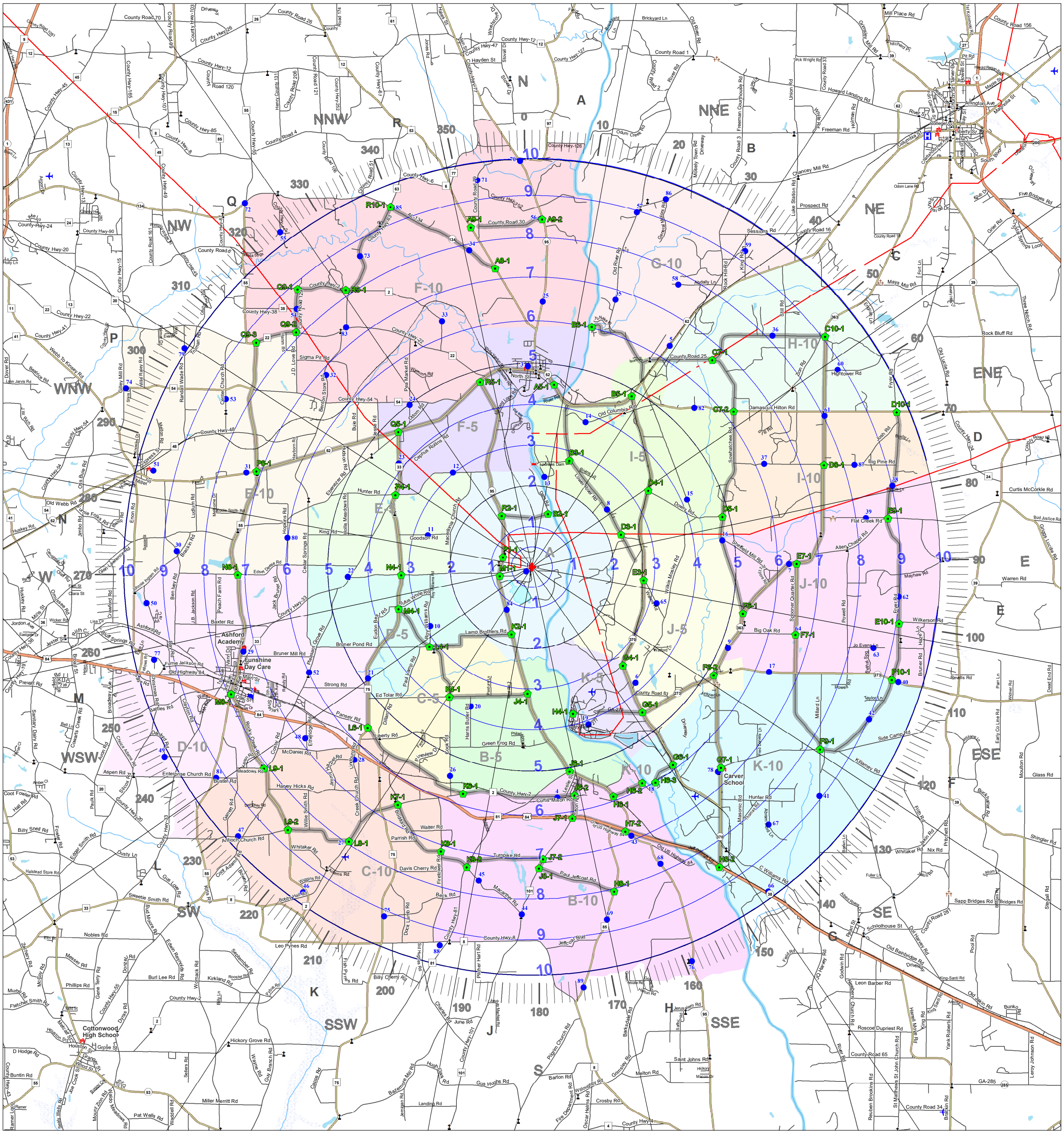
- PAR Beyond 10 Miles Sectors
- Evacuation Sectors
- Interstate
- State or US Highway
- County Road, Street, or Rural Route
- Railroad
- State Boundary
- County Boundary
- City or Town
- Water
- Stream

SCALE 1:325,000

Projection and 10,000-meter grid, Zone 16: Universal Transverse Mercator
100,000-foot grid ticks based on Alabama (West) coordinate system
1983 North American Datum

Produced by Tennessee Valley Authority
in cooperation with
Alabama Emergency Management Agency

BASE REVISION 2015



Version 3.4
Dec 2019

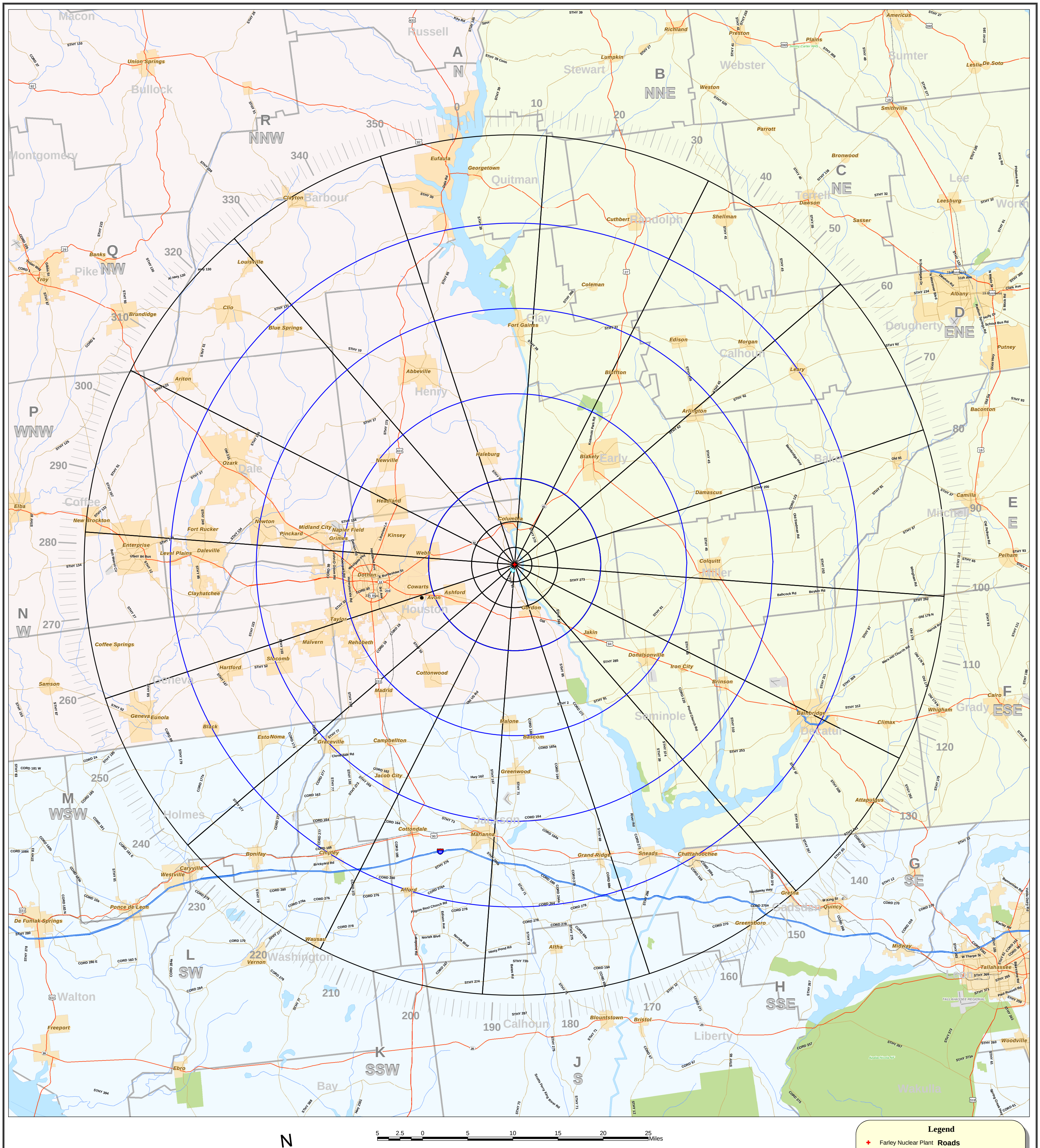
GiS SERVICES

N
W E
S

0 1 2 4 Miles

Joseph M. Farley Nuclear Plant
Emergency Planning Zone
10 Mile Radius

- Farley Nuclear Plant
- Field Monitoring Points
- Sirens
- Churches
- Cemeteries
- Schools
- 500 kV
- Stream/River
- Water Body
- Swamp/Marsh
- Primary Limited Access or Interstate Highways
- Primary US and State Highways
- Secondary State and County Highways
- Minor Roads
- Local Street



Joseph M. Farley Nuclear Plant
Ingestion Planning Zone
50 Mile Radius

Legend

- Farley Nuclear Plant
- Airport Area
- Runway
- Parks
- Lakes
- Swamp or Marsh
- City Limits

Roads

- Limited Access Higway
- US Highway
- State Highway
- Railroads
- Streams
- 50 Mile IPZ Grid

Version 0.0

RADIOLOGICAL SAFETY BRIEFING – RECEPTION CENTER

All Emergency Workers will be issued the following equipment:

- **Radiation Exposure Record**
- **Thermoluminescent Dosimeter (TLD card)**
  - **Fill out Radiation Exposure Record information**
- **Low Range Pocket Dosimeter (0-200mR)**
  - **Fill out Radiation Exposure Record information**
  - **Black**
- **High Range Pocket Dosimeter (0-20R)**
  - **Fill out Radiation Exposure Record information**
  - **Yellow**
- **Maximum Radiation Dosage Limit Card (green card)**
- **Potassium Iodide (KI) will be issued by ADPH KI Nurse. DO NOT TAKE UNTIL TOLD TO DO SO BY EMA.**

- When reading your dosimeter, point toward a good light source. Read through the clip end. Keep the scale in the horizontal position to assure an accurate reading.
- Read your dosimeters every 30 minutes, and record on your radiation exposure record.
- The TLD card is your permanent record and cannot be read in the field.
- Read your dosimeters and record on the Radiation Exposure Record **at least every 30 minutes.**
  - Seek relief at 100mR (black dosimeter)
  - Do not wait until the dosimeter is on 100mR before requesting relief; call when it's approaching 100mR.
- Your TLD and dosimeters should be worn in your black pouch on the *outside* of your clothing.
- If you reach the limit on your black low range dosimeter (200mR), use your yellow high range dosimeter (20R).
- Authorization to exceed emergency worker exposure guidelines must be obtained from the State Health Officer prior to any exposure limit being exceeded. This will be done through the local EMA office.
- Remember to stay in contact with your department's safety officer.
- If you have any questions, contact the local EMA office at ###-###-#### (--------- County EMA) for assistance.

<read the green card dosimetry limits>

Outside Vehicle Decontamination:

- All outside personnel will wear turnout fire gear or OREX water resistant coveralls with face shield, water repellant booties, and gloves.

Inside Personnel Decontamination:

- All inside personnel will wear OREX coveralls with face shield, shoe covers, and gloves.
- Follow all donning and doffing directions when putting PPE on and taking PPE off.
- Do not eat, drink, chew gum, smoke, dip, apply make-up, or put on lip balm while on duty as an emergency worker.

RADIOLOGICAL EMERGENCY ASSISTANCE CONTACTS

FOR USE WITH...
EMERGENCIES & INCIDENTS INVOLVING RADIOACTIVE MATERIAL
(NON-REACTOR EMERGENCY)

LICENSEES & REGISTRANTS	FIRST RESPONDER
NON-EMERGENCY: Alabama Radiation Control Office (M-F, 8AM - 5PM CT) 334.290.6244 800.582.1866	**CALL #1:** __________________ County EMA (_____) _____ - ______________
EMERGENCY: Alabama Radiation Control Office 24-hour Duty Officer 334.324.0076	**CALL #2:** Alabama EMA 24-hour State EOC Communication Center 205.280.2310 800.843.0699 **CALL #3:** Alabama Radiation Control 24-hour Duty Officer 334.324.0076

**Current as of January 1, 2023*

**Destroy all Earlier Editions*

Alabama Department of Public Health
Office of Radiation Control
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