

Great Western Painting

Naturally Occurring Radioactive Materials (NORM)

NATURALLY OCCURRING RADIOACTIVE MATERIALS

29 CFR 1910.1096 - Ionizing Radiation

All employees must understand the below definitions which are extracted from the above referenced OSHA standard:

Radiation includes alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but such term does not include sound or radio waves, or visible light, or infrared or ultraviolet light.

Radioactive material means any material which emits, by spontaneous nuclear disintegration, corpuscular or electromagnetic emanations.

Restricted area means any area access to which is controlled by the employer for purposes of protection of individuals from exposure to radiation or radioactive materials.

Unrestricted area means any area access to which is not controlled by the employer for purposes of protection of individuals from exposure to radiation or radioactive materials.

Dose means the quantity of ionizing radiation absorbed, per unit of mass, by the body or by any portion of the body. When the provisions in this section specify a dose during a period of time, the dose is the total quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body during such period of time. Several different units of dose are in current use.

Rad means a measure of the dose of any ionizing radiation to body tissues in terms of the energy absorbed per unit of mass of the tissue. One rad is the dose corresponding to the absorption of 100 ergs per gram of tissue (1 millirad (mrad)=0.001 rad).

Rem means a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of 1 roentgen (r) of X-rays (1 millirem (mrem)=0.001 rem). The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions for irradiation. Each of the following is considered to be equivalent to a dose of 1 rem:

- a. A dose of 1 roentgen due to X- or gamma radiation;
- b. A dose of 1 rad due to X-, gamma, or beta radiation;
- c. A dose of 0.1 rad due to neutrons or high energy protons;

- d. A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye;
- e. If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron dose in rads, 1 rem of neutron radiation may be assumed to be equivalent to 14 million neutrons per square centimeter incident upon the body; or, if there is sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equivalent to 1 rem may be estimated from Table G-17:

TABLE G-17 NEUTRON FLUX DOSE EQUIVALENTS

Neutron energy (million electron volts (Mev))	Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm ²)	Average flux to deliver 100 millirem in 40 hours (neutrons/cm ² per sec)
Thermal	970 X 10 ⁶	670
0.0001	720 X 10 ⁶	500
0.005	820 X 10 ⁶	570
0.02	400 X 10 ⁶	280
0.1	120 X 10 ⁶	80
0.5	43 X 10 ⁶	30
1.0	26 X 10 ⁶	18
2.5	29 X 10 ⁶	20
5.0	26 X 10 ⁶	18
7.5	24 X 10 ⁶	17
10	24 X 10 ⁶	17
10 to 30	14 X 10 ⁶	10

Exposure of individuals to radiation in restricted areas: As an employer, we will not possess, use, or transfer sources of ionizing radiation in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from sources in our possession or control a dose in excess of the limits specified in Table G-18:.

TABLE G-18

	Rems per calendar quarter
Whole body: Head and trunk; active blood-forming organs; lens of eyes; or gonads	1 ¼
Hands and forearms; feet and ankles	18 ¾
Skin of whole body	7 ½

Note: A calendar quarter means any 3-month period determined as follows:

1. The first period of any year may begin on any date in January: Provided, That the second, third, and fourth periods accordingly begin on the same date in April,

July, and October, respectively, and that the fourth period extends into January of the succeeding year, if necessary to complete a 3-month quarter. During the first year of use of this method of determination, the first period for that year shall also include any additional days in January preceding the starting date for the first period; or

2. The first period in a calendar year of 13 complete, consecutive calendar weeks; the second period in a calendar year of 13 complete, consecutive weeks; the third period in a calendar year of 13 complete, consecutive calendar weeks; the fourth period in a calendar year of 13 complete, consecutive calendar weeks. If at the end of a calendar year there are any days not falling within a complete calendar week of that year, such days shall be included within the last complete calendar week of that year. If at the beginning of any calendar year there are days not falling within a complete calendar week of that year, such days shall be included within the last complete calendar week of the previous year; or
3. The four periods in a calendar year may consist of the first 14 complete, consecutive calendar weeks; the next 12 complete, consecutive calendar weeks, the next 14 complete, consecutive calendar weeks, and the last 12 complete, consecutive calendar weeks. If at the end of a calendar year there are any days not falling within a complete calendar week of that year, such days shall be included (for purposes of this section) within the last complete calendar week of the year. If at the beginning of any calendar year there are days not falling within a complete calendar week of that year, such days shall be included (for purposes of this section) within the last complete week of the previous year.

Duties of our NORM and Ionizing Radiation Program Administrator:

Our Program Administrator is: Robert Evans

Duties and responsibilities include:

1. Ensuring surveys are made as necessary to comply with the provisions of the above referenced standard [29 CFR 1910.1096]. A survey means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.
2. Ensuring every employee is supplied with appropriate personnel monitoring equipment, such as film badges, pocket chambers, pocket dosimeters, or film rings.
 - a. Every employee will have received training in these monitoring devices and are required to use them.

3. Ensuring that appropriate signage is posted for each radiation area. For the radiation area, itself, the signage must state “CAUTION RADIATION AREA”.
 - a. Warning signs indicate the presence of radioactive materials. These signs have a magenta, red or black symbol, called a trefoil, on a yellow background.



4. Ensuring all individuals working in or frequenting any portion of a radiation area are informed of the occurrence of radioactive materials or of radiation in such portions of the radiation area and they are instructed in the safety hazards associated with exposure to such materials or radiation and in precautions or devices to minimize exposure. They will also be instructed in the applicable provisions of the referenced standard for the protection of employees from exposure to radiation or radioactive materials. Lastly, they will be advised of reports of radiation exposure which employees may request pursuant to this standard.
5. Ensuring a copy of the reference standard, 29 CFR 1910.1096 is conspicuously posted along with a copy of the operating procedures applicable to the work being performed.
6. Ensuring the immediate evacuation warning signal is designed, installed, tested and functioning in accordance with paragraphs 1910.1096(f)(1) through (f)(3)(vii).
 - a. All employees whose work may necessitate their presence in an area covered by the signal shall be made familiar with the actual sound of the signal-preferably as it sounds at their work location. Before placing the system into operation, all employees normally working in the area shall be made acquainted with the signal by actual demonstration at their work locations.
7. Ensuring radiation exposure records are maintained for all employees for whom personal monitoring is required and advise each employee of his individual exposures at least annually.

All persons on the earth are exposed to ionizing radiation. The average person's exposure in the United States is approximately 360 millirems of

radiation from natural sources each year. Actual exposures vary depending on location, altitude, type of building one lives or works in, and behaviors (for example, a person who smokes one and a half packs of cigarettes per day increases his or her exposure by 8000 millirem/year), and other factors.

Radiation sources are:

Natural sources:

Radon	200 millirems
Internal radiation	39 millirems
Cosmic radiation	31 millirems
Terrestrial radiation	28 millirems

Manmade:

X-rays and nuclear medicine	50 millirems
Consumer products	11 millirems
Miscellaneous	1 millirems

Total: 360 millirems

Source: U.S. Environmental Protection Agency, *Radiation: Risks and Realities*, August 1993.

Radiation is radiation and the source does not matter, it the **amount over time** that can cause health problems.

NORM is an acronym for Naturally Occurring Radioactive Materials.

Certain industrial processes such as those found in the petrochemical industry, can cause NORM to accumulate at concentrations greater than natural background levels.

Workers cutting and reaming oilfield pipe, removing solids from tanks and pits, and refurbishing gas processing equipment may have **elevated exposure** to particles containing levels of alpha-emitting radionuclides that could pose health risks if inhaled or ingested.

Radionuclides sources would include:

- Pb-210 lead-210
- Ra-226 radium-226
- Ra-228 radium-228
- Th-232 thorium-232
- U-238 uranium-238

NORM is actually produced when oil and natural gas from underground reservoirs carry small quantities of radium to the surface. Over time, the

radium, typically radium-226 and to a lesser extent, radium-228, can concentrate in pipe scale and oil sludge. These scales and sludges can contaminate soils and equipment. The health effects of exposure to NORM are minimal not counting concentrations caused by human activities such as our found in drilling operations. The presence of NORM in concentrations that exceed natural background levels may present a potential human health risk.

Technologically-Enhanced, Naturally-Occurring Radioactive Material (TENORM) is produced when activities such as oil drilling **concentrate or expose** radioactive materials that occur naturally in ores, soils, water, or other natural materials.

TENORM contamination levels in equipment varies widely among types of equipment and geographic region. The geographic areas with the highest equipment readings were northern Texas and the gulf coast crescent from southern Louisiana and Mississippi to the Florida panhandle. Very low levels of TENORM were found in California, Utah, Wyoming, Colorado, and northern Kansas.

TENORM radioactivity levels tend to be highest in water handling equipment. Average exposure levels for this equipment were between 30 to 40 micro Roentgens per hour ($\mu\text{R/hr}$), which is about 5 times background radiation. Gas processing equipment with the highest levels include the reflux pumps, propane pumps and tanks, other pumps, and product lines. Average radiation levels for this equipment is between 30 to 70 $\mu\text{R/hr}$.

Exposures from some oil production and gas processing equipment exceeds 1 mR/hr.

Gas plant processing equipment is generally contaminated on the surface by lead-210 (Pb-210). However, TENORM may also accumulate in gas plant equipment from radon (Rn-222) gas decay. Radon gas is highly mobile. It originates in underground formations and dissolves in the organic petroleum areas of the gas plant. It concentrates mainly in the more volatile propane and ethane fractions of the gas.

Protection from radiation:

1. Shielding – Placing material between the worker and the source of radiation. This could include placing plastic sheeting on the ground to stop Alpha particles.
 - a. Alpha particles can be stopped by a piece of paper.
 - b. Beta particles can be stopped by aluminum foil.

2. Time - The less time of exposure reduces the exposure and reduces the damage to cells and organs in the body.
3. Distance – The greater the distance from the source, the less radiation exposure.
4. Isolation – Keeping the radiation source contained and isolated and away from people is the best method of protection.

Our NORM Program administrator will ensure that **annual**, documented training is provided by a competent person knowledgeable NORM and TENORM safety procedures to affected employees prior to work assignment.

The following reference sources will be used for training:

- a. 29 CFR 1910.1096 - Ionizing Radiation
- b. Argonne National Laboratory, Advanced Science Division
- c. Health Physics Society
- d. EPA TENORM page
- e. tenorm.com - Home of all things NORM/TENORM
- f. Health Physics Society - Radiation Safety Program Summary
- g. OSHA Radiation
- h. CDC - Radiation Measurement
- i. ISU - Radiation and Radioactivity
- j. U.S. EPA - Radiation
- k. U.S. NRC - Radiation

Training will include:

- a. The safety procedures established by the company for whom we are working for both normal and emergency situations.
- a. Identification of hazards as well as the acute and chronic health hazards resulting from employee exposure.
- b. Location of potential contaminants.
- c. Methods to identify and isolate the hazards (signage, barricade tape, etc.)
- c. The Emergency Action Plan developed by the company for whom we are working.

- d. PPE including:
 - 1. Tyvek (disposable suits)
 - 2. Gloves
 - 3. Eye protection (goggles)
 - 4. Hard Hats
 - 5. *Respiratory protection using half or full face respirators with appropriate HEPA filters per our Respiratory Protection Program.
 - 1. Alpha particles can be stopped by a piece of paper or skin.
 - 2. Beta particles can be stopped by a sheet of plastic.
- Note: Alpha and Beta particles are only hazardous if inhaled or ingested. This is why there is no eating, smoking, chewing and the reason for half or full face respirators that stop the radioactive material from entering the respiratory system.
- e. The prohibition of eating, drinking, smoking, or chewing anything in the area where TENORM contaminated materials, air, or soil is located.
- f. The requirement that hand washing facilities will be readily available for personal hygiene.

***Respirator selection:**

Respirators will be selected on the basis of hazards to which the employee will be exposed.

All respirators will be NIOSH approved.

Work area surveillance will be made by the Program Administrator taking into consideration the actual work area conditions, the degree of exposure and employee stress.

Respirator selection will take into consideration the air quality; the contaminant; the amount of the contaminant; the time exposure to that contaminant; and the work area surveillance.

The respirator selected will be adequate to protect the health of the employee and ensure compliance with all other OSHA statutory and regulatory requirements under routine and reasonably foreseeable emergency situations. Of course, the respirator selected will be appropriate for the chemical state and physical form of the contaminant.

For protection against particulates, the respirator provided will be:

- a. air-purifying equipped with a filter certified for particulates by NIOSH under 42 CFR part 84; or

Note: These respirators and filters, other than PAPR's are identified on the packaging with numbers that take the form: TC-84A-XXX.

- a. Filters will have an "N", "R", or "P" designation followed by "100", "99" or "95".
Examples: N100 or R99
 1. "N" indicates the filter is for any solid or non-oil containing particulate contaminant.
 2. "R" indicates the filter is for any particulate contaminant.
If used for an oil containing particulate, a one shift use limit applies.
 3. "P" indicates the filter may be used with any particulate contaminant.
- b. The number indicates the filter efficiency – the higher the number, the more efficient.
100 = 99.97% efficiency; 99 = 99% efficiency; and 95 = 95% efficiency.
- b. air-purifying equipped with any filter certified for particulates by NIOSH for contaminants consisting primarily of particles with mass median aerodynamic diameters (MMAD) of at least 2 micrometers.

The Program Administrator will select respirators based on:

- a. the nature of the hazardous operation or process.
- b. the type of respiratory hazard including permissible exposure limits.
- c. the period of time for which respiratory protection must be worn.
- d. the activities of workers in the hazardous area.
- e. the respirator's characteristics, capabilities, and limitations.

Example: Respirator Selection for lead exposure

<u>Airborne Concentration of Lead or Condition of use</u>	<u>Required Respirator</u>
Not in excess of 0.5 mg/m ³ (10X PEL)	Half mask, air purifying respirator equipped with high efficiency filters. ^{2 3}
Not in excess of 2.5 mg/m ³ (50X PEL)	Full facepiece, air purifying respirator with high efficiency filters. ³
Not in excess of 50 mg/m ³ (1000X PEL)	(1) Any powered, air purifying respirator with high efficiency filters ³ or (2) Half-mask supplied air respirator operated in positive pressure mode.
Not in excess of 1000 mg/m ³ (2000X PEL)	Supplied-air respirators with full facepiece, hood, helmet, or suit operated in positive pressure mode.
Greater than 100 mg/m ³ , unknown concentration or fire fighting	Full facepiece, self-contained breathing apparatus operated in positive pressure mode.

PARTICULATE RESPIRATOR SELECTION

Prior to respirator selection, the following factors must be known:

- a. The identify and concentration of the particulates in the workplace air.
- b. The permissible exposure limit (PEL), the NIOSH recommended exposure limit (REL) or other occupational exposure limit.
- c. The hazard ratio (HR). The (HR) is obtained by dividing the airborne particulate concentration by the exposure limit.
- d. The assigned protection factor (APF) for the type of respirator to be used. The (APF) is the minimum anticipated level of protection provided by each type of respirator worn in accordance with an adequate respiratory protection program. For example, an (APF) of 10 means that the respirator should reduce the airborne concentration of a particulate by a factor of 10 (or to 10% of the workplace concentration).

The (APF) should be greater that the (HR) and multiplying the occupational exposure limit by the APF give the maximum workplace concentration in which the respirator may be used.

All filters will have a 99.97% efficiency rating indicated by the number 100.

Testing:

An outside industrial hygienist using a calibrated radiation survey meter with Geiger-Mueller pancake probe or a radiation survey with a Gamma Scintillation Detector will test for areas where TENORM could possibly exist or where personal exposure could occur. Air samples will be at least 60 cubic feet of air. After the sample has been collected, the filter disk will be sent to an EPA-Certified Radiochemistry laboratory for analysis.

Should an employee be exposed to radiation levels that exceed allowable levels that employee will be notified as soon as this information becomes available.

Monitoring results will be compared to the ANSI Standard for occupational exposure to determine if an exposure level has been exceeded.