

Oilfield Worker NORM Safety – A Few Observations

Ray Johnson, MS, PSE, PE, FHPS, CHP
Director
Radiation Safety Counseling Institute
16440 Emory Lane, Rockville, MD 20853
ray@radiationcounseling.org
301-370-8573

May 28, 2015

Concerns for NORM Worker Safety

Employers of oilfield workers have a duty, according to OSHA regulations, to provide reasonable protection to workers from all hazards that may occur in oilfield operations. One of the potential hazards for oilfield workers is exposure to **Naturally Occurring Radioactive Materials (NORM)**. Such exposures have become a special concern to oilfield workers who are not trained for radiation safety. Since oilfield management and workers have not received training on radiation, their natural tendency is to be very conservative on the side of safety. Because the media has continuously referred to radiation as “Deadly Radiation,” since the advent of nuclear weapons and nuclear power, most everyone is now conditioned to believe all radiation is deadly and to be avoided at all costs. Most people do not understand that potential harm is related to the extent of their radiation dose. While people have died from extreme exposures to radiation, we are actually very resistant to harmful effects of radiation. Medical doctors know this from the enormous amounts of radiation needed to kill cancer cells (cancer treatment with radiation is based on the fact that cancers cells are more susceptible to damage by radiation than normal cells).

Fears of Radiation and Radiation Mythology^{1,2}

Because most people have only heard of radiation as “bad news,” special precautions for NORM safety seem warranted. What workers do not realize is that most everything they have heard and come to believe about radiation is mythology (what is commonly believed, but not technically true). Radiation myths perpetuated by the media have come to be accepted as facts and have resulted in a universal fear of radiation. Everyone who has ever heard of radiation now

-
1. **Johnson, R.H., Psychological and Mental Health Aspects of Ionizing Radiation Exposure.** Encyclopedia of Environmental Health, Elsevier Publications. October 2010. 18 pages.
 2. **Johnson, R.H., Communication Issues about NORM/TENORM for Workers, the Public, and the Media** (Chapter 11, 34 pages) In: *Naturally Occurring Radioactive Materials (NORM) and Technologically Enhanced NORM (TENORM)*. P. Andrew Karam and Brian J. Vetter, Editors. A Textbook for the Health Physics Society Professional Development School, Minneapolis, MN July, 16-18, 2009. Medical Physics Publishing, Madison, WI (549 pages).

has an instinctive fear of radiation similar to natural fears of heights, snakes, spiders, immersion, etc. These fears are also fueled by imagination of terrible consequences anticipated as a result of radiation exposures. Some of the most popular myths include:

1. **Deadly Radiation** - This is a myth because radiation is only deadly under extreme circumstances (such as a catastrophic accident which is exceedingly unlikely to ever happen). Since ordinary aspirin can also be deadly, the analogy would be to say, "I have a headache, so I am going to take a dose of "deadly aspirin."
2. **No Safe Level of Radiation** - This is false because we are all exposed to substantial amounts of radiation all the time, without evidence of effects (we average over 300 mrem in a year (a millirem is a quantify of radiation energy deposited in our body) from natural background radiation in the US and over 20,000 mrem a year in other countries).
3. **Radiation Will Kill You** – True, but only under extreme conditions. Only 29 people have died from documented radiation exposures in the US since 1945.
4. **Radon and CT Scans are OK** – This is false. Radon is the largest source of all natural radiation exposures (much greater than NORM or any other radiation workers will likely ever receive on the job) primarily in our homes averaging over 200 mrem in a year in the US at an average radon level of 1.3 pCi/L. CT scans can result in 1,000 to 2,000 mrem or more per scan. Many people seem to believe that radiation which is naturally occurring or doctor prescribed does not count.
5. **Radiation Will Make You Glow** – This is false and the origin of this myth is unclear.

Such myths are popular because they explain the mysteries of radiation in simple terms that do not require any technical understanding. These myths are also generally accepted because they are aligned with what everyone has heard repeatedly through the media for decades.

The Power of Images Behind Radiation Fears

Psychologists know that all fears can be tracked back to underlying images. The person fearful of radiation does not know that their fear is related to any particular image, they just know and feel that their fear is prudent and justified. Most everyone can recall horrible pictures of persons injured in Hiroshima or Nagasaki. It is interesting to note, however, that most people do not recall such images in relation to radon exposures or CT scans. Since terrifying images are related to feelings and fears for survival. Unfortunately, better technical information may not change people's views. Thus, even when people appear to understand the technical basis for radiation safety, when suddenly confronted with a need to make a safety decision, they may automatically revert to their images of consequences and what they have heard for their lifetimes (mostly mythology).

Industry Guidelines for NORM Safety

There are no federal or national regulations for NORM and only a few states have developed their own regulations, mainly related to the oil and gas industry. In many states, such as California, the oil industry has had to set its own guidelines for safety. For example, the American Petroleum Institute issued guidelines in 2006³. Unfortunately, while this bulletin contains much good information, it also perpetuates common mythology. For example, in Section 1- General - it states, “*If body tissues or organs are exposed to excessive radiation, biological damage can occur in the individuals exposed or in their descendants, increasing their risk of cancer and birth defects.*” The first part of this quote is true, although it gives no indication on what “excessive” means and for many people that is any radiation above zero. The second part about “birth defects” is false. No birth defects on descendants have ever been identified⁴. API Bulletin E2 goes on to define NORM impacted equipment as any equipment for which the external radiation levels exceed direct radiation levels specified by the State. This leaves the definition ambiguous when the State does not have regulatory limits for NORM.

In lieu of specific State guidance, Suggested State Regulations for Radiation Control may be useful⁵. These regulations only apply to licensed sources of NORM. However, two guidelines may be considered, namely; 1) the limit of 100 mrem in a year (100,000 microRoentgen - μR) for NORM exposures to the public (a member of the public is anyone not trained for radiation safety), and 2) to release metal for recycling the exposure level on any accessible surface should be less than 50 μR /hr including background radiation. Some recycling facilities have more restrictive limits, such as 25 μR /hr. While that limit may assure the facility does not incorporate NORM into its recycling process, that recycling limit should NOT be used to designate limits for worker safety for many reasons. First of all the recycling limit is to assure that recyclers can sell their product without public fears of contamination with radioactive material. Secondly, even at a surface exposure rate of 50 μR /hr a worker would have to be in continuous contact with the metal surface for a working year of 2,000 hours to reach the annual public limit of 100 mrem. For short exposure times the USNRC specifies a public limit of 2,000 μR in an hour. Depending on the length of time handling a particular piece of NORM contaminated equipment, the limits could be 4,000 μR /hr for 30 minutes, or 8,000 μR /hr for 15 minutes, and so on.

-
3. **Bulletin on Management of Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Production.** API Bulletin E2, Second Edition, April 2006.
 4. **US. Nuclear Regulatory Commission. Regulatory guide 8.29. Instruction Concerning Health Risks From Occupational Radiation Exposure.** USNRC, Office of Nuclear Regulatory Research, Washington, DC. February 1996.
 5. **Regulation and Licensing of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM).** Part N, Suggested State Radiation Control Regulations, SSRCC Volume 1, 2004, Available from the Conference of Radiation Control Program Directors at CRCPD.org.

Measurements of NORM

Many errors can cause measurements of NORM to be very misleading. Some of these errors include;

- 1 In many cases measurements are made with the wrong detector for a particular safety decision
- 2 The instrument is not calibrated for NORM
- 3 The instrument is not used as it was calibrated.
- 4 Mistaking beta particle measurements as gamma radiation
- 5 The measurements are made in the wrong location.

Some facilities use Geiger Mueller (GM) detectors for measuring count rates when they should be using an exposure measuring instrument to determine worker safety. Also ideally, NORM measurement instruments should be calibrated with a NORM source, such as radium-226. Instruments normally calibrated with cesium-137 could give readings too high or too low by factors of two or more. Some instruments, such as a pancake GM, also respond to a beta particle signal which cannot be measured in units of $\mu\text{R/hr}$. Since all NORM emits beta particles, exposure readings on a GM detector could be too high by a factor of 20 due to beta particle interference. To obtain a true measure of exposure in $\mu\text{R/hr}$, the beta signal has to be blocked by a piece of plastic for shielding. Another common error is to make surface exposure readings without considering the location of workers and whether they actually have any significant time in contact with the NORM surface.

Interpretation of NORM Measurements⁶

Some of the common errors in the interpretation of NORM measurements include;

1. Attempting to assess worker health risks on the basis of count rate measurements. Such measurements may be used to determine whether one reading is higher or lower than another, but they cannot be used to assess health risks. Also, such readings may be mainly due to short lived decay products of radon (lead- 214 and bismuth-214), which will decay away in four hours (if not continuously replenished from radon).
2. The second most common error is to assign radiation doses for workers based on exposure readings taken on a metal surface (such as a pipe) without considering the location of workers or the occupancy time in connection with the surface reading. API Bulletin E2 recommends measurements at one foot and one meter away from a NORM contaminated item (without regard to where workers are located). However, to assess actual radiation dose to workers, it is important to take measurements at occupied locations and also take into account the occupancy time.
3. As noted above, mistaking a beta signal for a gamma signal can result in readings that are too high by a factor of 20.

6. **Johnson, R.H, and Kenoyer, J. Is Your Radiation Instrument Telling you What you Think it is?** Technical article for the American Industrial Hygiene Association monthly magazine, *The Synergist*, March 2012. 3 pages.

Practical Considerations for NORM Safety

When NORM is encountered at facilities where radiation is not expected and no one has training for radiation safety, the tendency is to drastically over protect. Many facilities treat NORM as if any radiation exposure is “deadly.” Getting NORM on your skin or clothing is NOT necessarily dangerous. Since all soil contains NORM, getting dirt on your hands or clothing should be handled in the same way that workers would protect themselves on any dirty job by wearing coveralls and gloves. Such NORM can be removed by washing.

Inhalation of NORM may also not be a hazard by itself. If the air is so dusty that respiratory protection is needed, then that protection will also minimize inhalation exposures to NORM. In most cases a throwaway P95, N95 or R95 particulate mask will be adequate. Actions to protect workers should be commensurate with the amount of actual NORM exposures. No special precautions are needed for exposures less than 2,000 μR in an hour (unless these exposures would add to 100,000 μR in a year). Decisions for safety should be based upon actual measurements of worker exposure (with appropriate instruments) taking into account worker locations and actual contact time with NORM. Measurements at one foot or one meter from a NORM contaminated object have no meaning unless that location is occupied a significant amount of time. Workers who handle NORM should also know that our hands are very resistant to harm by radiation.

Summary and Conclusions

Management and workers without training for radiation safety and encountering NORM for the first time are typically very fearful of potential radiation exposures. Fears of radiation have been fostered for decades by radiation mythology propagated by the media. These fears may lead to extremely conservative practices for radiation safety that may actually increase worker risks (excessive protective clothing can cause heat stress). Fears may also be compounded by radiation measurements with inappropriate instruments or taking readings on surfaces or other locations without consideration of worker locations or occupancy time. Radiation instruments are also not usually calibrated for NORM sources and consequently the measured values may not be true measures of NORM.

State and industry guidelines for radiation safety are lacking, ambiguous, or misunderstood. The greatest misinterpretation of guidelines is the use of recycling limits as an indication of hazard to NORM workers. The very low limits for recycling (such as 25 μR /hr) are based on fears that the recycled product will not be saleable if people believe it is consummated with NORM or any radioactive material. The recycling limit was never intended to be a limit for protection of workers. Trained NORM workers are allowed 5,000,000 μR in a year or 2,500 μR /hr for continuous exposure. (a 4 – 5 hour class on NORM Safety would qualify workers as trained radiation workers). Untrained workers are allowed 2,000 μR in an hour or 100,000 μR in a year. Normal coveralls may also provide adequate protection from

contamination with NORM and throwaway P95, N95, or R95 dust masks may be adequate for inhalation protection.



Ray Johnson, MS, PSE, PE, FHPS, CHP, is a 50 year career specialist in radiation safety. He currently directs the Radiation Safety Counseling Institute where he provides consulting, training, and counseling on issues involving radiation safety. He has been a Certified Health Physicist for 33 years and specializes in radiation instruments, nuclear gauges, industrial x-ray, NORM, and radiation risk communication. He has trained over 3,500 radiation safety officers since 1985. He is a past president of the Health Physics Society and the American Academy of Health Physics and has over 600 publications and presentations on radiation safety.
