# How to Deal with Worker Concerns for NORM

**Round Table 225**

## Controlling NORM Hazards

## (Naturally Occurring Radioactive Material)

## AIHce, Montreal, Canada

**Tuesday, May 21, 2013,    2 – 5 PM**


**Presented by**

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# Abstract

## How to Deal with Worker Concerns for NORM*

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Industrial hygienists may encounter NORM in workplaces where it is unexpected and of great concern to workers not trained for radiation safety. Without such training most of what workers may believe about radiation is mythology (not technically true). Case studies show that the sound of a clicking Geiger Counter in response to a NORM signal can set workers into a panic. The unexpected presence of radiation brings up images of Hiroshima (or Fukushima) and anticipated terrible consequences from radiation exposure. Helpful responses for concerned workers begin with active listening to hear their feelings. Workers should be assured that it is OK to feel afraid. After establishing rapport workers may then be open to understanding the steps from cause to effect for answering questions on radiation safety. A one-hour class on NORM safety awareness can also help answer questions and alleviate concerns when presented by a knowledgeable specialist in radiation safety.

- Raymond H. Johnson, ***Communication Issues about NORM for Workers, the Public, and the Media***, Chapter 11 in Naturally Occurring Radioactive Material (NORM) and Technologically Enhanced NORM (TENORM), Edt. by P. Andrew Karam and Brian J. Vetter. A textbook for the Health Physics Society Professional Development School, Minneapolis, MN July 16-18, 2009. Medical Physics Publishing, Madison, WI.

# How to Deal with Worker Concerns for NORM

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## Introduction

- What happens when you first discover NORM
- What do you tell workers ?
- How will they react ?
- What will go on in their minds about radiation ?
- How do you respond to worker fears ?
- What NOT to do
- Most helpful response – Active Listening
- NORM safety awareness training
- Show steps, cause to effect - Answer questions

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## Main Issues for NORM

- What is the actual hazard of NORM ?
- What workers believe is the hazard ?
- How will management react ?
- How will the worker's Union react ?
- How will workers' families react ?

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## Is it OK to be Afraid ?

- What will workers think of when they hear a clicking Geiger Counter?


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## Concerns for Radiation

- Fear
  - Common denominator for all radiation issues
- Often enhanced by discovering unanticipated NORM exposures, i. e.
  - NORM in the workplace
  - NORM contaminated materials
  - Radium scale in pipes
- Without special training, people resort to what they have always heard about radiation
  - Namely - "Bad News"

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## Radiation – Bad News

- Can you remember ever hearing anything good about radiation?
  - Occasionally someone will think of cancer treatment
- After studying radiation fears for many years
  - I conclude that most radiation fears are based on myths about radiation that have come to be accepted as facts.
- Helpful communication on NORM issues
  - Will require dispelling many radiation myths

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## Myth of "Deadly Radiation"

- Media has used these words for over 60 years
- Now accepted as basis for understanding radiation
- Assumes cause and effect automatically
  - Analogy with "Deadly Aspirin"
- Results
  - Fears of radiation seem out of proportion to risks as we would technically understand them


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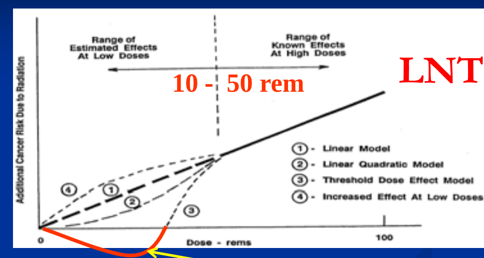
## Myth of Models for Estimating Risk




Hormesis

Are small doses of radiation beneficial ?

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## "No Safe Level of Radiation" - Myth

- The only safe level is zero radiation
- Predicted by LNT
- Every radioactive atom is harmful
- Every atom must be removed
- Basis of antinuclear sentiments and opposition to nuclear technology
- Ignores radiation all around us

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## Myth of LNT

- Leads to views - "No Safe Level of Radiation"
  - No level without risk
  - The only safe level is zero
- However,
  - There is no zero
  - We are all exposed to radiation all the time
- The debate on low dose effects will go on
  - because of lack of data
- Propose a new message:

"It is actually very difficult to harm someone with radiation!"

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## What Does Zero Mean ?

- Zero health effects start at 560,000 cancer deaths a year in US
- Zero radiation starts at background
  - 310 mrem / year — average across US
  - 600 – 800 mrem / yr — in Yangjiang, China
  - 1,500 – 2,500 mrem / yr — in Kerala, India
  - 6,000 - 8,000 mrem / yr — in Guarapari, Brazil
  - 10,000 – 26,000 mrem / yr — in Ramsar, Iran

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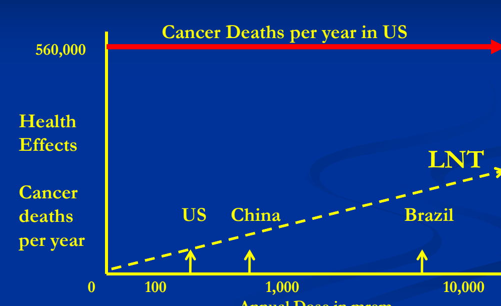
## True Model for Estimating Cancer Risk

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## "Is it Safe?"

- Primary question for workers
  - When beginning to use radiation
- This question is what staff want answered
  - Basis for radiation safety awareness class
- Response to concerns hampered by LNT – risks down to zero dose
  - Difficult to conclude any level is inherently safe, without risk

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## Dealing with NORM Issues, What Will be the Greatest Challenge ?

- Technical Issues ?
  - Inadequate instruments or understanding how to interpret the readings
  - Inadequate knowledge or skills
- People Issues ?
  - Dealing with fears of radiation
  - Radiation phobia
  - Dealing with feelings

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## Are You Prepared to Deal with Feelings ?

- Such as :
  - An upset person ?
  - An overly alarmed person ?
  - An overly complacent person ?
  - A person who to tells you how you should be responding to radiation ?
  - A person you says he does not believe anything you are saying ?

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## Why Will People Issues Be So Difficult ?

- Fear of radiation is common factor
- Fear is an emotional feeling
- How many of us have had training in dealing with feelings?
- How well do we understand feelings?
- How much of our lives are affected by feelings that we do not understand?

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## There Would Be Less Fear of Radiation, if only …… !

- *If only* - people understood radiation, the way we do !
  - Is the answer better education of the public?
- *If only* - people were more rational and logical.
  - Do irrational emotions lead to extreme reactions?
- *If only* - people did not have such strange perceptions of radiation risks ?
  - People need to deal with "What is" vs "What if"
- What is true on this slide ?

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## Results of Worry

- I've experienced a great many terrible things in my life,

  a few of which have actually happened.

  Will Rogers

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## How to Help Workers

- How to answer, "Is it safe ?"
- It's OK to be afraid
- Active listening
  - Hear and reflect content and feelings
- NORM Safety Awareness Training
  - What is NORM, risks, ALARA
- Answer questions
- Provide steps from cause to effect

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## Active Listening

- Hearing the message and the feelings
- Why bother?
  - To establish rapport as basis for presenting your risk message
  - To get down to the real issue of concerns for radiation risks
- Active listening is not easy for technical experts and managers

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## Natural to Give Answers

- Not a matter of right or wrong responses
- Two precautions when giving answers:
  - Are you answering the right question ?
  - Who owns the problem ?
- The giver of answers assumes the responsibility
- Giving answers sets up opportunities for adversity

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## Why Not Troubleshoot Right Away?

- By giving answers first
  - You miss opportunity to connect with feelings and real reasons for concern
- Hearing feelings establishes basis for rapport and credibility
  - They may then "hear" your answers
- When you go directly to answers you may discover you are answering the wrong question
- Fearful people may not want specific answers, but rather to know that someone hears their feelings

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## Active Listening Approach

- Respond to your perception of speaker's message and feelings
- There are four feelings:
  - Mad, Sad, Glad, Afraid
- Opens doors to "real issues"
- Does not take away from:
  - Other person's right, responsibility, and capacity to solve their own problems

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## Hearing and Reflecting Feelings

- Fears are best handled by hearing and reflecting feelings
- Do not say, "I know how you feel."
  - You can never know another person's feelings
- Describe the feeling in your own words
  - Let the other person correct you
  - Four feelings - mad, sad, glad, and afraid
- Dialogue process
  - Paraphrase and reflect
  - Do not interpret or rationalize

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## Hearing Feelings

- "I don't want to go near radiation"
  - "Radiation makes you nervous"
- "Yes, I might still like to have children"
  - "You are afraid that radiation may affect whether you can have children"
- "Yes, I don't want children with 3 eyes"
  - "So your real concern is whether radiation will affect future children"
- "Yes" Ok, here is what I have learned"

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## Examples of Active Listening

- "Radiation, I don't want any of it !"
  - "Radiation is scary isn't it ?"
- "I don't believe a word you are saying!"
  - "You are concerned that I may not be telling you the truth ?
- "I know what happens when you are exposed to radiation ?"
  - "If you are exposed to radiation, you feel that something bad will happen?

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## Steps from Cause to Effect

1. What are properties of RAM ($\alpha$, $\beta$, $\gamma$)? form and quantity?
2. Where is it located?
3. How is it contained?
4. How will it move in the environment?
5. What are the exposure conditions?
6. How much energy is deposited in body?
7. What is the health risk?
   - "It is very actually difficult to seriously harm someone with radiation"

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## NORM Awareness Training – 90 min

- Review of ideas and views on radiation
- What is radiation and NORM
- What do we know about NORM risks
- Everyday sources of radiation, show antiques
- Regulatory guidelines
- Comparison with NORM at the facility
  - Many pictures and actual measurements
- Are these sources safe, who decides, and how do we know?
- Answer questions

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## A TENORM Case Study

- Workers at a large paper making plant
- Became alarmed upon hearing of radium scale from Alum in pipes and pumps
- Questions
  - What is NORM?
  - How long will NORM stay in my body?
  - How much do I need to inhale before I get cancer?
  - Does smoking increase my risk?
  - How can I tell if I have been exposed?

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## More Questions on NORM

- What should I do if I have been exposed?
- If I get cancer, can I tell if it is from NORM?
- What happens to NORM in my body?
- What kind of cancer does NORM cause?
- Am I going to die from NORM exposures?
- Will a dust mask protect me?
- What medical procedures will help me?
- Are there regulations for safe work?
- Could I get NORM on my clothes, take it home?
- Will my family be harmed?

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## Meetings

- Informal – about one hour around a table
- Explained NORM
  - Sources and types of radiation
  - Normal exposures to background
  - Discussed how to measure
  - Answered questions on health effects
- Included show-and-tell
  - Radioactive antiques
  - Samples of uranium ore

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## Measurements with Workers

- Passed out radiation instruments to workers
- Explained how they worked
- Determined normal background readings
- Invited them to check readings on antiques
- Went into plant – spent all day, checked where ever workers wanted. Took samples
- I explained results as we went along
- At the end of the day, I gave conclusion
  - Results not very exciting

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## Summary

- Many workers may have concerns for possible exposures to radiation
- Use active listening to hear their fears and feelings
- Ask lots of questions
- Address mythology
- Provide NORM awareness training
- Help workers find their own answers
  - Hands on measurements are best

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# Communication Issues about NORM/TENORM for Workers, the Public, and the Media*

**Raymond Johnson, MS, PE, FHPS, CHP**

## Introduction

To provide a context for my insights in radiation risk communication, at the end of this chapter I have included a brief review of the history of how I came to deal with communication issues as an engineer and health physicist. The material in this chapter was derived from more than 30 years of experience with radiation risk communication beginning with an assignment in 1976 dealing with public communication on concerns about atmospheric fallout from nuclear testing by the People's Republic of China. My experience included extensive training in the 1970s to practice psychological counseling which I am continuing today as a commissioned Stephen Minister. While I have not gone into counseling as a full time profession, what I have been attempting over the years could be called technology transfer. Professionals in psychological and behavioral sciences know very well how to deal with fears, however, they usually do not understand radiation risks. Conversely, those of us who are specialists in radiation safety, usually do not know about tools and insights available from behavioral and communications sciences. My continuing efforts over the years have been to apply what I have learned from the psychological sciences to address issues of great concern to health physicists, such as how to effectively communicate NORM and TENORM issues to workers, the public, and the media.

## Outline for this Chapter

While this chapter is intended to address communication concerns for NORM/TENORM, you will probably not be surprised to learn that common communication factors apply, no matter what the nature of the radiation issue. Thus, people who are afraid of radiation (virtually everyone), will have concerns for exposure to NORM/TENORM because these materials are potential sources of radiation exposure. To address communication issues about NORM/TENORM, I will first present several sources of insight and tools for radiation risk communication and then conclude with an example of how these tools were applied to an actual TENORM case study. This chapter will provide the following insights and tools for radiation risk communication:

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* **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).

- Understanding concerns for radiation in general
- How mythology affects what people believe about radiation
- The power of images behind fears of radiation consequences
- Hearing, identifying, and reflecting peoples feelings about radiation
- What to say, when you do not know what to say (five keys to impasses)
- A TENORM risk communication case study

## Understanding Concerns for Radiation in General

When communicating any type of radiation issue to workers, the public, or the media there is always a common denominator, namely fear of radiation. These normal fears are often enhanced by new knowledge of potential exposures to radiation that were not expected. This is often the case with NORM/TENORM exposures which usually occur under circumstances where radiation is not anticipated, such as radon in homes, radioactivity in granite countertops, and radiation from radium in pipe scale. Thus, the people involved in radiation exposures from these sources would not likely have had any training in radiation, such as would commonly be expected for radiation workers.

Without special training, people may resort to what they have always heard about radiation, which is usually bad news. At the beginning of a radiation safety class, I like to ask, “Can you remember ever hearing anything good about radiation?” Typically, the class goes silent. Occasionally someone will admit, usually with my prompting, that they have a relative who has received radiation treatment for cancer.

As I have studied people’s fears of radiation over the years, I have come to the conclusion that most of what people are afraid of is based on myths about radiation which over time have come to be accepted as facts. To communicate effectively about NORM issues will require addressing, dispelling, or busting a myriad of radiation myths as described in the following sections.

## How Mythology Affects What People Believe About Radiation

## What is a Myth?

What do we mean by a “myth?” According to the dictionary, a myth has many meanings, including:

1) a traditional story used to explain a natural phenomenon and purported to be historical. For historians, myths reveal the culture of the peoples at the time the myths were in vogue.
2) a theme, motif, or character type that expresses significant truths about human nature.

3) an imaginary or fictitious person, thing, event, story, legend, tale, fairy tale, allegory, fable, fantasy, false-hood, made-up story, lie, fib, tall tale, prevarication, canard, hearsay, or yarn.
4) a collective opinion, belief, illusion, delusion, or ideal that is based on false premises or the product of fallacious reasoning. (The Reader's Digest 1968 and 1975).

The word myth comes from the Greek *muthos* or story. Something mythical is imaginary, fantasized, fictitious, fabricated, unsubstantial, illusory, unreal, pretended, or conjured-up. The opposite of a myth is historical fact, real-life occurrences, truth, and actuality. Unfortunately, when radiation is the issue, what we may consider myths, others may consider reality.

## The Media Perpetuates Radiation Myths

The media has reported some radiation myths, such as "deadly radiation," for so many decades that most everyone believes these two words go together automatically. Because some people have died from radiation exposures, the words "deadly radiation" have now become the definition and basis for understanding radiation. Putting these two words together, however, also assumes a direct link from cause (radiation) to effect (health risk) (without regard to type of radiation, quantity, exposure conditions, or radiation dose). Technically we know that radiation is only "deadly" under extreme conditions. The analogy could be similar to taking an extreme amount of aspirin (100 tablets would definitely be deadly) and then describing the use of a single table for a headache as a dose of "deadly aspirin."

Because of the constant use of the words "deadly radiation," it is common to assume that the presence of radiation will lead directly to terrible effects, usually cancer and death. With such images in mind (of terrible consequences related to radiation) we should not be surprised that virtually everyone is afraid of radiation. The mythical based fears of radiation play directly into the hands of those most strongly opposed to radiation. Since everyone is already afraid of radiation, it is easy to build upon those ingrained fears to create feelings of great concern among people who, for example, hear for the first time that they may be exposed to unexpected radiation, such as from granite countertops.

Appallingly, actual radiation does not even have to be present to trigger the fears, only the possibility. People's imaginations will take over and likely lead to decisions founded on mythology based fears, rather than reality. In fact fears are almost never about reality, but rather are triggered by our imaginations of consequences of what is to come (de Becker 1997 and 2002).

Many radiation messages reported by the media are myths that have come to be accepted as facts by repetitious reporting over decades. The subtlety of radiation mythology is that reporters do not know they are perpetuating myths. Reporters are reporting what is "reality" to them based on what they have always heard. If all they have ever heard is "deadly radiation," why should they report anything different? Besides, the words "deadly radiation" lend themselves to the notion of what is news, namely "bad news." One reporter indicated that the basis for a good story is, "If it bleeds, it reads."

The media seems to thrive on telling us all the things we should be afraid of, not just at home, but around the world. Thus, the evening news tells us everyday that we should be afraid of what is happening to the stock market, to the value of our retirements, to the security of our jobs, to the real estate market, and to the price of fuel, etc., and how many people have died in Iraq and Afghanistan. Since the media continuously reminds us of the risks that we face everyday, we are also encouraged to avoid risks when we can. Therefore, why should we be exposed to another risk (namely radiation) if we can avoid it? Since we live in a dangerous world and are constantly reminded to be afraid, what can we do to avoid danger, such as radiation?

While "good news" stories about radiation abound everyday through the lifesaving benefits of radiation in medical diagnostics and cancer treatment, the "good news" does not fit the definition of news and therefore does not get reported. Because the media only seem to report "bad news" about radiation, everyone has learned to fear and avoid radiation at all costs. The result of such perpetuation of radiation myths is that fears of radiation seem out of proportion to risks from radiation as we (specialists in radiation safety) would understand them. People tend to be most afraid of what they know the least about, and most people do not know much about radiation, except the myths perpetuated by the media.

## We Need to Become Radiation Myth Busters

To help people understand NORM risks, perhaps we should take a cue from the popular show on the Discovery channel, MythBusters. Jamie Hyneman and Adam Savage have become household heroes as MythBusters, by conducting experiments to show what is real and what is a myth. Maybe its time for us to become radiation "myth busters" to dispel myths and tell and show the world the truth about radiation. Discussion of a few radiation myths follows, as examples.

**"No Safe Level of Radiation"** This is a conclusion about radiation for which even radiation professionals do not have uniform agreement. This conclusion is predicted by the linear non-threshold (LNT) model of radiation dose and effects as shown in Fig. 1**.** The straight dashed line down to zero dose indicates that radiation effects should be expected as soon as radiation doses rise above zero. In the 2005 BEIR VII report, the National Academy of Sciences concludes that,

*"Current evidence is consistent with the hypothesis, that at low doses (0 – 10 rem), there is a linear relationship between dose and solid cancers in humans. A threshold is unlikely, although the number of cancers at low doses will be small. Risks of heritable effects are small compared to the baseline of genetic diseases."* (NAS 2005).

The assumption that LNT is the correct model leads to many conclusions by the workers, public, and the media.

1) There is no safe level of radiation
2) There is no level of radiation that is without risk
3) The only safe level of radiation is zero
4) Every radioactive atom is harmful
5) Every atom of radioactive material must be avoided
6) All radiation should be avoided, at all costs

Unfortunately, there are many additional factors that the public, workers, and the media may not understand about radiation. The most important being "***There is no zero.***" There is no "zero" on health effects. About 1/3 to ½ of all people will suffer from some form of cancer in their lifetime (ACS 2008). Cancer is one of the prevailing causes of death in the United States. Thus, for the LNT model, zero health effects means zero for radiation effects, but the health effects scale actually starts at 560,000 or more cancer deaths that occur every year in the US.

There is also no point in our lives when we have "zero" radiation. We live in a sea of natural radiation from outer space, from the ground, and from the food and air that we take into our bodies. In the US, these sources of natural radiation have been estimated at 300 mrem a year on the average (NCRP 2009). In other parts of the world, normal background radiation can give doses from a 1,000 mrem to 25,000 mrem, without effects that can be observed (Ghiassi-nejad, et. al. 2002). Again, for the LNT model, zero radiation starts at whatever the normal level of radiation may be and in many cases it is far from actual zero.

The NAS BEIR VII report has concluded that if 100 people each get a dose of 10 rem (0.1 Sv), the result would be one cancer death. This is the same as saying, one cancer death for each 1,000 person-rem. If we apply this risk conversion factor to the current US population of 300 million, at the average dose of 600 mrem a year (natural and man-made radiation – NCRP 2009), this would equate to 180,000 cancer deaths from radiation or 32 % of all cancer deaths each year.

If anyone objects to this analysis, I would ask the question, "What is zero dose?" Where does the LNT model begin? Is it at 300, 600, 1,000, 4,000, 10,000, or 25,000 mrem a year? If the model is truly linear, why should we assume that affects only occur above our US background? Especially since background varies considerably, by orders of magnitude in various places around the world. If we assume that the normal cancer incidence already takes into account the differences in background radiation, then we should see evidence of higher cancer mortality in areas with high background radiation. However, this does not appear to be the case. Since the debate on low dose radiation effects will likely go on forever, due to lack of conclusive data, I would like to propose a new myth busting message, namely,

***"It is actually very difficult to seriously harm someone with radiation."***

This message is based on the amount of radiation that it takes to kill tumor cells, which are more sensitive to radiation than normal cells. A typical dose for cancer treatment may require as much as 3 to 5 million millirem or more (30 to 50 Gy).

**"Radiation Will Kill You"** John Stossel reported on several radiation myths in 2007 for the TV program 20/20. He says, "The most popular myth is that "***Radiation will kill you."*** However, contrary to predictions of the New York Times, "Japanese lives will change for centuries and genetic effects will occur for the next 1,000 years," no such damage has appeared. Atomic bomb survivors may actually be living longer than normal." Also contrary to popular beliefs, radiation is not the most destructive result of a nuclear bomb. Based on observations in Japan, if you survive the heat and the blast, the chances of dying from radiation are relatively small. Stossel also reported, contrary to "radiation will kill you," that people go to Montana radon health mines because they feel better. No one has died from radiation in nuclear power, and yet the media continues to foster that you are going to be killed by radiation, its scare tactics." (Stossel 2007).

**"The Myth of Chernobyl Deaths"** If you do a word search on the internet for "Chernobyl Deaths," you will find hundreds of websites reporting from 100,000 to 500,000 deaths from Chernobyl. If these numbers are true, where are the bodies? How many deaths do we actually know about? The answer is about 40, among those who were first responders and plant workers dealing with the accident. About 15 additional deaths have been attributed to childhood thyroid cancer (Chernobyl Forum 2003-2005). So then, where do the hundreds of thousands of deaths come from? The answer is based on using the LNT dose conversion factor of one death per 1,000 person-rem and then applying microrem doses to billions of people in the northern hemisphere. Thus, the projected deaths are theoretical calculations, but the websites do not tell you that.

**"Radon and CT Scans are OK"** From the way the public and media seem to perceive radiation risks, it appears that radon exposures in homes and exposures to CT scans are not considered dangerous. People seem to have a concept of "good radiation" and "bad radiation." If the radiation is naturally occurring (such as radon) or if it is prescribed by a medical doctor (such as CT scans or fluoroscopy), apparently those kinds of radiation are OK. At least the public does not seem to be very worried about these sources. Every other type of radiation is bad, and the public is very concerned (such as radiation from nuclear plants and radioactive wastes, or today the possibility of unsecured radioactive materials being used for a dirty bomb). The question to consider here is whether our bodies react differently according to the source of radiation? Of course our bodies do not make that distinction. Most people do not seem to worry that they could be getting 100s or 1,000s of mrem per year from radon in their homes, or that a whole body CT scan could give them from 1,000 to 2000 mrem (10 to 20 mSv) or more per scan.

**"Radiation Will Make You Glow"** Every HP has a favorite "glow in the dark" anecdote. The notion of glowing as a reaction to radiation seems to be one of the most popular ideas that people have about radiation. When someone hears that you work with radiation they may say, "Then you don't have to turn on the lights at night." The origin of this myth is not clear, but may be traced back to the use of radium fluorescent paint for night time illumination of clocks, watches, and instruments, etc. in the 1920s to 1950s.

**"Granite Countertops are Dangerous"** This is a current myth developing through the news media. Homeowners are now being told by the media that they should be afraid of radiation from granite countertops. The news reports are partly right, granite may contain small amounts of uranium and radium. Actually these radioactive elements are found in all materials that come from the ground. They are a natural part of the composition of all earthen materials. Granite, in particular, has long been known for having measurable mounts of radium and also to be a source of measurable gamma radiation.

With the recent publicity about granite as a radioactive material, many people across the country have attempted to make measurements to determine the levels of radiation with a common pancake or end-window Geiger (GM) detector. Unfortunately, the common GM detector is not very well suited for such measurements for two reasons. One is that a GM detector is best suited for measuring beta particles and not very efficient for measuring gamma rays. What this means is that the signal from granite with a pancake or end-window GM detector will be 90 to 95% beta particles. On this basis alone, GM exposure readings in milliroentgen per hour (mR/hr) will be too high by at least a factor of 10 to 20 or more.

Regrettably, reporters have been given data from GM readings taken in the air (which is called background radiation - gamma rays from the ground and outer space) and compared with mostly beta particle readings from granite counter tops, as if the measurements are comparable. The second reason the GM readings are not valid is that most likely the detectors are not calibrated for readings from beta particles which cannot be measured in units of mR/hr. Thus, the media have reported erroneous high readings for radiation and unnecessarily scared much of the public with a new myth about granite countertops (Johnson 2009).

## The Power and Resiliency of Radiation Myths

**Why Are Radiation Myths So Popular?** Myths help to explain the "unexplainable" in terms that are easy to understand and seem simple, direct, and make sense to the general public. Reporters use myths because they relate to what has been said before and popularly accepted. Radiation myths sound credible and can often be reinforced with pictures or with anecdotes provided by virtually anyone. The myth of "deadly radiation" helps bridge the links from radiation (the cause) to cancer (the effect). Myths also help to point to the blame for risks of radiation which the public usually does not understand.

Its easy to believe people who say what we already agree with. It is also easier to believe hearsay, rumor, and gossip which reiterate what we have always heard before. On the other hand, it is harder to believe those who say something different than we have always heard, especially when they only speak the language of "radiation science."

Studies with the Myers-Briggs Type Indicator (MBTI) show that people do not absorb information in a deliberate manner (Johnson 2004b). People will commonly rely on "rules of thumb" to tell them the meaning of science. The media is good at providing the rules-of-thumb (myths) to tell people the meaning of radiation. Also, once a myth has been reported, denying it can serve to reinforce the myth. Over time the "negative tags" offered by HPs may fall out of memory. Denials and clarifications, for all of their rational appeal, may contribute to the resiliency of myths. The reason is shown by the MBTI. Namely, rational appeals apply to logical thinking, but at least half of the population makes decisions on the way they feel. Ignoring myths does not work either. An unchallenged mythical claim gains the ring of truth.

Historically HPs have attempted to deal with radiation myths by countering bad information with good information. While this can be helpful and needs to be continued, we should also not be surprised when many people do not hear or understand what we are saying as rational thinkers. People who are afraid of radiation (most everyone) come to that state on the basis of feelings, not rational thinking. Fears are feelings based on images of unacceptable consequences.

## The Power of Images Behind Fears of Radiation Consequences

Psychologists know that all fears can be tracked back to underlying images. The fearful person is not aware that their fear is related to any particular image. They just know and feel that their fear is prudent and justified. A person fearful of heights will automatically avoid high places. A person fearful of snakes will avoid places where snakes may live. A person fearful of radiation will avoid most associations with radiation. Although it is interesting to note that most people have come to accept medical applications of radiation as beneficial. Likewise most people accept exposures to radon in their homes as a natural part of the environment. However, any radiation that is not medical or natural is often automatically considered to be bad.

The images behind the fear of radiation may be identified by asking the question. "What's so bad about that?" This question has to be used gently and should not be used while a person is experiencing their fear. This question is most useful when helping a person understand their reaction to some event (such as discovering that they may have TENORM exposures in their workplace). To invite workers to consider how they might react when confronted with a radiation scenario, for example, I often use a scenario involving a truck with a radioactive placard on the back door. I ask workers to imagine they are approaching the truck on a highway and they notice that the truck seems to be doing something strange. I then ask what would they do? Workers usually answer immediately that they would quickly go past the truck, or they would back off.

A cardiologist in one class said that he would back off. When asked why he would do that, he said that the truck might crash. I then asked, "So what?" He said that it might spill radioactive material. I again asked, "So what?" He replied that he might drive through the material. I again asked, "So what?" He then said that he might get radioactive material on him. Then I asked the most important question, "What's so bad about that?"  He was quiet for a moment and then he said, "Oh my God, I will melt!"  Of course, the class all laughed at this point (Johnson 2004a).

I believe that any of us who thought that exposure to radiation would cause us to melt, would likely do everything possible to avoid radiation exposure.  The idea of melting was a vivid image in the mind of this student. He did not know that his decision to back off from the suspicious truck was based on an image of melting. His decision seemed justified and prudent for the circumstances. In fact his reaction would be normal for any of us driving on a busy highway and alert for possible dangers of people changing lanes or slowing down in front of us.  We would likely make the same decisions regarding any large truck.

Even before we attempt to talk with people about radiation, they will likely already have ideas (or images in their minds) about radiation.  In fact these ideas may be very strong and may overshadow the best information that we can present.  When telling people what is known about the health effects of radiation, much of what they will hear will be contrary to all that they have ever heard or believed about radiation (described as radiation mythology above).  If what you tell them does not match up with what they have always heard, they may discount your best information or your credibility.  If what you say does not sound believable from their point of reference, they may not accept anything that you tell them. Or they may appear to be listening and understanding, but when they have to make decisions about radiation safety, they may automatically revert to the images and what they have believed their entire lifetimes.  Thus, guidelines for acceptable radiation exposures may be totally forgotten and replaced by an instinctive response, "If radiation is there, it is bad!"

## The Gift of Fear

We have all been endowed with gifts of fears that we have acquired over our lifetimes for self protection (de Becker 1997). True fear is part of our defense system as a signal of imminent danger.  Other fears (worries or anxieties) are based upon our memories or our imagination.  For example, worry is not a true fear but something that we manufacture and it is not part of our defense system. Worry is a choice, but true fear is involuntary (de Becker 2002).  True fear can be a gift, other fears can be a curse.
Now the question is, "Does anyone have true fear of radiation." Some fears may be natural or instinctive.  For example, infants often react in great fear to a sudden loud noise.  This is a true and involuntary fear that prepares our body for defense. Other fears we learn from experience (our memories) what we are told by our families, our friends, our schools, or our society and the media.  For example, we learn about fear of heights by falling or seeing someone else fall and get injured.  For some this fear is overwhelming when confronted with heights.  For others, the fear prompts careful precautions (holding on to the ladder tightly or avoiding high places).

Since no one has ever had an experience of radiation (that I know of), then fears of radiation are not true fears, but manufactured fears.  De Becker says the answer to manufactured fears is better predictions of consequences (de Becker 2002).  Thus, rather than asking the person fearful of radiation, "What could happen, if you are exposed?" It could be better to ask, "Will this happen?" or "Is this happening?" This suggests that one way to deal with people's fears of radiation is to provide a better understanding of the consequences of exposures as a basis for determining if the fears are really warranted.

## How We Hear or Learn About Radiation

In addition to images that may prevent hearing new information on radiation, we also have a middle brain that acts as a filter on what is transferred to long-term memory. The middle brain controls our hormonal system, our emotions, and an important part of our long-term memory (Tracy and Rose 1995). Thus, our emotions play a key role in what we remember. Our middle brain serves as a switchboard that filters or transmits information on to the neo-cortex or thinking brain. Information with a positive appeal to the emotions is transmitted for thinking and processing. Negative emotions, such as fear, anxiety, or stress, may result in suppression of the information which never gets to the thinking brain. If the anxiety is high enough the thinking brain goes blank. We all have times under stress when we just cannot (or do not want to) "think" any more. Such stress may be more than the worry or concerns for which you are aware. Stress could be the result of previous difficulties in learning such that a person feels threatened by new learning experiences. This may result in a vicious cycle in which a person with poor learning experience feels threatened and their brain receives less information. When a person is anxious, less of their thinking brain's potential is available. All of this means that for best learning to occur, the attendees need a positive mental attitude. Real learning may only occur when the student is stress-free, calm, comfortable, trusting in the instructor, and therefore open to hearing new information.

Part of the answer on reducing stress is to make learning fun. Entertainment is a key factor (Johnson, 1996b). This does not always involve humor. It includes dramatization, surprise, and challenges to curiosity, perceptions, and understanding. Effective instruction gets the students actively involved in the class. This requires not only an appeal to their intellect, but also an appeal to their senses. The most effective mode of instruction often is "show and tell."

The value of this approach is explained by Eric Jensen who notes that the "stand and deliver" approach to teaching is brain antagonistic (Jensen 1995). He says that the brain is not very good at absorbing countless bits of factual information. He proposes that better learning occurs when students are provided a variety of experiences from which they can extract their own learning. Ideally the learner will be provided an opportunity to engage physically, mentally, and emotionally in the learning process. He also suggests that learning best occurs when about half of the time is spent on input of new information and half for processing the new learning. More time could be well spent on allowing learners to manipulate, experiment, discuss, and review the new learning. He suggests more learning by simulation, theater projects, field trips, role plays, complex games, model-making, and real-life experiences. The ability to make good choices is made better by trial-and error, rather than someone telling us the right or wrong answers.

## The Importance of Memory

Without the ability to learn, store, and recall appropriate responses to dangers from our memory, we would not be able to survive (Wolfe 2001). She proposes that we have three areas of memory. 1) The sensory memory provides short-term storage of impressions received from our five senses. 2) The working memory consciously processes information. It integrates information from the senses with stored knowledge to think about it or talk about. Information is stored at this level for only 15 to 20 seconds and either forgotten or forwarded to 3) long-term memory. Adding an emotional hook plays a key role in learning or long-term memory. Teaching for long-term memory is not about covering the material and encouraging memorization. Long-term retention may be more a matter of processing the information over time where more connections are made and memory is improved. Thus learning is enhanced by allowing students to reflect on the information, relating it to something they already know, and forming meaningful mental associations.

## Comparisons with Antique Items

One technique that has been found helpful for learning about radiation involves demonstration of antique glassware items that contain uranium oxide as a coloring agent. Items such as green depression glass, vaseline glass, and red Fiesta ware typically produce readings of one to five millirem per hour in contact (Johnson 2009). Students are shown the items and then invited to make measurements with their radiation meters. The students are asked to remember these readings and they are then invited out on the plant floor to measure the signal from an x-ray machine, an industrial nuclear gauge, or radium in pipe scale. Often the students will observe that the readings on the antique items are 10, 100, or 1,000 times greater than the signal from their licensed or registered radiation source, or from TENORM. From this comparison, students can see with their own eyes that their radiation source may produce a very small signal relative to antique items that would be considered innocuous. What students discover by their own hands is much more meaningful than being told that their radiation sources are not likely to be a cause for concern.

Thus, helping people learn about radiation is more than a matter of presenting good technical information on radiation. It involves presentations in a way that allows the middle brain to pass along the information to the thinking brain for rational analysis and understanding. This means the communicator needs to consider ways to reduce stress and resistance to hearing new information. Effective communication is a process that enables people to relate new information to what they already know, or experience that they have had or can identify with. The process also involves repeated evaluations of radiation risk perceptions, questions, and understanding as you gently introduce new information on radiation that may confront all that people have heard before. The approach that seems most helpful uses “show-and-tell” as much as possible to take the mystery out of radiation. Comparisons of the sources of concern (such as exposures to NORM or TENORM) with the radiation signal from radioactive antiques is helpful to provide perspective on magnitudes of potential radiation exposures (see the TENORM case study at the end of this chapter).

The radiation trefoil symbol has come to serve as learned reminder of the most deadly force known to man, the atomic bomb. By association with atomic bombs, everything involving radiation is immediately judged as automatically bad. Many years ago, while talking with a new neighbor, I mentioned that I worked for the EPA Office of Radiation Programs. He immediately broke eye contact, looked at the ground, and shaking his head backed several steps away saying, “Radiation, I don’t want anything to do with that!” Just the mention of the word radiation was enough to cause this man to back away in alarm. Because of my association with radiation, he responded as if I was somehow dangerous.

In classes I usually ask trainees, “What will happen to you if you are exposed to radiation?” In a recent class when a man was asked this question, he said, “I will turn color.” When asked what color he said, “Purple.” In another class, a woman said that she would get red bumps all over her body.

While the classes usually laugh at these answers, I do not treat them lightly. Whatever answer a person gives is providing some insight into the basis for decisions that they may make related to radiation safety. I also do not let anyone get away with saying that they do not know what will happen. When people say, “I do not know,” I like to come back with, “What could you imagine or what have you heard?”

## Hearing, Identifying, and Reflecting People’s Feelings about Radiation

Concerns for radiation safety are based on fears of radiation and the consequences of exposure. The only thing most people have heard about radiation is that “it’s bad.” For over sixty years the news media has built a mental mindset in the population that radiation is deadly and causes cancer or birth defects. Fears of radiation exposures can be addressed by inviting workers to examine the basis of their beliefs and values. This can best be done by asking lots of questions, such as:

1. What is radiation?
2. What do you think, or feel, about exposure to radiation or x-rays?
3. What have you heard or read about radiation?
4. Is it OK to be exposed to radiation?
5. If you are exposed to radiation, what will happen to you?
6. What’s so bad about exposure to radiation?
7. What are the risks?
8. What if you are pregnant?
9. What is safe?
10. Who decides?
11. How do we know?
12. What is the evidence?

While interacting with workers, it can be helpful to keep asking such questions, perhaps in different ways. The most important question is, ***"What will happen to you if you are exposed to radiation?"*** In a radiation safety awareness class, I do not allow workers to say, "I do not know!" This comes from experience that shows everyone has some ideas (images) of what will happen. When asking this question, you should be very careful not to discount any images or feelings people may share about radiation. All are OK. Hearing feelings is more important than giving detailed technical answers.

## How Radiation Safety Training Can Help with Worker Concerns for TENORM

The goal of radiation safety training is to help workers find a balance between being overly alarmed or overly complacent about exposures to radiation. This balance cannot be easily dictated by management. Each person needs to find their own balance and comfort zone based on factors such as knowledge, understanding, risk perceptions, feelings, images of consequences to radiation exposure, and peer factors. Training is typically oriented towards a transfer of knowledge of radiation, health effects, regulations, instrumentation, and safety practices. Training does not normally address matters of risk perceptions, feelings, fears, or images of radiation consequences. Technical trainers are usually not prepared to address these matters and may believe that if they do a good job conveying their technical understanding, then workers will have the same basis for decisions as the trainer and will behave accordingly. If the trainers do not do a good job, the workers may be more confused after hearing a technical explanation.

## Insights from the Myers-Briggs Type Indicator (MBTI)

**Decision Making.** MBTI insights show that about half of the population makes decisions on a thinking, logical, analytical basis ***(Thinking preference)***. The other half makes decisions on the basis of feelings, values, and personal circumstances ***(Feeling preference).*** The thinking approach is often favored by technical people who attempt to present information in a very logical, analytical manner. Alarm for radiation, however, is most likely a matter of feelings, fears, and risk perceptions. When these matters are not addressed, personnel who prefer to make feeling-based decisions are faced with logical analyses that do not connect with their personal values and needs to have their feelings heard.

**Data Gathering**. The majority of radiation workers (75% or more) are likely to prefer to gather information by their five senses in terms of what is tangible, factual, specific, practical, sensible, and directly observable ***(Sensing preference)***. Technical people, on the other hand, often prefer to present information in a more intuitive approach that involves imagination, patterns, abstract concepts, variety, innovations, and inspiration ***(Intuitive preference).*** Unfortunately, radiation does not give any data accessible by our five senses. Thus, for people who rely on their senses to warn them of danger, radiation may be viewed as an abstract concept of something that is mysterious, sinister, and deadly. Words to describe radiation are abstractions, even words on slides and handouts. Therefore, the normal training approach using handouts and slides may have meaning for those who prefer to gather data intuitively (usually a minority of 25%

or less), but may not meet the needs of the majority who prefer to gather information by their senses (Johnson 2004b, 2004c).

## How to Best Address Feeling and Sensing Preferences

The best way to connect with people who prefer to gather data by their senses and make decisions on the basis of feelings is by show-and-tell. Thus, as much information as possible about radiation should be presented by demonstrations. Actually, hands-on learning is even better. Matters of feelings and risk perceptions can be addressed by continually inviting workers to examine the basis for their beliefs and values. This can best be done by asking them lots of questions.

I like to repeatedly ask students to compare what I am saying with what they have heard or what they believe. I like to ask in different ways,

***"What will happen to you if you are exposed to radiation?"***

I believe everyone has some ideas (images) of what will happen. I am also very careful not to discount any images or feelings people may have about radiation.

I like to position myself as a resource for information to help people find their own answers. I try not to be the "giver of answers." My answers can always be discounted. Worker's behaviors will more often be guided by the answers that they derive themselves from their own observations and experience. That is why it is helpful to provide information that is as experiential as possible. Hearing and reflecting feelings are also an important part of the process for helping people find answers that are meaningful for them.

Asking questions may be the most helpful way to present radiation safety training. I like to encourage radiation workers to ask questions of themselves and of me. I encourage skepticism and invite questions about everything. I encourage people to seek information and proofs that are meaningful to them. I often tell students not to believe anything I say, unless I can prove it to their satisfaction. I like to ask continuously, "Is this information believable?" If attendees say yes, I then ask, "How do you know?" If they say no, I ask, "How come?" Such questions should be asked repeatedly every time new information is presented, especially if the data are likely to differ from what attendees have always heard before.

## How to Deal with Images that Drive Worker Concerns for Radiation

I would like to believe that better information can make a difference in the images or attitudes that workers may have about radiation. For such changes to occur, the workers need to be invited to compare new information that you may present to their previous experience or expectations. When they are aware of differences, it's important to talk about them right away. This may mean interrupting the class schedule to respond to skepticism from a single student. Pushing on in the face of skepticism is almost assuredly going to result in not meeting the goals for training. Remember, be gentle about confronting skepticism. You do not have to convince them of any particular answer. You are a resource for information, which they may or may not accept. The choice is theirs.

Workers may change their views when provided with new experiences, observations, or credible data from which they can revise their images. New images then give new perceptions and become the basis for a more informed understanding. For adult education it is important to note that some people need to have a dialogue with the instructor to assimilate new data, because they learn from what they hear. Others need to see the evidence for themselves, because they learn from what they see. Some will only learn when they have the opportunity for hands-on experience. Some will need time to reflect and digest the new information. We learn from what we can see, hear, touch, smell, or taste (Johnson 2006).

Approaches that enhance understanding by adults include:

1. Demonstrate new information by show-and-tell
2. Provide options for hands-on learning, such as handling instruments
3. Prove everything that you can by demonstration
4. Challenge the audience to verify everything that they can
5. Connect new information to experience or information that the workers already have
6. Use anecdotes that the workers can identify with
7. Anchor each learning experience with humor

There is an axiom for learning that says:

***"We learn to the extent that we can connect new information to information or experience that we already have."***

To enhance learning by connections to previous experience we need to use analogies, illustrations, demonstrations, stories, and real-life experiences that relate to the world of the workers in our class. To facilitate such connections requires knowing as much about the attendees as possible. This means asking lots of questions and paying attention to the answers, including the words, the feelings, and the body language.

## Reflecting People's Feelings about Radiation

The best answer for helping workers, who are afraid, is to hear and reflect their feelings. This does not mean telling the person, "I know how you feel." We can never be sure what another person feels and when we say we know, the other person knows we are not really sure. What we can do is to describe the feeling we perceive and let the other person correct our perception until they are satisfied that we know how they feel. This requires a dialogue in which you as the listener do not try to interpret or rationalize the other persons' feelings, but simply paraphrase and reflect back to the other person the feeling that you believe you are hearing. If the feeling you define is not accurate the other person will correct you. For example, a person says, "I don't want to go in the room with the radiation sign on the door." You reflect with, "The radiation sign makes you nervous?" "Yes, it makes me nervous, I might still like to have children." "You are afraid that radiation may affect whether you can have children?" "Yes, and I don't want my children to have three eyes." "So your real concern is that exposure to radiation may affect your future children." "Yes!" "OK, I also had that concern at one time and here is what I have learned from studies over the past 50 years."

You could have made assumptions about why this worker did not want to enter a posted room and attempted to provide answers right away. However, you would have missed the opportunity to connect with the other person's feelings and the real reason for their concern. By listening and responding to the feelings first you will establish a basis of rapport and credibility with the other person, whereby they may hear what you have to say. Otherwise, they may not be ready or willing to listen to your answers. When you go immediately to answers, you may also discover that your answers are not about what was really troubling the other person. Besides, fearful people are not always looking for specific answers, but rather they would like others to know what they are feeling.

Thus, one of the ways to deal with the worker concerns for radiation is to hear their feelings. This will require a dialogue with individual workers or in a group. Most technical people do not like to hear or attempt to deal with feelings, especially feelings of fear and terror. We want to give people our technical understanding rather than deal with their feelings. We usually believe that if people could understand our technical views then they would have different feelings and be less afraid. While providing technical answers may be helpful, it may not reduce people's fears. Dealing with worker concerns may be more a matter of dealing with feelings rather than dealing with technical answers.

***"People may not care how much you know, until they know how much you care."***

## The Most Powerful Tool for Effective Risk Communication - Active Listening

Perhaps our greatest challenge when talking with people about radiation risks is when the dialogue gets emotional. We may find ourselves not knowing what to do when our best technical data and logical analyses are not accepted by those who are afraid of radiation. What can we do when confronted with hypothetical questions which do not seem to have clear rational answers? How can we respond when our best answers seem to be causing the other person to become more and more upset? Suppose we do not have the data from which to give a good technical answer? Is there any hope?

The effectiveness of any communication is not about the message that we send, but the response of the other person, Thus, the best opportunity for communication is to start with what the other person is saying. This may be difficult for specialists in radiation safety when the information provided by the other person does not make any technical sense. Typically we want to hear good data for which we can apply our well developed analytical logic to resolve the problem and give an answer accordingly. When the other person appears to be speaking emotional nonsense, what options do we have? The answer is active listening. This may be the single most powerful tool for effective risk communications.

Active listening does not take ownership of the problem. In other words, we do not have to give a problem-solving answer. Active listening is also non-defensive and avoids a dozen roadblocks to effective communications. Active listening is based on the insight that every communication has two parts, a feeling or emotional part and a content part. By training and experience, we are usually very good at hearing the content part of a message. Identifying the feelings is more difficult. For technical types, it may help to suggest that all feelings can be captured by synonyms of four words, mad, sad, glad, and afraid.

An active listening response paraphrases the content and identifies the underlying feeling. For example, a person says, ***“Radiation, I don’t want anything to do with that!”*** An active listening response could be, “You are worried that radiation may be harmful for you.” By hearing the feelings first, we may find that the feelings are defused (when you really hear the feeling, the other person does not have to keep trying to express that feeling). Hearing feelings also opens the door for further dialogue and helps identify the real issues.

## Active Listening

This is an approach to verbally show acceptance of the other person and respect for his feelings. The statement of the man above invites us to give data to try to change his mind about radiation. As well meaning as such efforts may seem, however, they discount his feelings, which is his reality. Dr. Thomas Gordon (Gordon 2001) has identified 12 such categories of responses, including:

1) ordering, directing, commanding,
2) warning, admonishing, threatening,
3) exhorting, moralizing, preaching,
4) advising, giving solutions, suggestions,
5) lecturing, teaching, giving logical arguments
6) judging, criticizing, disagreeing, blaming
7) praising, agreeing
8) name-calling, ridiculing, shaming
9) interpreting, analyzing, diagnosing
10) reassuring, sympathizing, consoling, supporting
11) probing, questioning, interrogating
12) withdrawing, distracting, humoring, diverting.

Active listening is a way of responding that does not discount feelings. The listener does not send a message of his own, such as an evaluation, opinion, advice, logic, analysis, or a question. Instead, he responds with only what he feels the speaker's message meant, nothing more, nothing less. An active listening approach to the man above would take into account his apparent feelings. For example, an active listening response could be, **"Radiation is scary, isn't it?"**

The man then said, "Yes it is, because you cannot feel it, see it, or taste it and you have no way of knowing when you are being exposed." Active listening gives the other person permission to feel and express his feelings. All feelings are OK. Active listening does not try to change feelings. Whether we agree or not, we do not have to make the other person wrong for his feelings. We do not have to try to make the other person feel better. To do so, implies that their feeling is not OK and it needs to change.

## Listening is the Key

An important factor in dealing with people who are fearful is to deal with the images of losses. Although the fears will seem to be triggered by the presenting circumstances of radiation issue, the basis for the fears has to do with images of unacceptable consequences. Identifying the basis of fears is a matter of asking questions and listening, rather than trying to provide answers. This approach is called active listening or reflective listening.

The most important part of a communication is the response that you get. Responses are in two parts: verbal and visual. People will not only give a verbal response, but will exhibit body language that sometimes is more powerful than the words. Real listening is also more than hearing the data for understanding. Risk messages always include components of data and feelings. Active listening emphasizes hearing the message (data) and the feelings. The listener then reflects to the speaker the essence of data communicated and the feeling (s) perceived by the listener.

Most technical people find that active listening is not easy and may question whether it is worth the effort. Active listening is especially difficult for technical specialists in radiation safety, experts, and managers (especially for those who rely on logical thinking for making decisions). For most technical people, their natural response is to give answers. Their lives are about giving answers and the chances are that their roles as experts, supervisors, or managers are primarily as the "giver of answers." Now, there is nothing inherently wrong with giving answers. It's a matter of options. However, there are two precautions or questions to consider when giving answers:

***1. Are you answering the right questions?***
***2. Who owns the problem?***

When you give answers, you automatically take responsibility for the problem. By giving the answers, you may take away other people's opportunity to find their own answers. In other words, when you solve other people's problems for them, you may take away from their options or ability to solve their own problems. By giving answers, you may also set up opportunities for adversity. People have a vested interest in their answers, and may reject your answers.

Active listening is a way to hear and respond to another person's feelings without discounting their views or knowledge (or lack of knowledge). For those who have trouble identifying feelings (most everyone), remember that all feelings can be captured by synonyms of four words:

***"Mad, Sad, Glad, and Afraid."***

By reflecting your perceptions of one of these feelings, you open doors to the "real issues." The active listening approach also does not take away from other people's rights, responsibilities, and capacity to solve their own problems.

There are two axioms on listening that may be helpful to understand.

1. **Feelings are more important than what is said.**
2. **Listening is more important than solving problems.**

The best answer for a fearful person is to hear and reflect the feelings. You can do this by describing the feeling that you perceive. Do not interpret, but simply paraphrase and reflect back. If your paraphrase is not what the speaker intended, they will correct you. Thus, you do not have to identify the feeling exactly. Simply reflect the feeling the best that you can. For example, if you reflect, "That sounds really frustrating." If this is not accurate, the other person may say, "I'm not frustrated so much as I am angry with - - - - -." You can then reflect, "This - - - - - situation makes you angry." When you apply the principles of active listening, you open the door for establishing rapport as a basis for presenting your risk message. By this approach you also get down to the real issues of concerns for radiation risks.

The temptation for technical people is to go directly to technical answers, especially if the other person appears to be asking for answers or data. For example, if a worker says, "Radiation, I don't want anything to do with that," a technical person might respond with data that radiation is part of our natural world. Again, there is nothing wrong with giving technical answers, however, it might be better to establish rapport first by hearing the feelings. An active listening response could be, "Radiation is scary isn't it?" Hearing feelings first establishes rapport and credibility, because this approach shows that you care. Without establishing the feeling rapport the other person may not hear your answers. You may also discover that your answers are about the wrong question or concern. The fearful person also may not expect answers, they just want someone to hear their fears (Johnson 2004c).

## Responding to the Media or the Public

When a reporter or a member of the public asks questions that seem illogical or emotional, we should be wary of attempting to correct the logic. We may find ourselves making technically logical arguments, when the real issues of concern to the reporter or his/her audience are conflicts in views, values, and feelings. This is not to say that we should condone erroneous technical logic, but we might do better to deal with the feelings first and get the audience on our side before attacking differences in logic.

When we address the logic first we may find that we have won the battle, but lost the war. The reason that hearing feelings first is so difficult for managers and technical professionals is that we want to analyze the situation to figure out a solution. Health physicists, in particular, are generally very adept at problem solving. This is what we are good at and this is what we get paid for. Now, there is nothing wrong with problem-solving, which is often necessary for resolving issues. However, there may be pitfalls in moving to problem-solving too quickly.

We may discover that while trying to solve the problem, we are:

1. solving the wrong problem
2. solving problems, when the audience is not looking for answers
3. missing the feelings, which the audience wants us to hear
4. taking away the opportunity for others to solve their own problems
5. not allowing others to build problem-solving skills
6. inferring that others do not have the ***right, responsibility, or capacity*** to solve their own problems
7. giving our answers, that others can reject with the game of, "Yes, but ......."

Giving answers to problems may seem like the most expedient way to resolve the immediate issues, and that may be true. We have to consider the circumstances to determine whether a problem-solving approach will meet the needs, maintain or enhance credibility, and keep the doors open for continuing communication. As with all communications, ***"Its not a matter of right or wrong, but does our approach bring us closer to our communication goal."***

## Ask Questions First

Dealing with fears is not accomplished by trying to change people's minds. A better way is to begin with what people already think or believe and work backwards to science and understanding. This means asking lots of questions to determine people's feelings and images about radiation effects. The challenge is how to communicate in the form of questions rather than giving answers. People value their own answers more than the answers of experts. When the expert gives data, it may help to ask the audience if the data are believable. An even better way is to present new information by show-and-tell to demonstrate the properties of radiation and the principles of radiation safety: time, distance, and shielding.

## Responding to Questions about Radiation

The most helpful response to questions about radiation may be opposite to the normal approach of technical experts, which is to present factual information first. The following sequence is proposed for best addressing feeling concerns about NORM/TENORM radiation:

1. hear the feelings first, use active listening
2. check out perceptions and images by asking questions, rather than giving answers
3. establish rapport by identifying with the perceptions
4. share personal experiences
5. lastly, provide factual information.

Once the word “radiation” is spoken or heard, efforts to clarify or explain the technology of radiation safety may not be heard. A better approach may be to hear the feelings first. People are asking questions because of their fears of radiation consequences. Therefore, checking out perceptions, fears, and images may be the best place to start. This means asking many questions rather than giving answers. Hearing the feelings also helps to establish rapport and credibility. Identifying with the perceptions of radiation risks can be very helpful. Another option is to share personal experience and the last step is to provide factual information. For factual information to be helpful it has to be presented in terms the audience can relate to or can verify by their own experience.

## What to Say, When You Do Not Know What to Say (Five Keys to Impasses)

Suppose you are confronted with the statement, "I don't want any nuclear dumps poisoning my water and killing my children!" As a health physicist, you attempt to explain that radioactive waste disposal sites can be operated safely. The person then exclaims, "You work for the nuclear industry and you are paid to cover up for them. You just want to cram this dump down our throats. You think you can do anything you want, because you are so smart. You don't really care because you don't have to live here. Why should I believe anything you say?"

When you are confronted in this manner, you may find your stomach knotting up and suddenly you realize there are greater risks to deal with than radiation. How do you respond when challenged about your motives, your integrity, your honesty, your ethics, your competence, and your sense of caring. How do you avoid getting defensive when everything your life stands for, and your most cherished values, are challenged?

There are five ways you can respond non-defensively and keep the door open for a continuing dialogue.

**1) You can state your perceptions of the other person's feelings.** "You are worried about the effects of a radioactive disposal site on your family and you are concerned that I may be a paid spokesman for the nuclear industry and therefore not telling you the truth."

**2) You can state your own feelings.** "I hear the concerns you are sharing I am also concerned about the safety of radioactive waste disposal sites, and I feel badly that you would doubt my efforts to provide a helpful response to your questions."

**3) You can describe the situation briefly.** "You do not like the idea of a radioactive waste disposal site in this area and you have doubts about what I am telling you."

**4) You can state what you would like.** "I would like to hear all of your concerns and I would like to answer your questions the best that I can as a professional in radiation protection.

**5) You can ask the other person what they would like?** "I hear your concerns, how can I be most helpful for you in this situation?

The use of any of these responses is intended to help you to unhook from your own defensive feelings. At the same time, your response does not challenge, threaten, or make the other person wrong. Your response invites a continuation of the dialogue for mutual benefits.

## A TENORM Risk Communication Case Study

### Introduction

The Radiation Safety Officer for a large papermaking facility alerted his workers to potential for NORM exposures based on a report with results of surveys in pulp and paper mills for the presence of scales and precipitates containing NORM (Fisher and Easty 2003). Because of the alarm expressed by his workers, he called me to assist with a response to concerns for exposure to radium pipe scale. I went to the facility and met with supervisors and concerned workers at the beginning of a new shift at 6 am to answer questions and to provide information on TENORM. Following these discussions, I went with a team of workers to conduct radiation exposure measurements around the facility. The site study also included collection of samples and placement of radon detectors at pertinent locations. I also provided five (one and a half hour) sessions on NORM Radiation Safety Awareness to about 150 workers.

### Worker Questions on NORM

To help me prepare for talking with supervisors and concerned workers, the RSO sent me the following list of questions:

1. What is NORM and where does it come from?
2. How are we exposed to NORM?
3. How can we minimize exposures?
4. How long will NORM stay in my body if I am exposed?
5. Since I have cut alum pipes with a torch, and used a grinder on alum pipes, is it likely that I have been exposed to NORM?
6. How much NORM alum scale do I need to inhale or ingest to cause cancer?
7. What kind of cancer does NORM cause?
8. If I get cancer, can I tell if it was caused by NORM?
9. Am I going to die from NORM? If so, when?
10. Does smoking increase the risk from NORM exposures, like asbestos?
11. Will a regular dust mask protect me from alum scale?
12. How can I tell if I have been exposed?
13. Is there a way to quantify my exposure?
14. What should I do if I have been exposed?
15. What medical procedures will help me if I have had long term exposure?
16. What actions should I take after being exposed?
17. Should I spit out the alum and drink milk if I get it in my mouth?
18. What happens after NORM gets into my body by inhalation or ingestion?
19. How does the body metabolize NORM?
20. How concentrated is NORM in our alum lines and how can it be measured?
21. What should I do if I drop a pipe and NORM scale falls out onto the ground?
22. Are there ways to prevent NORM build up in alum lines?
23. Can NORM be extracted from bauxite before making alum?

24. Who regulates NORM and what do they say about exposure limits?
25. Are there regulations for safe work practices for handling NORM?
26. Does NORM cause radon and if so, what precautions should I take for working in confined spaces?
27. Is there danger working in areas with external exposure to NORM?
28. Could I get NORM on my clothes and carry it home to my family?
29. Will my family be harmed?
30. Is NORM from alum getting into the paper we produce?

## Report on NORM Exposures at the Paper Mill

To address the worker questions above, besides meeting with the workers and providing NORM awareness training, I also prepared an extensive exposure assessment report.

**Source of NORM.** The papermaking facility uses aluminum sulfate (alum) as an additive to paper. This material is derived from bauxite mined in Australia. Like any earthen material removed from the ground, the alum contains naturally occurring radionuclides, including isotopes of uranium, thorium, bismuth, radium, and potassium. Although the amount of NORM in alum is very small, over time the storage tanks, pumps, and pipelines in contact with alum collected deposits of various NORM radionuclides as scale on the walls. As these materials built up over a period of many years there were four possible modes of exposure to workers, as follows:

1. **Gamma radiation** emanating from the collected NORM that could result in external whole body exposures to workers.
2. **Inhalation of airborne NORM** as pipes or pumps are disassembled, cut apart, welded, or as a result of grinding.
3. **Ingestion of NORM** which might occur if workers got NORM on their hands that was then transferred to food items.
4. **Exposure to radioactive radon gas** released from buildup of radium scale in tanks and pipes.

My report reviewed each of the four possible modes of exposure. In the introduction to my report I also noted that NORM is not regulated in most states across the country. A few states have regulations for NORM primarily related to pipe scale from gas and oil drilling. The regulations of the U. S. Nuclear Regulatory Commission apply only to licensed radioactive materials which are related to nuclear power plants. Historically NORM has not been regulated because it is part of our natural world and not the result of human actions. In some cases, however, NORM has been enhanced or concentrated by technological processes. These enhanced materials have been called Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM). The enhancement of NORM as scale on pipes is an example of TENORM.

**External Gamma Radiation Exposure.** The report described how each member of the worker study group was provided with a portable radiation detector for measuring external gamma radiation exposures at locations of alum storage and pumping around the plant site. Before taking exposure readings, workers were shown how to measure the normal background signal from gamma radiation from outer space and emanating from the ground. The normal background readings were found to vary from about 5 to 10 μR/hr (micro Roentgen per hour). Although several radiation detectors were used, the report only included the results from one meter – a Bicron micro rem, extended low energy range, plastic scintillator, SN: C225C, in current calibration. This meter was the most sensitive and gave a good energy independent response over the range of gamma radiation energies expected from NORM.

For interpreting external gamma exposure readings, I provided the reference levels often used to evaluate NORM exposures, as shown in Table 1 below. These are 2,000 μR (20 μSv) in an hour or 100,000 μR (1 mSv) in a year. These levels correspond to regulations on radiation dose limits published by the US Nuclear Regulatory Commission (NRC - Title 10 CFR 20) in the units of 2 mrem in an hour or 100 mrem in a year. These are the limits that apply to members of the public for exposure of the whole body to licensed radioactive materials in unrestricted areas.

Note: a member of the public is defined as anyone who has not had training to qualify as a radiation worker. Also note that these public limits are far, far below any levels where any possible effects would be expected. Trained radiation workers are legally allowed 5,000 mrem or 5,000,000 μR (50 mSv) in a year as a whole body exposure and 50,000 mrem or 50,000,000 μR (500 mSv) to the skin, lower arms, hands, and feet. These regulatory limits are also below levels at which any effects would likely occur. Although NORM at the paper mill is not licensed material and thus is unregulated, the NRC public dose limits are often used to evaluate potential exposures to NORM.

**External Exposures to Pipe Scale** - The exposure readings and samples were obtained by the study team at all locations of interest throughout the paper mill. All of the readings were taken with the radiation detector in contact with the source. This means that for a person to actually receive the exposures measured by the detector, they would have to put their whole body in the same position of contact with the source. In most cases, only a person's hands would be in contact with the source. Thus, the corresponding exposure to the body would be a small fraction of the exposure to the hands. Typically the readings at one foot from a source were only about 5 to 10 percent of the contact readings. For example, the highest readings found were 3,000 to 4,000 μR/hr in contact with a pump flange, but at one foot away the readings were less than 300 to 400 μR/hr.

Note: these readings are well below the public whole body limit of 2,000 μR in an hour. Although there is no published limit on exposures to the hands for members of the public, for trained radiation workers the limit to the hands is 10 times above the whole body limit. Thus, the corresponding limit of exposure to the hands for the public would be 20,000 μR in an hour. Even at the highest exposure rates of 3,000 to 4,000 μR/hr, there is no way to ever get to 20,000 μR in an hour. While all the readings from external exposures to pipe scale would be below the hourly limit for members of the public, we also need to consider the annual public limit of 100,000 μR. For example, again looking at the highest reading of 3,000 to 4,000 μR/hr, to reach the annual public limit would require a person to sit on the pump flange for 25 to 30 hours. For all of the other sources, a person would need to have their whole body in contact with the source for 50 to 1,000 hours or more to reach the annual public dose limit.

It would not seem very likely during routine work or maintenance that anyone would hold their whole body in contact with any of these sources for any amount of time, much less for matters of hours or days. More likely, a person could be standing near one of the sources for short periods of time. However, as noted above, if a person is standing a foot away from any of these sources the potential exposures would be about 1/10 of the reported readings. Thus, a person would have to stand at a distance of one foot away for 250 to more than 2,000 hours to receive the annual public dose limit.

**Inhalation or Ingestion of NORM** Samples of NORM were collected by the study team at numerous locations. These samples were sent to a radiation laboratory for analysis by gamma spectrometry with a very high sensitivity solid state germanium detector. The results of these lab analyses were reported for Radium – 226 and Radium – 228 in units of picocuries per gram of sample (pCi/g). The highest results were found for a sample of scale scraped from a large open pipe no longer in service. Considerable effort was required to obtain as much as 5 grams of this scale material by scraping most of the area inside of the pipe. This piece of pipe was also not typical of other alum piping in that it was part of a stock line which had been removed after service for over 40 years. Most alum piping is replaced in 20 years or less and would have much less build-up of scale.

To understand what these measurements mean, the results were compared with amounts in grams that a worker would have to inhale or ingest in Table 2 below, to reach the Nuclear Regulatory Commission annual limits on intake corresponding to exposure limits of 5,000 mrem (50mSv) in a year.

Table 2 shows that inhalation is the exposure mode or pathway of most concern, by the fact that the limiting quantities for inhalation are about half of those allowed for ingestion. For the samples with the highest readings, the limiting quantities were 8 grams for Ra-226 and 7 grams for Ra-228. Since only 5 grams of sample were collected for the sample with the highest readings and then only with considerable effort, a worker would have to inhale more than the entire amount collected to reach the annual worker limit. This sample was also very hard and brittle. Therefore, not only was it difficult to remove by scraping, it would also be difficult to create fine enough particles to be inhaled.

Furthermore, as I explained in the training sessions, the lowest levels of intake resulting in cancers to radium dial painters in the 1920s were 100 microcuries (100,000,000 pCi) ( Rowland 2009). To reach such levels, a person would have to inhale or ingest from 3 to 180 pounds of material from various samples. Since the radium scale is associated with alum, it should also be noted that according to the Material Safety Data Sheet, alum is a strong irritant to eyes and skin. Therefore, contact with alum by inhalation or ingestion would cause considerable irritation (a burning sensation) and likely lead a worker to quickly take measures to avoid such irritation. Alum is also very bitter and if any is gotten in the mouth it would quickly lead a worker to spit it out and rinse to clear the bitter taste. Because of such irritation, it is unlikely that workers would have inhaled or ingested alum materials in the past.

**Inhalation Exposures to Radon – 222.** Radon- 222 is of potential concern since it comes from Ra-226. Anywhere that Ra-226 may be present, radon-222 may also be present in the air and represent an airborne pathway of radiation exposure by inhalation. The measurements were made with activated charcoal canisters. All of the radon measurements showed radon levels below 1 pCi/L.

The U.S. Environmental Protection Agency recommends that radon-222 levels should be reduced when measured above 4 pCi/L in a home that would be occupied for a lifetime. As noted, all of the results were far below the EPA action level of 4 pCi/L. Three of the measurements were < 0.4 pCi/L which was below the detection limit for charcoal canisters. All of these measurements were at levels that represent typical amounts found in normal outdoor air. These results are also typical of industrial buildings with large ventilation rates. The average radon level in homes across the country is about 1.3 pCi/L. Higher results could be expected in the homes of workers near the paper mill.

**Case Study Report Summary and Conclusions.** The RSO initiated a review of potential NORM exposures to workers at a paper mill and I was invited to meet with managers and workers to discuss radiation concerns, to take measurements, to collect samples, and to present training sessions on NORM Radiation Safety Awareness. I spent most of a day with a group of five workers and the RSO measuring and collecting samples of NORM materials throughout the plant site.

Measurements of gamma ray exposure rates from sources of scale in alum tanks, pipes, and pumps showed that even at the highest levels, workers would have to place their bodies in contact with the pipe scale sources for tens to hundreds of hours to reach the allowable public exposure limits. Since workers are not likely to place their body in contact with the sources, but possibly to work in the vicinity, such as a foot away, then they would have to spend many hundreds of hours to reach the public dose limit.

The study team also collected six scale samples from several locations. These were analyzed in a laboratory to detect Ra-226 and Ra-228. Two of the samples (solidified material from pipe leakage) had no measurable activity. The sample with the highest activity came from considerable scraping effort to collect 5 grams from a large piece of pipe no longer in service. The analyses showed that a worker would have to inhale 7 or 8 grams of the scale material from this pips (more than the collected sample) to reach the annual worker exposure limits of 5,000 millirem. Ingestion would require 14 to 26 grams of this material to reach worker limits. In addition to Ra-226 and Ra-228, other NORM nuclides may also be present, but these are the two normally of concern.

The sample measurements indicate that workers should take normal precautions to prevent inhalation or contamination of their hands when disassembling, cutting, or grinding pipe or components that may contain radium scale. These precautions would be normal for handling materials that have been in contact with alum, because alum is a strong skin and eye irritant.

Measurements of radon-222 showed all results were far below the EPA action level of 4 pCi/L. Workers might actually find higher levels in their homes in the area of the paper mill.

## NORM Radiation Safety Awareness Training

About 150 paper mill workers were provided NORM awareness training as ancillary personnel. Before presenting such training, I like to talk with the RSO or other managers about what they hope to gain from awareness training. Here are some of the questions that I use.

1. What does management want to accomplish by employee training?
2. What is the motivation of management regarding training?
3. What are the liabilities or risks to management that awareness training may address?
4. What are the goals for knowledge, attitudes, decisions, and behaviors?
5. What goals are stated and which are hidden?
6. How will you know when training is successful?
7. What information or perspectives do you want employees to hear?
8. What do employees need to know?
9. What do employees want to know?
10. How do employees view risks associated with their jobs?
11. What questions have employees raised?
12. What are employee concerns, fears, and feelings about radiation?
13. Do employees have issues of trust, credibility, and beliefs?
14. What is the safety culture from top management down?
15. What does management gain from successful training?
16. What do employees gain?
17. What do employees want from management related to training?

With answers to the questions above and a good technical understanding of potential radiation exposures at the facility, I like to prepare about to 60 to 90 minutes of non-technical information to help answer questions about radiation safety. While employees may have concerns for their safety, they often do not receive adequate information to judge for themselves. They often rely on the comments of co-workers or supervisors which may be misleading, inaccurate, and usually not responsive to workers' fears of radiation. Radiation safety awareness training can be very beneficial for helping ancillary personnel answer the question "Is it safe?" This question cannot be easily answered by a health physicist, however, without some discussion of "What does safe mean?" "How safe do we need to be?" "How safe is safe?" "Who decides?" and "How do we know?" Ancillary personnel may be guided to deriving their own answer for "Is it safe?" by an agenda that includes a review of workers' ideas about radiation, what we know about radiation effects, and a review of sources of radiation that are part of our everyday world (including radioactive antiques).

These sources are then compared to the radiation levels that may occur from NORM sources in the facility and the legal dose limits for members of the public. Ideally, workers would be provided an opportunity to take measurements on a collection of common radioactive items and antiques (uranium glazed dinner ware, lantern mantels, K-40 (KCl), depression glass, and vaseline glass) for comparison with NORM sources in their facility. When they do this they will often find that the antiques give readings of 10 to 1,000 times greater than the sources in their facility. With this information ancillary personnel can see from their own observation that the NORM sources in their facility may not warrant the fears for safety that they held previous to the awareness class.

Thus, plant workers are able to answer their questions about safety based on their own observations and not just the word of the instructor. Such training can go a long way towards answering questions about radiation safety. The best answers for the question "Is it safe?" are the ones that ancillary personnel derive for themselves rather than being given the answer by someone else.

The following agenda was used for the NORM radiation safety awareness class:

1) Introduction and review of ideas and views about radiation safety
2) What is radiation and NORM?
3) What do we know about NORM radiation risks?
4) Sources of radiation exposure in our everyday world
5) What are the regulatory guidelines?
6) Comparisons with NORM radiation sources at this facility
7) Are these sources safe, who decides, and how do we know?
8) Review, answer questions, and adjourn

The following information is to provide an explanation for each of the agenda items above.

## Why Not Just Tell Workers, "It is Safe?"

Although, "Is it safe?" is the main concern of ancillary personnel and radiation workers alike, I do not attempt to answer that question directly. Managers and their staff often want me to just tell them the answer. I have even experimented with starting a radiation safety awareness class by saying, "I have come to talk with you as a specialist in radiation safety and I know you are concerned for your safety so I would like to tell you that you are safe from radiation!" "OK, I have answered the main question, is that enough?" At this point attendees usually look back with blank or puzzled expressions as they attempt to comprehend what I have said. Of course my answer is not enough, because I have not given the attendees any basis for evaluating or accepting my answer.

Essentially the question “Is it safe?” is unanswerable or least not directly answerable without any supporting information.

**“Why Can’t We Simply Say, it is Safe?”** Answering the question is difficult at best for two reasons. First of all, what does “safe” mean to a particular person? For many people safe means “no radiation.” This view would seem to be supported by the linear non-threshold dose response model for radiation risks. Secondly, if I try to share what I believe is safe, the trainees can disagree and discount my views. Rather than trying to answer the question, a better approach may be to provide information and evidence from which the trainees can arrive at their own answers on what safe means for them. Choices on safety also involve feelings and feelings come from lifetime values. When it comes to values, everyone is an expert. Thus, everyone has a sense of what safe means, although everyone’s meaning of the word may be different. The answer to “What is safe?” is also related to perceptions of radiation risks and the images of consequences to radiation exposures. Perhaps the best way to answer the question “Is it safe?” is to provide information as given in the agenda above to allow ancillary personnel to answer the question for themselves.

Historically health physicists have also been hampered in responding to worker or public concerns for radiation safety by the LNT model which implies radiation risks down to zero dose. Thus, we have found it difficult to conclude or defend that any level of radiation is inherently safe, ie, without any risk. On the other hand, we have come to accept that typical occupational exposures are well within tolerable levels of risk, especially when compared to other risks that we confront everyday.

## Roles of Radiation Risk Perceptions (views)

I like to begin each NORM awareness class with invitations for attendees to share what they have always heard or believe about radiation. Why should we be interested in radiation risk perceptions or views on radiation? The answer is that perceptions drive beliefs, decisions, and reactions to radiation. Fear of radiation is the most common reaction. Understanding these fears is important for helping people to understand radiation. Without an understanding of radiation, fears may take over. People are most afraid of what they know the least about.

Even before trainees attend your class on radiation safety awareness, they will already have ideas or views about radiation and radiation risks. Trainees will then compare the information that you present with what they already believe, think, or feel about radiation. If their mental set or views are different than what you present, they may not hear your information or they simply will not believe you. Thus, for effective instruction of ancillary personnel, it is imperative to keep checking their views and inviting comparisons with information that you are presenting. While this may sound like an invitation to challenge the views of trainees, if you criticize their views, they may further disbelieve you. Therefore, it’s important not to make the trainees wrong for their views, but to offer alternatives with supporting evidence.

**Do Not Challenge the Views of Trainees.** The goal is to provide trainees with a foundation for making decisions about radiation safety based on an informed understanding. The process may invite attendees to confront the perceptions they have always held regarding radiation and this needs to be done gently with patience and caring. It's OK to invite trainees to question their own views, by providing alternative sources of insights or data.

**Can Radiation Safety Awareness Training Change Images?** I would like to believe that training can make a difference in the images or attitudes that ancillary personnel may have about radiation. For such changes to occur, personnel need to be invited to compare new information that you may present to their previous experience or expectations.

Ancillary personnel may change their views when provided with new experience, observations, or credible data from which they can revise their images. New images then give new perceptions and become the basis for a more informed understanding. For adult education it is important to note that some people need to have a dialogue with the instructor to assimilate new data, because they learn from what they hear. Others need to see the evidence for themselves, because they learn from what they see. Some will only learn when they have the opportunity for hands-on experience. Some will need time to reflect and digest the new information. We learn from what we can see, hear, touch, smell, or taste.

## Data to Support Conclusions on NORM Radiation Safety

After spending 15 to 20 minutes on reviewing worker's ideas about radiation, I then like to describe briefly what we know about radiation and radiation risks. We definitely know that very high levels of radiation can cause harmful effects and even death. And, although we have no evidence of effects at low radiation doses, we assume that effects may occur and apply the principles of ALARA for radiation safety. I also like to point out that contrary to popular beliefs promoted by the news media, "It is actually very difficult to harm someone with radiation." For those who may believe that no amount of radiation is safe, I like to describe sources of radiation in the world around us everyday. In particular, to demonstrate that we live in a sea of radiation, I like to lift up a 3 in. by 3 in. NaI detector to show the normal background reading. This detector usually gives about 30,000 cpm from cosmic and terrestrial radiation. I explain that the detector is only seeing about 1/4 of the actual number of gamma rays passing through the detector and the real number is probably about 100,000 gamma rays per minute. I then invite the class to consider if 100,000 gamma rays are passing through the detector volume about the size of a coffee cup, how many are passing through the volume of our body? We all conclude that the number is probably greater than one million gamma rays per minute from the moment we are born until we die. I usually ask the class if they wish they did not know that?

I like to point out especially that the largest source of everyone's radiation dose is probably from inhalation of radon decay products in their own homes. I also ask if anyone has measured radon in their homes and find that most have not. I conclude the presentation on radiation sources by showing an assortment of radioactive antiques that could be everyday items in someone's home. These items include uranium glazed dinner ware, green depression glass, and yellow vaseline glass. Besides demonstrating the radiation readings on these items with a GM meter, I also bring a black light to show how the glass items glow a brilliant green under UV light.

The next step in the NORM awareness class is to compare the information on everyday sources of radiation to the radiation sources in the facility and the legal dose limits for members of the public and ancillary personnel. For example, if the exposure rate near a radioactive material source 0.1mrem in an hour, it would take 1,000 hours to reach the public limit of 100 mrem in a year. I also like to ask personnel, "If you are standing in one spot near a source for 1,000 hours, wouldn't a supervisor want to know what you were doing there?

The last part of a radiation safety awareness class agenda is to invite the class to observe radiation readings on the radioactive antiques and to compare those readings with measurements around radiation sources at the facility. Ideally, it would be most helpful to have the attendees actually perform the measurements. Where possible, I like to pass out radiation meters to the class and have them come forward to observe readings on the antiques. I then ask them to remember those readings as we go out in the facility to take readings on radiation sources.

Based on comparative readings described above, ancillary personnel are able to answer the question "Is it safe?" by their own observations and I do not need to say anything more. By providing information and an opportunity for direct measurements by ancillary personnel, each person is able to answer their own questions about radiation safety. Thus the unanswerable question "Is it safe?" becomes answerable by each person and the answer is "their answer" not the answer of the instructor.

## Author's Experience with Radiation Risk Communication

After measurable fallout in the US resulted in a public uproar about not being told, President Gerald Ford issued an Executive Order to seven Federal agencies which directed that all information on foreign nuclear testing events and fallout be sent to the US Environmental Protection Agency for communication to the public. Since I was Chief of the Radiation Surveillance Branch, with responsibilities for monitoring all sources of radiation in the US, the assignment came to me to prepare daily press releases on fallout information.

Every day for about six weeks after each nuclear test, I would summarize fallout information in a press release, hand-carry it up the chain-of-command for approval by the Administrator and then take it to the press office by 4 pm for the evening news. On one of my earlier visits to the press office, where all the phone lines were active with calls from concerned citizens, I offered to help. I remember a call from a lady in Seattle who said, "It's raining, should I keep my children home from school?" Another lady asked, "I'm breast feeding my baby, should I stop?"

What I quickly realized is that my technical knowledge of radiation fallout did not prepare me to hear and respond adequately to people who were afraid of radiation. Hearing and dealing with fears was entirely outside of my training and experience as an engineer. There was no training available in those years on risk communication, since those words had not yet been invented. By coincidence, I was in a weekly men's group at church where listening to each other and providing helpful responses was part of our reason for meeting. Here I learned about a year long program to train counselors for hearing and responding to feelings. Because I had so much to learn, I went through the program three times. After the training, I practiced counseling for groups and individuals with weekly reporting to a supervisor for my own guidance and counseling for several years.

The first use of my counseling training came in 1978 when I was on a Federal response team to tell States about possible radiation exposures from re-entry of the Soviet satellite, Cosmos 954, which contained a nuclear power source. Fortunately for us, the satellite came down in Canada. If it had landed in the US, my job would have been to notify the State and counsel them on appropriate responses.

In 1979, the accident at Three Mile Island showed how public fears could be triggered by a nuclear incident. As part of the Federal response team, I worked with a social psychologist at the US NRC to address the psychological aspects of Three Mile Island. Drawing upon that experience and my counseling experience, I presented my first paper on radiation risk communication at the HPS meeting in Philadelphia in July 1979, "Communication – the Health Physicists Dilemma." Following that I was invited to be the dinner speaker at a REAC/TS course in Oak Ridge to address issues of responding to radiation fears. In 1980, I was invited to speak on the psychological aspects of Three Mile Island, with the NRC psychologist, at a joint dinner meeting of several HPS chapters in Cherry Hill, NJ.

In 1982, Allen Brodsky as the President of the Baltimore-Washington Chapter HPS, convened a Saturday afternoon meeting at his home to address public communication issues. Over 40 attendees agreed that we needed communication training. I volunteered to chair a committee with Larry Petcovic and Jim Deye to organize such training. We put together an all day workshop which included a presentation by staff from Johns Hopkins University using the Myers-Briggs Type Indicator (MBTI). At the time, Larry was enrolled in a year-long program at Hopkins on communication and community systems. I subsequently enrolled in the same program and also qualified by training and examination to present the MBTI. In 1983, Larry and I organized a Chapter sponsored two-day radiation risk communication workshop with about 15 attendees from around the country. Together we also presented a two-hour PEP session on radiation communications at the annual HPS meeting in Baltimore in 1983.

In 1984, Larry and I began writing monthly columns in the HPS Newsletter on Communication Insights, which we continued until 1989. In 1985, we began offering the MBTI at midyear and annual HPS meetings for several years. Eventually the MBTI was presented to over 5,000 people and groups including the American Nuclear Society, the

Canadian Radiation Protection Association, and the Conference of Radiation Control Program Directors. In 1985, after retiring my commission in the US Public Health Service, I began a consulting practice as the Communication Sciences Institute (which eventually became the Radiation Safety Academy).

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**Fig. 1  Models for Estimating Risk**

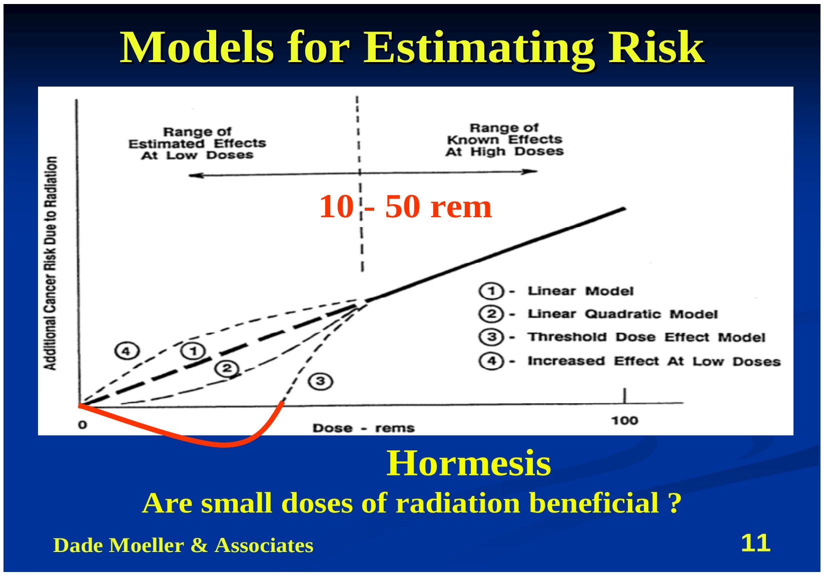

Table 1 – Regulatory Limits

| Exposure to | Whole Body | Skin and Hands |
|---|---|---|
| Public | 2,000 μR in an hour (2 mrem)*<br>100,000 μR in a year (100 mrem) | 20,000 μR in an hour (20 mrem)**<br>1,000,000 μR in a year<br>(1,000 mrem)** |
| Trained Radiation Workers | 5,000,000 μR in a year<br>(5,000 mrem) | 50,000,000 μR in a year<br>(50,000 mrem) |

Note: * 1 mrem = 1,000 μR

** A factor of 10 was used to extrapolate from public whole body doses to skin and hands, in the same way as for radiation workers.

Table 2 NRC Regulatory Annual Limits of Intakes for Workers

| Exposure Mode | Ingestion ALI pCi | Grams for Ingestion Limit | Inhalation ALI pCi | Grams for Inhalation Limit |
|---|---|---|---|---|
| Ra-226 | 2,000,000 | 25 – 1,700 | 600,000 | 8 – 500 |
| Ra-228 | 2,000,000 | 14 – 2,900 | 1,000,000 | 7 – 1,450 |

# Raymond H. Johnson, MS, SE, PE, FHPS, CHP

Director, Radiation Safety Counseling Institute 301-370-8573

- BS, Civil Engineering (1961) University of Vermont
- MS, Sanitary Engineering (1963) Massachusetts Institute of Technology (MIT)
- SE, Professional Sanitary Engineer Degree (1963) MIT and Harvard University
- PhD Studies, Radio and Nuclear Chemistry (1966–1972), Rensselaer Polytechnic Institute
- Greater Washington Institute for Transactional Analysis - Counseling (1977–1979)
- American Board of Health Physics Certification (CHP) (1983–present)
- Licensed Professional Engineer (PE, Sanitary) in Vermont since 1965
- Johns Hopkins Fellow, Organizational Systems and Communications (1984–1985)
- Past President and Fellow of the Health Physics Society (FHPS) (2000)
- President, American Academy of Health Physics (2013)
- Commissioned Stephen Minister – Counselor, United Methodist Church (2003–pres)

## *Experience*

| | |
|---|---|
| 2010 – pres. | Director , Radiation Safety Counseling Institute. Workshops, training, and counseling for individuals, companies, universities, or government agencies with concerns or questions about radiation safety. Specialist in helping people understand radiation, risk communication, worker counseling, psychology of radiation safety, and dealing with fears of radiation and nuclear terrorism for homeland security. |
| 2007 – 2012 | VP, Training Programs, Dade Moeller Radiation Safety Academy, training and consulting in radiation safety. |
| 1984 - 2007 | Director, Radiation Safety Academy. Providing x-ray and radiation safety training, audits, and consulting to industry (nuclear gauges and x-ray), universities, research facilities, and professional organizations. |
| 1988 - 2006 | Manager and Contractor to National Institutes of Health (NIH) for radiation safety audits of 3,500 research laboratories and 2,500 instrument calibrations a year, along with environmental monitoring, hot lab and analytic lab operations, and three accelerators and over 100 x-ray machine inspections. |
| 1990 - 2005 | President of Key Technology, Inc. a manufacturer and primary laboratory for radon analysis with over 1,500,000 measurements since 1985. Primary instructor at Rutgers University 1990-1998 for radon, radon measurements, radiation risks, radiation instruments, and radon risk communication courses. |
| 1986 - 1988 | Laboratory Director, RSO, Inc. Directed analytical programs and Quality Assurance for samples from NIH, Aberdeen Proving Ground, radiopharmaceutical companies, and the nuclear industry. |
| 1972 - 1985 | Chief, Radiation Surveillance Branch, EPA, Office of Radiation Programs. Directed studies of radiological quality of US, coordinated 7 Federal agencies for nuclear fallout events, QA officer 8 years. Head of US delegations to I.A.E.A and N.E.A. on radioactive waste disposal. ANSI N-13, (1975-1985). Retired PHS Commissioned Officer (0-6) in 1985 with 29 years of service. |
| 1963 - 1972 | U.S.P.H.S. Directed development of radiation monitoring techniques at DOE National Labs, nuclear plants, and shipyards in the US and Chalk River Nuclear Laboratory in Canada. |

## *Health Physics and Professional Activities*

Health Physics Society (HPS) plenary member 1966; President-elect, President, Past President (1998-2001), Fellow (2000), Treasurer (1995-1998); Secretary (1992-1995); Executive Cmte. (1992-2001), Chair, Finance Cmte. (1996-1998); Head of U.S. delegation to IRPA X (2000); RSO Section Founder and Secretary/Treasurer (1997-2000); Co-founder and President, Radon Section (1995-1996). Co-Chair Local Arrangements Cmte. Annual Meeting in DC (1991); Public Info. Cmte. (1985-1988); Summer School Co-Chair (2004); Chair, President's Emeritus, Cmte (2006); Chair, Awards Cmte. (2002); Chair, History Cmte. (2005-2012); Historian (2012-pres.), Continuing Education Cmte. (2005-2012). Academic Dean for HPS Professional Development School on Radiation Risk Communication (2010); PEP, CEL and AAHP Instructor; Journal Reviewer; AAHP Treasurer (2008 – 2011). AAHP President (2013). Baltimore-Washington Chapter: President (1990-1991) and Honorary Life Member; Newsletter Editor (1983-2005); Public Info. Chair (1983-1991), Science Teacher Workshop Leader (1995 – Pres.). New England Chapter: Newsletter Editor, Board of Directors, Education Chair (1968-1972). American Association of Radon Scientists and Technologists Charter Member (1986), President (1995-1998), Honorary Life Member (2000), Board of Directors; Newsletter Editor (1990-1993). Founder and first President, National Radon Safety Board (NRSB) (1997-1999). Member of American Industrial Hygiene Association (1997 – Pres.) (Secretary, Vice Chair, Chair, Ionizing Radiation Committee, 2009-2012), Conference of Radiation Control Program Directors (1997-Pres.), Studied H.P. communication styles and presented Myers-Briggs seminars to over 3500 H.P.s since 1984. Over 30 professional society awards. Registered Professional Engineer since 1965. Certified Health Physicist since 1983.

## *Publications*

Authored over 500 book chapters, articles, professional papers, training manuals, technical reports, and presentations on radiation safety. Author of monthly column, "Insights in Communication" HPS Newsletter 1984 – 1989, 1994 -2001, and 2012 – Pres.

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