Reclamation Closure Limits for Radium in Uranium Mines

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Summary: The author presents the basis for the rules for radium levels and radiation dose limits for Reclaiming Uranium Mines upon completion of mining. The Rules of the International Committee on Radiation Protection will be presented. The Legislative basis for the rules for signoff of reclaimed uranium mines are discussed. The practice of measurement of impact and license closure in the United States and in particular Texas will be discussed, in relation to the scientific and legal basis for such practices. This paper describes why the practice in the United States and Texas is not consistent with International Rules and the Federal and State laws. The reasons for this misinterpretation of the law is discussed. A practical solution is proposed.

Basis for the Rules: The basis for our rules is the Principles of ALARA. This stands for As Low As is Reasonably Achievable. This means economically reasonably achievable without unnecessarily use of resources without corresponding benefit to public health and safety. We all agree that the rules should be based on good radiation health physics data as we do not want to adversely impact public health and safety. We want to be regulated to health based standards. The regulation of radiation and the Issuance of Licenses based on "no significant impact to public health and safety", not only protects the public, but it also protects the industry from frivolous lawsuits based on inadequate public understanding of radiation and it's impact. Please notice this term as it is very important; "does not adversely impact public health and safety".

There is some considerable room for interpretation as to what "Reasonably Achievable" means. It is defined in the federal register as including economic factors and prudent use of resources. It means that a cost-benefit analysis for the regulation should be applied. The cost of reducing radiation exposure should be evaluated in relation to reduction in health risks. Another important term to remember; "cost-benefit". This means what is the value to society from the added cost of lower standards in relation to the improvement in health benefits.

International Rules: So what are the International rules from the International Committee for Radiation Protection and who is the International Committee for Radiation Protection? The International Committee for Radiation Protection is a United Nations Organization, organized as part of the International Atomic Energy Agency. The International Atomic Energy Agency is an United Nations Organization formed to promote the peaceful uses of Atomic Energy and to promote safe and proper rules and disseminate information for developing peaceful uses for Atomic Energy. The International Committee for Radiation Protection is a Committee of professional scientists from many disciplines and a variety of nations, but including Radiation Health Physicists, Medical Doctors, and Environmental specialists. This committee commissions studies and reviews radiation health physics information and promulgates rules as guidance to National Governmental Radiation Regulation Commissions such as the U.S. Nuclear Regulatory

Commission. This body has been in operation for many years and now is in a lengthy process of revising the basis for the rules and reconsidering some rules

However, the ICRP has just reconfirmed some long standing rules after a lengthy process of considering input from and meeting with stakeholders such as the World Nuclear Association (formerly the UI) and the U.S. Nuclear Energy Institute. Both of these bodies represent the business interests of companies that actually have to live with and practice these rules, two organizations that consist of very important stakeholders; the uranium miners and other fuel cycle facilities such as Converters, Enrichers and Fabricators and also the Nuclear Utilities that use this fuel.

I have been involved with a Committee at the World Nuclear Association that has been working with the ICRP to provide input from the international regulated community. We have had a favorable impact in resisting a further and unnecessary reduction in the radiation and radium standards for reclaIming uranium mines. There was no health data justifying this unnecessary and costly attempt to reduce the standards which have been in place for more than 30 years. These standards have operated very well in protecting "public health and safety" for more than 30 years.

So what is the Radiation Standard for Release for Unrestricted Use for Uranium and other Fuel Cycle facilities and for Nuclear Power Plants? This term "Release for Unrestricted Use" means the standard for closing the Radioactive Materials License and releasing a reclaimed site to full access by the public. The ICRP standard is 100 millirems (1 millisievert) above background. This is a dose standard which has been determined to cause no adverse health impact from reclaimed fuel cycle facilities. This is a standard, below which one must consider whether it is As Low As is Reasonably Achievable. Even if this level is reached, one should consider if it is feasible to further reduce the radiation to as low as is economically feasible considering the cost benefit analysis. In other words, "is the benefit to public health and safety worth the added expense".

So what does this translate to in terms of radium concentrations in soil, which is our primary concern in reclaiming uranium mines? It is roughly equivalent to 30 picocuries of Radium 226 above natural radiation present at the site prior to initiation of mining activities.

U S Nuclear Regulatory Rules The U.S. Nuclear Regulatory rules which are promulgated in the Federal Register and should be read completely in context are as follows: If the site is less than 5 picocuries Radium 226 in the first 6 inches of topsoil and less than 15 picocuries in the second and third six inches, then no further action is required. If the Radium 226 is higher than 5 picocuries per gram in the top 6 inches of soil or higher than 15 picocuries per gram in the second six inches and/or in the third six inches; then one can get the site released based on radon emanation of less than 20 picocuries per square meter per minute. No sampling density is including in the regulation, that is provided by Guidelines which have not gone through the Rule Making Process. The Rule Making Process provides for public hearings and input from uranium miners and provides "due process" to the regulated community. Guidelines are merely suggestions.

So what is this strange rule based on? The entire concern here is radon exposure to the nearest real person, which needs to be less than 3 picocuries per cubic meters ambient air standard as measured at the nearest residence. None of our sites exceed these limits even before reclamation. Obviously, this is not in accordance with principles of ALARA. We should reduce the radation health impacts to As Low As Reasonably Achievable. The radium portion of this rule was to relate radium levels in soils to radon emanation rates.

Based on very many field measurements, I can attest to the fact that this calculated relationship of 20 picocuries of radon emanation from 5 picocuries of radium is very, very conservative. For example, at the Mt. Lucas site of Everest in Irrigation plot 1, the average radium concentration in the top 6 inches is 22 picocuries per gram and the measured average radon emanation is about 2.5 picocuries if I remember correctly. The radium is more than 4 time the 5 picocurie per gram concentration and the radon is below the EPA indoor radon standard. Obviously, even with seriously elevated radium levels above background, the radon emanation is acceptable.

So what DOSE does the Nuclear Regulatory Commission rules determine are "not adversely affecting public health and safety"? It has been 100 millirems (1 millisievert) above background which is the ICRP rule. However, the U.S. Environmental Protection Agency has been trying to establish 25 millirems dose above background per year. This is based on their opinion that they have the right to regulate public health and safety in spite of the Atomic Energy Act delegating that regulation to the U.S. Nuclear Regulatory Commission. How can they do that? They claim that the U.S. NRC rules do not properly protect public health and safety. So what does 25 millirems per year above background relate to in radium concentration in soils? About 5 picocuries per gram in the top six inches.

So, 5 picocuries per gram is a very safe number for the regulatory bodies to use, which does not require them to understand the scientific basis for the protection of public health and safety. However, the 5 picocuries rule is not based on proper understanding of the rules and how they are to be used to protect public health and safety. The Regulatory Agencies have simply reduced the number to an easy number to understand and if the industry will accept it, the Regulatory Agencies have no problem. This rule of 5 picocuries per gram in the top six inches is clearly more restrictive and unnecessarily expensive than the health based rule of 100 millirems of dose which is the law of the United States and which the ICRP has determined does "not adversely impact public health and safety".

In fact both the Federal Register and the Texas Radiation Control Act, in their preamble, state that if the Program Administrator for the Regulatory Agency can agree, after examining the proposal of the operator, that the proposed action (release for unrestricted use) does not "adversely impact public health and safety" then the Administrator may take exception to any or all of the rules. I contend that this allows the administrator to use his good professional judgment to examine the situation and to apply appropriate radiation health physics rules to determine that the operator has expended sufficient time, money and resources and that additional expenditures do not materially improve public health and safety proportional to the costs of further reduction in health risks. Provided that the dose is less than 100 millirem per year, the site should be released based on their evaluation that the operator has reduced the radiation on the site to lower than the "dose that does not adversely impact public health and safety" and has satisfied the

requirements of ALARA as the further expense is not producing an equivalent reduction on the impact on public health and safety.

The proper application of the NRC and State Laws by Radiation Health Physicists that understand the science and the basis for the Rules is the function of the Regulatory bodies. Why should we be interested in the proper application of these rules? To use 5 picocuries of radium per gram as the standard, instead of 100 millirems of dose (equivalent to 30 picocuries) does not impact public health and safety in a meaningful way as determined by well qualified scientists with the ICRP, yet it has been estimated and is built into the closure cost for each nuclear power plant that it costs $50 million added closure costs for each nuclear reactor in the U.S. to reduce the radium from 30 picocuries to 5 picocuries. This is more than $5 billion in closure costs for U.S. Nuclear Power Plants.

At one site, the Lamprect and Zamzow in situ uranium mines in Live Oak County, Texas, operated by Westinghouse and IEC, and reclaimed under contract by my company Cima Energy, there was never any radium levels as high as 30 picocuries, yet I have personally spent more than three million dollars of my own money and eight years reclaiming this property to the 5 picocurie standard and arguing with the Texas Department of Health, Bureau or Radiation Control about these issues. The cost for mining uranium are dramatically increased by the application of a standard that is not based on protecting public health and safety. It is bad administration and bad science.

The law and the rules provide for reasonable interpretation by the Administrator to resolve these conflicts. This rarely happens as it is easier for an Administrator to enforce 5 picocuries by refusing to consider any arguments. The time and cost for convincing a regulator to apply his professional judgment is usually not worth it and the operator gives in. Appeals to the higher authorities in the government, such the Governor of the State of Texas or the Commissioner of Health or the Chairman of the House Environmental Committee, which I have done, usually fail as the politicians who work for the voters do not want to be involved in radiation issues, and the bureaucrats that work in the executive branch do not want to make any decision that can be considered controversial. So, in Texas, in spite of two lawsuits and five years of presenting information and fighting their delaying tactics, I and my banker, now give up and nothing is happening to release the sites and yet these no health hazard on this site and the Court is holding up reimbursing Cima Energy, $1,4 million of my money that I previously spent on reclaiming these sites.

Sampling There is an NRC guideline which describes how to determine the radium levels at a site. Guidelines are not the law but merely a proposed method for the operator to consider. Of course, if the operator chooses another procedure, the agency will not consider the data.
The guideline provides that the radium is sampled on a ten meter by ten meter grid. It is the average radium level over the 10 meter by 10 meter (100 square meters). The radium is supposed to be sampled at the corners of the grid and at the center. The baseline is measured on adjacent 10 meter by 10 meter grids that have not been impacted by mining. Gross gamma surveys are taken on a 10 meter by 10 meter grid to correlate to soil radium levels as sampling soil by chemical analyis for radium is too expensive. Soil samples are taken at representative locations and radium is measured chemically in the laboratory. The cost of analysis for one sample for

radium is about $60. It takes three samples at each point from successive six inch intervals; 0-6" depth, 6'-12"depth, and 12"- 18" depth. So each point cost $180 to analysis. It is impossible to sample the surface this way and take sufficient samples to ensure an accurate average for the site as the radium is not distributed evenly, these are just isolated spots. Sampling accurately a non uniform solid material is a very expensive and difficult procedure. However, correlating gross gamma to radium levels is very imprecise.

The current procedure is completely illogical. The radium is tightly bound to the clays, which are present in all soils, and is immobile. The radium is not the hazard, the gamma radiation is the hazard to public health and safety. The NRC rules are: less than 20 picocuries radon emanation, less than 3 picocuries radon at the nearest residence, and less than 100 millirems annual dose on site average over the site. We measure the gamma radiation and correlate gross gamma to radium levels in soils and then estimate radon emanation and impact on "public health and safety" based on a estimation technique that provides more than 40 times safety factor in the estimate of radon emanation as demonstrated repeatedly by actual site data.

At the IEC site, we reclaimed approximately 83 hectares. We did a 5 meter by 5 meter grid gross gamma survey using GPS to locate the grid points and sample points.This is twice the statistical accuracy required by the rules. If we had sampled all 8300 of these 100 square meters squares at the four corners and the center of each square in the grid, we would have had to sample 18,260 points with three depth levels of samples. These 54,670 samples would have cost $3,286,800 to analyze. So we sampled a representative set of grid squares to correlate the gross gamma to radium levels. The first time we did this we found some spots higher than 5 picocuries and reclaimed and resurveyed. When we submitted the data the State refused to accept it, so we resurveyed again. We also did a radon survey which showed that the average radon (100 locations surveyed) emanation was less than the national average for soils and less than the indoor radon standard of the EPA. There are two 100 sq. meter grids which are slightly above 5 picocures by correlation, yet the State has yet to agree on the plan for reclamation for the last five years.

The costs for removing and hauling soil from this site in Texas to the White Mesa Mill in Utah is about $300 per cubic meter with the cost of mixing the soil to meet the 5 picocurie standard is about $6 per cubic meter. To expend this kind of money to reduce the radium from 15 picocuries to 5 on a portion of the site, is not in keeping with ALARA, when Mixing the Soil laterally and vertically will achieve the same impact at significantly lower costs. Especially since the ICRP Standard for Release for Unrestricted Use is 100 Millirems above background equivalent to 30 picocuries per gram.

It is ironic, that we measure the gross gamma, correlate it to radium rather imperfectly, and the reclamation criteria is radium in soil; which itself depends on a poorly documented and inaccurate correlation to radon emanation.. When we have already measured the gamma that is impacting the public health and safety and the radon emanation, this is very illogical and ineffective. Why not measure directly those things that directly impact human health and safety; Gamma Dose, and radon emanation. The radium concentration in soil does not impact the public health and safety as we must examine the pathways to human exposure. To measure gross

gamma, correlate it to radium, so we can then estimate the radon at the nearest residence and estimate the gamma dose is not using science properly.

Recommendation We now can purchase at reasonable costs gamma spectrometers suitable for use in the field. These meters are used for mineral exploration surveys and by Homeland Security for detecting radionuclides in packages crossing the border. The handheld version costs about $10,000. It will measure Gamma dose based on the part of the gamma spectrum that impacts the human body. It also will measure the radium by measuring the portion of the spectrum that is due to radium. It corrects for potassium 40 gamma that is always present in soils.
By surveying with an instrument that measures DOSE directly we measure in relation to the rules and do not depend on poorly correlated relationships that are not demonstrated in practice. Why not directly measure the radiation that impacts "public health and safety" ; Gamma Dose and Radon Emanation. Indeed, I personally have never seen a site that is above 100 millirems annual dose above background and above the indoor radon standard, even while in operation, much less reclamation. Much ado and costs about nothing that impact adversely public health and safety. Why are we alarming the public with rules that classify sites as contaminated that do not violate health and safety rules and add unnecessarily to the costs of reclamation?

Our current laws are rules that are based on the Uranium Mill Tailings Reclamation and Conservation Act of 1979. These rules were instituted because some home developer built homes over an abandoned and unreclaimed mill tailings in Grand Junction, Colorado. This site was operated under contract with the U.S. Government and unreclaimed. It is the radon in the basements of these homes that was the problem this law was supposed to remedy.

I suggest that it is time that the law is clearly written to protect public health and safety to the 100 millirem above background Annual Dose Standard and a Radon ambient air standard of 4 picocuries which the EPA has determined is safe in our homes. Provide clear provision requiring principles of ALARA to require the operator to provide information showing that the operator has made sufficient efforts to reclaim to a lower radiation level, and that further expenditures of time, money, and resources are not cost effective. Provide that lower cost procedures that provide the same reduction in radiation risks do not require the approval of the Regulatory Agency, only measurements when the operator believes the reclamation is finished. The current law and rules are based on bad legislation and bad science. It would be well worth our time to join forces with the Nuclear Power Industry to lobby Congress for a properly crafted law that takes what we know from these 26 years of operating under a poorly written law and poorly written rules and provides clear rules for protecting public health and safety. Then the Public will understand that our projects are not harmful to public health and safety and we can spend money on more productive areas of environmental protection.