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July, 28 2008

The NRC Commissioners:

Attached are supplement information as to why the Department of Energy - Yucca Mountain Project (DOD-YMP) License **application for should be denied** on the ground of non compliance with Federal Acts and Regulations and finally incomplete scientific data to support DOD-YMP **License application** (see scientific review attachment).

The Department of Energy (DOE) submitted its license application to the Nuclear Regulatory Commission (NRC) on June 3, 2008. The License Application (LA) is deficient in many ways. One important deficiency is that it fails to address the issue of risk assessment of complex mixtures: first, mixtures of chromium and nickel are highly potent carcinogens, and finally, a mixture of radionuclide (plutonium and neptunium) and heavy metals). The Department of Energy has knowledge of both laws and regulations that cover how to submit an accurate and complete application for a license to build a nuclear facility. Why have regulatory agencies ignored the following laws and regulations?

First, NEPA Act 1969 Sec. 101 [42 USC § 4331] section **3 states "...that attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences."** Furthermore, **NEPA regulation 40 CFR Sec 1508.7 states that "Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal).** Why did the Department of Energy not discuss the health hazard of complex mixtures to population which could be synergistic mixtures in the License Application submitted to the NRC?

Next, why has the regulatory agency ignored studies of the synergistic effects? In the Drinking water Amendment 1996 Section. 300j-18. (a) Subpopulations at greater risk clearly directed regulatory agency to **"conduct a continuing program of studies to identify groups within the general population that may be at greater risk than the general population of adverse health effects from exposure to contaminants in drinking water." Additionally, section** of the (3) **develop new approaches to the**

study of complex mixtures, such as mixtures found in drinking water, especially to determine the prospects for synergistic or antagonistic interactions ...

Finally, YMP my question how YMP is going to is going to protect employees against Zeolite hilly potent cancer causing agents such Mordonite and Eronite (4 to 100 times more potent than asbestos) during YMP tunnel construction? This question should have been spelled out very clearly in the License Application. But, I have hard time to find the correct answer in the LA!

Has the DOE fully complied with NRC regulations Section 63.10 (a) and (b) of 10 CFR 63? Which stated the following "require the DOE must submit a complete and accurate license application; and § 63.10 (b) report a significant implication for public health and safety... licensee fails to notify the Commission of information that the applicant or licensee has identified as having a significant implication for public. It seems absolutely clear that the DOE has not complied, and the application for the license should be denied.

If you have any questions please feel free to communicate with me either by e-mail at drjacobpaz@gmail and/or by phone at 702-309-3780.

Yours,

Dr. Jacob Paz

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A Review of Health Risks due to Complex Mixtures in a Geologic Nuclear Waste Repository

Jacob D Paz,[*] William G. Culbreth[+], Delbert Barth[*]

[REVIEW]

ABSTRACT

The authors have conducted an extensive review of the scientific literature related to several aspects of the nuclear repository safety. We have identified several areas where additional scientific studies are needed to ensure public safety. New phenomena outlined in this review should be further investigated before the licensing of any geologic repository for radioactive waste storage. The potential toxicological interactions between radionuclide's and heavy metals must be further studied and is an area of a major concern. In addition, recent scientific studies involving exposures to Cr, Ni, As, and ionizing radiation have yielded contradicting results. In some instances, literature has indicated synergistic effects and in others, antagonistic effects. It seems clear that additional studies are needed to elucidate the mechanisms underlying these findings. Finally, the health impacts of combinations of heavy metals and radiation leading to the bystander effect on cells are not known. Critical analysis of the available literature has indicated that there are outstanding scientific issues that can potentially lead to public health problems if not further investigated before licensing application to the Nuclear Regulatory Commission.

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Key word: interactions; synergistic, antagonistic, complex mixtures, radionuclide, heavy metals, risk assessment, high nuclear repository, bystander effect and public health.

INTRODUCTION

Repository Design

The proposed nuclear waste repository at Yucca Mountain, Nevada, will be the nation's primary destination for permanent storage of high-level nuclear fuel assemblies from civilian power plants and from the Departments of Defense and Energy. This waste contains radioisotopes with shorter half-lives that present significant health risks for approximately 300 years. Long-lived radioisotopes including fission byproducts, plutonium, and uranium, present additional health risks as they are released to the environment over time. Waste will be placed in cylindrical containers with high-nickel chromium alloy and stainless steel layers to retard corrosion. These containers are to be placed in drifts 300 meters below the surface of and approximately 250 meters above the groundwater. Over time, the containers will corrode and leach both heavy metals (Cr, Ni, Fe, Mo, V), and radioisotopes into the surrounding volcanic tuff and, eventually, into the habitable environment.

Several technical critical areas have been identified that require additional scientific input since they have not been fully addressed by USDOE-YMP in their Final Environmental Impact Statement and other documentations. These include: a) risk assessment of complex mixtures, b) interaction between biological effects of ionizing radiation and heavy metals, c) and metal corrosion, the radiation bystander effects. These items and their health impacts are all interrelated in a manner not yet understood. These scientific issues are complex in nature and need additional study.

LITERATURE REVIEW

A major concern at Yucca Mountain Project (YMP) is the ultimate health risk to human populations in the future due to canister failure and the subsequent migration of radionuclides and heavy metals into the groundwater. The large amount and high-level of radioactive nuclear waste from commercial power plants and other nuclear waste source's may present long-term health hazards. Various countries, including the United States, are exploring the storage of high-level waste in geologic repositories as a viable method for providing human and environmental safety. The United States has progressed through the study of a single site for storage at Yucca Mountain, Nevada. These studies and an analysis of remaining problems are of concern internationally for entities preparing geologic storage for high-level radioactive waste. The U. S. Department of Energy Yucca Mountain Project (USDOE-YMP) is planning to submit a license application for the Yucca Mountain Site to the Nuclear Regulatory Commission (NRC) sometime in 2008.

The authors have identified several areas where additional scientific data is needed prior to license application. It appears that there are several major uncertainties and scientific data deficiencies that must be addressed by additional research before the proposed YMP high level nuclear waste repository can be approved as the nation's first such repository. This conclusion is in sharp contrast to what was ~~that~~ expressed in a recent commentary by (Macilwain 2001). He stated that the only real scientific concern involves possible future volcanic activity in the Yucca Mountain region. In the current paper, several scientific issues and uncertainties associated with approval of the Yucca Mountain site as a high-level nuclear waste repository are discussed. This literature review will be focused primarily on; interactions between metals and radionuclides, radiation bystander and effects and the metals gnomonic instability and possible health risk associated with the proposed High-Nuclear Waste Repository.

Metal Corrosion Issues and Radionuclides and Heavy Metals: Sorption Rate and Distribution Coefficients (K_d).

In the Final Environmental Impact Statement (FEIS) (2002) for the Yucca Mountain Project, the composition and the amount of various substances to be buried included 86,000 tons of Alloy 22 containing 22.5% Cr, 14.5% Mo, 57.2% Ni and 0.35% V; along with 140,000 tons of stainless steel which is 17% Cr, 12% Ni, and 2.5% Mo with Fe comprising the remaining percentage in the (FIES 2002). This is in addition to the 77,000 tons of high level nuclear waste to be buried at YMP. The authors believe that the health risk posed by the potential releases of a fraction of this amount of heavy metals along with radionuclides is remained unknown and must be further investigated. In order to assess the public health risk associated with the behavior of radionuclides in the environment, knowledge of the partitioning of each radionuclide between different phases is required.

This requires information on the basic physicochemical properties of the radionuclides, soil/mineral surfaces, and colloids/particulates. A distribution coefficient (K_d) describes the partitioning of radionuclides between the solid and aqueous phases of a system and ultimately provides an estimate of each radionuclide's transport interactions and movement via the groundwater pathway. While, the authors of (USDOE-YMP 2000)] stated that "it is assumed that sorption parameters measured for a single radionuclide are applicable for the case where more one radionuclide is present, that is assumed that competitive effects are negligible (assumption 5 section 5; requires conformation for the near-field)."

In the author's opinion, when modeling sorption, the YMP Performance Assessment Model YMP did not consider the competing effects of radionuclides between heavy metals. While sorption properties of individual radionuclides and heavy metals may be known (mostly in the near field), has not been completely studied what is the variations in these properties when two or more radionuclides and heavy metals may or may not be present. For instance, a canister must degrade before the radionuclides can be released. Therefore, heavy metals such as Ni, Cr, V, Ti, and Mo will likely migrate from the site first and be adsorbed within the near field. This limits the number of soil binding sites for subsequent radionuclide sorption. YMP assumed that competitive effects are negligible. This requires additional large-scale testing confirmation near-field and far-field conformation.

It is the authors' opinion that the following questions must be answered scientifically because these phenomena ultimately will have an effect on the potential health risk to the population. First, ~~what is~~ the long-term impact of elevated temperatures on fracture formation is unknown. Only very limited relevant data is available on the cooling effects following a prolonged period of time and the impact of increasing fractures. There is a good probability of fracture formation leading to the increased migration of water into the repository through additional fracturing of the rock in the YMP. This would accelerate the rate of canister corrosion due to contact of metal with water, ultimately increasing the release rate both of radionuclides and heavy metals into the environment. We also believe that an additional large-scale study is needed to verify test results obtained in the laboratory and to reduce the scientific uncertainties associated with the YMP environment and corrosion.

The potential environmental risk posed is highly uncertain and it must be addressed by original research. We also believe that the elevated temperatures of 140 to 160°C will kill and could sterilize most of the microorganisms found in the YMP environment. The oxidation-reduction reactions and the potential of acid corrosion caused by sulfur bacteria should also be addressed by research. Microorganisms could also contribute to the accelerated corrosion of canisters. The long term effect of elevated temperature on microbial population in the future is remaining unknown. This problem area has not been fully investigated or reported in the (FIES 2002).

The U.S. Congress created the U.S. Nuclear Waste Technical Review Board (NWTRB) in the 1987 amendments to the Nuclear Waste Policy Act to review the Department of Energy's (DOE) technical and scientific activities related to disposing of the nation's commercial spent nuclear fuel and high-level radioactive waste. These activities include characterizing the Yucca Mountain site, as well as packaging and transporting the waste. The Board; makes scientific and technical recommendations to the DOE before decisions are made, not after the fact.

There has been debate within the scientific community: At least two studies presented to the Nuclear Waste Technical Review Board by the State of Nevada consultants, based upon laboratory studies concluded that these metal canisters could ~~be~~ corrode under various laboratory conditions (Staehle et al 2001). In addition, the State of Nevada recently stated that corrosion rates vary from 0.1 mm to 1.0 mm per year, ~~and~~ may increase and reach a peak value of 10 mm per year, (Pulveireti et al 2001). One study suggested that C-22 Alloy developed a "protective layer" that forms as a result of the corrosion of Alloy C-22. In contrast to the state of Nevada reports (Blink 2001) stated that this Alloy has been proposed for use in the spent nuclear fuel canisters. In our opinion, the protective layer could break down due to physical mechanisms such as mechanical abrasion, rock falls, and seismic activity any or these which will accelerate corrosion of canisters.

The NWTRB made the following comments on metals corrosion in the past few years to USDOE. A letter dated November 23, 2003 from the NWTRB and addressed to Dr. Margaret Chu, Director of the Office of Civilian Radioactive Waste Management (OCRWM), discussed the Board's evaluation of experimental data submitted by the state of Nevada. The NWTRB indicated that they believed that all environmental conditions necessary to cause localized waste package corrosion will likely be present during the thermal phase at the repository. Operation of the repository at temperatures greater than 140°C is likely to cause localized corrosion due to the deliquescence of salts on waste package surfaces, NWTRB, 2000. Concentrated brines formed by the deliquescence of calcium and magnesium chloride salts will likely lead to localized corrosion.

At a recent meeting of the US Nuclear Waste Technical Review Board) on May 18-19, 2004, in Washington D.C., the potential local corrosion of Alloy C-22 in the Yucca Mountain environment was discussed. Several Board members stated their opinions based on their review of scientific data submitted by the state of Nevada. Some of the Board members reiterated their previous concerns about localized corrosion of the waste packages. However, the DOE has challenged the state of Nevada scientific data on the grounds that calcium and magnesium chloride were unlikely to be present in the proposed high level nuclear waste repository tunnels. The brine will immediately be transformed into non-deliquescence phases because of its natural instability at elevated temperature. In addition, any corrosive gaseous environment formed will be modified and/or absorbed by the water held in the rock. This finding should raise a great deal of concern due to the high volume of heavy metals and radionuclides to be stored at YMP.

On July 28, 2003 the NWTRB wrote a letter to Dr. Chu, Director of OCRWM, stating the following, "Based primarily on information presented at the Board's May 18-19, Meeting 2004 meeting, it appears unlikely that dusts that accumulate on waste package surfaces during the pre-closure period would contain significant amounts of calcium chloride or that significant amounts of calcium chloride would evolve on waste package surfaces during the thermal pulse. Consequently, the calcium chloride-rich environment selected for corrosion tests does not appear representative of the conditions that can be expected on waste package surfaces in a Yucca Mountain repository. If calcium chloride is not present, calcium chloride-rich brines will not form by deliquescence, and crevice corrosion due to the presence of such brines in the temperature range of roughly 140°C to 160°C will not occur. Thus, the Board concludes that deliquescence-induced localized corrosion during the higher-temperature period of the thermal pulse is unlikely."

Subsequently, in a letter dated November 30, 2004 from the NWTRB to Dr. Margate Chu OCRWM addressed their scientific opinion on the corrosion of C-22 Alloy. The Electric Power Research Institute (EPRI) presented a paper on this issue at the NWTRB Fall meeting on September 10, 2004 Las Vegas NV. EPRI presented preliminary data presented which is based upon "short-term tests with synthetic magma; indicate that Alloy 22 may have significant corrosion resistance to some magmas. Nevertheless, the NWTRB stated that chemical compositions of possible magmas at Yucca Mountain vary widely. Therefore, the Board believes that EPRI's results, although very important as an early indicator, do not provide a sufficient technical basis for determining the corrosion resistance of Alloy 22 in magma. The possibility of stress corrosion cracking of the titanium drip shield also was mentioned at the meeting. The NWTRB also recommend that the DOE determine the likelihood that conditions necessary for stress corrosion cracking of the drip shield would occur at Yucca Mountain. The Board also stated that "these two issues need to be addressed within the context of other corrosion tests that should be carried out in environments that closely approximate the various conditions to which Alloy 22 and titanium will be exposed and in environments that reasonably bound those conditions. For example, the Board's July 28, 2004, letter mentions the need for further investigation of the possibilities of localized corrosion. The extent to which the DOE has characterized likely waste package environments accurately is unclear at this point."

In addition the NWTRB also issued several recommendations dealing with corrosion issues that require additional analysis and research. "First, the DOE raised the possibility that when temperatures in repository tunnels fall below boiling, localized corrosion could occur in concentrated sodium chloride solutions with low concentrations of inhibitors. The Board believes that further investigation of the possibilities for localized corrosion at below-boiling temperatures is warranted and that such an investigation should focus on (1) possible mechanisms that might create environments that would facilitate localized corrosion and (2) the likelihood that such environments could exist. Next, the presence of ammonium ion and the implications of its presence for corrosion or other performance aspects need to be explained. Inlay, the State of Nevada suggested that nitrates could promote an aggressive corrosion in some circumstances."

Effect of Mixtures of Radiation and Chemicals

Over the past several year efforts have been made to develop methodologies for risk assessment of chemical mixtures, but mixed exposures to two or more dissimilar agents such as radiation and chemical agents have not yet been addressed in any substantive way. The National Research Council in (1988) also addressed concerns regarding exposures to complex mixtures, (1988). The Presidential/Congressional Commission on Risk Assessment and Risk Management in 1977 stated that it "considered the risk assessment of mixtures to be a matter of considerable concern and importance, (1997)." Very little research is currently available on the potential interaction between chemical agents and radiation. There are examples of important interactions between chemical agents, such as asbestos and cigarette smoking, and a few reports that document interactions between chemical agents and radiation; (e.g.); combined chemotherapy and radiation therapy increases the risk of secondary leukemia), (Lin and Teitell 2005).

In 1987 (Goodwin et al in 1987) pointed out a significant risk for man and the environment from a nuclear waste repository. The authors recommended that an assessment of potential chemical impacts along with radiation should be part of the formal safety assessment. They also noted that there are over 50 toxic elements are linked to high-level nuclear waste that should be considered in assessing chemical toxicity. While the National Council on Radiation Protection and Measurements, (6) confirmed that further study is needed to address issues such as damage to the immune system, and the possible combined effects of chemicals and irradiation causing either synergistic or antagonistic effects.

Sometimes later (Persson 1990) he recommended that part of the safety analysis used for a nuclear waste repository should include evaluation of chemo-toxic impacts on man and the environment. He also pointed out that for the short term the radiological toxicity of materials in a nuclear waste repository is of primary concern. On the other hand, the potential chemical toxicity should not be overlooked. For the longer time frame as radioactive materials decay, chemical toxicity may even become dominant as shown in Figure 1.

Fig.1. Generalized relationship of radiological and chemical risk at nuclear waste (Persson 1990).

Fig.2. Shows changes in absolute chemical risk in a geological repository due to the possible synergistic interactions among heavy metals and possible synergistic interaction between Ni, Cr and Ti both known carcinogens, and the Conversation of Actinides (^{239}Pu into Pb).

In contrast, to (Persson 1990) statement that absolute chemical toxicity will remain constant at a high level nuclear repository, the authors believe as time progresses the absolute toxicity will increase due to: First, the authors believes that there will be an increase in the magnitude of the absolute toxicity due to synergistic interactions among Cr, Ni, Ni, and Ti heavy metals however no value can be set. Another aspect (is it shown in Figure 2. Shows there are possibility synergetic interactions between Ni and Cr both known potent carcinogens and subsequently increase in cancer risk. We can not assign a value for the health risk because of lack of applicable data. Finally, the conversion of actinides into Pb, eventually could also increased the again the chemical toxicity will start to increase as time progresses. The decay of actinides, such as uranium and plutonium, in the fuel will result in the formation of significant quantities of lead in repository as time progresses. For every metric ton of buried waste (Pu) 325 grams of lead will be produced within a one million years. For a repository containing 77,000 metric tons of waste, over 25 metric tons of lead will be created by decay. In addition, as it shown in figure 3, spent nuclear fuel within a high-level nuclear waste repository will radioactively decay producing new nuclides.

Figure 1. Generalized relationship of radiological and chemical risk at nuclear waste (Persson 1990)

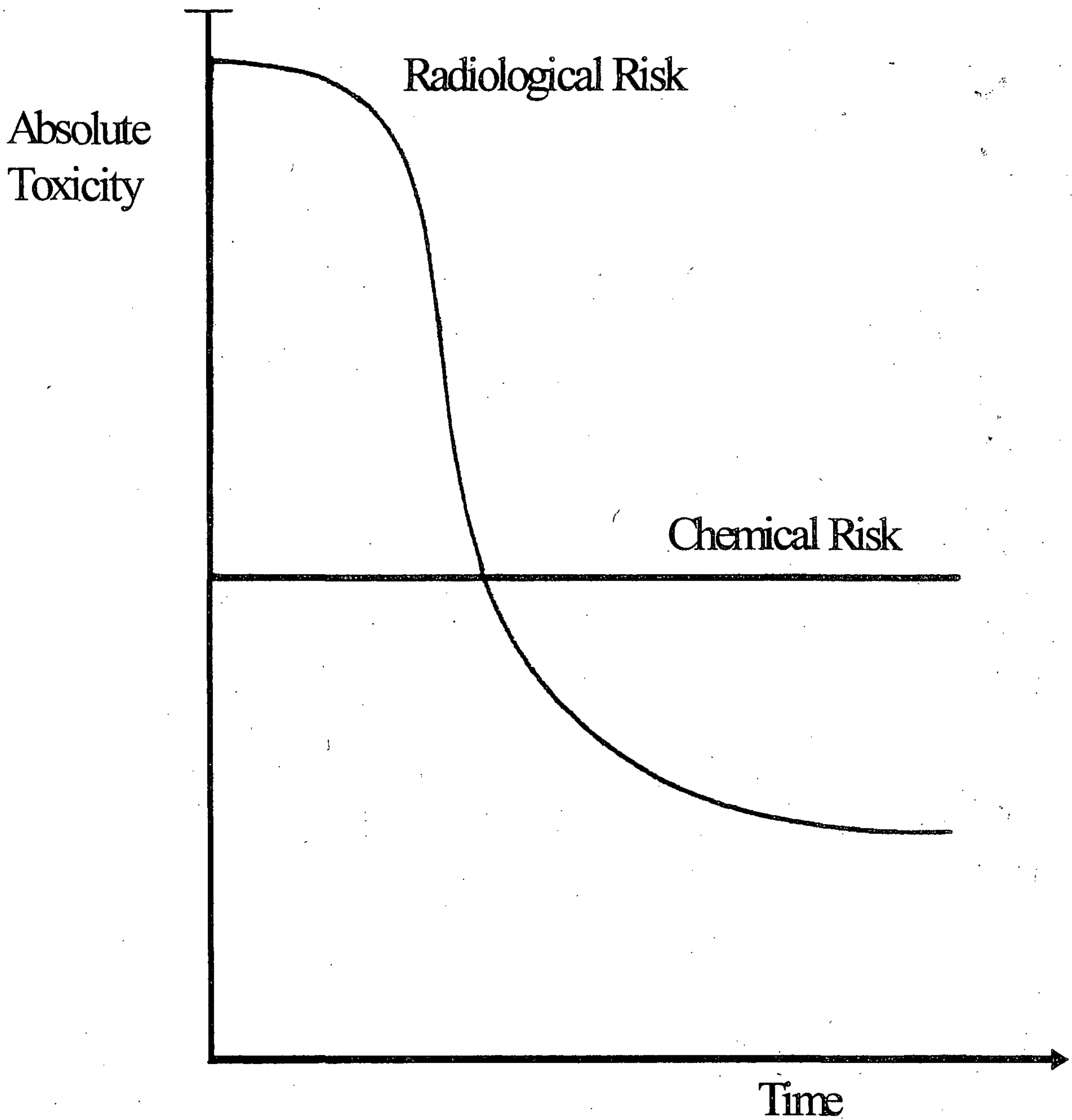

Figure 2. Hypothetical changes in absolute chemical risk in a geological repository due to interactions among Cr, Ni, and Ti, and the Conversation of Actinides into Pb.

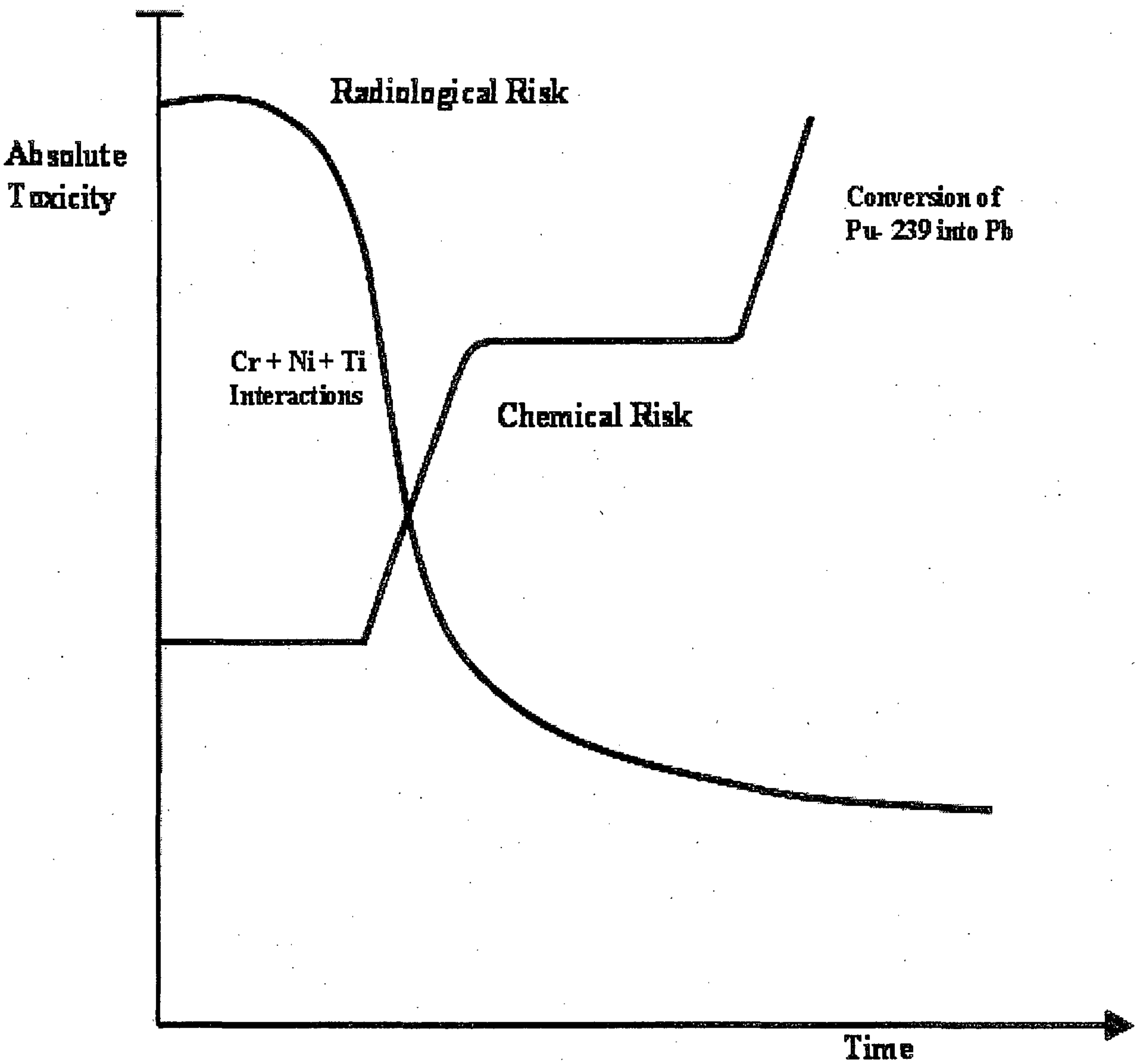

Figure 3. Illustrate the Calculated Radioactive Decay of Plutonium into Lead in Spent Nuclear Fuel at a Nuclear Repository

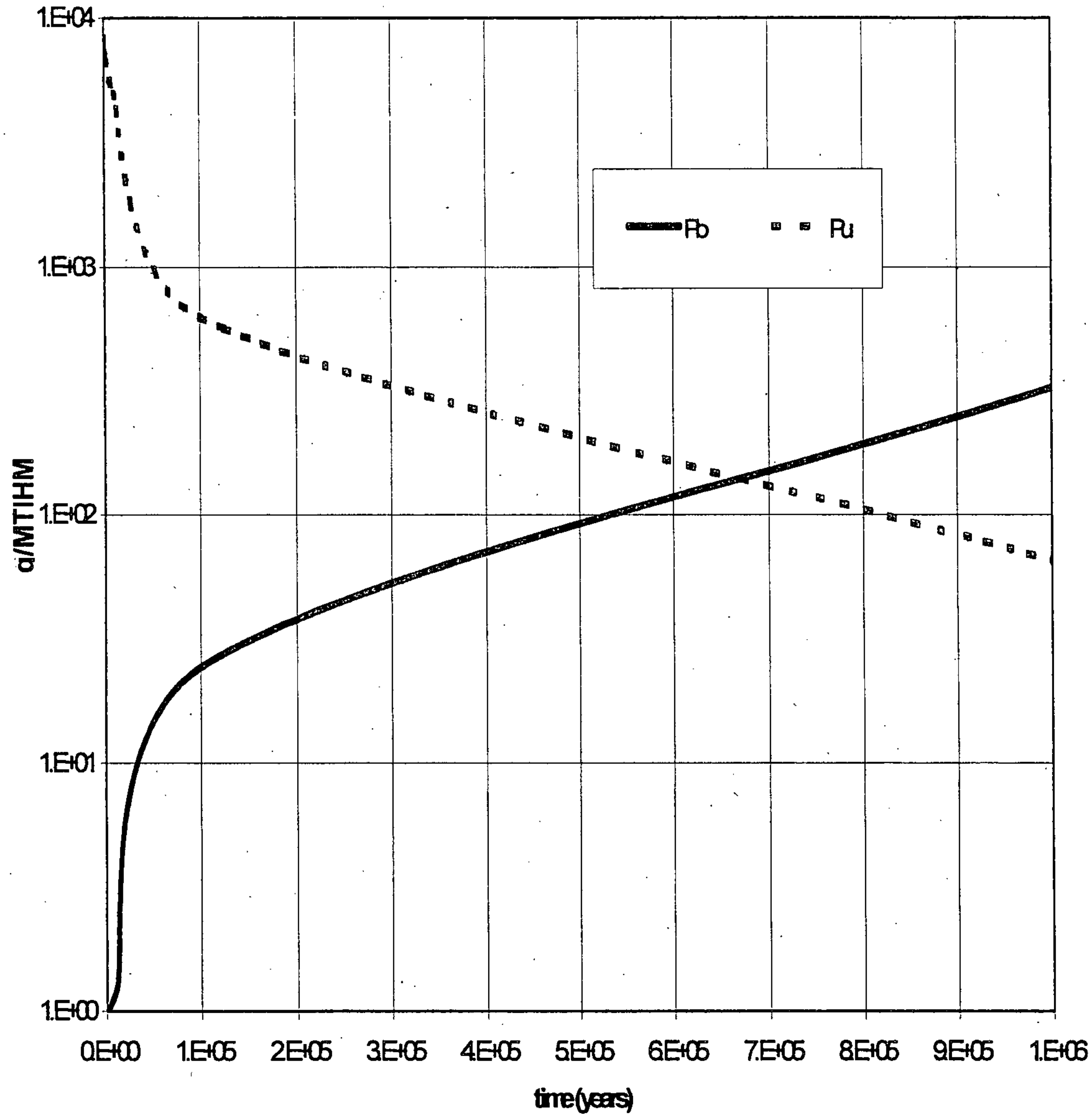

Figure 3 Illustrates the Calculated Radioactive Decay of ^{239}Pu into Lead in Spent Nuclear Fuel at a Nuclear Repository.

The decay in the fuel of actinides, such as uranium and plutonium, will result in the formation of significant quantities of lead in the repository as time progresses. For every metric ton of buried waste (^{239}Pu) 325 grams of lead will be produced within one million years. For a repository containing 77,000 metric tons of waste, over 25 metric tons of lead will be created by decay.

Interactions between Metal and Radiation

In 2000 the United Nations Scientific Committee on the Effects of Atomic Radiation (2000) issued an extensive report on the combined effects of radiation and other agents. It was concluded that a comprehensive approach for the study and quantitative assessment of combined effects of radiation and chemical agents must be developed. The gap between different conceptual approaches in the assessment of risks associated with chemical toxicology and radiological protection has to be bridged. Multidisciplinary approaches to this research have to be forged.

In addition, (Chen and McKone 2001) executed an extensive literature review concerning the health effects associated with exposure to ionizing radiation and chemicals under a DOE sponsored grant. The authors concluded that very little quantitative information is currently available on the cumulative effects of exposure to multiple hazardous agents that have either similar or different mechanisms of action. Their literature review summarized three types of interactions between radiation and chemicals. 1). synergistic effects, exemplified by the observation that exposure of human lymphocytes to benzene and radiation showed an increase in chromosome aberrations, and concurrent smoking and radon exposures in uranium miners resulted in an increase in the lung cancer rate. In both cases, the combined effects of exposure were greater than the sum of the effects caused by each agent acting individually. 2). Additive effects such as those resulting from smoking and ionizing radiation exposure in Japanese atomic bomb survivors. 3). Antagonistic effects exemplified by the fact that in vitro exposure of rodent cells to ionizing radiation and selenium resulted in fewer radiation-induced cell anomalies.

More recently, the Agency for Toxic Substances and Disease Registry ((2004) also cited several Russian epidemiological studies which illustrated an interaction between 90Sr and ^{137}Cs in a population in the Ural Mountains undergoing chronic exposure. The estimated dose levels for the exposed population were 3-4 Sieverts (Sv) from 1949 - 1956, 0.9 Sv for the 1957 release, and 0.003 Sv for the 1967 release. The study demonstrated that the exposed population had a variety of medical symptoms, such as: chronic radiation sickness characterized by hematological symptoms, neurological disturbances, immune system changes, and cardiovascular changes, (Akleyevet et al 1995). A significant increase in long-term morbidity and mortality, both general and cancer specific, has also been observed as reported by (Kossenko et al 1994).

The Agency for Toxic Substances and Disease Registry(ASTDR) 2004 also acknowledged in their Publication Interaction Profile For: Cesium, Cobalt, Strontium, Polychlorinated Biphenyls and Trichloroethylene (2004) the following "No in vitro or in vivo studies were located regarding possible joint toxic actions between stable or radioactive strontium and cobalt compounds in affecting health-related endpoints in humans or animals. No PBPK models for co-exposure to strontium and cobalt were located. Shared targets of toxicity following internal exposure to radiostrontium and exposure to radiocobalt compounds include hematological effects (alterations in erythrocyte number), reproductive effects, immunological effects, and an increased incidence of cancer. Because calcium-related mechanisms have been demonstrated for chemical uptake and toxicity for stable forms of both strontium and cobalt, several in vitro studies have been performed using stable strontium."

Additionally, the ATSDR (2004) also confirmed that "No in vitro or in vivo studies were located regarding possible joint toxic actions of cesium radionuclides and trichloroethylene; Cesium and PCBs; Strontium and PCBs; Strontium and Trichloroethylene both in humans or animals.' The ASTDR also confirmed that "Mixtures containing strontium, cobalt, cesium, trichloroethylene, and PCBs may be found together at hazardous waste sites, most notably those located at present or former Department of Energy (DOE) facilities. "No studies examining a five-component mixture of these compounds were located, nor were studies of three - or four-component mixtures available in the literature. No PBPK models are available for the complete mixture, or for any of the three - or four-component sub-mixtures. In the absence of studies that examine relevant endpoints and describe dose-response relationships following oral exposures to mixtures that contain these five chemicals (e.g,. in food or in soil), component-based approaches to assessing their joint action that assume dose additively for noncancerous effects appear to be reasonable for practical public health concerns (e.g,. the hazard index approach or the target-organ toxicity dose modification of the hazard index approach). Likewise, a component-based approach assuming response additively appears reasonable for assessment of cancer risks from oral exposure to mixtures of these five chemicals."

Long and Ewing (2001) in their excellent recent review of "Earth-Science issues at a Geological Repository for High-Level Nuclear Waste" cited several authors, for example (Buscheck et al2003) who pointed out that operation of the hot repository at high temperatures greater then 100 °C possibly will have deleterious effects on corrosion of the canisters. Other publications point out that operation of a hot repository is very complicated and that the scientific uncertainty in the behavior of the repository is too large to accept. They also cited a letter from the NWTRB dated November 23rd, 2003 to Dr. Chu, in which the NWTRB pointed out that the "DOE has not yet shown how heat will affect the long-term behavior of the repository and recommended that the repository be kept below 100°C."

There is growing scientific evidence showing that exposures to Cr, Ni, and As, UV, x-ray and γ-radiation have yielded some very interesting results. These studies have been performed on human cells in vitro, mice, and human populations for endpoints related to mutagenesis or cancer. In some instances the test results have indicated synergistic effects and in other results antagonistic effects. The following is a summary of the recent literature. In 1998 (Katsifis et al 1998) studied the effects of exposures of individual human lymphocytes to Ni^{+2} (0.5 to 25 mμM), and Cr^{+6} (0.65 to 1.30 mμM); together with UV energy of (200, and 1000 ergs/mm2), and X-rays doses (0.1, 0.25, and 0.40 Gy). The experiment showed that sister chromatin exchange occurred in a dose-dependent fashion, and the combined treatments of Ni^{+2} with Cr^{+6} to UV-light and X-rays results in an antagonistic response. The experimental data pointed out that that Ni, at environmentally relevant exposure levels, can have the effect in complex mixtures of reducing an otherwise positive SCE response and could lead to underestimating human exposures to certain classes of chemicals or radiation. In addition, the test results data indicate that antagonism may occur when human lymphocytes are exposed simultaneously to Ni^{+2} and Cr^{+6}, suggesting an explanation for epidemiological studies reporting conflicting results for cytogenetic effects in lymphocytes of workers exposed to chromium and nickel.

In contrast to (Katsifis et al 1998) the results obtained by Aue and Chiewchanwit's (1994) differed in a study of the repair of radiation induced effects for lymphocyte exposure to nickel acetate at levels ranging from 0.1 to 100 mM nickel acetate for 1 hr during the G0 phase of the cell cycle. The cells were irradiated with two doses of gamma-rays (75 cGy per dose separated by 60 min). A significant dose-dependent increase of chromosome translocations was observed. The experimental data suggest that pretreatment with nickel interferes with the repair of radiation-induced DNA damage and potentially causes mistakes in DNA repair. Furthermore, they suggest that nickel-induced abnormal DNA repair may be a mechanism for its carcinogenic properties. In their opinion the DNA repair problems that are observed after exposure to low doses of nickel may be viewed as a type of adaptive response.

Recent report by (Davidson et al 2004) stated that exposure of hairless mice to Cr^{+6} concentrations of 0.5, 2.5 and 5.0 ppm in drinking water together with exposure to UV energy of 1.21kJ/M2 results in an increase in skin cancer with lesions (greater than 2 mm) which was statistically significant ($p < 0.05$). The data resulted in showing that at levels of 2.5 and 5.0 ppm mice developed skin tumors when they were exposed both to Cr^{+6} and to UV and the cancer frequency results were UV dose-dependent. The authors concluded that their study was the first one showing that the exposure to K_2CrO_4 at 2.5 and 5.0 ppm in drinking water increased susceptibility to UV-induced skin cancer in this animal model. These data may also provide an interesting link between Cr^{+6} and skin tumorigenesis that should be the subject of further studies. In a study by (Vaglenov et al 1999) reported that they evaluated employees with Cr exposure in electroplating operation and in a control group. Test results showed a significant increase in the frequency of micronuclei (MN) as a measure of genetic damage. Blood cells were collected from veins of workers who were exposed to chromium levels in air of 83 ±10 μM/M3 and from a control group. Part of the blood samples from 10 members of the control group and 10 patients were subjected to a γ-radiation dose of 1 Gy from a ^{137}Cs source at a rate of 0.87 Gy/min. Test results showed a lower induction of MN following gamma-radiation in lymphocytes exposed to Cr. The authors stated that the test results of this experiment should be considered an indication of an adaptive response.

In an earlier study, (Lazutka et al 1995) carried out an investigation to measure the frequency of Sister **Chromatied** Exchange (SCE) in lymphocytes of 33 Chernobyl clean up workers and 12 controls. The workers were exposed to a range of 0.04 to 0.249 and an average of 0.13 Gy external radiations. SCE measurements were conducted about 6 to 8 years following exposures to the radiation. The experimental data indicated that mean SCE frequency was 7.45 ± 0.69 cells in a control group, and 10.30 ± 0.31 cells in clean up workers. Analysis of variance of the experimental data showed that occupational exposure to radiation and chemicals (organic solvent) increased SCEs by 19.6% and for organic solvent alone by11.9% compared to various chemicals (not specified); and an 8.3% increase for coffee consumption alone.

While, (Rossman et al 2004) investigated the exposure of mice to 10 mg/L of arsenic, a know carcinogen in drinking water and UV radiation at a dose of 1.7 kJ/M2. The data showed that after 26 weeks the As plus UV exposed mice had a 2.4 fold increase in skin tumors compared with mice that were subjected to UV irradiation only. The authors concluded "These results are consistent with the hypothesis that arsenic acts as a co-carcinogen with a second (genotoxic) agent by inhibiting DNA repair and/or enhancing positive growth signaling." In a more recent study Rossman et al (2004) reported recently "that concentrations as low as 1.25 mg/L sodium arsenite were able to enhance the tumorigenesis of solar UV irradiation in mice." The experimental data suggested that arsenic in drinking water may need a carcinogenic partner, such as sunlight, in the induction of skin cancers.

additionally, (Dannaee et al 2004) studied the effect of As^{+3} exposure of lymphoblastoid TK6 human cells at concentrations ranging from of 0 to 5 μM and UV-irradiation at a dose rate of 0.385 J/M2/s at a wave length of 254 nm. The experimental data indicated that As^{+3} enhanced the UV mutagenesis in a more than additive fashion. An earlier study of (Yager and Wiencke 1997) investigated the exposure of sodium arsenite at levels at 2.5 to 25 μM on Molt-3-cells along with a UV-irradiation dose rate of 0.385 J/M2/s at a wavelength of 254 nm. The test results revealed that arsenite decreased Poly (ADP ribose) Polymerase (PARP) activity in a dose-dependent manner with about a 50% reduction in enzyme activity at 10 μM arsenite and 80% viability. The percent of cells in S-phase showed an increase with increasing arsenite levels. These experimental data give further indication that arsenite may potentiate genetic damage in DNA repair proteins such as PARP and interfere with normal repair functions.

Furthermore, (Tapio et al 2005) reported on the exposure of lymphoblastoid TK6 human cells to a combination of 1 μM arsenite and a 137Cs gamma radiation dose of 1 Gy. The authors stated that "the main conclusions are that both arsenite and γ-radiation influence the levels of several proteins involved in major metabolic and regulatory pathways, either directly or by triggering the defense mechanisms of the cell. The combined effects of both exposures on the level of some essential proteins such as glutathione transferase, proteasome or serine/threonine phosphatase may contribute to the co-carcinogenic effect of arsenic."

At the annual meeting of the Toxicological Society in 2003, Julian Preston of EPA's National Health and Environmental Effects Laboratory said that, "assumptions about assessments of the carcinogenic risks of radiation and chemicals traditionally have focused on the genetic damage that can occur in cells directly exposed to gene-mutating agents." However, Preston indicated that existing research suggests that bystander cells near those that are directly exposed may also be important. Bystander cells may also experience an increased impact due to chemical and/or radiation exposure. Cancer-causing chemicals may be more potent than previously thought.

According to Preston, "Due to new technologies such as use of microbeams that allow a single radioactive particle to pass through a cell, researchers have recognized that the damaged cell appears to signal to other cells, increasing the effects of the damage." In his opinion Preston also indicated that the phenomenon is so clear in radiation research that it is presumed to apply to chemicals. These include the ability of radiation or chemicals to cause genomic instability that can result in mutations that lead to cancer. Preston indicated this too could increase the potency of a carcinogen Preston also stated that small doses of radiation might cause a biological response in cells that could reduce the risk of cancer. The information, he stressed, has been observed at the cellular level. Whether or not these cellular changes translate into tumors is not clear.

In a more recent publication (Preston 2005) paper on bystander effects, adaptation and interaction between chemical and radiation stated "There is a limited evidence for induction of bystander responses and genomic instability by chemicals and future evaluation is clearly needed. Of paramount importance in risk framework ... a large challenge dose has been quit clearly described for both radiation and chemical exposures ... This is to develop the mechanistic understanding which will be best done by rigorously defining the experimental conditions." He concluded "The nature of the dose-response from both endpoints (bystander effect and genomic instability) required further clarification if a rate for these phenomena in cancer risk assessment is ever to be established."

The response of exposure divalent cations such as Co^{+2}, Cu^{+2}, Fe^{+2}, Ni^{+2}, and Mn^{+2} to a gamma radiation dose of 360 Gy at a levels ranges from 0 to 0.1 μM on the generation of lipid peroxidation (LPO) by (Sitasawad and Kale 1994) studied. The experimental data showed that both Co^{+2}, and Cu^{+2} inhibited the production of LPO radicals. In contrast, Fe^{+2}, Ni^{+2}, and Mn^{+2} enhanced the generation of LPO radicals. The enhancement of LPO due to Ni^{+2} was biphasic in nature, while an increase in Mn^{+2} concentrations above 0.8 μM showed a decrease in LPO level generation. Exposure to Co^{+2}, Cu^{+2}, Fe^{+2}, Ni^{+2}, and Mn^{+} and ionizing radiations levels of 138, 276, 414, and 552 Gy showed that LPO production reached a peak value at about 345 and decreased for higher radiation exposure. In contrast to Co^{+2} Fe^{+2}, Ni^{+2}, and Mn^{+2} divalent cations, Cu^{+2} ions inhibited the initiation of LPO radical production.

Metal-Induced Bystander Effect

The effects of chemical interactions present a health concern. As it was cited by (Lee 1998), he stated that "the carcinogenicity of nickel is enhanced by the presence of other carcinogens such as: arsenic, and hexavalent chromium." Additionally, Cr^{+3} is considered to be non-toxic, but is reported to be mutagenic at a concentration of 260 μM in Drosophila as reported by (Hepburn et al 2003). Furthermore, recent reports by (Coen et al 2003); (Cone et al 2001); they indicated that heavy metals such as Ti and Cd induced genomic Instability. Similar report by (Glaviano 2003) noted that Cr^{+6} also induce genomic Instability. In a more recent study (Glaviano et al 2006) reported that exposure of Cr^{+6} at a level of 0.04 and 0.4μM and V^{+5} concentration for 0.5, 5.0 μM to human BJ fibroblasts cells induce acute chromosome damage and genomic instability of exposed cells up to 30 days following 24 hours of single exposure. Exposure of depleted uranium cells to gamma radiation resulted in delayed lethality and persistent increase in micronuclei results in genomic instability, a characteristic of the radiation bystander effect. Compared to experimental data of exposure to gamma radiation or Ni, DU exposure resulted in a greater manifestation of genomic instability. These finding are extremely important since: these heavy metals and radiation originated in could poses a serious health threat to groundwater and the public. Last, interactions between metal and radionuclides can increase degree of genomic instability and posed serious health hazard (Miller et al 2003).

Low levels of Radiation Risk and Radiation Bystander Effects

Recently, the National Academy of Science (NAS) completed a comprehensive evaluation of the literature relevant to the risks of radiation exposure, (BEIR VII. 2005). The committee concluded that since, in the low dose range of interest, the difference between risks predicted by different models is small relative to the 95% confidence intervals for risk extrapolated from data at higher doses; the linear, no-threshold dose-response relationship is consistent with the data. The consequences of this model include the concepts that that there is no safe level of exposure to radiation-that even very low doses can cause cancer. Even exposure to background radiation causes some cancers. Additional exposures cause additional risks. The committee also concluded that radiation can cause other health effects such as heart disease and stroke, and that further study is needed to predict the doses that result in these non-cancer health effects. The committee noted that it is possible that children born to parents that have been exposed to radiation could be affected by those exposures.

The committee also concluded that risks from low dose radiation are equal to or greater than previously thought. However, it should be noted that in populations that receive several times the natural background dose or less, radiation is responsible for only a small fraction of the cases of cancer and other adverse health effects. The National Academy of Science BEIR VII committee reviewed some additional ways that radiation causes responses in cells; processes which had not yet been recognized at the time of the last committee report. Among these responses are:

The "bystander effect", a newly recognized method by which radiation produces changes in cells that were not directly hit but are in the vicinity of those that were. The changes include (but are not limited to) increased levels of repair proteins, increased apoptosis, and increased DNA damage. Some of these changes appear to constitute damage to the cell, while others probably reduce damage or cause damaged cells to disappear so that they can not grow to become a cancer. "Genomic instability" which can also occur in cells which survive exposure to a very low doses of radiation. According to the report this" might contribute significantly to radiation cancer risk. "Adaptive response" which describes the change in cells which have been exposed to a low dose of radiation and as a result have modified their repair processes so they are much more resistant to the effects of subsequent doses."

Each of these effects is newly discovered, but has been operating in our cells since before we discovered radiation. Their recent discovery does not necessarily change the health risks due to radiation, but may eventually allow us to improve the model we use to estimate risk at low doses. It is not clear, at this time, whether an improved model would predict higher or lower risk at environmentally relevant doses. These newly described mechanisms for radiation damage were not included in the evaluation of the dose-response model used in the BEIR VII report, but were recommended for further study. The Dose and Dose-Rate Effectiveness Factor or (DDREF) which had been suggested in the 1990 BEIR V report to be applied at low doses, has been reduced from 2 to 1.5. That means the current estimate of the number of health effects at low doses is greater than the estimate used previously. This is extremely important since it may have an effect on the EPA radiation standard for YMP of 15mRem effective dose.

Over the past 20 years previously unexpected responses to low levels of ionizing radiation exposure have been discovered. These new responses, the bystander effect, genomic instability, and adaptive response are most effective at low doses, Little (2003). The radiation bystander effect occurs when irradiated cells produce an effect in neighboring, unirradiated cells. These effects which occur at doses up to 20 cGy may result in changes which either increase or decrease the health risk at low doses, relative to the risks which are currently estimated on the basis of linear extrapolation from data obtained at much higher doses. The detailed mechanisms of these processes have not yet been discovered, but evidence points to the possibility that several different biochemical mechanisms lead to different (and sometimes the same) biological end points. It appears that both direct communication from cell to cell through gap junctions, and indirect communication through release of signaling compounds into the extra cellular environment are important. It is known that reactive oxygen species (ROS) such as OH-, H2O2, are involved, but it is not clear if they are the signaling compounds or if they are produced by the cells in response to the signal, (Narayanan et al 1997); (Shao 2004). It is known that bystander effects can function over substantial distances, at least several tens of cell diameters, and that the effect can be triggered by a relatively low radiation exposure. The passage of a single alpha particle or a modest number of low energy electrons through a cell nucleus can trigger the effect. The bystander cell response typically does not change with increasing dose.

The bystander effect of ionizing radiation is significant after low-dose irradiation in the range of below 0.2 Gy, and an "adaptive response" as well as possible increased risk has been outlined by (Oesterreicher et al 2002); (Monthersill and Seymour, 2002). It is stated"over the past 15 years, it has only recently become apparent that chemicals in the natural environment may induce a state of genomic instability in cells and hence low dose chemical toxicity probably also involves bystander effects." In a year later (Mothersill and Seymour 2003) reiterated that the "bystander effect is an emerging field of non-targeted radiation effects and their impact on low-dose radiation risk assessment and radiotherapy. The authors also affirmed that a "bystander effect plays a major role for experimental hematologists and cytogeneticists in changing the old view of radiation action on living things."

The authors also noted that bystander effects recently have been receiving major worldwide attention and now include genomic instability. "The impact of these effects, both on radiotherapy used to treat cancer and on radiation induction of cancer, still need to be clarified. Techniques developed by experimental hematologists are central to these efforts and have been instrumental in causing radiobiologists to consider that a paradigm shift is necessary." In a recent publication, (Grandi and Moccaldi 2003) express the opinion that there is growing experimental evidence that points out that ionizing radiation exposure has relevant biological effects, "including micronuclei induction, gene mutations, ROS production and gene -expression modification, in cells that were not directly hit by radiation." Such a phenomenon, recognized as the bystander effect, has been described for different types of radiation (α, γ, x-ray and β and it is relevant at low doses (e.g, a few mGy). Until now, the bystander effect has been primarily described in vitro for ionizing radiation. A crucial outcome of future research deals with the existence and quantification of this effect in relation to chemical agents displaying genotoxic and carcinogenic potential." In a more recent publication, (Grandi and Moccaldi 2003) have also stated that "A growing body of experimental evidence indicates that ionizing radiation is able to determine relevant biological effects, including reduction in cell survival, cytogenetic alterations, gene mutations, induction of apoptosis and gene - expression modification, in cells not directly hit by radiation. The search for these effects in vivo, the setting up of models of risk assessment at low doses of ionizing radiation accounting for the bystander effect and the identification and quantification of these effects in relation to chemical agents displaying genotoxic and carcinogenic potential are primary research goals "

CONCLUSION and RECOMMENDATIONS

1. The authors believe that the health risk posed by the potential releases of a fraction of this amount of heavy metals along with radionuclides is remained unknown and must be further investigated. In order to assess the public health risk associated with the behavior of radionuclides in the environment, knowledge of the partitioning of each radionuclide between different phases is required

2. Based upon literature review and the National Academy of Science report on "Low Levels of Ionizing Radiation (2005)" must be considered when setting radiation standards

for geological repositories of high-level nuclear waste and when calculating the potential health risk posed to the public, including specifically:

- The health risk posed by radiation bystander effect.
- Genomic instability and risk assessment imposed by complex mixtures of radionuclides and heavy metals.

3. Why regulatory agencies did not addressed the issue of complex mixtures and risk assessment in the FIES, while the French Government took into consideration health effects and risk of mixtures, Paz (2003).

4. The Regulatory Agencies and the U.S. Department of Energy should have implement research studies on the health effects of complex mixtures of radionuclides and hazardous chemicals for example using Physiologically Based Pharmacokinetic Modeling (PBPK). This will lead to the development of better mathematical models for describing interactions that should be used in the Total System Performance Assessment model.

5. In contrast to Persson (1990), who stated that absolute chemical toxicity will remain constant at a high level nuclear repository, the authors believe that due to the conversion of actinides into lead, the chemical toxicity will start to increase as time progresses and the absolute chemical toxicity will increase over time. In YMP there is a good possibility of synergistic interaction among heavy metals and subsequently this could increases in the absolute toxicity and cancer risk to populations.

6. The risk of long term health effects can become a consideration in planning all types of activities. Much of the concern is generated by the relatively large uncertainty which has to be assigned to the risk because of incomplete understanding of the biomolecular and cellular mechanisms which may contribute to the risk such as ROS stress, LPO, and the depletion of antioxidant protection which nay leads to alterations and DNA and subsequently cancer. It is necessary to reduce the uncertainty by clarifying the role of the interaction of radiation and toxic chemicals by additional research.

7. What are the corrosion rates large scale study is needed to be evaluated there are conflicting reports presented by USDOE-YMP and the State of Nevada.

8. The competition between heavy metals and radionuclides and the rate of releases of Cr, Ni and radionuclides into the environment remain unknown. This phenomenon must be investigated.

9. What the impact of elevated temperature of 140 or 160 ^{0}C for 1000 years at YMP on the corrosion rate of the Alloy-22 is debatable. There is needed to study corrosion rate in large scale in more detailed simulated a real conditions.

10. The impact of elevated operating temperatures and the subsequent long term cooling effect and the fracture of Zeolite; and the newly discover of fault where the proposed Repository to be build which will increase the transport rate of radionuclides and heavy metals released from the repository, completion between metals and radionuclidies rate is remained unknown.

REFERENCES

Akleyevet AV. Kossenko MM, Vyushkova OV. Health effects of radiation incidents in the Southern Urals. Stem Cells, (Suppl. 1) 58-68; 1995

Aue,WW, Heo MY, Chiewchanwit M YT. Toxicological interactions between nickel and radiation on chromosome damage and repair. Environ Health Perspect, 102:(Suppl 9), 73-77; 1994.

Blink JA, Evaluation of a Range of Operating Modes. Paper presented to the U.S. Nuclear Waste Technical Review Board, Las Vegas, Nevada, Meeting, on September 10; 2001.

Buscheck TA, Rosenberg N D, Blink J A, Sun Y, Gansemer J, Analysis of Thermohydrologic Behavior for Above-Boiling and Below Boiling Thermal-Operating Modes for a Repository at Yucca Mountain. Journal Contamination Hydrology, 62-63:441-57; 2003.

Chen W G, McKkone TE, (2001). Chronic health risks from aggregate exposures to ionizing radiation and chemicals, scientific basis for an assessment framework. Risk Anal 21: 25-42; 2001

Coen N, Kadhim MA. Wright EG, Case, C P. Mothersill CE, Particulate debris from a titanium metal prosthesis induces genomic instability in primary human fibroblast cells. Br J Cancer 88: 548-553; 2003.

Dannaee H, Nelson HH. Liber H, Little J, Kelsey, B, Karl, T, Low dose exposure to sodium Arsenite synergistically interacts with UV radiation to induce mutations and alter DNA repair in human Cells. Mutagenesis 19:143-148; 2004.

DavidsonT. Kluz T, Burns F, Rossman T, Zhang Q, Nadas A, Costa, M. Exposure to chromium VI the drinking water increases susceptibility to UV-induced skin cancer. Toxicol Appl Pharmacol :431-437; 2004.

Goodwin BW. Garisoto NC, Bernard JW,. An Assessment of Long-term impact of chemically Toxic Contamination from disposal of Nuclear Fuel Waste. Pifiata, Manitoba White Shell Nuclear Research Establishment AECL-8367; 1987.

Glaviano A, Mothersill C, Campisi , Rubio,MA, Nayak V, Sood A, Case C P, Genomic instability caused by metal ions. Hip Inr 13: 53-56; 2003.

Glaviano, A., Nayak VV Cabuy DM, Baird E, Yin Z, R Newson R, Ladon D, Rubio, A, P Slijepcevic P, F Lyng,F, Mothersill C, and CP, Case, P, C, Effects of hTERT on metal ion-induced genomic instability. Oncogene 25: 3424 –3435; 2006.

Grandi, C, and Moccaldi R (2003). Bystander effect, possible effects on the risk assessment by carcinogenic agents. G Ital Med Lav Ergon 25: (Suppl 3), 50-51. Medline; Abstract; 2003.

Grandi C, and Moccaldi R. Bystander effect, critical review and implications for risk assessment in padioprotection. G Ital Med Lav Ergo, 27, 21-34. Medline Abstract; 2005.

Hepburn D DD, Xiao J, Bindom S, Vincent J B, O'Donnell. J Nutritional supplement chromium picolinate causes sterility lethal mutations in drosophila melanogaster. Proc Natl Acad Sci U S A. 100, pp. 3766-3771; 2003.

Katsifis, SP, Shamy M, Kinney L P, Burns FJ, Interaction of nickel with UV - light in the induction of cytogenetic effects immune Peripheral lymphocytes. Muta Res, 422, 331-337; 1998.

Kossenko M M, Degteva MO. Cancer mortality and radiation Risk evaluation for the Techa River population. Sci Total Environt, 142, 73-89; 1994.

Lee, V. R. In Hamilton Hardy's Industrial Toxicology; ED., Harbison, D, R. Fifth Ed. Pub. Mosby St. Louis, 1998; p. 103, Chapter 28.

Lin H, MJ Teitell, AH. Second malignancy after treatment of pediatric Hodgkin disease. J Pediatr Hematol Oncol, 27: 28-36; 2005.

Little BJ Genomic instability and bystander, effects, An historical perspective. Oncogene, 22: 6978-6987; 2003.

Long C S J, and Ewing C R, (2004). Yucca Mountain: Earth-Science Issues at a Geological Repository for High-Level Nuclear Waste. Annual Review Plant Science, 32:363-401.

Mackilwain, C. Out of mind out of sight. Nat. 412: 851-852; 2001.

Marcos, R. Genotoxicity and radioresistance in electroplating workers exposed to chromium. Mutat Res, 446, 23-34; 1999.

Miller, A. C. Brooks K. Stewart M Anderson B, Shi L, McClain D, Page,N. Genomic instability in human osteoblast cells after exposure to depleted uranium, delayed lethality and micronuclei formation. J Environ Radioact, 64: 247-59 -259; 2003.

Mothersill C. Seymour C. Low-dose radiation effects, experimental hematology and the changing-paradigm. Exp Hematol, 31:437-445; 2003.

Monthersill, C. and Seymour, C. Relevance of radiation-induced bystander effects for environmental risk Assessment. Radiats Biol Radioecol, 42, 585-587; 2002.

Narayanan, PK. Goodwin, EH. Lehnert E,B. Alpha particles Initiate biological production of superoxide anions and hydrogen peroxide in human Cells. Cancer Res, 57:, 3963–3971;1997.

National Academy of Sciences, Health Risk from Exposure to Low Levels of Ionizing Radiation, BEIR VII. Pub National Academy of Science; 2005..

Oesterreicher J, Prise MK, MiChaelm DB, Vogt Jurtgen,T,J, M. Strahlenterapie, O, Alpha particles initiate biological production of Superoxide Anions and Hydrogen Peroxide in Human cells. In J Oncology 21:337-349; 2002.

Paz JD. Personal Communication International Conference of High Nuclear Waste, Las Vegas, April 10th; 2003.

Persson L, Chemical risks from nuclear waste repositories, Review of the literature Health Phys, 59, 915-917; 1990.

Perston R J. Bystander effects, Genomic Instability, Adaptive Response, and Cancer risk Assessment for Radiation and Chemical Exposures. Toxicol Appl Pharmacol 207: (Suppl 2), S550-S556; 2005.

Perston RJ, In: Risk Assessment, Bystander Cells May Play Important Role in Determining, Official Says. Chemical Regulation Volume 27 Number 11, March 17; 2003.

Plulveiret MA, Barkatt CW, Markes C, Stsehle WR. Paper on Continuing Investigation of Local Environment of Waste Container Surfaces. Paper Presented to the U.S. Nuclear Waste Technical Review Board Meeting Las Vegas, Nevada January 28, (2003).

Rossman TG, Uddin AN, Burns FJ, Bosland MC. Arsenite co carcinogenesis, an animal model Derived from Genetic Toxicology Studies. Environ Health Perspect. 110: Suppl 5, 749-752; 2002.

Rossman TG, Uddin AN, Burns FJ. Evidence that Arsenite acts as a cocarcinogen in Skin Cancer. Toxicol Appl Pharmacol, 198, 394-404; 2004

Tapio, S., Danescu Maye, J. Asmuss M. Posch, A. Gomolka M. Hornhardt S. Combined effects of gamma radiation and arsenite on the proteome of human TK6 lymphoblastoid cells. Mutat Res, 581: 141-152; 2005.

Shao C, Stewart V Folkard M, Barr Michael D, Kevin M, Prise M K. Nitric Oxide-Mediated Signaling in the Bystander Response of Individually Targeted Glioma Cells. Cancer Res 63: 8437-8442; 2004.

Stalehe WR, "Results of Laboratory Test o the Corrosion resistance of Alloy 22 and Titanium-7. Paper presented to the U. S. Nuclear Waste Technical Review Board, Las Vegas, Nevada September 10; 2001.

Sitasawad LS, Kale RK, (1994). Divalent cations and Radiation induced lipid peroxidation. Ind J Exp Biol 32: 55-59; 1994.

The National Research Council Complex Mixtures, Methods for *in vivo* Toxicity. National Academy Press, Washington, D.C; 1988.

The Presidential Congressional Commission on Risk Assessment and Risk Management Report on the Accomplishments of the Commission on Risk Assessment and Risk Management Ed. by Gilbert S O. Commission Chair, The Government Printing Office stock number, 055-000-00567-2.

United Nations Scientific Committee on the Effects of Atomic Radiation March ;1997.

UNSCEAR (2000). Report to the General Assembly, with Scientific Annexes, Appendix. H.199-208; 2000.

U.S. Department of Energy Yucca Mountain Project, Final Environmental Impact Statement, DOE/EIS-0250 Inventory of Chemically Toxic Material, Chapter. 5, pp 5-7, February; 2002

U.S. Department of Energy August Unsaturated Zone and Saturated Zone Transport Properties, ANL-NBS-HS-000019, REVISION 00, ICN 02, Sec 5; 2000.

U.S. The Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. Guidance Manual for the Assessment of Joint Toxic Action of Chemical; 2004.

Vaglenov A, Nosko M, Georgiev AR, Carbonell E, Creus A, and Lazutka, JR, a Dedonte V. Increase frequency of sister chromatid exchange in lymphocytes of Chernobyl clean-up workers. Int Radiat Bio, 67: 671-676; 1995.

Yager, J, W, and Wiencke, J, K. Inhibition of Poly ADP Ribose Polymerase by arsenite. Mutation Research - Reviews in Mutt Resh 386: 345-351; 1997.

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