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RADIATION STANDARDS

Scientific Basis Inconclusive, and EPA and NRC Disagreement Continues

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Mr. Chairman and Members of the Subcommittee:

We are pleased to be here today to discuss the regulatory standards used to protect the public from the risks of low-level nuclear radiation. The scientific basis for these standards has been in question, as well as what level of protection is appropriate and adequate for the public. As you know, historically federal agencies, including especially the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC), have sometimes disagreed over how restrictive U.S. radiation standards should be. They have set differing standards, which include varying limits on radiation exposure to the public. The standards cover regulatory applications such as cleaning up major weapons production sites, decommissioning commercial nuclear power plants, and potentially constructing an underground repository for the disposal of highly radioactive waste at Yucca Mountain, Nevada.

On the basis of our June 30, 2000, report to Senator Pete Domenici,[1] our statement today addresses three issues: (1) whether current radiation standards have a well-verified scientific basis, (2) whether federal agencies, particularly EPA and NRC, have come closer to agreeing on exposure limits (how much radiation people can be safely exposed to) in the standards since we reported on this issue in 1994,[2] and (3) how implementing these standards and limits may affect the costs of nuclear waste cleanup and disposal activities. In regard to the scientific basis of radiation standards, we examined many scientific studies and interviewed recognized scientists in the fields of radiation protection and radiation research. In addition, we employed an expert consultant to help review scientific research correlating natural occurring (background) radiation levels around the world with local cancer rates.

In summary:

- U.S. radiation standards for public protection lack a conclusively verified scientific basis, according to a consensus of recognized scientists. Below certain radiation exposure levels, the effects of radiation are unproven, despite many years of research efforts. Evidence of

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[1]*See Radiation Standards: Scientific Basis Inconclusive, and EPA and NRC Disagreement Continues* (GAO/RCED-00-152, June 30, 2000).

these effects is especially lacking at regulated public exposure levels—levels of 100 millirem a year and below from human-generated sources.[3] At these levels, scientists and regulators assume radiation effects according to what is commonly known as the "linear no threshold hypothesis," or model. According to this model, even the smallest radiation exposure carries a cancer risk, and risks double as the exposure doubles. The model is useful and relatively simple, but controversial. Some scientists argue that the model overestimates radiation risks. Others take the position that the model underestimates these risks. Research into low-level radiation effects continues, including studies attempting to statistically correlate natural background radiation levels in the United States and around the world with local cancer rates. A promising long-term research area is focusing on low-level radiation effects within human cells, including a 10-year Department of Energy (DOE) program begun in 1999. Also, a major National Academy of Sciences reassessment of the status of research into low-level radiation risks, called BEIR VII, is under way, for which U.S. regulators have set high expectations and which is due to conclude in 2001.

- Lacking conclusive evidence of low-level radiation effects, U.S. regulators have in recent years set sometimes differing exposure limits. In particular, EPA and NRC appear no closer to agreeing on exposure limits today than in 1994. The two agencies continue to favor different policies and regulatory approaches for various nuclear cleanup and waste disposal applications, especially those relating to groundwater protection. At nuclear sites, EPA favors applying restrictive standards---originally applicable to community drinking water--to limiting groundwater contamination. The drinking water standards include contamination limits for a long list of radioactive substances, equivalent in some cases to fractions of a millirem a year. On the other hand, NRC favors less restrictive standards that treat groundwater as one of various potential exposure means, or "pathways," within an all-pathway exposure limit of 25 millirem a year.[4] The disagreement involves EPA- and NRC-preferred protection levels that are both well below the range where radiation effects have been conclusively verified. In this regard, the disagreement essentially involves policy judgments--not strictly scientific judgments. The disagreement has complicated efforts to

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[2]See *Nuclear Health and Safety: Consensus on Acceptable Radiation Risk to the Public Is Lacking* (GAO/RCED-94-190, Sept. 19, 1994).
[3]A millirem is a commonly used unit of measurement of the biological effect of radiation. The radiation from a routine chest X-ray is equivalent to about 6 millirem.
[4]All-pathway exposure refers to exposure through soil, water, and air.

clean up nuclear facilities, as well as planning for the prospective Yucca Mountain, Nevada, high-level waste repository. It does not appear that EPA and NRC will readily agree on appropriate groundwater protection approaches for Yucca Mountain. Also, while the two agencies are working on a memorandum of understanding to clarify their regulatory roles related to nuclear facility decommissioning, they have made little progress on this matter since 1994 and before. Our June 2000 report to Senator Domenici concludes that intervention by the committees of jurisdiction may be needed to resolve the policy differences and clarify the regulatory responsibilities between the two agencies.

- Costs of implementing radiation protection standards at nuclear cleanup and waste disposal facilities vary from site to site. For all sites nationwide, long-term overall costs could be immense, although these costs have not been comprehensively estimated. An indication of the potential costs is that agencies, especially DOE, expect to fund hundreds of billions of dollars in nuclear cleanup and waste disposal projects over many years in the future. Differences in the costs of the EPA and NRC regulatory approaches to radiation protection have not been comprehensively estimated. However, agency analyses indicate that more restrictive radiation standards cost more to implement, as might be expected. These analyses also generally show accelerating costs to achieve the most restrictive protection levels.

Background

U.S. radiation standards protect the public from very low radiation levels. Specifically, the standards regulate human-generated exposures to the public in the range of 100 millirem a year and below. This regulatory range is in the lowest portion of the low-level radiation exposure range—which extends up to about 10,000 total millirem. The low-level range includes natural background radiation, which varies locally in the United States, but averages about 300 millirem a year. At exposure levels equivalent to or below background radiation levels, radiation is commonly considered to be a relatively weak source of cancer risk, although there is limited understanding of such causation.[5] Above about 10,000 total millirem, the high-level radiation

[5]Low-level radiation, along with many other environmental and biological events, may mutate cell structure. To counter these mutations, which occur by the thousands daily in each human cell, the human body has active cell-repair processes, though such processes are not entirely error free.

exposure range begins. In this range, extending without limit into the hundreds of thousands of millirem or even more, the cancer risks of radiation are better understood, and other, immediate health effects become apparent. Above about 30,000 total millirem, radiation exposure is a well-known cause of cancer. At about 200,000 millirem of instantaneous or short-duration radiation exposure, there can be blood cell changes, infections, and temporary sterility. Above about 400,000 millirem, short-duration exposure can cause death within days or a few weeks.

EPA and NRC administer the majority of federal radiation standards. EPA issues environmental radiation protection standards as mandated under Presidential Reorganization Plan No. 3 of 1970. NRC issues standards as part of its mandate to regulate civilian sources of nuclear radiation, under the Atomic Energy Act. Under the same act, DOE has issued public and worker protection standards applicable on-site at the department's nuclear installations. Both EPA and NRC have major regulatory roles related to nuclear site cleanup and decommissioning and nuclear waste disposal. In regard to nuclear cleanup, EPA administers Superfund, the legislation that governs cleanups of federal and nonfederal facilities, and NRC regulates the decommissioning of commercial nuclear power plants, as well as other commercial nuclear facilities, under the Atomic Energy Act. DOE is involved in nuclear site cleanup as the manager of over a dozen major nuclear weapons production sites. In regard to Yucca Mountain, EPA has the role of issuing standards to protect the public from releases of radioactive materials from the facility. NRC has the role of issuing technical requirements and criteria and licensing the facility. DOE is involved as the developer and potential operator of the facility.

EPA and NRC have historically implemented different regulatory approaches in their radiation standards, as we reported in 1994. EPA has implemented a risk-based radiation protection approach, setting a range of acceptable risk—between 1 chance in 10,000 and one chance in a million of an individual getting cancer. In association with this approach, the agency addresses individual environmental contamination sources, co-regulates chemicals and radioactive substances, and seeks to protect both human health and environmental resources. EPA's approach has been described as "bottom up," setting a relatively restrictive risk goal to be pursued through the best available technology—but allowing less restrictive acceptable risks in site-specific situations. In contrast, NRC favors a dose-based, radiation-specific protection approach. The commission's regulations focus on human health protection and "all pathways" of exposure in the environment. NRC's approach has been described as "top down," setting a relatively less restrictive dose limit but reducing doses well below the limit in site-specific situations where the reductions are "reasonably achievable." (In implementing its standards, DOE has historically implemented the same "top down" protection approach.)

U.S. Radiation Standards Lack a Conclusive Scientific Basis

U.S. radiation standards for public protection lack a conclusively verified scientific basis, according to a consensus of recognized scientists. Below certain exposure levels, the effects of radiation are unproven. At these levels, scientists and regulators assume radiation effects according to the "linear no threshold hypothesis," or model, under which even the smallest radiation exposure carries a cancer risk. However, the model is controversial among scientists, and decades of research into radiation effects have not conclusively verified or disproved the model, including studies attempting to statistically correlate natural background radiation levels in the United States and around the world with local cancer rates. Research is continuing, including a promising 10-year DOE program begun in 1999, addressing the effects of low-level radiation within human cells. Also, the National Academy of Sciences is conducting a major reassessment of the status of research into low-level radiation risks, called BEIR VII, for which the regulators requesting the work have set high expectations.

According to a consensus of recognized scientists, below about 5,000 to 10,000 total millirem of exposure, the effects of radiation are unproven. Evidence of these effects is especially lacking at regulated public exposure levels—levels of 100 millirem a year and below from human-generated sources. The consensus view that we encountered among scientists and in the scientific literature is that the research data on low-level radiation effects are inadequate to either establish a safety threshold or to exclude the possibility of no effects. Individual viewpoints differed. Some scientists and studies held that the data support the existence of a safety threshold—an exposure level below which there are no risks from radiation. Other scientists and studies held that there is no such threshold and there can be risks at even the lowest exposure levels. In addition, other scientists and studies noted that risks from low-level radiation are complicated and variable, depending on factors such as the type and amount of radiation involved, body organs exposed, sex of the person, and/or age at exposure. For example, some researchers hold that children and fetuses may be more at risk from low-level radiation than adults. Some scientists and studies held that there are considerable data to support the view that low levels of radiation can actually be beneficial to health—the highly controversial theory of hormesis. Proponents of hormesis argue that research indicating beneficial effects has not been adequately considered in the “consensus” scientific community.

Although conclusive evidence of low-level radiation effects is lacking, regulators still have the task of developing radiation standards to protect the public. In doing so, regulators routinely assume that low-level radiation effects exist, according to the “linear no threshold hypothesis” or model. According to this model, even the smallest radiation exposure carries a cancer risk, and risks double as the exposure doubles. This model is endorsed by national and international radiation protection organizations and is used as a preferred model by EPA, NRC, and DOE. It is thought by many to be a conservative “fit” to the data, unlikely to underestimate the risks of radiation. However, the model is controversial. Some scientists argue that use of the model to assess risks from radiation may result in either over- or underestimating radiation risks.

Decades of radiation effects research have neither verified nor disproved the linear model. The research data on low-level radiation effects generally include two different types of studies. One type follows the long-term health of a studied population, seeking statistically significant cancer effects, and is called epidemiology. Another type subjects animals or tissue or cell cultures to radiation, seeking biological evidence of radiation effects, and is called radiobiology. Epidemiology has been a key basis for the linear model, including research evidence accumulated on over 85,000 Japanese survivors of the Hiroshima and Nagasaki atomic bomb blasts. The Japanese data have well established high-level radiation effects, and scientists have extrapolated this relationship to the low-level radiation range as well—with considerable inherent uncertainty. Extrapolating from high-level exposures, delivered instantaneously or for a short duration, to low-level exposures delivered over years, may be subject to question. Also, the estimated doses received by the Japanese survivors are still subject to re-evaluation, even after many years of effort devoted to determining these doses.

In addition, epidemiological studies have attempted to statistically correlate natural background radiation levels in the United States and around the world with local cancer rates, with inconclusive results. A premise relating to such studies is that if the linear model of low-level radiation effects holds, places with significantly higher background radiation levels should have elevated cancer rates. With the help of an expert consultant, we examined 82 such studies, done in the United States, Europe, Asia, and South America. In the United States, areas of high natural background radiation include the Rocky Mountains, where levels are over three times higher than along the Gulf Coast. Also, in some areas of the world, mean annual doses can be more than double the average U.S. levels. Such studies are subject to methodological difficulties, including the small size of the studied population and the pursuit of small radiation-caused cancer effects that are difficult to detect among all cancers in the population. The results of the studies were inconclusive overall. Studies differed, though they generally found little or no evidence of elevated cancer risks from high natural background radiation levels. One prominent U.S. statistical study, by Bernard Cohen, University of Pittsburgh, in 1995, found a strong tendency for lung cancer rates to decrease with increasing radon exposures in 1,601 counties nationwide. However, the study has been criticized by epidemiologists as methodologically flawed because it is a compilation of average statistics in these counties--not data on individuals.

Conclusive evidence of radiation effects may not soon be obtained, but radiobiological studies may hold more future promise than epidemiological studies, according to researchers and regulators. Recently, there has been interest in research into the cellular processes through which radiation causes cancer, and since fiscal year 1999, the Congress has funded a DOE research program targeting the biological effects of low-level radiation at the cellular level. Many scientists and regulators we interviewed said this type of research could eventually help to determine more conclusively the effects of low-level radiation and their potential link to causing cancer. The DOE program projects total funding of almost $220 million over 10 years. The program is considered unique in that it is designed specifically to better validate the effects of very low radiation levels, in areas such as cells’ response to radiation damage, thresholds for low-dose radiation effects, and features distinguishing radiation-caused cell damage from damage from other, intra-cellular causes.

U.S. regulators have concluded that a major reassessment of the status of epidemiological and radiobiological research into low-level radiation effects is warranted. At their request, a committee of the National Academy of Sciences is conducting such a reassessment, called BEIR VII. The last such Academy study was done in 1990. The 1990 analysis, called BEIR V, established risk estimates that have been influential for U.S. regulators in setting radiation standards.[6] It also gave the linear model a qualified endorsement, stating that the model was not inconsistent with the available research data, but that at low radiation exposures, risks either less or greater than expressed in the linear model could not be excluded. U.S. regulators have set high expectations for the BEIR VII effort, which to a degree may shed light on the controversy concerning the linear model. The effort is due to conclude in 2001. In requesting BEIR VII, the regulators set expectations that the committee would focus on areas not necessarily emphasized in the 1990 study, including (1) any clear indications of the weight of evidence for radiation risks at low doses and dose rates, (2) epidemiological studies on nuclear workers, (3) evidence of radiation effects specifically at the very low levels where regulators set radiation standards, and (4) evidence of hormesis. However, according to scientists and agency officials, and on the basis of the research evidence to date, it may be too much to expect BEIR VII to fully resolve the current controversy by either validating or disproving the linear model.

EPA and NRC Continue to Disagree on Radiation Standards

In 1994, we reported that EPA and NRC disagreed on radiation standards. Today, they appear no closer to agreement. In the absence of conclusive scientific evidence of low-level radiation effects, the two agencies continue to have a policy disagreement concerning how much radiation risk is acceptable to protect the public. The disagreement essentially involves groundwater protection, at dose levels well below the range where radiation effects have been verified. EPA prefers a more restrictive approach than does NRC. Essentially, EPA favors specially protecting groundwater at nuclear sites, regulating groundwater to drinking water standards. Conversely, NRC favors including groundwater and other exposure means, or pathways, under an all-pathway exposure limit. The all-pathway exposure limit is less restrictive than the drinking water standards. The disagreement is affecting the implementation of nuclear site cleanup regulations and the development of regulations for the disposal of highly radioactive waste at Yucca Mountain.

The EPA-NRC disagreement involves policy judgments, not strictly scientific or technical differences. For both the cleanup and decommissioning of nuclear facilities and the disposal of nuclear waste, EPA's standards reflect the agency's "bottom up" protective approach, setting a

[6]BEIR VI was a 1999 Academy assessment of risks from radon.

relatively restrictive risk goal to be pursued through the best available technology. Also, EPA is attempting to implement a consistent regulatory policy—for both chemical and radioactive pollutants--of protecting groundwater as a national resource. In this respect, at nuclear sites EPA (1) sets a risk-based limit of 15 millirem a year for exposure from all pathways and (2) favors additional, more restrictive groundwater protection, to the same standards the agency applies to drinking water in community water supplies. In relation to various radioactive substances, these standards set exposure limits that are equivalent in some cases to fractions of a millirem a year. Conversely, NRC's approach does not include special groundwater protection. The commission's approach reflects its "top down" strategy--setting a relatively less restrictive dose limit but pursuing lower doses where reasonably achievable. NRC prefers to set radiation-specific, dose-based standards, and the Commission includes groundwater and other exposure means (or "pathways") under an all-pathway exposure limit of 25 millirem a year. (DOE also prefers an all-pathway approach.)

In specific cleanup and waste disposal applications, the differing EPA and NRC approaches have been implemented as follows. In 1995, EPA drafted cleanup standards reflecting 15-millirem-a-year all-pathway protection, plus separate groundwater protection. The agency withdrew the standards unfinalized in 1996, after other agencies objected to them, and implemented the same approach in 1997 in the form of nonbinding Superfund guidance. Also in 1997, NRC finalized its own cleanup standards, in the form of decommissioning standards reflecting all-pathway 25-millirem-a-year protection. Both EPA and NRC issued proposed standards for the Yucca Mountain high-level waste repository in 1999. EPA's draft standards reflect 15-millirem-a-year all-pathway protection, plus extra groundwater protection, while NRC's draft standards reflect 25-millirem-a-year all-pathway protection. (Under the Energy Policy Act of 1992, NRC's final standards are to be consistent with EPA's final standards.)

The differing EPA and NRC approaches have contributed to various regulatory complications. For example, in the 1990s, perceived dual regulation by EPA and NRC has complicated the cleanup and decommissioning process at some sites where both agencies' standards may apply. Such situations can lead to duplication of effort, regulatory delays, and added compliance costs. Also, such situations can raise public questions about what cleanup levels are appropriate and safe. For example, in 1999, in individual situations at NRC-licensed sites, EPA has indicated that it might not view cleanups performed to NRC's standards as adequately protective under its

Superfund guidance. EPA considers such situations to be the exception, not the rule. However, licensees, including two New England power plants in 1999, have construed EPA involvement in such a situation as a warning that EPA could reevaluate the adequacy of a cleanup that has met NRC's requirements. Also, as we have reported, EPA and DOE have had historical differences concerning standards and acceptable risks for cleanups at DOE sites. These differences have contributed to regulatory delays and higher regulatory and cleanup costs while raising public questions about what cleanup levels are appropriate.[7]

Further, the EPA-NRC disagreement over standards for Yucca Mountain is complicating planning for the repository. How the disagreement is resolved could affect the technical credibility and acceptability of the final standards that are to be issued, prospectively in the summer of 2000. In large part, the disagreement has centered on the technical basis for EPA's extra groundwater protection approach for the repository. In particular, the National Academy of Sciences, mandated to recommend standards for the repository, has commented that EPA has not provided a technical rationale for its groundwater approach and that the agency is proposing to apply outdated drinking water concentration limits to groundwater at the repository. The limits are based on 1970s-era dose estimation methods. NRC, DOE, and other commenters have raised similar criticisms. NRC and DOE have also pointed out that EPA has not done a comprehensive analysis of the health benefits and costs of its groundwater approach for Yucca Mountain.

EPA says that its proposed groundwater protection approach for the repository is justified on policy grounds and is technically justifiable as well. The agency seeks to protect groundwater at the site as an environmental resource in a region where the population has been growing quickly. In addition, EPA says that the standards for Yucca Mountain should be in accord with agency policy of coregulating chemicals and radionuclides according to similar regulatory requirements. EPA believes that its regulatory approach has fully addressed the pertinent overall technical issues related to setting radiation standards for the site. EPA officials recognize that the drinking water concentration limits to be applied to groundwater at the repository are outdated, but they said the agency is in the process of updating the limits by the

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[7] See for example *Nuclear Cleanup: Completion of Standards and Effectiveness of Land-Use Planning Are Uncertain* (GAO/RCED-94-144, Aug. 26, 1994); and *DOE: Accelerated Cleanup of Rocky Flats—Status and Obstacles* (GAO/RCED-99-100, Apr. 30, 1999).

fall of 2000. Further, EPA officials agreed that the agency has not done a comprehensive analysis of the health benefits and costs of the agency's groundwater approach for Yucca Mountain. However, they are developing a regulatory impact analysis to accompany their final standards. While according to EPA this analysis will not constitute a specific technical rationale for its groundwater approach, and will not be a comprehensive cost-benefit analysis, the analysis will address in detail various technical and cost issues related to the standards' implementation.

It does not appear that EPA and NRC will readily agree on appropriate groundwater protection approaches for Yucca Mountain. Also, while the two agencies are working on a memorandum of understanding to clarify their regulatory roles related to nuclear facility decommissioning, they have made little progress on this matter since 1994 and before. Our June 2000 report to Senator Domenici concludes that intervention by the committees of jurisdiction may be needed to resolve the policy differences and clarify the regulatory responsibilities between the two agencies.

Costs To Implement Radiation Standards Vary But Could Be Immense In the Long Term

The costs of implementing radiation protection standards at nuclear cleanup and waste disposal facilities vary from site to site. For all sites nationwide, the long-term overall costs could be immense, likely in the hundreds of billions of dollars, although these costs have not been comprehensively estimated. Also, EPA, DOE, and NRC analyses indicate that (1) more restrictive radiation standards are more costly to implement than less restrictive standards and (2) costs accelerate to achieve the most restrictive protection levels.

The costs of nuclear cleanup and waste disposal are largely radiation standards driven. Over the long term, DOE, as well as regulated activities, may spend hundreds of billions of dollars in nuclear cleanup and waste disposal projects, in large part to help protect the public from radiation exposure. For example, DOE has projected funding for environmental cleanup at its nuclear sites from fiscal year 2000 through fiscal year 2070 to be anywhere from \$151 billion to \$195 billion (in 1999 dollars). And this estimate could go higher. In addition, the Nuclear Energy Institute has estimated over \$38 billion in costs to NRC licensees to decommission their nuclear facilities, including nuclear power plants, in coming decades. Further, DOE has estimated long-term funding of over $43 billion, and potentially over $55 billion according to the latest projections, for the Yucca Mountain repository system, in large part to help ensure that the public is protected from the high-level waste stored there. This estimate could also go higher, considering that since 1993 there have been repository-performance-related cost increases of over $10 billion to achieve added confidence that performance requirements and radiation protection requirements can be met over thousands of years. (Furthermore, in planning for commercial low-level nuclear waste disposal, state compacts and unaffiliated states have incurred almost $600 million in costs, although no disposal sites have yet been built.)

Differences in the costs of the EPA and NRC regulatory approaches to radiation protection have not been comprehensively estimated. However, agencies' cost analyses indicate that more restrictive radiation standards cost more to implement, as might be expected. Agencies routinely do such cost analyses to support their nuclear regulatory efforts. Many such analyses estimate both the costs and health benefits from meeting radiation standards, relying on the linear model. Such analyses sometimes determine hypothetical cancer deaths averted from meeting different protection levels, as well as dollars expended per hypothetical cancer death averted.[8] We examined numerous DOE, NRC, and EPA cost analyses, which the agencies provided to us as best available data. Most of the analyses were site-specific, but EPA attempted a nationwide analysis in 1996. The analysis, to support a prospective EPA cleanup standard, addressed potential nuclear cleanup costs for 16 generic types of facilities around the country, based on actual DOE, NRC-licensed, and Department of Defense sites. The analysis did not address overall soil cleanup costs for these sites. Instead, it estimated incremental costs to clean up soil at these sites below a 100 millirem a year baseline, as shown in table 1.

[8]Such analyses can be potentially controversial, relying on the linear model to estimate population risks—i.e., projecting low radiation exposures across large populations to enumerate hypothetical cancer deaths.

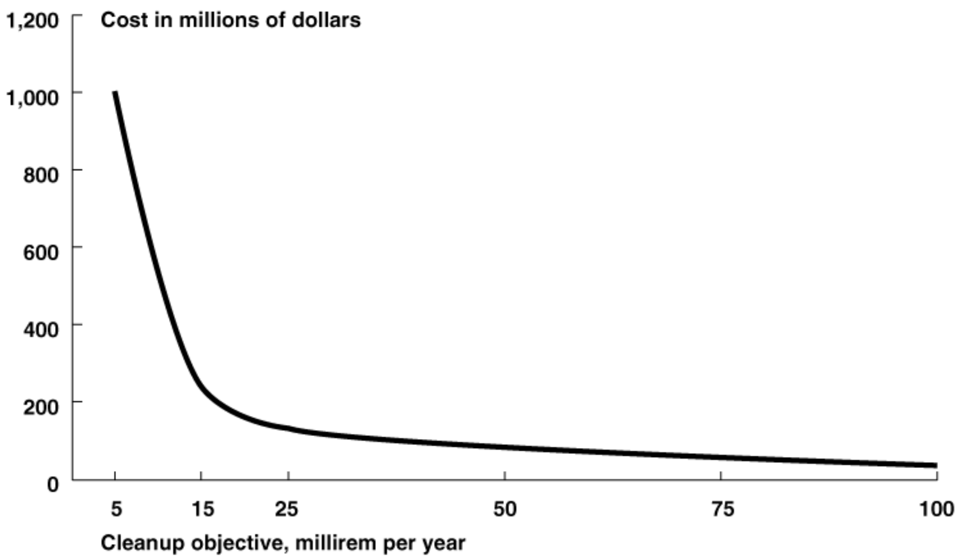
Table 1: Potential Incremental Costs to Achieve Different Soil Cleanup Levels—EPA Analysis, 1996

Cleanup level achieved, millirem a year	Incremental cost, in billions of dollars
25	1
15	1.5
3	3.2

As shown in table 1, EPA estimated significant nationwide cost differences to achieve different cleanup levels, including differences between the 15 millirem a year and 25 millirem a year levels, favored by EPA and NRC, respectively, as all-pathway protection levels. In addition, some DOE and NRC analyses of individual soil cleanup sites—either actual or generic sites--showed cost differences in the multiple millions of dollars per site between the 25-millirem-a-year and 15-millirem-a-year levels. (According to DOE and NRC officials, soil cleanup analyses do not represent overall site cleanup costs, which may include additional expenditures, such as for the decontamination and removal of structures, as well as liquid waste treatment.)

The EPA, DOE, and NRC analyses also generally showed accelerating costs to achieve the most restrictive protection levels, below 10 millirem a year. For example, a 1995 DOE analysis of the plutonium-contaminated Nevada Test Site and test ranges estimated, from a 100-millirem-a-year baseline, cost increases of over three times to achieve 25 millirem a year, and over six times to achieve 15 millirem a year, but over 28 times achieve the 5-millirem-a-year level. These accelerating costs can be shown graphically in the form of a cost curve, as depicted in figure 1:

Figure 1: Cleanup Costs As A Function of Cleanup Levels—Nevada Test Site Analysis, 1995



Agencies generally did not have analyses showing the cost differences between EPA's groundwater protection approach and NRC's all-pathway approach. However, two DOE analyses showed potential multi-million dollar added costs to meet EPA drinking water standards in onsite aquifers through long-term "pump and treat" techniques, involving pumping the water out of the ground, treating it, and discharging it back into the ground. Less aggressive approaches, such as allowing natural attenuation or dilution of the contamination, were less expensive.

Mr. Chairman, the cost data and analyses we examined indicate that protecting the U.S. public from the risks of low-level radiation is a costly undertaking. This is especially the case at the currently regulated public exposure levels of 100 millirem a year and below from human-generated sources—in some cases, levels of fractions of a millirem a year. Protecting at such levels, well below the levels where radiation effects have been verified, is essentially a policy judgment by regulators. Such an approach may be arguably prudent, using the linear model as its fundamental scientific basis. To the extent that the linear model is in question, new and better research evidence relating to the validity of this model could alter regulatory policies. In this regard, the National Academy of Sciences BEIR VII effort is important and bears watching. However, according to scientists and regulators, conclusive evidence either validating or disproving the linear model may not be forthcoming for years, despite the promise of ongoing radiobiological research.

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Mr. Chairman, this concludes my prepared statement. I will be pleased to respond to any questions that you or Members of the Subcommittee may have.

Contact and Acknowledgement

For future contacts regarding this testimony, please contact me at 202-512-3464. Individuals contributing to the testimony included Duane G. Fitzgerald and Dave Brack.

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