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CONTENT

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"I have discovered that the siting of a nuclear waste repository will never be made on the basis of popular demand."**

ABSTRACT

Our collective consciousness of atomic energy has increased dramatically since WWII. Unfortunately, our collective understanding of how to control it has not expanded in a commensurate fashion. One manifestation of the general lack of consensus on radioactive matters is the increasingly complicated subject of waste disposal. The fact that waste is radioactive does not mean that it is per se *more hazardous or more difficult to handle than many categories of nonradioactive waste. Nevertheless, radioactive waste seems to be perceived as especially undesireable. For purposes of analysis, most nuclear waste can be divided into four categories: mine waste, mill tailings, low-level waste, and spent-fuel. Mine waste remains the largest category as well as potentially the greatest problem, but it is essentially unaddressed by federal regulatory programs. The remaining three categories are the subject of extensive federal regulation, but that regulation has not promoted a solution to the key question of siting disposal facilities, nor has it produced standards for disposal facilities, nor has it generated standards for disposal which are consistent across categories. Perhaps the solution lies in establishment and enforcement of scientifically-based substantive standards for decisions on siting and design, rather than in the complex and procedurally intensive dispute resolution mechanisms thus far favored. Progress toward a solution might also benefit from a more market-oriented approach.*

Seven years ago, federal policy with respect to nuclear waste disposal was in disarray. The basic standards applicable to disposal of uranium mill tailings—the voluminous residues of uranium processing—were under attack.[1] The three remaining host states for low-level radioactive waste disposal facilities were threatening to close their facilities to out-of-state

**Statement attributed to the Honorable Morris Udall, Chairman, House Committee on Interior and Insular Affairs, INSIDE ENERGY, at 2 (May 19, 1986).

1. *See Management of Commingled Uranium Mill Tailings, Hearing Before the Procurement and Military Nuclear Systems Subcomm. of the House Armed Services Committee*, 97th Cong., 2d Sess. 382 (1982) [hereinafter *Management of Commingled Uranium Mill Tailings*].

waste.[2] The basic assumption, made by the Nuclear Regulatory Commission [NRC] in civilian nuclear power reactor licensing proceedings, that disposal facilities for spent nuclear fuel and high-level radioactive waste would be available when needed, was under challenge.[3]

One cannot say that all the turmoil, confusion, and differing views have dissipated. It is clear, however, that the playing board has changed significantly. The basic standards for tailings set by the Environmental Protection Agency [EPA] have been judicially upheld.[4] Congress has twice attempted through legislation to force the states to develop new low-level waste repositories.[5] And Congress has adopted a convoluted "road-map" for the siting and construction of one and possibly two repositories for spent nuclear fuel.[6]

Congress' solution to the problem of nuclear waste has taken the form of searching for political accommodation through the diffusion of decisionmaking authority rather than of the selection of objective rules of decision. As a result, the nuclear waste disposal program, although largely federal in its inception and controlled by a single agency (the Atomic Energy Commission [AEC]), has become increasingly de-centralized and de-federalized. Moreover, Congress has supplied no significant additional guidance with respect to standards either for disposal or for siting repositories. Because the approach which Congress has evolved is more political than scientific, the regime for siting facilities for the various categories of nuclear waste differs dramatically, and in a fashion which has only a limited relationship to the hazards involved. And to the extent basic nuclear waste regulatory standards exist, they not only sometimes fail to harmonize with, but also, display limited association with standards applicable to non-nuclear waste.

There is little doubt that the federal government had to develop institutional arrangements to address waste disposal problems. However, the direction seems to be accentuating rather than resolving the political

2. H.R. REP. No. 96-1382, Part II, 99th Cong., 2d Sess. 25 (1980).

3. In Minnesota v. NRC, 602 F.2d 412 (D.C. Cir. 1979), petitioners challenged decisions by NRC to allow reactor licensees to expand their on-site storage capacity for spent nuclear fuel, arguing, among other things, that NRC had failed to consider whether reactors may be operated safely without a permanent off-site repository. NRC claimed that it had confidence that such a repository would be available when required. Judge Leventhal upheld the licensing decision. 602 F.2d 419. NRC subsequently initiated a rulemaking proceeding on the issue. 44 Fed. Reg. 61,372 (1979).

4. American Mining Congress v. Thomas, 772 F.2d 640 (10th Cir. 1985) (active sites); American Mining Congress v. Thomas, 772 F.2d 617 (10th Cir. 1985) (inactive sites).

5. Low-Level Radioactive Waste Policy Act, 94 Stat. 3347-49; Low-Level Radioactive Waste Policy Amendments Act of 1985, 99 Stat. 1842-1925.

6. Nuclear Waste Policy Act, 42 U.S.C. §§ 10,100-10,226. NRC subsequently determined, in partial reliance on the statute, that it has reasonable assurance that repositories would be available when required. 49 Fed. Reg. 34,658 (1984).

struggle over waste disposal. In addition, because there has been a proliferation of decisionmaking authorities, each insisting on its own piece of the action, the current approach not only may lead to a lack of uniformity but also to additional costs to consumers—costs on the order of billions and even tens of billions in additional dollars over the next twenty years.

Perhaps all this is inevitable. It would be incredibly naive to suggest that the siting of nuclear waste disposal facilities is not an intensely emotional and highly politicized issue in an open society such as the United States. But frequently solutions, like the caloric theory of heat, are elaborations on old habits of thought rather than true progress on a problem. It is time to look at where the nuclear waste disposal program is, how it got there, and whether this is really a desirable position for the program to be in.

I. WHAT IS NUCLEAR WASTE?

It is necessary first to arrive at some understanding of what constitutes radioactive,[7] or nuclear, waste. A clear-cut definition is not available. There are naturally occurring radioactive materials in virtually all terrestrial objects. In addition, the Earth is continually bombarded with cosmic radiation, which creates additional radioactive materials. As a consequence, virtually any substance—including the soil, buildings, plants, animals, human beings and the air we breath—is radioactive to some degree.[8] It follows that esentially all waste is also radioactive.

Fortunately, the Environmental Protection Agency in 1978 suggested an approach to radioactive waste which can serve as a basis for evaluating federal regulatory activities. EPA proposed that:

> [r]adioactive materials should be considered radioactive wastes requiring control for environmental and public health protection if they have no designated product or resource value; and (a) are human produced by nuclear fission or activation, fabricated from naturally radioactive materials into discrete sources, or as a result of regulatory activities are prohibited from uncontrolled discharge to the environment; or (b) contain diffuse naturally occurring radioactive materials that, if disposed into the biosphere, would increase exposure to

7. Radioactivity is a property in which the nucleus of an atom "decays" by means of release of alpha particles (helium nuclei composed of 2 protons and 2 neutrons), beta particles (electrons), or gamma rays (similar to x-rays). All the isotopes of some naturally occurring elements, such as thorium, uranium, radium and radon, are radioactive. Other elements, like carbon, have stable and "unstable" (or radioactive) isotopes.

8. *See generally* Upton, *The Biological Effects of Low-Level Ionizing Radiation*, SCI. AM. 41 (Feb. 1982); International Atomic Energy Agency, *Nuclear Power, the Environment and Man* 65-66 (1982).

humans above that which would occur normally in pathways due to the pre-existing natural state of the area. Examples of radioactive waste materials that should be subject to environmental protection requirements are:

All radioactive materials associated with the operation and decommissioning of nuclear reactors for commercial, military, research, or other purposes and the supporting fuel cycles, including spent-fuel if discarded, fuel reprocessing wastes, and radionuclides removed from process streams or effluents.

Artificially produced radioisotopes, including discrete radium sources, for medical, industrial, and research use and waste materials contaminated with them.

The naturally radioactive residues of mining, milling, and processing of uranium and phosphates.[9]

There are two basic and not necessarily related parameters employed in this definition to distinguish radioactive waste: first, it must be produced, manipulated, or regulated by man; and second, in some instances it must enhance background radiation exposure. The first of these parameters is institutional; the second is relative. As a result, either parameter may result in arbitrary distinctions which lead to different treatment of radioactive material displaying similar levels of potential health hazards. For example, the definition could result in stringent measures for a particular "waste" in areas of low-background radiation but no measures in areas of high-background radiation. Moreover, radioactive material not subject to human manipulation (as in naturally occurring radium-rich soils) may pose significant potential hazards but be totally unregulated, whereas radioactive material subject to human manipulation may be subject to tight control even though it represents a comparable level of hazard.[10] The difficulty in defining what constitutes radioactive or nuclear waste makes a consistent approach to the issue somewhat troublesome. A consistent approach to the problem of radioactive waste is further complicated by the numerous statutory authorities pertaining to one or more aspects of radioactive waste disposal and the multitude of federal and state agencies involved in the regulation of disposal, or in the construction and operation of disposal facilities.

II. MINE WASTE AND OVERBURDEN

There are several different kinds of mine waste: solid waste, mine water, and airborne emissions from mining operations. This article will concentrate on solid waste and airborne emissions.

9. 43 Fed. Reg. 53,261, 53,263 (1978).
10. 42 U.S.C. §§ 2011-2296.

Solid mine waste is the soil or rock that is generated during the process of gaining access to ore or to a mineral body. Such wastes in some ways resemble tailings (wastes generated by various physical or beneficiation processes that may be used to separate a valuable metal or mineral from its ore), or heap leaching wastes (which result from the spraying of material with acid or cyanide to leach out metals).[11]

EPA views mine waste as radioactive if it contains "a radioactivity level of more than 5 picocuries/gram (of radium-226)."[12] The agency estimates that approximately 443 million metric tons of radioactive mine waste are generated each year. Of this amount, 352 million metric tons are phosphate wastes, and 91 million tons are uranium mine overburden.[13] Approximately 93 million tons of this waste (mostly associated with uranium) exceed 20 pCi/gram.[14]

The scope of the radioactive mine waste problem can be better understood by comparing the amount of such waste to the amount of hazardous waste generated from all non-mining sources. According to EPA, about 150 million metric tons of hazardous waste from non-mining sources were generated in the United States in 1981.[15] The amount of potentially hazardous phosphate mine waste alone is thus more than twice as large by weight than all non-mine chemical hazardous waste combined. Moreover, potentially hazardous radioactive mine waste is much greater in total amount by weight than all other radioactive waste produced each year; indeed, the annual amount exceeds the total weight of all spent nuclear fuel and uranium mill tailings produced by the U.S. nuclear power industry since its inception.[16]

In addition to the generation of large quantities of solid wastes, uranium mining and phosphate production results in the release of relatively large quantities of radon—an inert radioactive gas—into the environment. In-

11. EPA, Report to Congress, *Wastes from the Extraction and Beneficiation of Metallic Ores, Phosphate Rock, Asbestos, Overburden from Uranium Mining, and Oil Shale*, ES-4 (1985) [hereinafter EPA, Report to Congress].

12. *Id.* ES-12. A Curie (Ci) means that quantity of radioactive material producing 37 billion nuclear transformations per second. One Picocurie (pCi) = 0.000000000001 Ci. 40 C.F.R. § 192.01(f). A gram of pure radium-226 contains one Curie of radioactivity. The unit is named after Marie Curie, the discoverer of radium.

13. *EPA*, Report to Congress, *supra* note at 11, ES-12, Table ES-3 at ES-13, 6-6.

14. *Id.* at 6-6.

15. N.Y. Times, Aug. 31, 1983, at A1, col. 1.

16. Nuclear power reactors currently produce about 2,000 metric tons of spent-fuel per year. *See* 50 Fed. Reg. 38,066 (1985) (EPA estimate). The largest waste category produced by the nuclear power industry is uranium mill tailings. There are approximately 175,000,000 tons of uranium mill tailings at active uranium processing sites. *See EPA Radon and Radionuclide Emission Standards, Hearing Before the Procurement and Military Nuclear Systems Subcommittee of the House Armed Services Comm.*, 98th Cong., 1st Sess. 45 (1983) (EPA estimate). There are approximately 24,000,000 tons of tailings at inactive sites. *Management of Commingled Uranium Mill Tailings, supra* note 1, at 330.

deed in order to meet requirements established by the Mine Safety and Health Administration to reduce exposures of underground uranium miners to levels not exceeding 4 WLM[17] per year,[18] underground uranium mines vent large quantities of mine air to the atmosphere when in operation. Open-pit phosphate and uranium mines automatically allow the venting of radon to the atmosphere.

A. Potential Health Hazards

In order to appreciate the regulatory problems posed by mine wastes, it is necessary to understand the potential health hazard with which they are associated. The potential hazards chiefly flow from naturally occurring radioactive elements, or radionuclides, contained in the ores being mined. The most discussed potential hazards are all associated with the decay products of uranium. One of these radioactive decay products is radium-226. Radium-226 is a replacement for calcium in biological systems; its ingestion in high concentrations is known to result in early onset and excessive levels of cancer, as demonstrated in the famous cohort of radium dial painters.[19]

Of additional concern is radon-222, a decay product of radium-226. Radon-222 is an inert radioactive gas. Although the half-life of radon-222 is relatively brief (3.82 days), it is long enough for the radon to diffuse through interstitial spaces in piles of mine waste or overburden to the surface and thence into the atmosphere. There it may potentially travel many thousands of miles.[20] Radon-222 itself is generally not a significant health hazard; however, its decay produces (daughters) are relatively short-lived radioactive solids which emit alpha radiation (helium nuclei). Relatively high-levels of alpha radiation delivered to the bronchial epithelia of the lungs are associated with an increased incidence of cancer.[21]

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17. "WLM" stands for "working level month." It is the radiation dose which would occur if an individual were exposed for 170 hours to air containing 1 Working Level [WL] of radon decay products. A WL is defined as any combination of short-lived radon daughter products in one liter of air that can result in the ultimate emissions of 1.3×10^5 Mev of alpha energy. If one assumes that radon decay products are at 100 percent equilibrium with radon (a rare event), .01 WL translates into a radon concentration of 1 pCi/liter of air. *Cf.* 10 C.F.R. § 20, App. B, note 3.

18. 30 C.F.R. § 57.5038.

19. Martland, et al., *Osteogenic Sarcoma in Dial Painters Using Luminous Paint*, 7 ARCH. PATH. 406 (1929); Martland, *The Occurrence of Malignancy in Radioactive Persons*, 15 AM. J. CANCER 2735 (1931); Rowland, et al., *Dose-Response Relationships for Radium-Induced Bone Sarcomas*, 44 HEALTH PHYSICS 15 (1983). *See also National Council on Radiation Protection and Measurement (NCRP), Exposure from the Uranium Series with Emphasis on Radon and its Daughters* 10 (NCRP Rep. No. 77) (1984) (calcium replacement).

20. *EPA, I Final Environmental Impact Statement for Standards for the Control of By-product Materials from Uranium Ore Processing* (40 C.F.R. § 192) (1983); Active Sites FEIS at 6-3.

21. *See, e.g.*, Samet, et al., *Uranium Mining and Lung Cancer in Navajo Men*, 310 NEW ENG. J. MED. 1481 (1984); Radford, et al., *Lung Cancer in Swedish Iron Workers Exposed to Low Doses of Radon Daughters*, *id.* at 1485; Harley, *Radon and Lung Cancer in Mines and Homes*, *id.* at

The longevity of the radium and radon hazards posed by mine wastes is determined by the presence in the waste of their radioactive precursors or parents. Since uranium-238, a parent of radium-226, remains present in most of the mine wastes at issue here, and since it has a very long half-life (4.51 billion years), the potential hazard posed by mine wastes may be viewed as essentially indefinite in duration.

The scope of the potential health hazard is dependent on two factors. The first is the concentration of radium-226—the parent of radon-222—in the overburden. In the case of mine overburden, that concentration, although elevated over average background levels, is nevertheless generally well below the concentration found, for example, in uranium mill tailings. The second important factor in evaluating the hazard is the amount and location of land affected by uranium and phosphate mining. Location has a bearing on likelihood of exposure to individuals as well as populations. Proximity to a population source increases both the population exposure and the potential number of maximally exposed individuals. The amount of land affected by the waste also has a bearing on the latter variable.

The question of population exposure to radon is somewhat complex and merits more detailed scrutiny. Radon generally disperses readily in the atmosphere. Consonant with this observation, studies of uranium mill tailings piles suggest that sources of radon produce detectible elevated concentrations (and thus potential health risks which may be relatively large in comparison to background radon hazards) only within a quarter to a half-mile downwind of the radon source.[22] Exposure to large populations is thus a matter of mathematical extrapolation rather than actual detection of increased levels of radon in the atmosphere. More specifically, if the radon source is located near population centers, higher extrapolated population exposures can be calculated based on theorized increased exposures that can be attributed to undetectible increases of radon extrapolated to be present in the atmosphere due to the nearby radon source. The concept of a maximally exposed individual is somewhat more precise, because close-in residents may be subject to the measureable quantities of increased exposure. However, in some cases, the risk figure for maximally exposed individuals is based not on an actual person but on an assumed individual occupying an assumed residence within X feet of the radon source. In any event, the most likely mode of exposure

1525; Active Sites, FEIS, *supra* at 6-3 to 4; NCRP, *Evaluation of Occupational and Environmental Exposures to Radon and Radon Daughters in the United States* 91-113 (NCRP Rep. No. 78) (1984) (no statistically significant increase below 60 WLM; excess cancer mortality above 100 WLM). The principal short half-life products of radon posing potential threats to the lungs are polonium-218, lead-214, bismuth-214, and polonium-214. *Id.*; Evans, *Comments on the Proposed Standards For Stabilization*, in *Management of Commingled Uranium Mill Tailings*, *supra* note 1, at 182 [hereinafter Evans].

22. Shearer & Sill, *Evaluation of Atmospheric Radon in the Vicinity of Uranium Mill Tailings*, 17 HEALTH PHYSICS 110 (1969).

for a maximally exposed individual to a local radon source is residential or business occupation of land contaminated with enhanced or elevated levels of radium-226.

Most uranium mining occurs in remote, relatively unpopulated portions of the American West. Most mining is relatively distant from large population centers. Moreover, it is generally believed that few people occupy land contaminated with uranium mine overburden for prolonged periods, at least at the present time. In contrast, roughly eighty percent of U.S. phosphate mine rock production occurs in Florida.[23] Because mining areas in Florida tend to be more populous than those in the West, there is arguably a higher risk of occupancy of contaminated land associated with phosphates. Indeed, EPA's original risk estimates for exposure to radon and its decay products were derived from the agency's study of hazards associated with Florida phosphate production.[24] One can arguably concentrate on phosphate mining for a "conservative" assessment of the radioactive mine waste problem.

At least 120,000 acres of land have been mined in Florida for phosphate. Of that amount, roughly 50,000 acres have been reclaimed to varying degrees. An estimated 7,500 of those acres are being used for residential housing or commercial purposes, which contain 1,500 to 4,000 structures.[25] EPA estimates that as many as twenty-four percent of these structures contain radon daughter products at a level exceeding 0.02 Working Levels (WL).[26] Concentrations at this level have long been viewed as posing a potential regulatory concern. For example, the Surgeon General's 1970 guidelines for remedial action for structures having uranium mill tailings under or around them suggest that remedial action be evaluated if indoor radon decay products exceed 0.01 WL.[27]

The fact that these levels have traditionally aroused regulatory concern does not quantify the potential hazard. Qualification of the potential hazard, like quantification of population exposure, turns out to be largely a matter of extrapolation. To date, there has been no demonstration of a level of exposure to radiation which is "safe" in the sense of harboring any possibility of ill-health effects, such as cancer.[28] On the other hand, at low-levels of exposure, any ill-health effects which occur are unde-

23. *EPA, Indoor Radiation Exposure Due to Radium-226 in Florida Phosphate Land*, at 1 (Feb. 1979) [hereinafter *Florida Phosphate*].

24. *Id.*

25. *Id.* at 93.

26. *Id.* at 95.

27. Letter from Acting Surgeon General Peterson to Dr. R.L. Cleare (Colo. Dept. of Health), July 27, 1970 (attachment).

28. *See, e.g.*, J. GOFMAN & A. TAMPLIN, POISONED POWER 92 (1971). The Committee on the Biological Effects of Ionizing Radiation of the National Research Council of the National Academy of Sciences (BEIR Committee) reports that it "does not know whether dose rates of gamma or x-rays of about 100 mrad/yr are detrimental to man." BEIR COMM., THE EFFECT ON POPULATIONS OF EXPOSURE TO LOW-LEVELS OF IONIZING RADIATION 3 (BEIR-III Report) (1980) [hereinafter BEIR-III].

tectible against background hazards. Accordingly, the potential ill-health effects of low-levels of radiation must be estimated. The most usual model, for purposes of making these estimates, is the linear non-threshold model. Under this model, it is assumed that because very high doses of radiation cause health effects, there will be proportional effects at low-levels.[29]

A residential exposure to 0.02 WL of radon decay products is generally assumed to result in a total annual radiation dose to the lungs of 1 WLM. Under the linear non-threshold model, EPA estimates that a dose of 1 WLM to the average individual may result in a risk of lung cancer of 1 in 100,000, or a potential risk for a lifetime (70 years) of exposure of approximately 1 in 1,000.[30] Given the high-background incidence of fatal cancer (about a 1 in 6 actual lifetime risk in the United States), a potential risk of this magnitude can be neither confirmed nor disproved.[31]

This level of risk is commensurate to the level of risk associated with other radiation limitations promulgated by EPA and NRC. A prime point of comparison is EPA's "uranium fuel cycle standard." This standard limits exposure to the general public from planned (that is, non-accidental) releases[32] of radiation (except radon and its daughters) from operation of the uranium fuel cycle (except mining and waste disposal) to 25 mrem[33] whole body dose equivalent.[34] Exposure to 25 mrem whole body dose equivalent equates to a risk of about 1 in 200,000 to 1 in 400,000 annually, or 1 in 2,000 to 1 in 4,000 lifetime.[35] Nevertheless, regulation of radon

29. Professor Evans has pointed out that the linear non-threshold model "was specifically chosen on a basis of mathematical simplicity and prudence to represent the *upper limit* of risk in the low-dose domain, for somatic radiobiological effects which had been observed only in high-dose domain." *Management of Commingled Uranium Mill Tailings*, *supra* note 1, at 186. The BEIR-III Report noted that the linear non-threshold model may overestimate cancer risk from "low-LET" (low linear energy transfer) radiation (gamma and beta radiation) but that the model was less likely to overestimate (and may in fact underestimate) risk from high-LET radiation (alpha radiation). BEIR-III, *supra* note 28, at 2.

30. *EPA, Florida Phosphate*, *supra* note 17, at 52.

31. NRC explains that "Although [risk estimates under the linear non-threshold model] may indeed be valid or even underestimate resulting health effects, presently available epidemiological data do not conclusively rule out the possibility of zero effects of the individual low doses and dose rates [associated with uranium processing wastes]." III NRC, Final Environmental Impact Statement on Uranium Milling (III GEIS) at U-4 (1980).

32. Release of mine overburden is intended or planned so the Part 190 standard is a plausible point for comparison.

33. "Rem" is a unit of dose equivalence which takes into account both absorbed radiation dose (measured in "rads" or the old unit "roentgens") and appropriate factors to account for differences in biological effectiveness (*e.g.*, a rad of alpha radiation is more effective at breaking chromosomes and causing other biological damage than a rad of beta or gamma radiation) and its spatial distribution in the body (some organs, such as the lungs and bone marrow, are more suspectible to ill effects from radiation). *Cf.* 40 C.F.R. § 190.02(h). One millirem (mrem) is 0.001 rem.

34. *See* 10 C.F.R. § 190.

35. Exposure to a whole-body radiation dose equivalent of 1 rem is generally believed under the linear non-threshold model to represent a risk of 1 in 5,000 to 1 in 10,000. *See Management of*

and its decay products to limit potential risk to these levels poses a difficult issue in terms of resource allocation. Many structures have radon decay product concentrations in this range solely because of naturally occurring radium in soil.[36] From some perspectives, it is arbitrary to expend resources to lower radon decay product concentrations in structures contaminated with uranium or phosphate mine wastes while ignoring the similar and indeed conceivably much more widespread potential hazard resulting from naturally occurring radium or from such practices as cigarette smoking.[37] Even more serious, federal energy conservation policies have encouraged people to reduce ventilation rates in homes and offices. Some calculations suggest that energy conservation has increased exposure to radon decay products far more than has non-regulation of uranium or phosphate mine wastes.[38] Again, this makes extensive efforts to regulate uranium or phosphate mining in order to reduce radon exposure appear arbitrary unless the government alters its support for at least certain forms of energy conservation.

The problem posed by radon emissions can be viewed from another angle. Although certain mine wastes emit substantial amounts of radon, the amount is dwarfed by natural radon emissions.[39] Thus, although EPA through extrapolation attributes several cancer fatalities among the general population due to such activities each year, these additional fatalities, even if they transpired, could not be detected against background fatalities

Commingled Uranium Mill Tailings, supra note 1, at 230 (1982) (testimony of Dr. Sinclair, President of National Council on Radiation Protection). Exposure to a whole-body dose of 25 mrem (1/40 of a rem) accordingly equates to a potential risk of between 1 in 200,000 and 1 in 400,000 annually, or, if it occurs each year, to a lifetime potential risk of between 1 in 2,000 and 1 in 4,000. For further comparison, average background radiation dose is approximately 80 to 100 mrem/year. *Id.* at 226. This would yield a potential lifetime risk for average background radiation equal to about four times that for maximally exposed people under EPA's 25 mrem standard and about double that for a .02 WL indoor exposure limit.

36. *See Management of Commingled Uranium Mill Tailings, supra* note 1, at 23 (1982) (Dr. John Harley notes that 4% of U.S. homes would exceed 1 WLM/year and 6% would exceed 2 WLM/year from naturally occurring sources rather than "enhanced" sources); NCRP, *Exposures from the Uranium Series with Emphasis on Radon and its Daughters, supra* note 19, at 42 (several percent of North American families may be subject to 14 rem/year to bronchial epithelium due to indoor radon). *See also* 16 BNA, ENV'T. REP. 2232 (Apr. 18, 1986) (concern over "Reading Prong," a naturally high uranium formation and source of radon extending from North Carolina through Virginia, Maryland, and Pennsylvania and terminating in Rhode Island).

37. *Cf. Management of Commingled Uranium Mill Tailings, supra* note 1, at 460 (Dr. Naomi Harley questions whether it is wise to spend substantial sums to address relatively low health risks given high background hazards).

38. *See e.g.*, Cohen, *Health Effects of Radon from Insulation from Buildings*, 39 HEALTH PHYSICS 937 (1980) (estimated 10,000 lung cancer deaths per year may double due to energy conservation efforts).

39. The overwhelming source of radon is natural soils. The next greatest contributors are evapotranspiration (release of water vapor by soils and plants), and soil tillage. The overwhelming sources of exposure to radon and its decay products are natural soils, building interiors, evapotranspiration, and soil tillage. *GEIS, supra* note 136, at 19.

potentially attributable to natural radon emissions and other causes.[40]

Mine waste is perhaps the greatest conundrum of all radioactive waste. It is the largest single component of all radioactive waste, yet the potential hazard which it presents is relatively low. On the other hand, that potential hazard—if added up over the time period during which radium-226 concentrations in (and radon-222 emissions from) the waste will remain elevated—is equal to or greater than the potential hazard presented from all the "planned" (that is, non-accidental) releases of the nuclear fuel cycle otherwise regulated by NRC and EPA. Depending on one's perspective, it is thus at the same time completely understandable and extremely surprising that so little action has taken place at the federal level to regulate those materials. Litigation and regulatory confusion are only to be expected under such circumstances.

B. The Absence of Federal Regulation of Radioactive Mine Wastes

The federal government has not regulated radioactive mine wastes except for three relatively minor exceptions: mine water releases regulated[41] under the Federal Water Pollution Control Act [FWPCA];[42] underground injection of material under the underground injection control program[43] of the Safe Drinking Water Act;[44] and regulation of individual sites under the Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA or Superfund].[45] There are, however, three potential vehicles for a more comprehensive control of mine waste: the Solid Waste Disposal Act,[46] the Clean Air Act,[47] and the Atomic Energy Act.[48] Developments under these three statutes will be briefly explored.

1. The Solid Waste Disposal Act and the Developing Standard for Land Contamination

The most significant effort in the direction of regulating the disposal of radioactive mine wastes has occurred under the Solid Waste Disposal Act [SWDA], the earlier version of which is called the Resource Con-

40. *See Management of Commingled Uranium Mill Tailings, supra* note 1, at 459-60 (testimony of Dr. Naomi Harley).

41. 40 C.F.R. §§ 440.30-.35 (1985).

42. 33 U.S.C. § 1254. The FWPCA does not apply to radioactive discharges regulated under the Atomic Energy Act. Train v. Colorado Public Interest Res. Group, 426 U.S. 1 (1976).

43. 40 C.F.R. § 146.6(c)(2) (in situ uranium mines); *id.* (e)(8) (sand backfill); *id.* (e)(13) (stopes leaching).

44. 42 U.S.C. § 201.

45. 42 U.S.C. § 9601. In Eagle-Picher Industries, Inc. v. EPA, 759 F.2d 922, 927 (D.C. Cir. 1985), the court of appeals rejected challenges by mining companies to inclusion of sites producing mining waste (or fly ash) on the National Priorities List established under Superfund.

46. 42 U.S.C. § 6901.

47. 42 U.S.C. § 7401.

48. 42 U.S.C. §§ 2011-2296.

servation and Recovery Act [RCRA]. When first enacted in 1976, the SWDA broadly defined "solid waste" to include "solid, liquid, semi-solid, or contained gaseous material resulting from . . . mining operations."[49] Although some regulation of "solid waste" was authorized, the focus of the SWDA is on "hazardous waste." The Act defined "hazardous waste" to encompass any solid waste which causes or contributes to death or serious illness, or poses a "substantial present or potential hazard to human health or the environment when improperly treated."[50] The early SWDA did not provide any quantitative standards for EPA to guide its regulation of hazardous waste, and is otherwise largely standardless except perhaps for the qualitative admonition that such wastes should be "properly treated," which seems implicit in the Act's definition of "hazardous waste." The Act is no longer totally standardless. It was amended in 1984 to incorporate a series of stringent technical requirements, such as double liners, for hazardous waste disposal facilities.[51]

When Congress adopted the SWDA, there was considerable uncertainty with respect to the effect of the statute on treatment of mine wastes. Section 8002(f) of the Act[52] accordingly directed EPA to conduct a:

> [D]etailed and comprehensive study on the adverse effects of solid wastes from active and abandoned surface and underground mines on the environment, including, but not limited to, the effects of such wastes on humans, water, air, health, welfare, and natural resources, and on the adequacy of means and measures currently employed by the mining industry, government agencies, and others to dispose of and utilize such solid wastes to prevent or substantially mitigate such adverse effects.

The study was to analyze waste volumes, hazards, alternative disposal techniques, costs and potential re-use of material.[53]

On December 8, 1978, EPA proposed regulations to identify hazardous wastes and for the management of those wastes. Based on a house committee report accompanying the house bill which was the predecessor to the Act,[54] EPA excluded from regulation as a hazardous waste "overburden resulting from mining operations and intended for return to the mine site" unless the overburden was specifically listed.[55] EPA proposed to specifically list uranium and phosphate mine wastes and overburden

49. 42 U.S.C. § 6903(27).
50. 42 U.S.C. § 6903(5).
51. *See, e.g.*, 42 U.S.C. § 6924, as added by P.L. 98-616 (Nov. 8, 1984).
52. *Id.* § 6982(f).
53. A date for completion of the study was not stated. A 1980 amendment subsequently prescribed 36 months from Oct. 21, 1980. *See* P.L. 96-482, § 29(1).
54. H.R. REP. No. 94-1491, 94th Cong., 2d Sess. § 2 (1976).
55. 43 Fed. Reg. 58,958 (1978).

because of their radioactivity.[56] The agency also proposed to establish, albeit in a rather backhanded fashion, a standard for determining when solid wastes were so radioactively contaminated as to be hazardous. More particularly, the agency proposed that a listed waste be deemed presumptively radioactive unless it were shown to have "an average radium-226 concentration less than 5 picocuries per gram for solid waste or 50 picocuries (radium-226 and radium-228 combined) per liter for liquid waste."[57] The proposal also envisioned somewhat less stringent standards for high-volume, low-toxicity mine wastes than for other hazardous mine waste.[58]

EPA subsequently proposed interim final regulations on May 19, 1980.[59] The agency dropped the two proposed listings of uranium and phosphate wastes, because the agency had decided against the approach of exempting overburden except for specific listings. EPA instead issued an interim final listing for three specific mine waste streams, none of which are necessarily associated with radioactivity. The agency declined to defer regulating these three mine waste streams pending completion of the mine waste study under Section 8002(f).

Congress amended the SWDA in 1980. The amendments[60] prohibited EPA from regulating mine wastes,[61] including phosphate rock and overburden from the mining of uranium ore, "until at least six months after the date of submission" of the Section 8002(f) study and a new study required under section 8002(p).[62] The amendments also required the EPA administrator to determine, after public hearings and an opportunity to comment, whether to promulgate SWDA regulations for mine waste or to leave such waste unregulated.[63] Notwithstanding this general proscription on regulating mine waste, the amendments reserved authority to the EPA administrator to issue SWDA regulations: "to prevent radioactive exposure which presents an unreasonable risk to human health from the use in construction or land reclamation (with or without revegetation) of (I) solid waste from the extraction, beneficiation, and processing of phosphate rock or, (II) overburden from the mining of uranium ore."[64] EPA has not taken any action to implement this reserved authority with respect to radioactive mine wastes.

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56. *Id.*
57. 43 Fed. Reg. 58,959.
58. 43 Fed. Reg. 58,992.
59. 43 Fed. Reg. 33,100 (1980).
60. Codified at 42 U.S.C. § 6912(b)(3).
61. 43 Fed. Reg. 33,100 (1980).
62. 42 U.S.C. § 6982(p).
63. 42 U.S.C. § 6921 (b)(3)(C).
64. *Id.* § 6921(b)(3)(B)(iii). The mine waste exclusion also did not exclude mine waste from regulation as a solid waste. Chemical Mfg. Ass'n v. EPA, 673 F.2d 507 (D.C. Cir. 1982).

Congress again amended the SWDA in 1984. The 1984 amendments among other things specified a number of technical requirements for hazardous waste disposal, such as double liners and restrictions on land disposal. Congress, however, authorized the EPA administrator to "modify" a number of these new requirements in the event of regulation of mine waste as hazardous waste in order:

> [T]o take into account the special characteristics of [mine] wastes, the practical difficulties associated with implementation of such requirements, and site-specific characteristics, including but not limited to the climate, geology, hydrology, and soil characteristics at the site, so long as such modified requirements assure the protection of human health and the environment.[65]

On December 31, 1985, EPA issued its long-awaited Report to Congress envisioned by Sections 8002(f) and (p) of SWDA.[66] The conclusions reached by the agency in its Report suggest that the agency is leaning toward regulation of at least some mine wastes. For example, EPA concluded that "the difference between 'best practice' and typical practice is often significant . . . in many major segments (of the industry)." The agency also noted that "there appear to be major opportunities . . . that could significantly reduce damage potentials in certain contexts" and that "many waste management practices being applied to hazardous waste in other industries—most notably caps and liners—have been attempted for mining wastes."[67] The agency went on to suggest that it was focusing on wastes with the hazardous characteristics of corrosivity or EP toxicity, and that it would also gather more information on "dump leach" waste, because of the high metal concentrations and low pH of such waste, and wastes containing cyanides.[68] The agency finally stated that it:

> Will continue to study radioactive waste . . . . The agency is concerned that radioactive wastes . . . may pose a threat to human health and the environment, but we do not have enough information to conclude that they do. We will continue to gather information to determine whether these wastes should be regulated.[69]

On June 30, 1986, EPA announced its determination not to regulate mine wastes generally as hazardous wastes.[70] EPA argued that its current

65. 42 U.S.C. § 6924(x), as added by P.L. 98-616, § 209.

66. EPA, REPORT TO CONGRESS, WASTES FROM THE EXTRACTION AND BENEFICIATION OF METALLIC ORES, PHOSPHATE ROCK, ASBESTOS, OVERBURDEN FROM URANIUM MINING AND OIL SHALE (Dec. 31, 1985).

67. *Id.* at 6-10 to 6-11.

68. *Id.*

69. *Id.*

70. EPA Press Advisory of June 30, 1986.

hazardous waste management standards "are likely to be environmentally unnecessary, technically infeasible, or economically impractical" when applied to high-volume mine wastes.[71] The agency announced that it intended to develop new standards for mine wastes under Subtitle D of RCRA (which covers solid wastes) and to focus, among other things, on control of radioactive material.[72] Since the agency's authority to regulate solid waste under Subtitle D of RCRA is limited in comparison to its authority over hazardous waste,[73] EPA indicated that it would also seek additional enforcement authority from Congress. In the interim, EPA would rely on Section 7003 of RCRA[74] and Section 104 and 106 of CERCLA,[75] which provide for relief from imminent hazards in order to address problems at individual mine waste sites.[76]

In short, how radioactive mine waste will be regulated under SWDA is not yet clear. There are two harbingers, however, which have some possible bearing on this question. The first indication is the soil cleanup standard issued by EPA pursuant to Section 275 of the Atomic Energy Act,[77] as addded by the Uranium Mill Tailings Radiation Control Act of 1978, to govern remedial action for soil contaminated with uranium or thorium mill tailings. EPA originally proposed the 5 pCi/gram radium-in-soil standard for cleanup of former uranium processing sites.[78] However, the agency's final clean-up standard applicable to such sites calls for radioactivity resulting from tailings to be removed. After removal, the concentration of radium-226 averaged over any area of 100 square meters will not exceed background concentrations by more than 5 pCi/gram averaged over the top 15 centimeters (cm) of soil or by more than 15 pCi/gram averaged over 15 cm thick layers of soil more than 15 cm below the surface.[79] This deviates from EPA's initially proposed criterion for regarding a waste as hazardous due to radioactivity under the SWDA in two respects: first, EPA's original criterion of 5 pCi/gram radium-226

71. 51 Fed. Reg. 24,496 (1986).

72. *Id.* at 24,501.

73. *E.g.*, the Act authorizes the EPA administrator only to issue "information" and "guidelines" to assist states regulating solid waste. 42 U.S.C. § 6907. The administrator does have certain authority which permits regulation of "open dumping" of solid waste. 42 U.S.C. §§ 6941.

74. 42 U.S.C. § 6973 (imminent hazard).

75. 42 U.S.C. §§ 10,904, 10,906 (similar).

76. 51 Fed. Reg. at 24,501.

77. 42 U.S.C. § 2022.

78. 45 Fed. Reg. 27,370 (1980).

79. 40 C.F.R. § 192.12(a). It is interesting to note that these are the first standards for clean-up of radiologically contaminated soils ever issued by EPA, NRC, or their predecessors as final rules. NRC and its predecessor, the AEC, did issue "Guidelines for the Unrestricted Use" (succeeding editions dated Apr. 27, 1970, Dec. 1973, and Nov. 1976). These guidelines, however, were not designed for contaminated soil. EPA's standards for active uranium processing sites apply a standard similar to that for inactive uranium processing sites for soil clean-up for portions of disposal or licensed sites not subject to radon release rate limitations. *Id.* § 192.32(b)(2). Unlike the case for

appeared to include background. EPA's subsequent 5 pCi/gram surface and 15 pCi/gram subsurface standard is above-background. Second, EPA originally proposed to apply the 5 pCi/gram standard both to the surface and the subsurface. The new approach allows subsurface concentrations to be up to 15 pCi/gram. It is somewhat unclear what impact a 5 pCi/gram surface, 15 pCi/gram subsurface radium-226 standard will have in terms of reducing the volume of mine wastes potentially subject to SWDA regulations. The agency has indicated, however, that a 20 pCi/gram standard would largely exclude phosphate wastes.[80]

The second possible indication of the direction EPA may take with SWDA regulation of mine wastes is the agency's incorporation of many of its standards for chemical hazardous waste disposal (for example, liners) into its standards for disposal of uranium and thorium mill tailings.[81] This incorporation, however, has more of a bearing on the non-radiological hazards posed by such material, and thus may not be so

inactive uranium processing sites, in the case of active sites the agency does not have standards applicable to off-site contamination.

NRC is in the process of preparing general standards to govern the decommissioning of nuclear facilities. These standards presumably will encompass soil clean-up standards for decommissioned columbium/tantalum, zirconium/hafnium, and rare earths plants, all of which sometimes employ raw material qualifying as licensable "source material" under the Atomic Energy Act and posing many of the same questions posed by uranium and phosphate mine wastes, or uranium or thorium mill tailings. NRC, with EPA's concurrence, has initially selected a basic standard limiting public exposure to residual radioactivity from decommissioned facilities to no more than 10 mrem/year, with a justification required for any dose greater than 1 mrem/year. *NRC, Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, 2-13 (Jan. 1981). Under current assessments equating exposure to one rem of whole body radiation to a potential risk of about 1 in 5,000 to 1 in 10,000, a 10 mrem whole-body exposure would result in a potential risk of roughly 1 in 500,000 to 1 in 1,000,000 per year. A one mrem standard would equate to a potential risk of 1 in 5,000,000 to 1 in 10,000,000 per year. For comparison, EPA's land clean-up standards for uranium and thorium appear designed to limit residential exposure to radon decay products to .02 to .03 WL. 10 C.F.R. § 192.12(b)(1). (EPA originally proposed a .015 WL limit. 45 Fed. Reg. 27,370 (1980)). .02 to .03 WL equates to a potential exposure of roughly 1 to 1-1/2 WLM of radon decay products per year, to which EPA attaches a risk of 1 to 100,000 or more. In short, EPA's land clean-up standard appears at the high end of the risk spectrum envisioned in NRC's facility decommissioning rulemaking.

Another point of comparison is EPA's proposed "Federal Radiation Protection Guidance" (pursuant to the authority of 42 U.S.C. § 2021(h), as transferred to EPA by Reorganization Plan No. 3 of 1970) for persons environmentally exposed to transuranium elements (*e.g.*, plutonium—an important isotope which is an alpha-emitter like the important radon decay products). 45 Fed. Reg. 60,956 (1977). This proposed guidance was intended to be applicable to four federal sites (Rocky Flats, Mound Laboratory, Nevada Test Site, Trinity Test Site) and to address soil cleanup issues. 42 Fed. Reg. 60,958. EPA's proposal was to limit annual alpha radiation doses "to members of the critical segment of the exposed population" to 1 millirad per year to the pulmonary/lung and 3 millirads per year to the bone. *Id.* at 60,959. Ordinarily a "quality factor" of 20 is applied to convert "rads" (which are measures of "absorbed dose") to measures of biological effectiveness like "rems." A 1 millirad dose to the lungs would accordingly result in about 20 mrem exposure. Lung risk accounts for about one-sixth of whole-body risk. The EPA proposed guidance is thus roughly in the middle of NRC's proposed 1 to 10 mrem whole-body standard.

80. EPA, Report to Congress, *supra* note 11, at 6-6.

81. 40 C.F.R. § 192.32(a), referencing *id.* § 264.221 and *id.* § 192.32 (b)(1) referencing *id.* § 264.111.

indicative of the agency's likely approach on uranium or phosphate mine overburden, so long as such overburden is not believed to present a groundwater contamination problem.

2. The Clean Air Act

Section 112 of the Clean Air Act,[82] which deals with hazardous air pollutants, is in a sense the Clean Air Act counterpart of the regime for regulation of hazardous solid waste established under the SWDA. Indeed, the definition of "hazardous air pollutant" is in some respects a paraphrase of the SWDA definition for hazardous waste. More specifically, Section 112 defines hazardous air pollutant to mean an airborne contaminant to which no ambient air quality standard is applicable and which "causes, or contributes to, air pollution which may reasonably be anticipated to result" in an increase in deaths or serious illnesses.[83] Like the early SWDA, Section 112 affords little guidance concerning how EPA is to regulate hazardous air pollutants (at least for which there is no ambient air quality standard applicable). The Act calls for the promulgation of a "standard at the level which . . . provides an ample margin of safety to protect the public health from such hazardous air pollutant."[84] The statute also states that if it is not feasible to prescribe or enforce an emission standard for the pollutant, the EPA administrator may instead issue a design, equipment, work practice, or operational standard or some combination thereof, so long as "an ample margin of safety" is provided.[85] At least until the recent *Vinyl Chloride* case,[86] Section 112 was widely perceived as intending what amounts to a zero-risk standard for the pollutants involved.[87] EPA, for example, professed concern that it could not establish a standard (other than an outright ban) providing that "an ample margin of safety" for substances known to be harmful when no threshold for harmful effects has been established.[88]

Just as it has focused on radioactive hazards under the SWDA, Congress has specifically legislated with respect to radioactive air pollution under the Clean Air Act, although with somewhat greater effect. In particular, Congress in 1977 adopted Section 122 of the Clean Air Act, which required EPA to "determine whether or not emissions of radioactive

82. 42 U.S.C. §7412.

83. *Id.* (a)(1).

84. *Id.* (b)(1)(B).

85. *Id.* (e)(1).

86. Natural Resources Defense Council v. EPA, D.C. Cir. No. 85-4150 *(Vinyl Chloride)* (1986). *vacated* and set for *reh'g* en banc. The panel decision, now vacated, held that EPA may also consider economic and technical feasibility in addition to health-based factors under Section 112 of the Clean Air Act.

87. Reply Brief of Environmental Defense Fund, at 1-19 (Feb. 25, 1986) in Environmental Defense Fund v. Thomas, D.C. Cir. No. 84-1524.

88. *See, e.g.*, Ruckelshaus, *Science, Risk and Public Policy*, 221 SCI. 1026, 1027 (1983).

pollutants (including source material, special nuclear material and by-product material) . . . will cause or contribute to air pollution which may reasonably be anticipated to endanger public health.[89] In the event of an affirmative finding, Section 122 provides that EPA must list the pollutants for purposes of issuing air quality criteria, must regulate them as hazardous air pollutants (if they meet the definition of hazardous air pollutant), must issue stationary source standards, or must take some combination of these actions.[90] Section 122 was a product of the House Interstate and Foreign Commerce Committee which supported the new provision on the basis of its concern with radioactive air emissions from inactive uranium processing sites, nuclear reactors, nuclear energy research, weapons testing, and coal combustion.[91]

EPA, after seeking public comment,[92] listed radionuclides as hazardous air pollutants on December 27, 1979.[93] Under the terms of Section 112, EPA was required to issue proposed regulations within 180 days of the listing, with final regulations 180 days thereafter.[94] In subsequent analysis, the agency projected relatively high risks to nearby residents from underground uranium mines (1 in 100 lifetime),[95] phosphate mines (about 1 in 3,000 lifetime),[96] and open-pit uranium mines (also 1 in 100 lifetime).[97] EPA also assessed the risk to the U.S. population of all underground uranium mining to "about two fatal cases per year.[98] No assessment for population risk was provided for uranium or phosphate surface mines, but the number is presumably somewhat lower given the EPA's estimates of total radon releases from "model" facilities and the number of facilities in question.[99]

89. 42 U.S.C. § 7422(a).

90. *Id.*

91. H.R. REP. NO. 95-294, 95th Cong., 1st Sess. 37-38 (1977). Several Senators and Congressmen expressed concern over the lack of hearings on the provision and its "potential impacts on the Nation's energy program." *See, e.g.*, 123 CONG. REC. 27,072 (1977) (Mr. Flowers); *id.* at 27,078 (Mr. McCormack), *id.* at 26,855 (Mr. Johnston).

92. 44 Fed. Reg. 21,704 (1979).

93. 44 Fed. Reg. 76,738.

94. 42 U.S.C. § 7412(b)(1)(B).

95. EPA RADIOLOGICAL IMPACT, RADIOLOGICAL IMPACT CAUSED BY EMISSIONS OF RADIONUCLIDES INTO THE AIR IN THE UNITED STATES, PRELIMINARY REPORT, at 4.1-13 (1980) [hereinafter RADIOLOGICAL IMPACT].

96. *Id.*

97. *Id.* at 4.3-10.

98. *EPA, Background Information Document, Proposed Standards for Radionuclides* 5-18 (1983). EPA later upped this assessment to about five fatal cases per year. *See supra* note 107.

99. EPA suggested that its "model" phosphate mine and beneficiation plant releases 1,300 curies/year of radon. EPA, RADIOLOGICAL IMPACT, *supra* note 95, at 4.3-10. EPA states that there are 35 phosphate mines in the United States. *Id.* at 4.3-1. EPA indicates that a "model" surface uranium mine releases 1,961 curies/year, *id.* at 4.1-10, and that there are about 36 surface mines, *id.* at 4.1-2. In contrast, EPA states that there were 251 underground uranium mines, *id.* and that the average emission for a "model" mine (which may be larger than many of the 251 existing underground mines) is 6,729 curies per year. *Id.* at 4.1-10.

EPA was subsequently placed under a court order to issue proposed regulations.[100] The agency did eventually issue proposed standards for four categories of sources, including underground uranium mines.[101] The proposed standard for underground uranium mines would have limited radon concentrations to 0.2 pCi/liter above background. For comparison, this standard would be one-fifteenth the level permitted for public exposure in connection with operating uranium mills.[102] Assuming that decay products are at fifty percent of equilibrium, a 0.2 pCi/liter standard would amount to a standard in working levels of about .01—roughly half of what is now EPA's indoor limit for structures contaminated with tailings.[103]

Sued again for failure to issue final standards in a timely fashion, EPA was placed under another court order to promulgate standards (or delist radionuclides) within ninety days of July 25, 1984.[104] Rather than comply with the judicially set deadline, EPA withdrew its proposed standards for all the categories other than underground uranium mines on the ground that current regulations and practices relating to those sources of emissions provided an ample margin of safety to protect the public.[105] As to underground uranium mines, the agency withdrew its proposed standard on the ground that it failed to meet the legal requirements of Section 112. The agency simultaneously published an "advance notice of proposed rulemaking" soliciting additional information on operational controls such as bulkheading—a practice involving the sealing-off of exhausted or unused underground mine workings.[106] At the same time, however, EPA stressed that it viewed the risk posed by underground uranium mines both to nearby residents and to the general population as significant. Indeed, the agency in effect increased its risk estimates.[107]

On the same date that these actions were published in the Federal Register, the United States District Court for the Northern District of California issued an order requiring EPA and its Administrator, Mr. Ruck-

100. Sierra Club v. Gorsuch, 551 F. Supp. 785 (N. D. Cal. 1982).

101. 48 Fed. Reg. 15,076 (1983) The agency proposed to regulate (1) DOE facilities, (2) NRC-licensed facilities and non-DOE federal facilities, (3) elemental phosphorous plants, and (4) underground uranium mines. The agency did not propose to regulate, but solicited comments on, (1) coal-fired boilers, (2) the phosphate industry, (3) other extraction industries, (4) uranium fuel cycle facilities, uranium mill tailings, and management of high-level radioactive waste, and (5) low-energy accelerators.

102. 10 C.F.R. § 20, App. B.

103. 48 Fed. Reg. 15,083-15,084. EPA estimated that its proposed standard would result in a lifetime risk of 1 in 500 to a nearby resident, a level which is relatively high and which seems higher than the risk the agency attributes to greater levels of exposure indoors.

104. Sierra Club v. Ruckelshaus, 602 F. Supp. 892 (N.D. Cal. 1984). 105. 49 Fed. Reg. 43,906 (1984).

106. 49 Fed. Reg. 43,915 (1984).

107. 49 Fed. Reg. 43,912 (1984) (5 deaths per year to the general population; lifetime risks to nearby residents up to 1 in 10).

elshaus, to show cause why they should not be held in contempt of the Court's July 25 order.[108] On February 6, 1985, EPA responded by issuing final standards[109] under Section 112 for Department of Energy [DOE] facilities,[110] NRC-licensed facilities and non-DOE federal facilities,[111] and elemental phosphorus plants.[112] On April 17, 1985, the EPA issued a final standard[113] for underground uranium mines requiring the use of bulkheads "to isolate all abandoned and temporarily abandoned areas"[114] in underground uranium mines producing more than 100,000 tons of ore for the life of the mine or more than 10,000 tons of ore per year.[115]

It is important to underscore the limited nature of EPA's Clean Air Act requirements. First, they do not regulate either open-pit uranium mining or phosphate production; they are limited solely to underground uranium mines. Second, the standards do not impose emission limits; instead, they call for uranium companies to employ work practices, such as bulkheading of open stopes, to minimize radon releases.[116] Since the uranium industry claims that it is generally doing this already to hold down occupational exposure, the new radon standards are unlikely to have a major impact on total radon release.

EPA's action with respect to radon under the Clean Air Act has been controversial. Some environmental organizations take the position that EPA is obligated to impose what amounts to a zero-emission standard with respect to hazardous air pollutants, regardless of cost.[117] EPA indicates that any zero or near-zero emission limit would shut down underground uranium mining because of the necessity of venting the mines limit exposure of workers and the high cost of removing radon from emissions vented to the atmosphere.[118] In addition to attacking EPA's risk assessments, the industry similarly contends that it is basically not feasible to limit radon releases during mining of uranium and phosphates.[119] Although phosphates are potentially the greater problem, the dispute has

108. 50 Fed. Reg. 5191 (1985).

109. 50 Fed. Reg. 5190 (1985).

110. The standard, modeled on EPA's uranium fuel cycle standard at 40 C.F.R. § 190, limited emissions from DOE facilities to 25 mrem to the whole body, 75 mrem to the critical organs, for members of the public, radon and its decay products excepted. 40 C.F.R. § 61.92.

111. 40 C.F.R. § 61.102 (same as § 61.92). DOE had originally proposed a limit of 10 mrem to any organ (*see* 48 Fed. Reg. 15,082) for DOE, NRC-licensees and other federal facilities.

112. 40 C.F.R. § 61.122 (limiting emissions of polonium-210 to 21 curies per year).

113. 50 Fed. Reg. 15,386.

114. 40 C.F.R. § 61.22.

115. 40 C.F.R. § 61.20.

116. 40 C.F.R. § 61.22.

117. *See, e.g., supra* note 87.

118. *See, e.g.*, 50 Fed. Reg. 15,386 (high cost and difficulty of removing radon).

119. *See, e.g.*, American Mining Congress, Comments on the the Environmental Protection Agency's Proposed Standards for Radon-222 Emissions from Underground Uranium Mines 69-77 (Mar. 28, 1985).

tended to center on uranium mining (especially underground uranium mining), and the issue of whether a zero-emission standard must be imposed on uranium producers is currently pending in court.[120]

The strong interest in, and the extensive judicial direction of, the Clean Air Act regulation of mine wastes contrasts sharply with the relatively quiescent picture under the SWDA. This is somewhat surprising from both legal and factual perspectives. From a legal point of view, the definition for hazardous air pollutant and hazardous waste are similar so one would expect similar legal treatment. From a factual standpoint, solid mine wastes regulated under the SWDA present an arguably long-term potential hazard, whereas EPA's Section 112 regulations are directed principally at facilities only during their comparably brief operating lives.

3. The Atomic Energy Act

Regulation under the Atomic Energy Act [AEA] is limited to three kinds of nuclear material and two kinds of nuclear facilities. The two kinds of nuclear facilities ("production and utilization facilities"[121]) encompass nuclear electrical power reactors, nuclear (plutonium) production reactors, and fuel fabrication (for example, plutonium reprocessing or uranium enrichment) plants. Facility regulation under the Atomic Energy Act does not apply to any sort of mine waste.

The three kinds of material regulated under the Act are "source material,"[122] "by-product material,"[123] and "special nuclear material."[124] "Source material" is of possible relevance to the regulation of uranium mine waste. The Atomic Energy Act defines "source material" to mean:

> (1) uranium, thorium, or any other material which is determined by the [Nuclear Regulatory] Commission pursuant to the provision of [42 U.S.C.] § 2091 . . . to be source material or (2) ores containing one or more of the foregoing materials, in such concentration as the Commission may by regulation determine from time to time.[125]

The latter half of the definition is arguably broad enough to encompass any ore containing uranium or thorium. Nevertheless, the Commission

120. Environmental Defense Fund v. Thomas, D.C. Cir. No. 841524. *See* Brief of Environmental Defense Fund, at 17-46 (Oct. 9, 1985) (attacking EPA action—or inaction—on open pit and especially underground uranium mining) in *id.* This case is being held in abeyance pending an *en banc* rehearing, scheduled for Apr. 29, 1987, in Natural Resources Defense Council v. EPA, D.C. Cir. No. 85-1150 (*Vinyl Chloride*).

121. 42 U.S.C. § 2014(v) and (cc).

122. *Id.* (z).

123. *Id.* (e) (radioisotopes produced from fission).

124. *Id.* (aa) (enriched uranium and plutonium).

125. *Id.* (z).

has long taken the position that its regulatory jurisdiction appertains only after the removal of uranium or thorium ore from its place of deposit in nature.[126] This position gains support from Section 61 of AEA, which specifically bars transfer, receipt, possession, ownership, import or export of uranium or thorium ore after removal from its place of deposit in nature, except pursuant to Commission authorization.[127] The AEA has in fact treated this provision as implicitly proscribing regulation before removal of ore from a mine. The Commission accordingly never attempted to regulate uranium or thorium mining under the Atomic Energy Act of 1954, much less other forms of mining which might pose radiation hazards.

When it adopted the Uranium Mill Tailings Radiation Control Act of 1978, Congress required EPA, in consultation with the NRC, to "provide a report to the Congress which identifies the location and potential health, safety, and environmental hazards of uranium mine wastes together with recommendations, if any, for a program to eliminate these hazards."[128] EPA's eventual report represented that Congress need not enact "a remedial action program like that for uranium mill tailings" for uranium mine wastes because they were "lower in radioactivity and not as desirable for construction purposes as uranium mill tailings."[129] EPA noted, however, that mine wastes had been misused for construction purposes, that such misuse posed a potential health hazard, and that construction of buildings on lands containing such wastes similarly posed potential hazards.[130] Moreover, the agency observed that "individuals living very near active underground mine exhaust vents would have an increased risk of lung cancer," although the agency minimized the health risk to the regional population.[131] Because EPA did not propose legislation for regulation of uranium mine wastes, the chance for any AEA regulation of uranium mine wastes is exceedingly remote for the foreseeable future.

III. URANIUM MILL TAILINGS

Uranium mill tailings are the sandy waste product remaining after most of the uranium has been extracted from its ore at a uranium mill. Typical domestic uranium ore ranges from two to eight pounds of uranium per

126. *See* 10 C.F.R. § 40.3.

127. 42 U.S.C. § 2092.

128. 42 U.S.C. § 7924(c).

129. *EPA, Potential Health and Environmental Hazards of Uranium Mine Wastes, Report to the Congress* 22 (June 1983).

130. *Id.* at 19.

131. *Id.* at 20. EPA's position minimizing population health risks from radon in its 1983 Report seems out of harmony with its risk projections for uranium mining presented in the context of the agency's Clean Air Act regulation.

ton; thus, the total tons of uranium mill tailings are roughly equivalent to the total tons of ore processed.[132]

A. Potential Health Hazards

Uranium mill tailings pose radiological hazards similar to those represented by mine waste and overburden except in two particulars. First, the radium content of tailings is generally higher. Indeed, tailings are approximately as radioactive as the original uranium ore since they contain some residual uranium as well as most of the products of the uranium decay series in their original concentrations. Second, since the milling and extraction processes have removed most of the uranium from the ore, the longevity of the remaining radioactive material in the tailings sands is determined principally by the presence of thorium-230, which has a 77,000 year half-life and which transmutes to radium-226.[133] Given the long half-life of thorium-230, uranium mill tailings piles constitute a potentially significant source for above-background rates of radium contamination and radon emission for hundreds of thousands of years.[134]

In the view of EPA and NRC, the radon emanating from mill tailings may pose a potential hazard in three ways: (a) tailings are an attractive construction material. If the tailings sands are used for construction purposes (such as backfill or in masonry), they may result in above-background levels of radon and radon decay products indoors.[135] Since most people in an urban society spend the bulk of their time indoors, this can result in high-levels of exposure.[136] (b) The radon emanating from the tailings may easily result in above-background concentrations of that gas in the near vicinity (one-half mile) of the pile.[137] Depending on weather conditions and the time available for radon decay products to "build-in," this may lead to above-background concentration of potentially hazardous daughters.[138] (c) If one assumes that the incremental radon arising from tailings is dispersed throughout the country, one may attribute to tailings

132. *See* Active Sites FEIS at 2-2.

133. Active Sites FEIS at 6-3.

134. *Id.* at 3-3 and 8-3. Nevertheless, it is interesting to note that the total amount of radon released by all tailings piles is less than one ounce per year. *See* Evans, *supra* note 21, at 178.

135. *Id.* at 8-4.

136. Early reports suggested that an increased incidence of birth defects and cancer had been found among people in areas where tailings had been misused as fill under buildings. *See* Ausness, *High-Level Radioactive Waste Management: The Nuclear Dilemma*, 1979 WISC. L. REV. 707, 719. According to NRC, these suggestions were erroneous. *NRC, Generic Environmental Impact Statement on Uranium Milling*, at A-35 (1980) [hereinafter *GEIS*]. Nevertheless, using the linear non-threshold model, some experts estimated that naturally occurring indoor radon may be responsible for approximately 10,000 cancers per year. *See*.Cohen, *Health Effects of Radon from Insulation of Buildings*, 39 HEALTH PHYSICS 937 (1980). Incremental (though undetectible) additional cancers could result from misuse of tailings material for construction purposes.

137. *See supra* note 22.

138. *But cf.* Evans, *supra* note 21 (calculating that build-in of significant daughters in near vicinity is unlikely absent stagnant air conditions).

an increased risk to the U.S. population of roughly three to six premature cancer deaths per year[139] using the linear non-threshold model of risk estimation. On the other hand, existing uranium mill tailings contribute less than two percent to the total amount of radon released into the ambient environment in the United States each year.[140] As is the case for radon from mining, this additional contribution is undetectibly small in comparison both to natural background and to other technologically enhanced sources.[141] Similarly, the additional potential deaths, even if they were to occur, would be undetectible against background cancer fatalities. Nevertheless, if one assumes that the incremental radon emission from uranium mill tailings occurs for several hundred thousand years, the number of potential deaths may reach the hundreds of thousands. In the calculus used to estimate the risk from nuclear power, the potential deaths from tailings are frequently cumulated for lengthy periods,[142] and uranium residues on this basis are sometimes viewed as responsible for approximately one-half the risk associated with reliance on nuclear power for electrical energy needs.[143]

Uranium mill tailings also may contain various potentially toxic metals, including selenium, molybdenum, mercury and others, as well as sulphates and chlorides. Depending upon local conditions and the nature of the tailings piles, these materials may leach into the surrounding soil and underlying groundwater.[144] This potential hazard is similar to that posed by mill tailings resulting from extraction of other minerals, such as copper.

B. Early Regulation

Prior to 1948, there was no domestic uranium mining or milling industry and, for that matter, very little elsewhere in the world, except for the Shinkolobwe radium mine in the Belgian Congo (now Zaire).[145] The AEC charged with supporting a major military nuclear build-up and con-

139. *GEIS* at 19.

140. *See GEIS* at 19. The overwhelming source of radon is natural soils. The next greatest contributors are evapotranspiration (release of water vapor by soils and plants), and soil tillage. According to agency figures, radon from uranium mill tailings is a relatively trivial contributor to the total radon burden, either in comparison to natural sources or in comparison to other technologically-enhanced sources.

141. Evans, *supra* note 21, at 178.

142. *See, e.g.*, Pohl, *Nuclear Energy: Health Effects of Thorium-230*, attached to July 3, 1975 supplement to letter, NRDC to Chairman Anders, Mar. 28, 1975.

143. The fact that uranium mill tailings may result in potentially hazardous effects over long periods of time does not necessarily mean that nuclear energy is undesirable in comparison to other energy sources. Coal, for example, has been associated with serious long-term environmental effects, including acid rain and the build-up of carbon dioxide, and is also itself a source of radiological hazards. *See GAO, Coal and Nuclear Wastes—Both Potential Contributors to Environment and Health Problems* (Sept. 21, 1981); Cohn, *The Role of Radon in Comparisons of Radioactivity Releases from Nuclear Power, Coal Burning and Phosphate Mining*, 40 HEALTH PHYSICS 19 (1981).

144. Active Sites FEIS at 3-12.

145. *Problems of the Uranium Mining and Milling Industry, Hearings Before the Joint Committee on Atomic Energy*, 85th Cong. 2d Sess. 287 (1958).

cerned about the security aspects of limited uranium supplies, directed its Raw Materials Division "to get as much uranium as possible from every available source."[146] A special emphasis was placed on production in the United States and Canada "for obvious strategic reasons."[147] The Commission accordingly adopted a relatively comprehensive program to stimulate domestic uranium production, operating the uranium milling aspect of this operation "something like a . . . utility."[148] The Commission, which was the sole market for domestic uranium due to legal restrictions[149] and lack of other sources of demand, ultimately invested an estimated $3 billion in the domestic industry.[150]

The Commission was also charged with regulating uranium milling activities. Section 5(b)(1) of the Atomic Energy Act of 1946 defined "source material" to include uranium ore if it contained uranium "in such concentration as the Commission may by regulation determine from time to time." This basic definition was carried forward in Section 11e of the Atomic Energy Act of 1954.[151] The Commission early determined ores containing more than .05 percent uranium constitute "source material".[152] This has been the consistent position of the Commission and its successor, the Nuclear Regulatory Commission[153] since that time.[154] Since uranium mills have to date processed ores containing greater than .05 percent uranium, they have all been required to operate in accordance either (a) with "source material" licenses required under both the 1946 and 1954 Acts, and in accordance with applicable Commission regulations, or (b) after the adoption of Section 274 of the Atomic Energy Act of 1959,[155]

146. *Id.* at 288.

147. *Id.*

148. Joskow, *Commercial Impossibility, the Uranium Market and the Westinghouse Case*, 6 J. LEGAL STUDIES 119, 127 (1977). Prof. Joskow explains that "[a] prospective mill owner would have to apply to the AEC for a certificate of need. If granted, the AEC would sign a long-term (five to seven) year cost plus profit contract for the delivery of a specified quantity of U_3O_8 over the contract period." *Id.*

149. Section 5(a)(2) of the Atomic Energy Act of 1946 forbade private ownership of nuclear fuel. This was carried forward in Section 52 of the Atomic Energy Act of 1954, 68 Stat. 929-30, until that proscription was dropped through the Private Ownership of Special Nuclear Material Act of 1964.

150. *GEIS* at 2-1. The Commission also largely created the South African and Canadian uranium industries. *See* Yokell & De Salvo, *The Uranium Default: Westinghouse and the Utilities*, PUBLIC UTILITIES FORTNIGHTLY 20, 23 (Feb. 7, 1985).

151. 42 U.S.C. § 2014 (z).

152. 10 C.F.R. § 40.4 (1950).

153. The Atomic Energy Commission was abolished by the Energy Reorganization Act of 1974, P.L. 93-438, 88 Stat. 1233. AEC's regulatory functions were transferred to the newly formed Energy Research and Development Administration [ERDA]. 42 U.S.C. §§ 5813, 5814(c). ERDA was abolished and its functions transferred to the DOE by the DOE Organization Act of 1977. 42 U.S.C. § 7151(a).

154. *See* 10 C.F.R. § 40.4(h) (1985).

155. 42 U.S.C. § 2021, added by P.L. 86-373 (1959).

with state regulatory requirements in those states which have entered into an applicable "discontinuance agreement" with the Commission providing for State regulation of certain Atomic Energy Act activities. However, the state regulatory requirements in general must be "coordinated and compatible" with the federal program in order to assure a reasonable degree of uniformity in health protection.[156]

The Commission's original position with respect to regulation of uranium mill tailings was a function of its definition of the term "source material." The Commission asserted authority to regulate tailings as an incident to the source material license under which the mill operated. However, once the mill was no longer operating and the source material license terminated, the Commission viewed its jurisdiction over the tailings to have ceased. Similarly, the Commission viewed itself as lacking jurisdiction over tailings removed from the tailings pile. The rationale was simple: Commission's regulatory authority with respect to milling activities attached only to "source material". The tailings, which did not contain more than 0.05 percent uranium, did not constitute "source material".[157] As a result, the Commission argued that it lacked regulatory authority to impose tailings reclamation requirements.[158]

In the early days, this position was not controversial because uranium mill tailings were officially viewed as essentially identical to other mineral tailings, with which no special hazards were associated or precautions taken.[159] Although the Commission issued general standards governing release of radionuclides, including isotopes of interest at uranium mills in 1958, these standards were operational in nature and did not themselves necessitate significant tailings reclamation efforts.[160]

This position gradually began to shift when groundwater contamination was discovered at AEC's research mill at Monticello, Utah.[161] When the Monticello mill was closed in 1960, the Commission contoured the tail-

156. *E.g.*, 42 U.S.C. § 2021(g). *See also, id.* § 2021(d)(2).

157. Memorandum from J.R. Mapes to N.A. Nussbaumer [NRC] at 2 (Dec. 19, 1973).

158. *See Uranium Mill Tailings Control Act of 1978, Hearings Before the Energy & Power Subcomm. of the House Interstate and Foreign Commerce Comm.*, 95th Cong., 2d Sess., at 228 (1978) (NRC Commissioner Gilinsky); *Uranium Mill Tailings Control, Hearings Before the Energy and Power Subcomm. of the House Interior and Insular Affairs Comm.*, 95th Cong., 2d Sess., at 132, 458 (1978) (NRC Chairman Hendrie); Memorandum from J.R. Mapes to N.A. Nussbaumer [NRC] at 2-3 (Dec. 19, 1973), citing H.K. Shapar [NRC], Commission's Regulatory Authority over Uranium Mill Tailings (Sept. 22, 1965); remarks prepared by Donald Walker for a panel presentation at the National Western Mining Conference, Denver, Co., Feb. 4, 1966; Letter, Chairman Seaborg [AEC] to Senator Aiken, Feb. 27, 1970, attaching AEC letter to Colorado, Mar. 7, 1961.

159. This may account for the fact that the AEC's uranium milling contracts did not contemplate stabilization or reclamation of tailings even apart from AEC's purported lack of regulatory jurisdiction.

160. *See* 10 C.F.R. § 20 (1959). The AEC regulation applied to on-site and off-site airborne and waterborne emissions of uranium-238, thorium-230, radium-226, and radon-222.

161. *See AEC, Uranium Mill Tailing Project, Monticello, Utah, RMO-* 3005 (Dec. 20, 1963).

ings to promote drainage, and stabilized them with rock, primarily to control dust problems associated with wind erosion of the pile.[162] However, the Commission quite clearly regarded the problem posed by tailings piles as aesthetic and cosmetic rather than health related. In Senate hearings in 1966, the Commission argued that "there is currently no significant hazard associated with uranium milling activities in the Colorado River Basin [and] we do not think that the data available at this time support a conclusion that there is a long-term radiological hazard."[163] The Commission expressly rejected a Public Health Service recommendation, based on that agency's survey of uranium milling in the Colorado River Basin,[164] that measures should be taken to prevent the erosion and spread of uranium mill tailings, because of the long half-life of radium-226 and the uncertainties relating to changes which may occur over the centuries in river hydrology and water use. The Public Health Service, the Commission said, "conjectures that the radiological situation could deteriorate in the future, but there is no present indication that this will occur."[165] The Commission testified that the question of tailings control was a matter for the milling companies and the states after milling activities were terminated. Indeed, the Commission generally resisted any costly measures pertaining to tailings reclamation, such as moving a tailings pile, in the absence of a "health hazard" (which the Commission did not perceive) or some "economic value" (for example, to recover uranium or other minerals) in doing so.[166]

Colorado nevertheless adopted regulations requiring its mill operators to stabilize their tailings so as to prevent dust, to ensure stability from river and stream erosion, and to bar alternative use of a site resulting in a radiation dose to the public exceeding 0.5 percent rem per year (the then current maximum exposure allowed for individuals in unrestricted areas).[167] The Colorado standard, however, did not envision heavy earthen covers or movement of piles. The Commission supported Colorado's approach, but also took the position that the "expenditure of large sums of money" for stabilization could not be justified since tailings did not

162. *See AEC Statement on Disposition and Control of Uranium Mill Tailings, Presented to the A&S Water Poll. Subcomm. of the Senate Public Works Comm.*, May 6, 1966, at 11.

163. *Id.* at 5-6.

164. *PHS, Disposition and Control of Uranium Mill Tailings Piles in the Colorado River Basin* (Mar. 1966) [hereinafter *PHS*].

165. Statement, *supra* note 162, at 6. In any event, the Public Health Service called for a little more than what the Commission was undertaking at Monticello; namely stabilizing mill tailings under light cover and providing some form of long term public oversight. *PHS*, *supra* note 164.

166. Memorandum from Quinn [AEC] to Price [AEC], Dec. 30, 1958.

167. Colorado Dept. of Health, Reg. No. 2 adopted Dec. 12, 1966. Colorado also urged AEC not to terminate mill licenses until the question of long-term stabilization was finally resolved. *E.g.*, Letter from Dr. Cleere to Chairman Seaborg, Sept. 21, 1966.

present a radiation hazard.[168] During the same month that Colorado adopted its regulations, the AEC, the Health, Education and Welfare Department, and the Department of Interior signed an Agreement entitled *Joint Federal Agency Position Regarding Control of Uranium Mill Tailings*.[169] The Agreement called for tailings to be stabilized to prevent wind and water erosion, but indicated that regulation to achieve this end was a state responsibility.[170]

There was, however, one cloud in the picture: radon. The Public Health Service was concerned that long-term radon emanation from tailings might pose a health hazard.[171] To study this possibility, the Commission and the Public Health Service jointly sponsored a year-long study of tailing piles at Salt Lake City, Durango, Monticello, and Grand Junction. The final report from the study, released in 1969, determined that elevated levels of radon could not be detected more then about one-half mile downwind of tailings and that radon from tailings did not pose a significant health risk.[172] The final report in fact stated that "recommendations to control public exposure to radon from uranium tailings piles are not necessary, as no significant public exposure is indicated by the results of the study."[173] The Health, Education and Welfare Department issued a press release declaring that there was "no significant radiation exposure to the public" from radon from the studied tailings piles in Colorado and Utah.[174] Colorado, the most active state on the matter, concurred that the radon problem was confined to misuse of the tailings.[175] In short, the federal health officials adopted a solicitous attitude toward what is now viewed as the principal potential health threat associated with tailings.[176]

The federal uranium procurement program drew to a close in 1970.[177] That year also marked an acceleration in a shift in attitudes toward the potential hazards posed by uranium mill tailings. Two events were es-

168. Memorandum from Mr. Faulkner to Mr. Erlewine, Oct. 10, 1966.

169. AEC, HEW, DOI, Joint Federal Agency Position Regarding Control of Uranium Mill Tailings, Dec. 8, 1966.

170. *Id.*

171. Letter from Dr. Lee [HEW] to Mr. DiLuzio [DOI], Nov. 25, 1966.

172. *US HPS & US AEC, Evaluation of Radon-222 Near Uranium Tailings Piles* 20 (Final Report 1969) ("The tailings . . . are not significantly affecting the atmospheric radon concentrations beyond a distance of one-half mile in the prevailing wind directions. . . . The results indicate no significant exposure to the public. . . .").

173. *Id.*

174. HEW Press Release, circa Nov. 20, 1969.

175. Letter from Dr. Roy L. Cleere (Colo.) to Cong. Aspinall, Oct. 8, 1969.

176. "From the early 1940s through the early 1970s there was little official recognition of the hazards presented by these tailings." H.R. REP. No. 95-1480, § I, 95th Cong., 2d Sess. 11 (1978).

177. *See* H. Albrethsen, Jr. & F. McGinley, *Summary History of Domestic Uranium Procurement under U.S. Atomic Energy Commission Contracts* 1 (DOE-GJBX-220(82)) (Sept. 1982).

pecially critical in this regard. First, in response to hearings detailing potential hazards arising from elevated levels of indoor radon due to widespread use of tailings sands as construction material in Grand Junction,[178] Congress adopted a special remedial action program to clean-up contaminated structures in that Colorado city[179] in accordance with guidelines issued by the Surgeon General.[180] Although the Joint Committee on Atomic Energy carefully indicated that it believed the probabilities of governmental legal liability "very low".[181] Congress agreed to fund seventy-five percent of the clean-up costs; Colorado picked up the remaining twenty-five percent.[182] Second, the Court of Appeals for the District of Columbia Circuit held in *Calvert Cliffs*[183] that under the National Environmental Policy Act [NEPA],[184] the AEC must consider general environmental effects flowing from its licensing actions, including those which are nonradiological, and, indeed, must also mitigate such effects if adverse.[185] This decision reversed prior precedent upholding the Commission's view that its authority under the Atomic Energy Act extended only to the regulation of radiological hazards.[186]

The *Calvert Cliffs* decision resulted in a temporary moratorium on nuclear licensing activities and in a rethinking of the agency's position on mill tailings. This rethinking had two dimensions: first, the Commission began to recognize some responsibility toward nonradiological hazards posed by groundwater contamination and, second, AEC began to consider requiring some form of tailings stabilization, or at least a commitment by mill operators to engage in stabilization activities, as a precondition to terminating a source material license.[187]

The trend toward increased federal regulatory control accelerated in

178. *See Hearings on Use of Uranium Mill Tailings for Construction Purposes before the Raw Materials Subcommittee of the Joint Comm. on Atomic Energy*, 92d Cong., 1st Sess. at 272-73 (1971). Indeed, one official asserted that tailings were used in "all" the children's sandboxes, in the sand traps at the golf courses, and so on throughout the town. Memorandum to the File by Donald Walker [AEC], Apr. 4, 1963.

179. P.L. 92-314, 86 Stat. 222 (June 16, 1972).

180. 10 C.F.R. § 12.

181. H.R. REP. No. 92-1006, 92d Cong., 2d Sess. at 47 (1972).

182. 86 Stat. 222, § 202.

183. Calvert Cliffs Coordinating Committee v. AEC, 449 F.2d 1109, 1112 (D.C. Cir. 1971).

184. Section 101 of NEPA, 42 U.S.C. § 4321, declares a general federal policy against environmental degradation. Section 102(1), 42 U.S.C. § 4332(1), calls for federal laws to be interpreted "to the fullest extent possible" in accordance with this policy. Section 102(2) contains various procedural requirements, including the important requirement, embodied in subparagraph (c), for environmental impact statements for all major federal actions significantly affecting the environment.

185. *See also* Public Service Co. v. NRC, 582 F.2d 77, 81 (1st Cir. 1978) (NRC under a duty to minimize non-radiological environmental damage); Detroit Edison v. NRC, 630 F.2d 450, 452-53 (1980) (same).

186. *See, e.g.*, New Hampshire v. AEC, 406 F.2d 170 (1st Cir.), *cert. denied*, 395 U.S. 962 (1969) (AEC need not regulate thermal pollutants); Cities of Statesville v. AEC, 441 F.2d 962 (D.C. Cir. 1969).

187. *See* Memorandum from J.R. Mapes to N.A. Nussbaumer, *supra* note 157, at 3.

1974-1976. First, the Raw Materials Subcommittee of the Joint Committee on Atomic Energy held hearings in 1974 on two bills providing for reclamation of the old Vitro tailings pile in Salt Lake City. Both EPA and AEC urged that a generic approach be devised applicable to all "inactive" (or no longer licensed) tailings sites, of which there were approximately twenty-two.[188]

Second, the Natural Resources Defense Council [NRDC] petitioned the Nuclear Regulatory Commission to prepare a Programmatic Environmental Impact Statement [EIS] pursuant to Section 102(2)(C) of NEPA applicable to uranium milling activities at all currently licensed sites.[189] NRDC initially argued that tailings were hazardous from three perspectives: misuse of tailings in construction, elevated concentrations of radon decay products near the tailings piles, and groundwater contamination.[190] NRDC later added the charge that radon from the tailings posed a long-term hazard to the population in general.[191] In addition to preparation of an EIS, NRDC requested the Commission to require its uranium milling licensees to post some form of surety sufficient to cover reclamation costs and long-term inspection and maintenance expenses.[192] NRC ultimately agreed to prepare the requested EIS.

Third, in November 1975, the New England Coalition on Nuclear Pollution filed a petition to amend the Commission's value for radon gas embodied in Table S-3. This value, like the other figures in S-3, was used for purposes of conducting the cost-benefit analysis required by NEPA after *Calvert Cliffs* in nuclear power reactor proceedings. The Coalition charged that the table seriously understated radon emissions by disregarding the long-term nature of tailings radon emanation and thus misrepresented the effects of nuclear power on human health.[193] The Commission deleted the radon value from the table, but decided to defer a rulemaking until it completed the generic EIS requested by NRDC.[194] In the meantime, intervenors in various nuclear reactor licensing proceedings had raised the same issue against the licensing of individual power plants. The Commission decided to allow the litigation of the radon question in each such proceeding.[195] NRC staff moved to consolidate some of these proceedings. The Atomic Safety and Licensing Appeal

188. *See GEIS* at 2-2.

189. Letter from NRDC to Chairman Anders, *supra* note 142.

190. *Id.* at 5-8.

191. NRDC supp. dated July 3, 1975, at 3.

192. Letter from NRDC to Chairman Anders, *supra* note 142, at 23-24.

193. *See* 10 C.F.R. §51, Table S-3 (1974 rev.). The Coalition petition was supported by an affidavit by Dr. Pohl, the author of a paper supporting a related aspect of the NRDC petition for the *GEIS*. *See Philadelphia Electric Co.* (Peach Bottom Atomic Power Station, Units 2 and 3), ALAB-640, 13 NRC 487, 490 n.3 (1981).

194. 43 Fed. Reg. 1,513 (1978).

195. *Id.* at 15,615-16.

Board adopted a "lead case" approach,[196] authorizing litigation of the radon question first in the *Perkins* proceeding.[197]

Obviously the pressure was mounting for more stringent regulation of uranium mill tailings. The pertinent licensing branch at NRC in May 1977 issued a "Branch Position" calling for tailings to be stabilized so as to reduce the radon flux (the rate of radon emanation from tailings) to no more than twice the background rate (usually taken to be 1 to 2 pCi/m^2 sec).[198] This generally would require placing the tailings under 10 to 20 or even more feet of soil. The Branch Position also called for stabilization so as to avoid the need for long-term maintenance and monitoring and for the posting of surety to assure reclamation. Finally, in November 1978, Congress passed the Uranium Mill Tailings Radiation Control [UMTRC] Act.[199]

C. The Uranium Mill Tailings Radiation Control Act

The UMTRC Act divides into two major titles. Title I establishes a program for remedial action by the DOE at some twenty specifically identified uranium mill tailings sites for which a license under the Atomic Energy Act was no longer extant, including "vicinity properties" designated as contaminated by the agency.[200] Vicinity properties in the area of TVA's Edgemont, South Dakota uranium mill, actually an "active site", were added to the Title I program in 1983.[201] These sites are known as "inactive sites". Title I provided that stabilization of inactive sites must conform to standards issued by the EPA. The original statute provided that the standards should protect "the public health, safety, and the environment from radiological and nonradiological hazards" and "shall, to the maximum extent practicable, be consistent with the requirements of the Solid Waste Disposal Act . . . . "[202] This provision was amended in 1983 to require the EPA administrator to "consider the risk to the public health, safety, and the environment, the environmental and economic costs of applying the standards, and such other factors as the administrator determines to be appropriate."[203] Upon completion of stablization, the sites are required to be licensed by NRC.[204] The federal

196. ALAB-480, 7 NRC 796, 805-06 (1978).

197. *Duke Power Co.* (Perkins Nuclear Station, Units 1, 2 and 3), Docket Nos. STN 50-488, 50-489 and 50-490 [hereinafter *Duke Power Co.*].

198. NRC, BRANCH POSITION—URANIUM MILL TAILINGS MANAGEMENT (May 13, 1977). The Branch Position noted that NRC sought to avoid a recurrence of the widespread misuse which transpired in Grand Junction and to prevent "problems" such as those associated with inactive sites.

199. P.L. 95-604, 92 Stat. 3021 (Title I is codified at 42 U.S.C. § 7901. Title II is codified in scattered sections of the Atomic Energy Act, 42 U.S.C. § 2011.

200. 42 U.S.C. § 7911(6)(B).

201. *See* 42 U.S.C. § 7912(e)(3).

202. Section 206(a) of the UMTRC Act, 92 Stat. 3039.

203. 42 U.S.C. § 2022(a).

204. 42 U.S.C. § 7914(f)(2).

government is to bear ninety percent of the cost; the remainder is to be borne by the states.[205] The onus is placed on the states to find alternative sites if the tailings must be moved in order to conform to EPA standards or to meet political objectives.[206]

Title II of the UMTRC Act defines uranium and thorium mill tailings and residues to be "by-product material". "By-product material" was already defined by the Atomic Energy Act to be the result of nuclear fission, such as cesium or strontium,[207] and a regulatory structure for such material had been elaborated pursuant to Sections 81[208] and 161[209] of the Atomic Energy Act.[210] Uranium and thorium residues are of course much different from fission by-products. Although subsequent administrative modification of the fission by-product regulatory regime to accommodate uranium and thorium residue would have been necessary, the simple act of defining uranium and thorium tailings to fall within the definition of "by-product material" would have sufficed to clarify NRC's authority to regulate tailings even after the termination of uranium or thorium milling operations and the cessation of a source material license.

Nevertheless, Title II added many additional and specific requirements relating solely to uranium and thorium mill tailings. For example, the new Title specifically required milling operations and stabilization to conform to standards set by EPA.[211] This requirement was largely redundant of Reorganization Plan No. 3, except to the extent that the new language also called for the EPA standards to be "consistent with the standards required under Subtitle C of the Solid Waste Disposal Act which are applicable to such hazards."[212] Ordinarily, RCRA does not apply to source material, by-product material, or special nuclear material[213] and, but for the language in Title II, RCRA would clearly be totally inapplicable

205. 42 U.S.C. § 7917. The Attorney General, however, must conduct a study to determine the legal responsibility which any person who owned, operated, or controlled a site before Nov. 8, 1978, may have for reclamation. The Attorney General, "to the extent he deems it appropriate and in the public interest," is further required to "take such action under any provision of law in effect when uranium was produced at such site" to recover the costs of remedial action. 42 U.S.C. § 7925(b). As of late 1986, the Attorney General had yet to make any determinations under this section, and he accordingly had taken no action to recover any costs.

206. 42 U.S.C. § 7914(b).

207. 42 U.S.C. § 2014(e)(1).

208. Section 81, 42 U.S.C. § 2111, authorized licensing of byproduct material and forbade the distribution of such material to any licensee "who is not equipped to observe or who fails to observe such safety standards to protect health as may be established by the Commission or who uses such material in violation of law or regulation of the Commission . . . . "

209. Section 161(b), 42 U.S.C. § 2201(b), authorizes the Commission to establish "standards and instructions to govern the possession and use of special nuclear material, source material and by-product material as the Commission may deem necessary [or] desirable to promote the common defense and security or to protect health or to minimize danger to life or property." *See also* 42 U.S.C. § 2201(p).

210. *See* 10 C.F.R. § 30.

211. *See* § 275 of the UMTRC Act, (codified at 42 U.S.C. § 2022).

212. 42 U.S.C. § 2202(b)(2).

213. 42 U.S.C. § 6903(27).

to uranium or thorium mill tailings once those substances had been defined as by-product material. Title II also provided that EPA and NRC were to regulate nonradiological as well as radiological hazards associated with tailings, although this seems redundant after *Calvert Cliffs*.[214] NRC was authorized to require a bond or other surety sufficient to cover not only stabilization but also long-term maintenance and monitoring.[215]

Federal control over Agreement State regulation of uranium and thorium milling was also tightened. In particular, instead of the traditional standard of "compatibility,"[216] Congress stated that Agreement States must impose requirements on their uranium or thorium millers "equivalent, to the extent practicable, or more stringent than" those imposed at the federal level.[217]

The major quid pro quo received by uranium producers in this program was the right to transfer their tailings disposal site (and license) to DOE (or a state agency) for perpetual monitoring and maintenance (if required) of the site upon the completion of stabilization activities and approval by the Commission.[218] The UMTRC Act suggested that private liability would continue after transfer only in the event of fraudulent or negligent acts done prior to transfer.[219] This is a substantial advantage not enjoyed by owners or operators of chemical waste disposal sites. The Comprehensive Environmental Response, Compensation and Liability Act [CERCLA or Superfund] may have subsequently eroded this shift of responsibility for perpetual care. CERCLA applies to "releases" of "hazardous substances". "Hazardous substance" is defined to include "any hazardous air pollutant listed under Section 112 of the Clean Air Act."[220] EPA has listed all radionuclides as hazardous air pollutants.[221] Since tailings sites emit radionuclides (radon and radioactive particulates), they therefore fall within CERCLA unless otherwise excluded. Section 101(22) of CERCLA excludes "any release of source, by-product, or special nuclear material from any processing site designated under (Title I of the UMTRC Act)" from the definition of release.[222] However, such releases from Title II

214. *See, e.g.*, 42 U.S.C. § 2114(a). The provision relating to NRC regulation was modified in 1983 specifically to require NRC to "tak[e] into account the risk to the public health, safety, and the environment, with due consideration of economic costs and such other factors as the Commission determines to be appropriate." The additional language, however, did not result in any significant alteration in the agency's approach to tailings regulation.

215. 42 U.S.C. § 2021(x).

216. 42 U.S.C. § 2021(d)(2) & (g).

217. 42 U.S.C. § 2021(d)(2) as amended by § 204(b) of P.L. 95-604 and § 2021(o) as added by § 204(e)(1) of P.L. 95-604.

218. 42 U.S.C. § 2113.

219. 42 U.S.C. § 2113(b)(6).

220. 42 U.S.C. § 7412. *See* 42 U.S.C. § 9601(14).

221. *See* 44 Fed. Reg. 76,738 (1979).

222. 42 U.S.C. § 9601(22).

sites are not excluded. Since CERCLA provides for liability not only on the part of the present "owner or operator" of a "facility", but also of the owner or operator at the time the "hazardous substances" were disposed, the uranium producers may be responsible for remedial action under its provisions notwithstanding a transfer of title to the site to DOE or to a state agency. Furthermore, CERCLA makes generators of the hazardous substances liable.[223] The uranium companies, not the subsequent government title holders, were the generators. To make matters worse, from the uranium company perspective, liability under CERCLA is strict.[224] In short, uranium producers may have lost a significant protection from ongoing liability originally afforded by the UMTRC Act.[225]

D. Standards for the Disposal of Uranium and Thorium Tailings

The actual adoption of standards under the UMTRC Act was anything but a textbook model of the regulatory process. The following only outlines the twists and turns which ensued. Congress provided that EPA was to issue standards for inactive sites in twelve months, and for active sites six months later.[226] However, EPA was late in issuing its standards. NRC, which had been working on the Generic Environmental Impact Statement [GEIS] sought by NRDC issued, proposed and final regulations[227] for stabilizing tailings before EPA had issued even proposed standards for inactive sites.[228]

The NRC regulations, called "Uranium Mill Licensing Requirements", were largely an elaboration of the agency's May 1977 Branch Position on uranium mill licensing. They called for mill tailings to be stabilized so that radon emanation was limited to 2 pCi/m^2 sec;[229] for disposal to

223. 42 U.S.C. § 9607.

224. Section 101(32) of CERCLA provides that the standard of liability shall be that applying under § 311 of the Clean Water Act. Cases arising under § 311 provide for strict liability. Steuart Transportation Co. v. United States, 596 F.2d 609, 613 (4th Cir. 1979); Burges v. MIV Tamano, 564 F.2d 964, 982 (1st Cir. 1977), *cert. denied*, 435 U.S. 941 (1978).

225. The uranium producers may draw some solace from § 107(j) of CERCLA, 42 U.S.C. § 9607(j), which exempts "federally permitted" releases from liability under the Act. Section 101(10)(K) defines "federally permitted release" to include "any release of source, special nuclear, or by-product material, as those terms are defined in the Atomic Energy Act of 1954, in compliance with a legally enforceable license, permit, regulation, or order issued pursuant to the Atomic Energy Act of 1954." Conceivably a transfer of the license and property to a government agency at the conclusion of stabilization activities may fall within the definition of "federally permitted release." However, this application is not yet clear. Moreover, how the term applies to "releases" of tailings when they were unregulated or were subject to limited Atomic Energy Act regulation (i.e., only of radiological hazards) is not yet resolved.

226. Section 275(a) & (b)(1) of P.L. 95-604.

227. 44 Fed. Reg. 50,015 (1979) (proposed); 45 Fed. Reg. 65,521 (1980) (final).

228. 46 Fed. Reg. 2556 (1981) (proposal for inactive sites).

229. 45 Fed. Reg. 65,534 (criterion 6).

be equivalent to that achieved if the tailings were placed below-grade;[230] for slopes of piles to be graded to ten-to-one;[231] for revegetation or rip-rapping in order to cut erosion;[232] and for tailings not only to be remotely sited but also to be sited so as to avoid geohydrologic events (for example, avoid disruption in the event of a "maximum possible flood").[233] The requirements also called for seepage of toxic materials into groundwater to be reduced "to the maximum extent reasonably achievable" and barred any seepage which "result(s) in deterioration of existing groundwater supplies from their current or potential uses."[234] The NRC regulations also called for restoration of adversely impacted groundwater.[235]

The lack of numerical or other objective standards for groundwater may be attributed to a number of factors. For example, EPA has thus far failed to adopt final RCRA groundwater standards for comparable mining and milling wastes. Moreover, any meaningful standards retroactively applicable to uranium sites might have severe adverse economic effects. Most uranium sites, for example, were designed to remove process fluids in part by seepage. Alteration of this practice might require cessation of operation and conversion to an entirely new tailings retention system. The NRC regulations also required each operator to post surety for all costs of stabilization and for the eventual payment of a sum totalling at least $250,000 (1978 dollars) to the U.S. Treasury, the real interest on which sum was to be sufficient to cover projected long-term monitoring and maintenance for the site in question.[236]

Although groundwater protection requirements are probably the most serious economic and technological concern at most mills, the controversy has tended to center on radon and longevity of control. The controversy began in New Mexico.

The State of New Mexico, which harbors roughly half of the lower cost uranium reserves in the United States and has traditionally been the principal uranium producing state, was at the time an Agreement State which regulated[237] its own tailings.[238] Under New Mexico procedures, regulations such as NRC was presenting could not be adopted without

230. *Id.* 65,533 (criterion 3).
231. *Id.* (criterion 4(c) & (d)).
232. *Id.* (criterion 4).
233. *Id.* (criteria 1 & 4).
234. *Id.* (criterion 5).
235. *Id.*
236. 45 Fed. Reg. 65,535 (criteria 9 & 10).
237. New Mexico voluntarily rescinded its Agreement States status under the administration of Governor Anaya. *See infra* note 258.
238. *See Uranium Ore Residues: Potential Hazards and Disposition, Hearing Before the Procurement and Military Nuclear System Subcomm. of the House Armed Services Comm.*, 97th Cong., 1st Sess. 487 (testimony of Mr. Topp) (1981).

the advice of a Radiation Technical Advisory Committee [RTAC] and an opportunity for a hearing and cross-examination before an Environmental Improvement Board [EIB].[239] EIB, upon the advice of RTAC, and with some limited encouragement from New Mexico's Environmental Improvement Division, revised a large portion of the NRC regulations after a hearing at which NRC witnesses were cross-examined. The EIB developed alternative regulations did not include any radon emanation limit or below-grade disposal performance standard. Moreover, the EIB alternative did not call for stabilization to survive thousands of years. Instead, the EIB alternative called for stabilization to last at least 200 years and for emissions of radionuclides to conform to NRC's general standards for off-site emissions,[240] which had already been incorporated by New Mexico.[241] EIB viewed its approach as equivalent in level of protection to that provided by the approach adopted by NRC given EIB's evaluation of the nature of the radon hazard as relatively slight. The DOE also heavily criticized the NRC standards as unduly stringent and expensive given the risks involved.[242] DOE indicated that it favored the New Mexico alternative. Congressman Stratton, Chairman of the House Armed Services Committee's Nuclear Procurement Sub-committee, won House adoption of a floor amendment[243] to an appropriation bill which in effect suspended enforcement of the NRC regulations. The amendment was eventually adopted by the Senate.[244]

The American Mining Congress and several individual uranium producers petitioned for review of the NRC regulations. The producers argued, among other things, that (a) the NRC regulations were invalid because they were premature since EPA had not yet issued standards; (b) the regulations were flawed under *Industrial Union Department, AFL-CIO v. American Petroleum Institute* (the *Benzene* case)[245] since NRC had failed to make a finding that tailings posed a significant risk; and (c) because there was no reasonable relationship between the risks and the regulatory requirements. NRC responded that there was no requirement that EPA proceed first; that the preamble[246] to the UMTRC Act called for regulation without regard to risk significance; that the risk to the general

239. A description of the New Mexico regulatory process and a portion of the hearing transcript is set forth in *id.* at 487 (description) and 453 (testimony).

240. 10 C.F.R. § 20.106.

241. *See* DOE, *Commingled Tailings Study* (June 30, 1982), *reprinted in Management of Commingled Uranium Mill Tailings, Hearings Before the Procurement and Military Nuclear System Subcomm. of the House Armed Forces Comm.*, 97th Cong., 2d Sess. 546 (1982) (compare standards).

242. *See id.*

243. 125 CONG. REC. H. 4873 (daily ed. July 24, 1981).

244. 125 CONG. REC. S. 12,982-84 (daily ed. Nov. 5, 1982).

245. 448 U.S. 607 (1980) (requiring a finding of significant risk for certain OSHA regulations).

246. 42 U.S.C. § 7901.

population posed by tailings was in any event significant; and that the regulations were reasonable.[247]

The uranium producers drew some solace from internal disputes at NRC. More specifically, an Atomic Safety and Licensing Board had ruled in *Perkins* that radon from uranium mines and mill tailings, even if totally unregulated, did not present a significant risk to the general population because the total incremental contribution of tailings radon to both total emissions and to total radon exposure was insignificant in comparison to natural background emissions and exposures.[248] More specifically, the Licensing Board ruled that "the increase in background [radon] associated with Perkins [Nuclear Power Plant] is so small compared with [natural] background and also in comparison with fluctuations in [natural] background as to be completely undetectable. Under such a circumstance, the impact cannot be significant."[249] Although the industry lost the initial round of the court battle in a two-to-one decision, it filed petitions for rehearing en banc. The petitions were fueled in part by leaked copies of documents regarding criticism of allegedly misleading statements in NRC's brief to the Tenth Circuit by three of the Commission's senior technical experts.[250] The three technical experts declared, among other things, that "the [population risk] rationale presented in the [NRC] brief is clearly inadequate to justify the Commission's uranium mill tailings regulations."[251]

In the meantime, several western senators led by Senator Domenici, won adoption of a floor amendment to the Senate version of an NRC authorization bill. The floor amendment contained extensive amendments to the UMTRC Act designed to clarify that EPA standards were to precede NRC regulations, that only significant risks were to be addressed, that the regulatory burden should be commensurate to the risks, and that Agreement States could deviate from federal requirements. The Domenici amendments also contained a provision requiring at least eighty percent of U.S. uranium requirements to be filled from domestic sources. The Senate version went to conference with the House, which had no comparable language. While the petitions for rehearing en banc were pending, the Conference Committee agreed to a compromise which seriously watered down all of the Domenici amendments. Gone was the language about

247. NRC Brief in Kerr-McGee Nuclear Corp., et al v. NRC, et al, 10th Cir. CA. Nos. 80-2043, et al.

248. *Duke Power Co.*, ASLB-78-25, 8 NRC 87 (July 14, 1978).

249. 8 NRC at 100.

250. Memorandum for Leonard Bickwit, Jr., by Messrs. Kreger, Lowenberg and Mills (Dec. 10, 1981). The petitions for rehearing (en banc) are *reprinted* in the *Management of Commingled Uranium Mill Tailings, supra* note 1, at 384-439. The Memorandum to Mr. Bickwit is *reprinted in id.* at 5-7.

251. *Id.* at 6.

EPA; gone was most of the language about risk and burden; gone was the domestic content requirement. In its place was language requiring NRC to conform its regulations to EPA standards when eventually issued and, in the place of the domestic content requirement, some provisions calling for annual determination of uranium industry viability and the initiation of trade studies if certain events ensued.[252] The legislative history carefully pledged neutrality as to the propriety of NRC's regulations. A few days later, but before the Conference Committee Bill was reported, the Tenth Circuit granted a rehearing en banc.[253] When Congress adopted the NRC authorization bill, the rehearing en banc was indefinitely postponed. With that postponement went the uranium industry's opportunity to turn around the federal regulatory program.

EPA subsequently issued standards for inactive and active sites[254] largely corroborating the NRC program with three significant differences. First, although EPA originally proposed a 2 pCi/m^2 sec radon emanation limit, it adopted a 20 pCi/m^2 sec figure in its final regulation. This had the effect of cutting the cover requirement roughly in half. Second, EPA called for sites to be stabilized so as not to require maintenance for at least 200 years, and, to the extent reasonably achievable, 1,000 years, as opposed to the "thousands of years" orginally sought by NRC.[255] Third, EPA in essence demanded that active uranium processing sites comply with its stringent RCRA groundwater standards for hazardous waste sites. These standards were subsequently upheld by the Tenth Circuit[256] except in one particular: the Tenth Circuit ruled that EPA must issue groundwater standards for inactive sites rather than proceed on a case-by-case basis.[257] EPA had proposed to proceed on a case-by-case basis in order to garner DOE (and Office of Management and Budget [OMB]) acquiesence.

Ironically, this ultimate judicial approval of the federal regulatory pro-

252. *See* 42 U.S.C. § 2210(b) (viability provisions). The uranium viability language in connection with § 161v. of the Atomic Energy Act, 42 U.S.C. § 2201(v), subsequently produced litigation going to the heart of the uranium enrichment program managed by the Department of Energy. *See* Western Nuclear, Inc., v. Huffman, No. 84-C-2315 (D. Colo., Sept. 18, 1985), *appeal pending*, No. 85-2428 (10th Cir.); Montange, *The Federal Uranium Enrichment Program and the Criteria and Full Cost Recovery Requirements of Section 161 of the Atomic Energy Act*, 2 J. MIN. L. & POL. 1 (1986-87).

253. *See Management of Commingled Uranium Mill Tailings*, *supra* note 1, at 413.

254. 48 Fed. Reg. 590 (1983) (inactive sites); 48 Fed. Reg. 19,584 (1983) (proposal for active sites); 48 Fed. Reg. 45,926 (1983) (final for active sites).

255. *See* 40 C.F.R. § 192.32(b)(1)(i). This distinction may not be that germane, because EPA believes that to protect a site for a thousand years requires protection against extremely infrequent hypothetical flood events, and that this necessitates extensive cover and design requirements. There are other aspects to the EPA standards. For example, EPA's standards for inactive sites limit gamma radiation in contaminated structures to .02 roentgen per hour above background. 40 C.F.R. § 192.12(b)(2).

256. American Mining Congress v. Thomas, 772 F.2d 617 (10th Cir. 1985) (inactive); American Mining Congress v. Thomas, 772 F.2d 640 (10th Cir. 1985) (active).

257. 772 F.2d 638-40.

gram was facilitated by the legislative effort of the western senators to assist their domestic uranium producers. In a final denouement, New Mexico under Governor Anaya's administration shifted its position to support the EPA and NRC approach.[258] Many morals can and should be drawn from this story for lobbyists and other denizens of the Hill, not least of which is to cut bait if the wrong fish bites.

Although the basic UMTRC Act standards appear to be in place, several loose ends remain. One of these problem areas relates to groundwater protection. NRC is in the process of adopting rules to deal with EPA's groundwater protection requirements.[259] One potentially controversial feature of NRC's approach is the agency's view that it may waive aspects of EPA's standards on a case-by-case basis without EPA approval, in contravention of express language in EPA's standards requiring EPA concurrence.[260] Another difficulty may arise from NRC's view that emphasis by EPA upon use of liners may exacerbate groundwater contamination and problems in assuring long-term stability in arid climates.[261] But the problem which poses the greatest potential for further regulatory confusion is that the RCRA standards which EPA has incorporated for uranium mill tailings are designed chiefly for low-volume, high toxicity chemical waste dumps. Uranium mill tailings, like other mine and mill wastes, are generally viewed as high-volume, low toxicity wastes. EPA has not yet issued standards for mine and mill wastes. In a determination made public June 30, 1986, EPA stated that "current requirements for hazardous wastes may be impracticable, technically infeasible and environmentally unnecessary for mine wastes."[262] Accordingly, EPA plans to regulate mining wastes as solid wastes under Subtitle D of RCRA rather than as hazardous wastes under Subtitle C.[263] If EPA eventually issues such standards and they are less stringent than its chemical waste regime, the uranium industry could presumably mount a strong and potentially persuasive effort to be treated in a comparable and less stringent fashion under the UMTRC Act.[264]

258. New Mexico in fact participated in an amicus brief with Colorado in support of the EPA standards in the Tenth Circuit litigation; Governor Anaya wrote NRC on behalf of New Mexico to resign in discontinuance agreement with respect to uranium millings; NRC has reasserted regulatory authority over mill tailings in the State of New Mexico. 51 Fed. Reg. 19,432 (1986).

259. 51 Fed. Reg. 24,697 (1986).

260. *See* 40 C.F.R. § 192.32(a)(2)(v).

261. These concerns were most concisely stated in comments filed by the Commission in response to EPA Clean Air Act proposals with respect to tailings. *See* Staff Comments on Proposed Clean Air Act Rule, attached to letter from John Davis [NRC] to Central Docket Section [EPA], May 22, 1986.

262. EPA Press Advisory, June 30, 1986. *See also EPA Drops Plans to Regulate Mining Waste as RCRA Hazardous Waste*, INSIDE E.P.A. WEEKLY REP. 1(June 13, 1986).

263. *See* 51 Fed. Reg. 24,501 (1986). EPA is, however, considering requesting congress to strengthen its powers to enforce Subtitle D. *Id.* at 24,501.

264. 42 U.S.C. § 2114(a)(3), *e.g.*, suggests that regulation of nonradiological hazards associated with tailings should be "comparable" to that under the SWDA for "similar hazardous material."

A second area of uncertainty relates to the Clean Air Act. As already noted, EPA has deemed all radionuclides to be "hazardous air pollutants" under Section 112 of the Clean Air Act. Pressed by another court order, the agency was compelled to consider regulating uranium mill tailings under this section on the ground that they emit radionuclides.[265] The Environmental Defense Fund [EDF] took the position that EPA must reduce risks from mill tailings under Section 112 to a de minimis level, which EDF defines as a 1 in 1,000,000 chance of a potential ill-health effect to any individual, or shut the industry down.[266]

EPA initially proposed various options which would lead to the phase-out of existing mill tailings piles (almost all of which are above-grade) in favor of disposal of tailings below-grade in lined trenches which are progressively covered as they are filled.[267] NRC expressed numerous concerns with EPA's proposal, calling portions of it either duplicative of, or inconsistent with, other EPA and NRC rules. Moreover, NRC noted that it "continues to believe its existing release limits and interim stabilization practices [are] adequate to protect public health and safety. . . ."[268] States, of course, have arguable authority under the Clean Air Act to impose requirements which are more stringent than those at the federal level.[269] Interestingly, however, the State of Colorado took the position that existing standards under the Atomic Energy Act were adequate to address uranium mill tailings. The State accordingly opposed EPA's Clean Air Act proposal and implicitly the EDF approach thereunder.[270] EPA nevertheless adopted final Clean Air Act standards requiring all future tailings piles to be below-grade and further requiring existing above-grade piles to be phased out by the year 2001.[271] If these EPA regulations are upheld on appeal,[272] NCR's original goal (below-grade, phased disposal) in its initial uranium mill licensing requirements will have been attained,

265. *See* 51 Fed. Reg. 6382 (1986).

266. *EPA, Hearing on Proposed Rule for Radon-222 Emissions from Licensed Uranium Mill Trailings*, transcript at 72 (Mar. 25, 1986) (testimony of Mr. Yhunke) [hereinafter *Hearing on Proposed Rule for Radon-222 Emissions*].

267. 51 Fed. Reg. 6382, 6383 (1986) (proposed rules).

268. Letter from John Davis [NRC] to Central Docket Section [EPA], May 22, 1986 and enclosure.

269. *See* 42 U.S.C. § 7412(d). *But see* People of the State of Illinois v. General Electric Co., 683 F.2d 206, 216 (7th Cir. 1982) (limits on state authority over Atomic Energy Act material under Clean Air Act).

270. *EPA, Hearing on Proposed Rule for Radon-222 Emission*, transcript at 6 (Mar. 26, 1986) (testimony of Mr. Hazel).

271. 51 Fed. Reg. 34,056 (1986).

272. The American Mining Congress has petitioned for review of the EPA regulations. American Mining Congress v. EPA, D.C. Cir. No. 86-2028. This petition is being held in abeyance pending the en banc rehearing, scheduled for Apr. 29, 1987, in Natural Resources Defense Council v. EPA, D.C. Cir. No. 85-1150. In the meantime, the American Mining Congress has moved to remand the case for additional evidence in light of a recent NATIONAL ACADEMY OF SCIENCE report suggesting that uranium mill tailings do not pose a substantial radiological hazard. *See* BOARD OF RADIOACTIVE WASTE MANAGEMENT NATIONAL RESEARCH COUNCIL [NAS], SCIENTIFIC BASIS FOR RISK ASSESSMENT AND MEASUREMENT OF URANIUM MILL TAILINGS (1986).

assuming that there continues to be an operating uranium industry in the United States.

This leads to the question of cost. The ultimate cost of the tailings reclamation program is difficult to estimate. Moreover, the incidence of that cost is not yet finally determined. NRDC originally estimated the cost for inactive sites at approximately one billion in 1974 dollars when it petitioned for a generic EIS in 1975.[273] EPA estimated the cost at inactive sites at $320 million in 1981.[274] The low EPA estimate for inactive sites may have reflected an ill-founded optimism as well as the probably mistaken belief that only one or two tailings piles would be removed to new locations. As the optimism faded, and as pressure has mounted to move more and more sites, the estimate of total cost at inactive sites has climbed toward $1 billion.[275] Similarly, EPA originally estimated that existing tailings at active sites could be stabilized for $260 million (1983 dollars).[276] However, DOE has testified that the cost for reclaiming active sites would be approximately $4 billion if the federal government were to conduct the effort in a fashion similar to the Title I program.[277] These hefty figures do not seem out of line, at least for a federal program, given the fact that the agency has signed one contract for a $245 million remedial action program to clean-up properties contaminated with mill tailings in the Grand Junction, Colorado, area alone.[278]

The price of uranium is much lower and the prospects of rising demand are much bleaker today than in the euphoric pre-TMI 1970s when the federal government projected a sky-rocketing increase in reliance on nuclear power and when the expansion of demand for uranium seemed relatively unbounded.[279] But there have been no new reactor orders in the United States since 1978, and no revival of reactor orders is currently in sight.[280] Absent relief from low priced imports of foreign source uranium, it is not likely that uranium producers can pass on much if any of projected stabilization expenses in today's market. Not surprisingly, elements of the uranium industry are accordingly seeking federal and nuclear

273. *See* letter from NRDC to Anders, Mar. 28, 1975, at 16.

274. *EPA, Final Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites*, 40 C.F.R. § 192(ix) (Oct. 1982).

275. *Nuclear Mess: Uranium Mill Wastes, Piled High in West, Pose Clean Up Issues*, Wall St. J., Feb. 25, 1986, at 1, 16, col. 1.

276. *EPA, Final Environmental Impact Statement for Standards for the Control of By-product Materials from Uranium Ore Processing* (40 C.F.R. § 192) at S-1 (Sept. 1983).

277. Statement of John J. Hanrahan, *DOE, Joint Hearing Before the Energy & Env. Subcomm. of the Senate Energy Comm.*, 99th Cong., 1st Sess. (1985).

278. DOE news release, May 16, 1986.

279. *See Nuclear Reaction: U.S. Uranium Mines, Thriving 5 Years Age, Are Nearing Extinction*, Wall St. J., June 12, 1986, at 1.

280. *See* J. Cook, *Nuclear Follies*, FORBES, (Feb. 11, 1985) at 82.

utility contributions to cover part of the reclamation costs at active sites.[281] Moreover, several companies have sued the federal government in Claims Court for a contribution associated with the tailings generated under old Atomic Energy Commission uranium procurement contracts on the theory that the parties to the contracts were mutually mistaken as to the costly reclamation which would be required to address potential health hazards.[282] The government denies any legal liability,[283] although the General Accounting Office and DOE in the past have acknowledged an equitable claim.[284]

E. The Siting of Uranium and Thorium Mill Tailings Disposal Sites

Most of the public controversy relating to tailings to date has involved disposal standards; the question of siting final disposal facilities has simmered below the surface. Unlike the situation for high-level waste disposal facilities (and, to a large extent, low-level waste facilities as well), the development of procedures and criteria for siting of uranium and thorium mill tailings disposal sites does not amount to writing regulations for new facilities. The nation's uranium and thorium mills were largely constructed not only prior to the adoption of the UMTRC Act but also prior to public recognition by the principal regulatory body that tailings might pose a potential radiological hazard.[285] The mills and their associated tailings piles were thus sited principally for geographical convenience to mineral deposits, transportation facilities and water supplies, and in reference to available infrastructure to support industrial development. Indeed, in the case of some older sites, the mills and tailings were sited chiefly in response to the proximity to ore buying stations selected by

281. *See, e.g.*, Domenici Amendment No. 1729 to S.1004, 99th Cong., 1st Sess., reprinted at 129 CONG. REC. S. 3793-99 (daily ed. April 8, 1986); S. 1100, 100th Cong., 1st Sess. discussed at 133 CONG. REC. S. 5604-13 (daily ed. Apr. 28, 1987).

282. *See, e.g.*, Atlas Corp. v. United States, Cl.Ct. No. 281-83C; Kerr-McGee Chemical Corp. v. United States, Cl.Ct. No. 143-84C; Quivira Mining Co. v. United States, Cl.Ct. No. 144-84C; Western Nuclear v. United States, Cl.Ct. No. 565-84C; Union Carbide Corp. v. United States, Cl.Ct. No. 579-84C; Homestake Mining Co. v. United States, Cl.Ct. No. 580-84C; Atlantic-Richfield Corp. v. United States, Cl.Ct. No. 576-84C; Pathfinder Mines v. United States, Cl.Ct. No. 581-84C.

283. *See DOE, Commingled Tailing Study*, at 9 (June 30, 1982), *reprinted in Management of Commingled Uranium Mill Tailings, supra* note 1, at 543 (1982).

284. *See DOE, Answer to Questions Commingled Tailings at Currently Operating Uranium Ore Processing Mills that Produced Uranium Under Atomic Energy Commission [AEC] Contracts*, Jan. 29, 1979; *GAO, Cleaning Up Commingled Uranium Mill Tailings: Is Federal Assistance Necessary?* (Feb. 5, 1979).

285. EPA lists 27 licensed uranium mills in *Regulatory Impact Analysis of Final Environmental Standards for Uranium Mill Tailings at Active Sites*, at D-2 (1983). One (Bokum) never operated. Thirteen have been in operation since the federal uranium procurement program in the 1950s. *See Management of Commingled Uranium Mill Tailings, supra* note 1, at 542. The nation's only thorium mill (the Kerr-McGee Chemical Corp. facility in West Chicago, Ill.) was in existence prior to World War II.

the old Atomic Energy Commission.[286] In other cases, existing mills and tailings sites were located near rivers, over aquifers, or in or near population centers. The quantities of tailings at such locations are enormous: literally tens of millions of tons of sandy residues, plus associated contaminated soil.

This situation poses a serious dilemma. For practical purposes, and unlike the situation with respect to high-level waste, the nation's stock of uranium and thorium tailings are already sited. The cost to move tailings and contaminated soil from existing sites is substantially greater—usually two to even ten times as great—as stabilizing the tailings in place.[287] Yet stabilizing many of the existing sites in place means acceptance of tailings disposal facilities at locations which would arguably not be licensed for construction of new milling and tailings storage facilities in the current regulatory climate.

It is perhaps because of this dilemma that little objective guidance has been developed with respect to the siting of tailings disposal facilities. The situation can be briefly described for the two major categories of sites: "inactive" or Title I sites, and "active" or Title II sites.

1. Siting Inactive Tailings Disposal Facilities

The only substantive requirement for a disposal site under Title I of the UMTRC Act is that the site be such that at the conclusion of stabilization activities the tailings will conform to the pertinent health and safety standards issued by EPA for inactive uranium mill tailings sites. The pertinent EPA standards set forth minimum performance requirements for tailings stabilization; they do not purport to require optimization of siting.[288] In short, serendipitously or not, the EPA standards for inactive sites are conducive to stabilizing tailings in place. Indeed, EPA officials have testified that "EPA believes that tailings piles should only be moved as a last resort because moving a pile is very costly and because transport methods could cause serious harm to people from accidents."[289] Moreover, they have specifically noted that: "We believe very few piles, if any, need to be moved in order to adequately protect public health and the environment."[290] In seeming confirmation of this position, DOE is

286. *See, e.g.*, Deposition of Sheldon Wimpfen (former general manager of AEC Grand Junction Office) at 40-41 in Atlas Corp. v. U.S., Cl. Ct. No. 281-83C.

287. *See, e.g., Management of Commingled Uranium Mill Tailings, supra* note 1, at 502 (1982).

288. 40 C.F.R. § 192.00-.23.

289. *Uranium Ore Residues: Potential Hazards and Disposition, Hearing Before the Procurement and Military Nuclear System Subcomm. of the House Armed Services Comm.*, 97th Cong., 1st Sess. at 67 (1981).

290. *Management of Commingled Uranium Mill Tailings, supra* note 1, at 332 (1982).

stabilizing its highest priority site (the Canonsburg, Pennsylvania tailings pile) in place.[291]

Nevertheless, the pressure to relocate many of the tailings piles at Title I sites has grown. DOE agreed to move the old Vitro tailing pile from a light industrial section of Salt Lake City after the State of Utah agreed to pick up a greater percentage of the costs[292] than the ten percent specified in the statute.[293] The Wyoming legislature has pressed DOE to move the Riverton tailings as opposed to stabilizing them in place.[294] Governor Lamm of Colorado has taken the position that at least four of the eight inactive tailings sites in his state should be moved to more remote locations.[295] In addition to the Salt Lake City site, DOE reportedly has thus far decided to move only the inactive site at Durango, Colorado (where tailings are on the banks of a river) and the site at Lakeview, Oregon (where the area is considered seismically and geothermally active).[296]

In the event that DOE, with the concurrence of the NRC, "determines that removal of [tailings] from a processing site is appropriate," Title I places the responsibility on the host state to acquire an appropriate permanent disposal site.[297] This largely relieves the federal government of the most difficult aspect of the nuclear waste disposal problem—namely finding a site for permanent disposal of the material in question with respect to inactive uranium processing sites.

2. *Siting Disposal Facilities for Active Tailings*

The situation at Title II sites is more complex. There are two basic sets of federal substantive requirements applicable to such sites: the EPA active site standards[298] and NRC's Uranium Mill Licensing Requirements.[299] The applicable EPA standards are minimum performance standards and, like their inactive site siblings, do not on their face necessitate wholesale relocation for final disposal. NRC's requirements are considerably more aggressive in terms of encouraging movement of tailings. The key NRC requirement is Criterion 1.[300]

291. *See DOE, Final Environmental Impact Statement: Remedial Actions at the Former Vitro Rare Metals Plant Site, Canonsburg, Penn.* (July 1983).
292. Telephone conference between Mike Walsh & Rich Marques [DOE], May 20, 1986.
293. 42 U.S.C. § 7917(a).
294. INSIDE ENERGY 7 (Mar. 24, 1986).
295. Telephone conference with Leonard Sloksy (consultant to Gov. Lamm), June 5, 1986 (two sites at Rifle, sites at Durango and Grand Junction).
296. INSIDE ENERGY 8 (Mar. 24, 1986).
297. 42 U.S.C. § 7914(b)(1).
298. 40 C.F.R. § 192.
299. 10 C.F.R. § 40, App. A.
300. *Id.*

That criterion on its face calls for "an optimization to the maximum extent reasonably achievable" of several site features conducive to long-term tailings stabilization.[301] These features include population density, hydrologic conditions pertaining to isolation or immobilization of contaminants, and potential for minimizing erosion.[302] Criterion 1 also calls for primary emphasis to be placed on isolation of tailings as opposed to short-term (that is, economic or transportation and construction risk) factors, and it instructs that "overriding consideration" be given to siting features as opposed to engineering design in the site selection process.[303]

Other aspects of NRC requirements also may push for movement of existing tailings. For example, Criterion 3 states that the "prime option" for tailings disposal is "placement below-grade, either in mines or specially excavated pits."[304] The criterion suggests that "where full below-grade burial is not practicable," the licensee "must" demonstrate that it is providing "reasonably equivalent isolation."[305] Criterion 4 also states a number of siting requirements in apparently mandatory terms:

> (a) Upstream rainfall catchment means must be minimized to decrease erosion potential and the size of the maximum possible flood which could erode or wash out sections of the tailings disposal areas. . . . (b) Topographic features should provide good wind protection . . . (e) The impoundment shall not be located near a . . .

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301. *Id.* criterion 1.

302. *Id.*

303. 10 C.F.R. § 40, App. A, criterion 1, provides in full as follows:

> In selecting among alternative tailings disposal sites or judging the adequacy of existing tailings sites, the following site features, which will determine the extent to which a program meets the broad objective of isolating the tailings and associated contaminants from man and the environment during operations and for thousands of years thereafter without ongoing active maintenance, shall be considered:
>
> 1. Remoteness from populated areas;
> 2. Hydrologic and other natural conditions as they contribute to continued immobilization and isolation of contaminants from usable groundwater sources; and
> 3. Potential for minimizing erosion, disturbance, and dispersion by natural forces over the long term.
>
> The site selection process shall be an optimization to the maximum extent reasonably achievable in terms of these features.
>
> In the selection of disposal sites, primary emphasis shall be given to isolation of tailings or wastes, a matter having long term impacts, as opposed to consideration only of short term convenience or benefits, such as minimization of transportation or land acquisition costs. While isolation of tailings will be a function of both site and engineering design, overriding consideration will be given to siting features given the long term nature of the tailings hazards.
>
> Tailings shall be disposed of in a manner such that no active maintenance is required to preserve conditions of the site.

304. 10 C.F.R. § 40, App. A, criterion 3.

305. *Id.*

> fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand. . . .[306]

Since existing mill tailings storage sites were determined long before the issuance of NRC's various siting requirements, it seems likely that many would not comport with one or more of the requirements. Although the NRC criteria afford some wiggle room, on their face they disfavor engineering solutions to address site deficiencies and they downplay economic and near-term risk arguments against moving existing tailings piles. Thus the pressure to move existing tailings piles regulated under Title II of the UMTRC Act can be expected eventually to be as great as that developing under Title I.

Indeed, the pressure may be even greater. As matters currently stand, private licensees are wholly responsible for locating disposal sites and performing stabilization activities at Title II sites.[307] This is significantly different from Title I where federal and state officials must pay for stabilization and the host state must locate a suitable disposal facility if it wishes tailings to be removed.[308] Since the federal and local governments have no economic responsibility for stabilizing or political responsibility for siting Title II disposal sites, there is less reason on the part of regulators to resist local pressure to move tailings. Consonant with this analysis, the first Title II tailings to be stabilized—at Edgemont, South Dakota—are being moved, and Illinois has vigorously contested proposals by Kerr-McGee Chemical Corporation for in-place stabilization of the old thorium mill tailings site in West Chicago, Illinois.[309]

The legal regime at Title II sites is conducive to possible gridlock on the siting question in another way: the many duplicative regulatory authorities pertaining to the siting decision offer opportunities to tie confound efforts to determine a site. This problem has two aspects. First, states have more latitude to regulate uranium or thorium mill tailings in a fashion divergent from NRC requirements than with respect to other materials regulated under the Atomic Energy Act. For purposes of analysis of this point, there are two categories of states: states which are parties to agreements discontinuing NRC's regulatory authority over uranium and thorium milling activities within their borders (Agreement States); and states which are not parties to such discontinuance agreements. The

306. *Id.* criterion 4.

307. *See, e.g., Management of Commingled Uranium Mill Tailings, supra* note 1, at 543 (government disavows responsibility).

308. *See supra* note 1, at 297.

309. People of the State of Illinois v. Kerr-McGee Chemical Corp., No. 80-CH-298 (18th Jud. Cir., DuPage County, Illinois) (state suit against thorium site as a "nuisance").

traditional requirement for Agreement States is that their regulatory programs be "compatible" with that of NRC.[310] In contrast, under the UMTRC Act, Agreement States can impose more stringent requirements for uranium and thorium tailings than those adopted at the federal level.[311] An Agreement State could thus in theory purport to adopt requirements which would necessitate moving a tailings site even if the current location of the pile conformed to NRC requirements. As to non-Agreement States, although NRC takes the position that its regulatory authority pre-empts state regulation of radiological hazards posed by mill tailings for all such states,[312] the Commission does not take a similar view with respect to nonradiological hazards.[313] In addition, the Seventh Circuit has specifically held that the UMTRC Act does not broadly pre-empt regulation of nonradiological aspects of uranium or thorium tailings stabilization.[314] A non-Agreement State desirous of upsetting a particular siting decision may accordingly seek to achieve its goal under the guise of regulating nonradiological concerns. Second, a state could attempt to regulate the siting of a tailings disposal facility pursuant to authority over radiological hazards arising from various statutes conferring that authority in a fashion supplementary to the Atomic Energy Act. Such statutes include the Clean Air Act,[315] the Safe Drinking Water Act,[316] and CERCLA.[317] This duplication of authority makes a siting decision difficult even in instances where a licensee's proposal for a particular disposal site may meet Atomic Energy Act requirements.

Given the legal regime applicable to Title II sites, it is fair to expect considerable regulatory, political, and public confusion over the question of siting permanent disposal facilities for a number of the tailings piles in question. NRC has suggested one solution to this conundrum in the form of regulatory approval for a kind of "interim" stabilization of tailings in place with the decision on final stabilization postponed until some future time.[318] However, this approach has been attacked by the host state as a de facto decision on permanent stabilization without full consideration of the propriety of such stabilization. Moreover, a licensee would naturally be wary of expenditure of substantial sums of money to complete an interim stabilization when it risks a subsequent requirement that the waste

310. 42 U.S.C. § 2021(d)(2) and (g).

311. 42 U.S.C. § 2021(o)(2), as added by § 204(e)(1) of the UMTRC Act.

312. *See* 10 C.F.R. § 8.4 (opinion of general counsel as to all nuclear facilities).

313. *See, e.g., NRC, Final Environmental Statement related to Operation of Split Rock Uranium Mill* (NUREG-0639) at 1-4 (Feb. 1980).

314. Illinois v. Kerr-McGee Chemical Corp., 677 F.2d 571, 580 & n.17 (7th Cir. 1982). The Wyoming attorney general initially rendered a contrary conclusion. Memorandum from Wyoming Attorney General Troughton to Gov. Herschler, Dec. 1, 1979.

315. 42 U.S.C. § 7401.

316. 42 U.S.C. § 300f.

317. 42 U.S.C. § 9601.

318. NRC, Final Environmental Statement for West Chicago, Ill. Thorium Mill (1983).

be dug out for transshipment to a new site a few years later. The question of siting of permanent disposal facilities for Title II mill tailings may yet have to be revisited by Congress.

IV. LOW-LEVEL RADIOACTIVE WASTE

Low-level radioactive waste is generally conceived in a negative fashion: all radioactive waste which is not high-level radioactive waste or spent nuclear fuel.[319] For regulatory purposes, however, the definition is considerably more complicated. It generally excludes uranium or thorium mill tailings.[320] The regulatory definition of low-level waste also contains an arbitrary demarcation line for transuranic waste.[321] This demarcation is currently fixed at 100 nCi/gm by federal regulation; material in excess of this concentration is considered high-level waste.[322]

Finally, the regulatory definition must take into account the fact that the only substances regulated under the Atomic Energy Act are "source material," "by-product material," and "special nuclear material." Low-level radioactive waste is thus regulated only insofar as it contains these materials or is generated by an activity regulated under the Atomic Energy Act. As a result there are important categories of low-level waste (which in fact may be very "hot") which are not covered by the Atomic Energy Act. Two such categories are various radium-bearing materials[323] and wastes from cyclotron operations.[324]

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319. *GAO, The Problem of Disposing of Nuclear Low-Level Waste: Where Do We Go from Here?* 8 (1980) [hereinafter *GAO, Low-Level Waste*].

320. *See* § 2(a)(A) of the Low-Level Radioactive Waste Policy Act, as amended by the Low-Level Radioactive Waste Policy Amendments Act of 1985, 99 Stat. 1842 (excludes "by-product material . . . as defined in § 11e.(2) of the Atomic Energy Act of 1954).

321. Transuranic waste is material contaminated with elements whose atomic number is greater than 92, such as americium or plutonium. The classical dividing line between low-level transuranic waste and high-level radioactive waste has been 10 nCi/gram (*GAO, Low-Level Waste, supra* note 319, at 2 (1980)), which was apparently selected because it is roughly the highest occurring concentration of radium-226 in nature and because the radiation hazard posed by radium-226 (alpha particles) resembles that posed by some of the more important transuranics.

322. NRC has selected 100 nCi/gram as the cut-off, 40 C.F.R. § 61.55, chiefly to facilitate volume reduction and to respond to arguments relating to measurement techniques. 47 Fed. Reg. 57,453 (1982). DOE changed its definition to 100 nCi/gram in DOE Order 5820.1, Sept. 30, 1982.

323. Two major categories of radium-bearing low-level waste which are not regulated under the Atomic Energy Act are radium tailings and so-called FUSRAP sites. The Nation's first nuclear industry was the radium industry, which flourished in the early 1900s. *See* Landa, *The First Nuclear Industry*, SCI. AM. 180 (Nov. 1982). This industry resulted in radioactive tailings and residues resembling uranium mill tailings. These tailings and residues may be addressed under CERCLA. *See* 126 CONG. REC. S. 14,975 (daily ed. Nov. 24, 1980) (CERCLA said to apply to "radium waste sites"). Another category of radium-bearing waste emanates from FUSRAP sites. These sites were employed by the Manhattan Engineer District [MED] or the early Atomic Energy Commission, or their contractors, to process nuclear materials. *See Uranium Ore Residues: Potential Hazards and Disposition, Hearing Before the Procurement and Military Nuclear System Subcomm. of the House Armed Services Comm.*, 97th Cong., 1st Sess. 323 (1981). These sites are essentially unregulated, except for the availability of Superfund.

324. Cyclotron (accelerator) products and cyclotron waste resemble fission by-products. Cyclotrons are used, *inter alia*, for the production of radioisotopes and radiopharmaceuticals.

Low-level radioactive waste may come in liquid, gaseous, and solid form. Liquid and gaseous low-level waste is frequently treated, diluted, or held for radioactive decay and then released to the environment.[325] Solid low-level waste, including sludge and solidified liquids, is frequently disposed of in shallow-trenches at burial sites.[326] Low-level radioactive waste presented for burial are generated from several different sources: hospitals and research (twenty-five percent); industry (twenty-four percent); federal government installations (eight percent); and commercial power reactors (forty-three percent).[327] All fifty states plus the District of Columbia generate both institutional and industrial low-level radioactive waste.[328]

A. Potential Hazards Posed by Low-Level Radioactive Waste

Low-level radioactive waste takes a variety of forms and varies widely in terms of hazard presented. Some such waste, for example, may initially emit significant amounts of radiation. However, because of the relatively short half-lives of the radionuclides involved, these emissions may relatively rapidly approach background. Many medically-related wastes are of this nature. Other waste classified as low-level may emit relatively low-levels of radiation but, because of the long half-lives of the radionuclides in question, may continue to emit such radiation for practical purposes in perpetuity. A prime example of such wastes are the residues produced from the processing of radium-bearing ores such as those of columbium, tantalum, zirconium, hafnium, or rare earths.[329] Another example of long-lived radioisotopes are certain transuranics, such as plutonium-239. Finally, some of the radioactive material disposed as low-level radioactive waste may also be hazardous for other reasons. For example, the waste may be pyrophoric, like some zirconium processing residues.[330] Alternatively, it may contain chemical contaminants which are themselves hazardous under EPA's Solid Waste Disposal Act[331] regulations or are otherwise toxic or dangerous.[332] The only general statement which can be made concerning low-level radioactive waste is that it is

325. *See GAO, Low-Level Waste, supra* note 319, at ii.
326. *Id.*
327. *Id.*
328. *Id.*
329. Uranium and thorium ores are also radium-bearing but are regulated under Title II of the UMTRC Act. NRC's recently issued regulations pertaining to disposal of low-level radioactive waste do not apply to disposal of uranium or thorium wastes in quantities greater than 10,000 kilograms and containing more than 5 millicuries of radium-226. 10 C.F.R. §61.1(b).
330. *See, e.g., NRC, Environmental Impact Appraisal, Amax, Inc., Parkersburg, West Virginia Site,* Docket No. 40-8355, Proposed Site Stabilization (Apr. 1982).
331. 42 U.S.C. §6901.
332. *See* Finamore, *Regulating Hazardous and Mixed Waste at Department of Energy Nuclear Weapons Facilities: Reversing Decades of Environmental Neglect,* 9 HARV. ENV. L. REV. 83 (1985).

composed of many different kinds of waste material presenting fundamentally different kinds and degrees of hazards.

B. Initial Regulation of Disposal of Low-Level Radioactive Waste

In contrast to the situation with respect to uranium or thorium mill tailings, the Commission's regulatory authority over disposal of most civilian low-level radioactive waste has been relatively clear from the inception of the Atomic Energy Act. This is in part because most low-level waste (aside from certain metal processing residues) is radioactive due to contamination with fission by-products or transuranics. Fission by-products fall within the definition of "by-product material" for purposes of Section 11e.1 of the Atomic Energy Act.[333] Such material has always been subject to licensing by the Commission.[334] The major transuranics are themselves either "by-product material" or "special nuclear material." Moreover, the Commission has jurisdiction over fission by-products or special nuclear material regardless of the low concentration of such material in a waste or residue.[335] Whether fission by-products or special nuclear material, the Atomic Energy Act authorized the Commission to impose requirements which it deems "necessary [or] desirable to promote the common defense and security or to protect health or to minimize danger to life or property."[336] Without question, the Commission from the inception of the Atomic Energy Act enjoyed broad authority to regulate disposal of such material.[337]

The Commission's initial regulatory standards and procedures for disposal of low-level radioactive material are set forth in 10 C.F.R. § 20—the basic "health physics" chapter of NRC's regulatory requirements. 10 C.F.R. § 20.301 has long authorized Commission licensees to dispose of radioactive waste by five basic means: (1) transfer to an authorized recipient; (2) disposal into a sanitary sewer as provided in 10 C.F.R. § 20.303;[338] (3) disposal by burial as provided in 10 C.F.R. § 20.304 (now repealed);[339]; (4) disposal into the environment so long as the requirements of 10 C.F.R. § 20.106 relating to release of radioactive effluents into "unrestricted areas" are met;[340] or (5) by some other means approved by

333. 42 U.S.C. § 2014(e).

334. 42 U.S.C. § 2114.

335. *See, e.g.*, 42 U.S.C. § 2073.

336. 42 U.S.C. § 2201(b).

337. *See, e.g.*, Harris County, Texas v. United States, 292 F.2d 370, 371 (5th Cir. 1961); City of New Britain v. Atomic Energy Commission, 308 F.2d 648, 649 (D.C. Cir. 1962).

338. 10 C.F.R. § 20.303 requires that the discharged material be readily soluble or dispersible and that it meet certain maximum quantity limits.

339. 45 Fed. Reg. 71,762 (1980) (effective Jan. 28, 1981).

340. NRC is currently in the process of revising its standards for effluents released to unrestricted areas.

the Commission on a case-by-case basis under 10 C.F.R. §2.302.[341] In essence, low-level waste repositories were regulated under the case-by-case approach based on the latter provision.

Although the Commission initially licensed several low-level radioactive waste disposal site operations, the agency had no general standards applicable to the permanent disposal of waste at the sites in question and had given little thought to standards applicable for such disposal. This gap became starkly apparent when the operator of the Sheffield, Illinois, low-level radioactive waste disposal site, unable to obtain regulatory permission to expand its site, declared the site closed, purporting to return its NRC license and renounced any continued responsibility for long-term stabilization, maintenance, or monitoring of the site.[342]

C. The Commission's New Standards for Land Disposal Facilities

In late 1982, NRC issued new standards for land disposal facilities.[343] The more significant standards conveniently divide into four separate parts: (a) performance standards; (b) siting standards; (c) disposal standards and associated stability requirements; and (d) provisions for institutional control. The performance standards are straightforward: Land disposal facilities may not release effluents into the environment so as to result in "an annual dose [of radiation] exceeding the equivalent of twenty-five millirems to the whole body, seventy-five millirems to the thyroid, and twenty-five millirems to any other organ of any member of the public."[344] Each disposal facility must also be designed, operated, and closed so as to "ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the site" after active control over the site has discontinued.[345] Finally, the facility is to be sited, designed, and closed to achieve long-term stability and to eliminate any need for ongoing maintenance.[346]

The siting standards are in some respects, less stringent than those set forth for uranium and thorium tailings in NRC's Uranium Mill Licensing Requirements. For example, rather than requiring "remoteness from pop-

341. NRC has also recently adopted regulations permitting certain methods of disposal of limited quantities of hydrogen-3 or carbon-14. 10 C.F.R. § 20.306.

342. *See Nuclear Engineering Co.* (Sheffield, Illinois, Low-Level Radioactive Waste Disposal Site), ALAB-606, 12 NRC 156 (1980).

343. Under Reorganization Plan No. 3, EPA has authority to issue generally applicable standards for Atomic Energy Act activities, including land disposal facilities. EPA has not yet issued any standards applicable to such facilities.

344. 10 C.F.R. § 61.41. This standard is an extension of EPA's standard for the uranium fuel cycle (codified at 40 C.F.R. § 190). Section 190, however, does not cover waste disposal operations or Atomic Energy Act activities outside the uranium fuel cycle. *C.f.* 40 C.F.R. § 190.02(b) *with id.* § 190.10.

345. 10 C.F.R. § 61.43.

346. 10 C.F.R. § 61.44.

ulated areas" as is the case for tailings,[347] NRC's low-level standard is site selection such "that projected population growth and future developments are not likely to affect the ability of the disposal facility to meet the performance objectives . . . ."[348] The Uranium Mill Licensing Requirements seem to call for protection from "maximum possible flood."[349] In contrast, the low-level standard simply provides that "waste disposal shall not take place in a 100 year flood plain, coastal high-hazard area or wetland."[350] Provisions for hydrologic protection are specified in somewhat more detail for land disposal facilities,[351] and more flexibility is provided with respect to means to achieve erosion control.[352]

The key disposal standard, which is tied to ultimate stabilization requirements, emerges from NRC's division of low-level waste into four classes: A, B, C, and greater than C.[353] According to NRC, the classification scheme is based on two considerations: (1) the concentration of long-lived radionuclides which may be hazardous despite deeper disposal, institutional controls and so forth; and (2) the concentration of shorter-lived radionuclides for which institutional controls may be effective.[354]

Class A waste in general has low concentrations of certain specified long- and short-lived radionuclides.[355] It may be buried for land disposal if it meets the minimum waste stability requirements specified in 10 C.F.R. §61.56(a).[356] Class B waste has moderate concentrations of the specified radionuclides.[357] It must meet not only the stability requirements of §61.56(a), but also the more rigorous stability requirements of §61.56(b).[358] Class C waste contains the maximum concentrations for which land disposal is generally permissible for the specified radionuclides.[359] It must meet all the stability requirements plus additional requirements to protect against inadvertent intrusion.[360] In its regulations, the Commission reserved the authority to permit land disposal on a case-by-case basis for concentrations of radionuclides exceeding those specified for Class C.[361]

347. 10 C.F.R. §40, App. A, criterion 1.
348. *Id.* §61.50(a)(3).
349. 10 C.F.R. §40, App. A, Item 4(a).
350. *Id.* §61.50(a)(5).
351. *Id.* §61.50(a)(7)
352. *Id.* §61.50(a)(10).
353. *Id.* §61.55.
354. *Id.* §61.55(a)(1).
355. *Id.* §61.55(a)(3)(i) & (4)(i).
356. *Id.* §61.55(a)(2)(i).
357. *Id.* §61.55(a)(4)(ii).
358. *Id.* §61.55(a)(2)(ii).
359. *Id.* §61.55(a)(3)(ii) & (4)(iii).
360. *Id.* §61.55(a)(2)(iii).
361. *Id.* §61.55(a)(2)(iv) & §61.58.

Class A wastes (unless they meet the more stringent stability requirements for Class B) must be segregated from other wastes so eventual instability of the Class A materials will not result in a failure on the part of other wastes to meet the various performance objectives.[362] Class C waste must be disposed "so that the top of the waste is a minimum of five meters below the top surface of the cover or such that the waste is disposed with intruder barriers "to protect against inadvertent intrusion for at least 500 years."[363]

The minimum prescription for institutional control is simply stated: 100 years.[364] The Commission's basic design standard for Class C waste (five meters or protection for 500 years) as well as its basic provision for institutional control (100 years) are potentially inconsistent with comparable requirements applicable to uranium and thorium mill tailings. Class C waste can contain long-lived alpha-emitting transuranics at concentrations up to 100 nCi/grams[365]—an amount roughly ten times the maximum concentration of arguably comparable alpha-emitting radium in nature. Under EPA standards, uranium and thorium tailings, which contain radium in concentrations well below those permitted for comparable Class C (and even Class A) transuranic waste, are to be stabilized for 1,000 years.[366] In even greater contrast, under NRC's original Uranium Mill Licensing Requirements, the objective is stabilization for "thousands" of years.[367] In short, the requirements applicable to uranium and thorium tailings appear more stringent than comparable requirements applicable to similarly hazardous Class C (or even some Class A or B) waste.

D. Controversies Relating to the Commission's Land Disposal Standards

Relative to the situation with respect to uranium and thorium mill tailings, NRC's land disposal standards have been largely noncontroversial. Nevertheless, NRC's handling of Class C and greater waste has attracted some attention in Congress. The House of Representatives passed a version of the 1985 Act which, had it been adopted, would have required NRC to identify waste (presumably chiefly in Class C) whose hazardous life exceeds the provision for institutional control specified in 10 C.F.R. §61.59 (100 years). The House passed measure would further have required NRC to revise standards for such waste to the extent that the

362. *Id.* §61.52(a)(i).
363. *Id.* §61.52(a)(2).
364. *Id.* §61.59(b).
365. *Id.* §61.55(a)(3)(ii).
366. 40 C.F.R. § 192.32(b)(1)(i).
367. 10 C.F.R. §40, App. A, criterion 1.

agency determined was "necessary to minimize the long-term threat to the public health and safety."[368] This language was not contained in the Senate version of the comparable bill, nor was it included in the version which eventually passed both houses. This resulted in a sharp dispute on the floor. Congressman Markey expressed "serious concern" with respect to Class C waste and took the position that "it is our intent that the NRC does conduct the review required in the House bill."[369] Senator Simpson, however, stated that:

> The Senate rejected the proposal that the NRC be required to reopen its regulations for the purpose of considering whether the hazards associated with Class C wastes exceeded the period of institutional control. The Senate reached the conclusion, and that conclusion is reflected in this bill . . . that the Commission's existing regulations in 10 C.F.R. §61 provide an adequate regulatory basis for all Class A, B, and C wastes.[370]

The question of waste which contains concentrations of radionuclides greater than those specified for Class C also has attracted congressional attention. Much of this material is transuranic in nature and includes waste material from fuel fabrication or private research and development efforts. In the 1985 amendments, the Senate and House agreed to language making the federal government responsible for, among other things, "low-level radioactive waste" with concentrations exceeding those specified by the Commission for Class C.[371] The newly adopted language provides that such waste must be disposed of in a facility licensed by the Commission to the extent that it derives from a licensed activity.[372] The Secretary of Energy is required to report to Congress concerning various options for disposal of such waste.[373] In short, the 1985 amendments modify NRC's proposed case-by-case approach to licensing land disposal of greater than Class C wastes.[374] It is conceivable that the federal government may adopt some kind of deep burial requirement for certain wastes which are greater than NRC's Class C, although not so stringent as that envisioned for high-level radioactive wastes.

Another problem which ultimately must be faced is the question of so-

368. H.R. REP. NO. 1083, § 12(b), 129 CONG. REC. H 11,408 (daily ed. Dec. 9, 1985) (emphasis added).

369. 129 CONG. REC. H 13,077 (daily ed. Dec. 19, 1985) (emphasis added).

370. *Id.* § 18,253. Senators McClure and Johnston concurred. *Id.* Other senators emphasized that the bill was neutral on whether the Class C regulations should be revisited or revised. *Id.* (*e.g.*, Senators McClure, Lautenberg, and Stafford).

371. Section 3(b)(1) of P.L. 99-240.

372. Section 3(b)(2).

373. Section 3(b)(3).

374. *See* 129 CONG. REC. S. 18,103 (daily ed. Dec. 19, 1986) (statement of Senator Hart); *id.* § 18252 (colloquy of Senators Thurmond and Simpson).

called "mixed wastes." Mixed wastes include material which is regulated as low-level radioactive waste under the Atomic Energy Act and by EPA as hazardous waste under the SWDA. Mixed waste is a relatively complex issue. The SWDA does not apply to "by-product material," "source material," or "special nuclear material" as defined by the Atomic Energy Act.[375] The Department of Energy, among other things, took the position that all waste contaminated with any of those Atomic Energy Act materials was itself Atomic Energy Act material and thus was excluded from the Solid Waste Disposal Act. In *Legal Environmental Assistance Foundation v. Hodel*,[376] the Federal District Court for the Eastern District of Tennessee rejected this position. This rejection seems well taken. Except for Section 11e.2 "by-product material" (that is, uranium and thorium tailings and residues) and some "source material" (that is, uranium or thorium "ores"), the terms "by-product material," "source material," and "special nuclear material" pertain to specific radionuclides and on their face do not also encompass non-radioactive material which they contaminate. The regulatory exclusion in the Solid Waste Disposal Act for Atomic Energy Act material thus does not exempt the contaminated material from Solid Waste Disposal Act regulation, with the exception of uranium and thorium tailings, residues, and ores.[377] In short, there is a clear jurisdictional overlap with respect to low-level radioactive waste disposal between NRC under the Atomic Energy Act and EPA under the Solid Waste Disposal Act.

This overlap creates a number of potential problems. First, it subjects operators of low-level radioactive waste disposal facilities to two quite different regulatory regimes, each with detailed performance, design, recordkeeping, closure, and licensing requirements. Second, these two regimes may be in partial conflict with each other. In the words of U.S. Ecology (which operates two of the three existing low-level waste disposal facilities), the SWDA "requires waste verification analyses; the NRC discourages such a program due to personnel exposure to radiation. The NRC's (low-level radioactive waste) regulations discourage leachate collection sytems; [SWDA] requires leachate collection systems at chemical waste disposal sites."[378] The dual jurisdiction thus results not only in costly duplication of effort but also in the possibility of conflict and

375. 42 U.S.C. § 6903(27). *See also id.* § 6905(a).

376. 586 F. Supp. 1163 (E.D. Tenn. 1984).

377. The UMTRC Act largely eliminates the substantive implications of this exception for purposes of uranium and thorium tailings and residues.

378. *Low-Level Radioactive Waste, Joint Hearing Before the Energy Res. & Dev. Subcomm. of the Senate Energy & Nat. Resources Comm. and the Nuclear Reg. Subcomm. of the Senate Env. & Public Works Comm.*, 99th Cong., 1st Sess. 220 (1985) [hereinafter *Low-Level Radioactive Waste*]. Indeed, U.S. Ecology notes that the Solid Waste Disposal Act regulations "are designed to discourage and even eliminate new landfills whereas the NRC has found that a low-level radioactive waste site constituted pursuant to 10 C.F.R. § 61 of its regulations is an acceptable method of disposal."

confusion which may further impede the already difficult process of siting (much less developing and operating) new low-level radioactive waste disposal facilities.[379]

In response to this problem, the version of the 1985 Low-Level Radioactive Waste Policy Act [LLRWPA] adopted by the House of Representatives included language which would have required EPA and NRC to jointly revise and promulgate regulations relating to mixed waste within twelve months so as to avoid conflicting requirements. The House language also would have made NRC "solely responsible for communication with low-level radioactive waste disposal facilities." Under the House-passed bill, EPA and NRC would also have been required to jointly issue regulations for mixed wastes, within twenty-four months, subject to congressional ratification.[380] The Senate adopted a different approach focusing on waste streams. Under the Senate approach, EPA and NRC were authorized to jointly determine that mixed waste was properly disposed in either a low-level waste facility or a solid-waste disposal facility so long as basic performance standards were met.[381] Congress could not resolve these differing approaches in the time available, and any mention of mixed waste was accordingly deleted from the 1985 LLRWPA as passed.

The problem presented by "mixed waste" in the context of low-level radioactive waste disposal facilities resembles the situation presented by uranium and thorium mill tailings. As is the case for "mixed waste", tailings present both radiological and nonradiological hazards. Under the Atomic Energy Act as amended by the UMTRC Act, NRC and its Agreement States enjoy licensing authority over uranium and thorium tailings to the exclusion of EPA Solid Waste Disposal Act jurisdiction.[382] However, the UMTRC Act requires NRC's tailings regulation to be "comparable" to those of the EPA for similar hazardous waste. In the words of the statute, the Commission's regulation of tailings "to the maximum extent practicable" must be "at least comparable to requirements applicable to the possession, transfer and disposal of similar hazardous waste regulated by the EPA administrator under the SWDA, as amended."[383] The UMTRC Act thus embodies a simple formula which (at least in theory) eliminates dual SWDA and AEC and jurisdiction but affords generally comparable levels of protection with respect to nonradiological concerns. The UMTRC

379. *Id.* at 221.

380. H.R. REP. No. 1083, § 13, *reprinted* at 129 CONG. REC. H 11,408-09 (daily ed. Dec. 9, 1985).

381. *See* 129 CONG. REC. S. 18,105 (daily ed. Dec. 19, 1985) (statement of Senator Hart).

382. 42 U.S.C. §§ 2022(d) & 2022(b)(2).

383. 42 U.S.C. § 2114(a)(3). *See also* 42 U.S.C. § 2022(a) & (b)(2) (EPA standards to be consistent with Solid Waste Disposal Act standards).

Act at the same time allows the NRC flexibility to avoid inconsistencies with requirements imposed for radiological purposes. Adoption of the UMTRC Act approach in the context of mixed hazardous waste and low-level radioactive waste would be an obvious solution to the mixed waste problem. It is however, not a perfect solution from a technological perspective given the differences between the two regulatory systems as well as the uncertainty concerning treatment of high-volume, low toxicity wastes under the SWDA.

An additional complication to the eventual resolution of the SWDA and Atomic Energy Act regulatory regimes arises from distrust in the environmental community of land disposal of low-level radioactive waste generally. For example, in testimony for the Sierra Club, Brooks Yeager argues that "conventional shallow-land burial has failed as an effective isolation mechanism for low-level radioactive waste, particularly in humid environments. Despite this history of failure and consequent environmental problems at Sheffield, Maxey Flats, and West Valley, shallow-land burial remains the reference technology for federal regulation. . . ."[384]

In response to this concern, the LLRWPA requires NRC to "identify methods for the disposal of low-level radioactive waste other than shallow-land burial, and establish and publish technical guidance regarding licensing of facilities that use such methods."[385] Within twenty-four months, the Commission must identify and publish "all relevant technical information regarding [such] methods" which a state or compact must provide to the Commission in order to pursue an alternative to shallow-land disposal.[386] Some of the alternatives may be gleaned from options identified in testimony by Sheldon Meyers of EPA's Office of Radioactive Programs:

> (1) engineered surface storage; (2) sanitary landfill; (3) improved shallow-land disposal; (4) intermediate depth disposal (over 10 meters deep); (5) deep geological disposal in mined cavity (over 100 meters deep); (6) hydrofracturing; (7) deep-well injection; (8) the engineered mound; and finally (9) disposal by modular concrete canisters placed in a trench.[387]

Apart from this requirement, NRC will presumably be required to consider options to shallow-land disposal upon licensing a new low-level waste facility pursuant to NEPA. The potential is thus great for confusion with respect to the basic approach to low-level radioactive waste disposal,

384. *Low-Level Radioactive Waste, supra* note 378, at 275.
385. Section 8(a) of LLRWPA.
386. Section 8(b).
387. *Low-Level Radioactive Waste, supra* note 378, at 71-72.

even if the basic standards applicable to such waste have largely been established.

E. Siting of Low-Level Radioactive Waste Disposal Facilities

Unlike the situation with respect to uranium mill tailings, disposition of classical low-level radioactive waste has suffered not so much from turmoil over standards as from turmoil over sites.[388] The perceived solution of this problem has shifted markedly over the last quarter century from the federal government to the private sector to the states. The latest solution seems to be encouraging a proliferation of disposal sites, the creation of regional disposal monopolies, and an increase in disposal costs possibly by an order of magnitude or more.

Prior to 1960, low-level wastes were buried at AEC sites regardless of whether they were generated in AEC facilities or by commercial activities. In 1960, AEC announced that its land burial sites would be available for commercial waste only until the designation of regional commercial waste sites.[389] The AEC envisioned the location of the commercial sites on federal or state land and called for the sites to be operated by private firms subject to regulation under the Atomic Energy Act.[390] In 1962, AEC licensed the first site at Beatty, Nevada. Five additional sites were licensed in 1963 at Maxey Flats, Kentucky, and West Valley, New York; Hanford, Washington, in 1965; Sheffield, Illinois, in 1967; and Barnwell, South Carolina, in 1971.[391]

The West Valley site closed in 1975 after radioactive contaminated waste seeped out of the caps of two burial trenches. The Maxey Flats site closed in December 1977 after the Kentucky legislature imposed a 10-cent-per-pound excise tax as a contingency against unforeseen problems. Burial capacity at Sheffield was exhausted in early 1978, and the site closed when the operator withdrew its application to expand the site in March 1979.[392]

In July 1979, the Governor of Nevada ordered the shutdown of the Beatty site. The governors of Washington, South Carolina and Nevada also wrote to NRC demanding enforcement of rules relating to low-level waste. The Beatty site was re-opened in late July 1979, but Washington's Governor Ray, a former chairman of the Atomic Energy Commission, closed the Hanford site in October 1979. The governor of South Carolina then ordered the Barnwell facility to scale down its activities. The Hanford

388. *See* Stanfield, *Radioactive Waste Can't Find a Home*, NAT. J. (Jan. 4, 1986).
389. *Id.* at 3.
390. *Id.*
391. *Id.*
392. *Id.*

site subsequently re-opened, but the availability of all sites was in doubt.[393] This doubt was compounded in November 1980, when voters of the State of Washington enacted Initiative No. 383 purporting to prohibit the transportation and storage within Washington of radioactive waste generated outside their State.

In *Philadelphia v. New Jersey*,[394] the Supreme Court invalidated a New Jersey statute prohibiting the importation of out-of-state waste. One state, the Court ruled, may not "isolate itself from a problem common to many by erecting a barrier against the movement of interstate trade."[395] The Court held that the measure "blocks the importation of waste in an obvious effort to saddle those outside the state with the entire burden of storing the flow of refuse into New Jersey's remaining landfill sites. That legislative effort is clearly impermissible under the Commerce Clause of the Constitution."[396] In *Washington State Building and Construction Trades Council v. Spellman*,[397] the Ninth Circuit, following the *Philadelphia* decision, struck down the Washington initiative as violating the Commerce Clause prohibition against interference with interstate commerce.[398] The Ninth Circuit also held that the initative violated the Supremacy Clause. More specifically, the court of appeals ruled that regulation of the disposal of low-level radioactive waste is a legitimate federal activity and that complete control of such disposal did not pass to Washington by reason of its Agreement State status.[399] The court held in effect that the ceding of authority to the State of Washington was subject to a requirement of regulatory compatibility under Section 274 of the Atomic Energy Act and that Washington's purported bar on interstate shipments was not compatible with the federal regulations.[400]

Agitation nevertheless mounted for a legislative "fix." The National Governors Association took the position that low-level radioactive waste was a state responsibility.[401] An approach emphasizing state responsibility for low-level waste was accordingly included in the House Interstate and Foreign Commerce Committee version of the then-pending high-level waste bill.[402] The House Interior Committee version of the bill took an even more aggressive position. The Interior version would have defined

393. *Id.* at 4.
394. 437 U.S. 617 (1978).
395. *Id.* at 628.
396. *Id.* at 629.
397. 684 F.2d 627 (9th Cir. 1982), *cert. denied sub. nom.* Don't Waste Washington Legal Defense Fund v. Washington, 461 U.S. 913 (1983).
398. *Id.* at 631-32.
399. *Id.* at 630.
400. *Id.*
401. *See* 118 CONG. REC. S. 10,057-58 (daily ed., July 29, 1980) (referring to the recommendations "The State Planning Council on Radioactive Waste Management" and the "recommendation of the National Governors Association Task Force on Low-Level Radioactive Waste Disposal").
402. H.R. REP. NO. 96-1382, Part I, 96th Cong., 2d Sess. at 11-12 (1980).

low-level radioactive waste to be a material regulated under the Atomic Energy Act (thus capturing virtually all such waste for purposes of Atomic Energy Act jurisdiction) and would have applied to such waste the basic regime applicable to uranium mill tailings under Title II of the UMTRC Act.[403] In addition, the Interior Committee bill authorized immediate exclusion of out-of-state waste.[404] On the Senate side, Senator Thurmond of South Carolina won passage of a regime similar to the House Interstate and Foreign Commerce low-level waste provisions in the Senate version of the high-level waste bill by floor amendment.[405]

Although the high-level waste bill[406] foundered, Congress did adopt a variation of the Interstate and Foreign Commerce Committee's state responsibility scheme for low-level waste. This bill, known as the Low-Level Radioactive Waste Policy Act of 1981 [1981 Act],[407] authorized states to enter into interstate compacts, the purpose of which was to establish new low-level radioactive waste disposal facilities for non-defense wastes.[408] As an incentive to establish such facilities,[409] Section 4 (2)(B) of the 1981 Act authorized states entering into such compacts to exclude wastes from states not participating in the compact after January 1, 1986.[410] Because Congress specifically gave permission for restricting disposal of waste pursuant to the 1981 Act, states which were signators to a compact provided by the Act could lawfully exclude waste from non-signator states without violating the Supremacy or Commerce Clauses, so long as the compact won congressional approval.[411]

Some additional legislation dealing with low-level waste was broached in the following Congress, again in the context of high-level waste legislation. The essence of the proposed low-level waste provisions was the House Interior Committee notion of treating low-level radioactive waste in a fashion similar to uranium mill tailings for purposes of regulation under the Atomic Energy Act. This effort was again unsuccessful. Congress, however, did eventually authorize the transfer of title to low-level waste sites to appropriate federal or state government agencies for perpetual monitoring and maintenance upon cessation of operations and completion of stabilization activities.[412]

As it turned out, the January 1, 1986, cut-off date established in the

403. H.R. REP. No. 96-1382, Part II, 96th Cong., 2d Sess. at 11-14 (1980).
404. *Id.* at 14.
405. 118 CONG. REC. S. 10,057 (daily ed. July 29, 1980).
406. Section 2189, 96th Cong. (1980).
407. PL. 96-573, 94 Stat. 3347-49 (formerly codified at 42 U.S.C. § 2021b-2021d).
408. Section 3 of P.L. 96-573.
409. H.R. REP. No. 1382, Part 1, 96th Cong., 2d Sess. at 341 (1980).
410. 42 U.S.C. § 2021d(a)(2)(B).
411. Washington State Building and Construction Trades Council v. Spellman, *supra*. art. I, § 10, cl. 3 of the Constitution provides that "No State shall, without the Consent of Congress . . . enter into any Agreement or Compact with any other State. . . ."
412. 42 U.S.C. § 10,171.

1981 Act was not attainable. Although seven low-level waste compacts were negotiated by mid-1982, only six states had acted to adopt one or more of them.[413] Indeed, organizing the compact commissions, siting repositories, arranging management, complying with license requirements, and beginning operation proved a formidable and time-consuming task. Perhaps not surprisingly, Congress did not get around to approving any of the compacts until adoption of the Low-Level Radioactive Waste Policy Act Amendments of 1985 [1985 Act],[414] which in turn was not signed into law until January 15, 1986. Title II of this Act, known as the "Omnibus Low-Level Radioactive Waste Interstate Compact Consent Act," granted consent "subject to the provisions of the Low-Level Radioactive Waste Policy Act [LLRWPA] as amended,"[415] to the following radioactive waste disposal compacts: Northwest Interstate Compact,[416] Central Interstate Compact,[417] Southeast Interstate Compact,[418] Central Midwest Compact,[419] Midwest Interstate Compact,[420] Rocky Mountain Compact,[421] and the Northeast Interstate Compact.[422] A number of important states, including California, Texas, New York, Massachusetts, and Pennsylvania, were not covered by any of these agreements and either will proceed on their own, will join an existing compact, or must seek congressional approval to create a new one.

F. The New Regime: The 1985 Low-Level Radioactive Waste Policy Act Amendments

Congressman Manuel Lujan (R-NM), the then ranking minority member of the House Interior Committee, described the 1985 Act as "one of the most detailed and complicated bills I have ever worked on."[423] The

413. *DOE, Status Report: Low-Level Radioactive Waste Compacts* 1 (1982).

414. P.L. 99-240, 99 Stat. 1842-59, (codified at 42 U.S.C. § 2021b-j).

415. P.L. 99-240, § 212 (2).

416. Section 221 (available to Alaska, Hawaii, Idaho, Montana, Oregon, Utah, Washington, and Wyoming), 99 Stat. 1860-63.

417. Section 222 (available to Arkansas, Iowa, Kansas, Louisiana, Minnesota, Missouri, Nebraska, North Dakota, and Oklahoma), 99 Stat. 1871-80.

418. Section 223 (available to Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia), 99 Stat. 1871-80.

419. Section 224 (available to Illinois and Kentucky), 99 Stat. 1880-92.

420. Section 225 (available to Iowa, Indiana, Michigan, Minnesota, Missouri, Ohio, and Wisconsin), 99 Stat 1892-1902.

421. Section 226 (available to Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming), 99 Stat. 1902-09.

422. Section 227 (available to Connecticut, New Jersey, Delaware, and Maryland), 99 Stat 1909-24.

423. 131 CONG. REC. H 11,411 (daily ed. Dec. 9, 1985). Congressman Lujan went on to state that Andrea Dravo, now a consultant in Washington, D.C. but then the pertinent subcommittee's staff member responsible for the legislation, "may be the only living human being who completely understands exactly how [the new legislation] will operate."

new legislation was indeed complicated—far more so than the virtual blank slate presented by the Atomic Energy Act a brief seven years before.

The 1985 amendments basically elaborated the concept adopted in the original Low-Level Radioactive Waste Policy Act of 1980[424] of providing federally-authorized penalties and incentives to encourage states to develop new low-level radioactive waste repositories. However, this goal is complicated by a complex allocation system designed to assure that the three existing commercial disposal sites need accept only a limited volume of waste,[425] and that adequate capacity for all generators is available within the newly set repository limits. The objective of assuring an adequate capacity is achieved by insisting on both an allocation of capacity for, and a reduction in the volumes of, low-level waste produced by nuclear power plants.[426]

The 1985 Act attempts to achieve its chief purpose—the development of new disposal sites—through a series of milestones. The milestones are designed to encourage all nonsited states to enter into compacts and to develop disposal sites within an interim period of ten years. Penalty surcharges are placed on the waste generated in states that fail to meet these milestones.[427] The penalties are in addition to surcharges paid by generators during the interim period.[428] Twenty-five percent of these non-penalty surcharges are rebated to states meeting the milestones.[429] The rebated money during the first four years of the interim period is paid to the pertinent compact commissions to assist in establishing new regional disposal sites; during the last three years it is paid to the states.[430] In addition, sited states are in some instances empowered to deny access to states or compact regions which have not met the milestones.[431] NRC, however, is authorized to grant emergency access to a generator "if necessary to eliminate an immediate and serious threat to the public health and safety or the common defense and security."[432]

The basic milestones are as follows:

1. By July 1, 1986, states must pass legislation indicating their intent to enter into compacts with other states or to have ratified compact

424. 94 Stat. 3347-48.

425. Section 5(b).

426. Section 5(c). The commercial reactor allocations are transferable within states or compact regions "for valuable consideration." Section 5(c)(4).

427. Section 5(e)(2)(A)(i), (B)(i), and (D). Whether the penalties will work to encourage the States to develop disposal sites is questionable since the penalities are losses to the generators, not to the States.

428. Section 5(d)(1).

429. Section 5(d)(2).

430. Section 5(d)(2)(B) and (D).

431. Section 5(e)(2)(A)(ii), (B)(ii), and (D).

432. Section 6.

legislation.[433] The mandatory surcharge in effect at all times during 1986-87 is $10 per cubic-foot.[434] A state missing the July 1 deadline is subject to an additional penalty surcharge of two times $10 per cubic-foot, or $20 per cubic-foot, through January 1, 1987.[435] After that date, the state may be denied access to waste disposal facilities.[436]

2. By January 1, 1988, compact regions must have selected a host state (the state which will have the disposal facility) or a developer and site.[437] The compact region or state must also have a siting plan, including procedures and a schedule for site selection, license application, and construction of the facility.[438] The mandatory surcharge during 1988-89 is $20 per cubic-foot.[439] The penalty surcharge for failure to meet the January 1, 1988, deadline is $40 per cubic-foot through July 1, 1988, and $80 per cubic-foot for July 1, 1988, through January 1, 1989.[440] After the latter date, states failing to comply may be denied access.[441]
3. By January 1, 1990, states are to have filed a "complete" application for a license with NRC or, alternatively, the governor of the state must certify that the state will be capable of providing for the storage, management of and disposal of low-level waste generated within the state.[442] The certification must include a description of how the state will provide for storage, management or disposal.[443] The mandatory surcharge during 1990-92 is $40 per cubic-foot.[444] No penalty surcharge is available for failure to meet this milestone; however, a defaulting state may be denied access.[445]
4. By January 1, 1992, all states must have filed a complete application for a license with NRC.[446] A penalty surcharge is applicable equal to three times the surcharge otherwise applicable, until the non-sited state complies.[447] Since the mandatory surcharge until the end of 1992 is $40,[448] the penalty surcharge is $120 per cubic-foot until January 1, 1993, and zero thereafter.

433. Section 5(e)(1)(A).
434. Section 5(d)(1)(A).
435. *Id.* (e)(2)(A)(i).
436. *Id.* (e)(2)(A)(ii).
437. Section 5(e)(1)(B)(i).
438. *Id.* (B)(i)-(iii).
439. *Id.* (d)(1)(A).
440. *Id.* (e)(2)(B)(i).
441. *Id.* (e)(2)(B)(ii).
442. Section 5(e)(1)(C).
443. *Id.* (e)(1)(C)(ii).
444. Section 5(d)(1)(C).
445. *Id.* 5(e)(2)(C).
446. Section 5(e)(1)(D).
447. *Id.* 5(e)(2)(D).
448. *Id.* 5(d)(1)(C).

5. By January 1, 1993, a state or compact region must be in a position to provide for the disposal of all waste generated within such state or compact region. If the state is unable to do so, one of two penalties are applicable: either (1) the state must take title to, and possession of, the waste and be liable for all direct and indirect damages incurred by the generator or owner of the waste due to any failure of the state to take possession, or (2) the state must rebate to the generator twenty-five percent of all surcharges collected by monthly payment over a thirty-six month period until the state is able to provide for disposal or until January 1, 1996, whichever is later.[449]
6. By January 1, 1996, each state either must provide for disposal of the waste or take title to, and possession of, the waste.[450] States failing to do so "shall be liable for all damages directly or indirectly incurred by [the waste] generator or owner as a consequence of the failure of the state to take possession of the waste as soon after January 1, 1996, as the generator or owner notifies the state that the waste is available for shipment."[451]

The 1985 Act does not expressly authorize compact regions to deny access to states which fail to meet the 1992 and 1993 deadlines. Thus, a recalcitrant state theoretically could force its generators to incur the increasingly stiff penalty surcharges (through January 1, 1993), accept title to the waste on or after that date, and (in reliance on the precedents barring state interference with interstate commerce in waste absent express congressional authorization) insist that sited states accept the waste for disposal.

If the 1985 amendments work, they will do so at a relatively high cost. The United States needs only a handful of low-level radioactive waste repositories; but under the 1985 Act, it is likely to end up with eight to ten sites. This proliferation of sites will result not only in the permanent commitment of unnecessarily large amounts of land to waste disposal but also in inefficient operations due to unnecessary duplication of efforts encompassing every aspect of the facility, from the initial planning stages all the way through facility stablization and long-term monitoring.[452] This inefficiency will almost certainly be compounded through the imposition by states of barriers to interstate commerce in waste disposal services under the 1985 Act. Indeed, the 1985 Act will likely be viewed by states

449. Section 5(d)(2)(C). The alternative of rebating a portion of the surcharge for up to three years is to provide a non-sited state with some time in which to develop an ability to assume possession of the waste produced by its generators while at the same time maintaining an incentive for the state to act. *See* 131 CONG. REC. S. 18,104 (daily ed. Dec. 19, 1985) (Senator Hart).

450. Section 5(d)(2)(C).

451. *Id.*

452. *See Low-Level Radioactive Waste Disposal*, *supra* note 378, at 226.

as authorizing the creation of regional radioactive waste disposal monopolies. Like other monopolies, these operations in the abstract would enjoy little (if any) incentive to hold down their costs, and if unregulated, might well be inclined to engage in monopoly pricing as well.

The whole anti-competitive nature of the 1985 Act (or, for that matter, its 1980 predecessor) has received little attention. The question of how state governments will deal with the anti-competitive features of the new waste disposal regime is yet to be determined. A number of approaches are available. All have drawbacks. One approach would entail ownership and operation of the disposal facility exclusively through a state government agency, in a fashion modelled after DOE's projected facility for disposal of high-level waste and spent nuclear fuel. This approach, however, does not really ensure cost- or price consciousness. Another approach would encompass government ownership of the facility, with private operation. This approach would resemble that adopted for many nuclear energy activities conducted by the DOE. Again, however, efficiency and price reduction is not assured. Yet another approach would involve private ownership with government regulation of cost-recovery and profit, similar to that of public utility regulation. However, public utility regulation historically has not been uniformly successful in controlling costs of nuclear facilities. Still another approach would have the facility owned and operated by its users—a kind of customer cooperative. This approach is more likely to result in an efficient operation, since the actual users (who have the greatest incentive to control costs and prices) would have direct influence over the policies of the disposal facility. However, state governments may be reluctant to transfer economic control over such a politically volatile activity to private users.

The new regime for low-level radioactive waste disposal may also be expected to spawn controversy in terms of what must be sent to the facility for disposal. On the one hand, in order to render the numerous new disposal facilities economically more attractive, there will be an impetus to decrease unit costs by increasing use. Some states or regions may accordingly try to force various generators of radioactive waste who currently do not employ low-level radioactive waste disposal facilities to use the new regional disposal sites. On the other hand, the increased expense of the likely inefficient disposal facilities created under the LLRWPA will probably result in increased efforts by users to minimize the amount of waste generated. Generators who cannot avoid the production of sizeable quantities of waste may seek alternative (and potentially unattractive) means of disposal, including dilution of the radioactive waste with nonradioactive material and subsequent release into the environment under NRC standards for unrestricted release, or under NRC standards for re-

lease to sanitary sewers. In addition, some licensees may seek permission for on-site disposal, or for disposal in specially created repositories. This would lead to an even greater proliferation of waste disposal sites. In short, there will be pressures both to increase the amount of waste going to the facilities and to decrease it. This tension may contribute to keeping the issue of low-level radioactive waste disposal in some degree of turmoil, despite the pages of statutory language which have been devoted to the subject.

G. Low-Level Defense Wastes

DOE is a major generator of low-level radioactive waste through its defense and research-and-development programs. Indeed, in 1985 the agency recently reported that it is generating about 90,000 cubic meters of low-level radioactive waste per year and that it has an inventory of 2,061,700 cubic meters of buried low-level radioactive waste.[453] DOE is in the process of planning a new low-level radioactive waste disposal facility at Oak Ridge, Tennessee.[454] In addition, DOE has five other major waste disposal facilities: Hanford Reservation (near Hanford, Washington); Idaho National Engineering Laboratory (near Idaho Falls, Idaho); Nevada Test Site (near Mercury, Nevada); Los Alamos National Laboratory (near Los Alamos, New Mexico); and Savannah River Plant (near Aiken, South Carolina).[455] In addition, DOE low-level radioactive waste has been buried in the past at National Lead facilities near Cincinatti, Ohio, and at DOE facilities near Paducah, Kentucky, and Portsmouth, Ohio.[456]

Disposal of low-level radioactive waste by DOE resulting from the agency's defense program is exempt from Atomic Energy Act licensing requirements,[457] and is thus unregulated by NRC. Similarly, DOE wastes are not subject to the Low-Level Radioactive Waste Policy Act or to interstate compacts entered into under that statute.[458]

Under Reorganization Plan No. 3 of 1970,[459] EPA enjoys authority to issue standards under the Atomic Energy Act to protect health and safety with respect to off-site emissions from DOE facilities attributable to low-level radioactive waste disposal. This authority is, however, unexercised

453. *DOE, Secretary's Annual Report to Congress* 170-71 (Dec. 1985).

454. *See DOE, Draft Environmental Impact Statement, Central Waste Disposal Facility for Low-Level Radioactive Waste, Oak Ridge Reservation* (Sept. 1984).

455. *Id.* at 2-4.

456. *Id.*

457. 10 C.F.R. § 61.3 (definition of "person" excludes DOE). *See also* 50 Fed. Reg. 45,736 (1985).

458. 42 U.S.C. § 2021d(b)(1)(A) & (b)(2).

459. 35 Fed. Reg. 15,623 (1970); 84 Stat. 2086.

as to DOE. Pursuant to a court order, EPA has issued standards for all DOE facilities, including low-level radioactive waste disposal facilities, under the Clean Air Act. These standards basically incorporate a variant of EPA's 40 C.F.R. § 190 uranium fuel cycle standard for all DOE operations.[460] Although EPA does not regulate Atomic Energy Act materials under the SWDA, at least some releases of Atomic Energy Act materials from DOE facilities are mixed with hazardous wastes to which EPA's SWDA regulations in general apply. In *Legal Environmental Assistance Foundation v. Hodel*,[461] the district court determined that DOE mixed wastes were not exempt from SWDA regulation. This ruling might result in some EPA regulation of DOE low-level radioactive waste disposal facilities. DOE, however, responded with a proposed rulemaking to define "by-product material" to include any material contaminated with the same.[462] If this gambit, which is opposed by NRC and EPA, is successful, the agency would presumably avoid SWDA regulation of its mixed waste.

V. SPENT NUCLEAR FUEL AND HIGH-LEVEL WASTE

Spent nuclear fuel is the intensely radioactive material withdrawn from the core of a nuclear reactor following irradiation but before constituent elements are separated by reprocessing.[463] Spent nuclear fuel contains hazardous concentrations of fission by-products such as cesium and strontium, as well as transuranics such as plutonium-239. Exposure to radiation from spent nuclear fuel, even for a short time, can be lethal. Spent nuclear fuel must accordingly be handled with great care. To make matters even more difficult, such material is thermally hot due to intense radioactive decay. It is therefore all the more difficult to handle. Spent nuclear fuel is generally solid in form.

Spent nuclear fuel is sometimes reprocessed in order to extract uranium and plutonium suitable for re-use as reactor fuel. High-level radioactive waste is the highly radioactive material resulting from the reprocessing of spent nuclear fuel.[464] It encompasses the intensely radioactive fission products which make up the major heat source in spent nuclear fuel. High-level radioactive waste may be either solid or liquid.

A. Standards for Disposal of Spent Nuclear Fuel and High-Level Waste

The dominant hazard presented by spent nuclear fuel for roughly its

460. *See supra* note 94 (the standards in general permit three times the level of exposure to individual organs permitted by § 190).

461. 586 F. Supp. 1163 (E.D. Tenn. 1984).

462. 50 Fed. Reg. 45,736 (1985).

463. *See, e.g.*, 42 U.S.C. § 10,101 (23).

464. *See, e.g., id.* (12).

first 1,000 years is radiation produced by fission by-products such as strontium and cesium. This radiation is intense and, in the earlier years, causes the spent nuclear fuel to be thermally hot. After approximately 500 to 1,000 years, the strontium and cesium have largely decayed. The dominant hazard at that point is alpha-emitters, such as plutonium-239 and residual uranium-238. If the spent nuclear material has been reprocessed to largely remove the re-usable uranium and plutonium, the remaining high-level waste after the lapse of a few centuries "begins", in the words of Dr. Mandel of Pacific Northwest Laboratory, "to resemble the radioactivity in a similar volume of average uranium ore . . . ."[465] If the alpha-emitters have not been removed by reprocessing, the waste is comparable to pitchblende, a highly concentrated but still naturally occurring uranium ore. Indeed, experts such as Dr. Mandel have argued that "after 500 years the hazard potential associated with radioactivity in the repository is actually lower than the chemical hazard potential associated with some naturally occurring ores."[466]

1. Assuming the Conclusion and Reaching None

The question of standards and requirements for disposal of spent nuclear fuel and high-level nuclear waste has received substantial attention only in the past several years. This is a reflection of many factors. First and foremost, until relatively recently the government paid virtually no attention to the development of institutional arrangements for waste management, including regulations and standards.[467] The government instead emphasized technologically-oriented policy goals. These basic goals were broadly stated in terms of containment and isolation of the waste from the biosphere. Moreover, as indicated in the statements of Dr. Mandel, spent nuclear fuel and high-level waste were widely viewed as no more problematic after the elapse of several centuries than uranium ore, or indeed, than many other naturally occurring nonradioactive ores. Because the problem of waste disposal was not viewed as technologically difficult, little was done to address it, and the technological goals of the program were therefore not elaborated.[468]

Second, most high-level waste was originally military in nature; its generation was directly associated with national security interests; and there was little legal or political opportunity to stir public controversy concerning its disposal. For example, under the terms of the Atomic

465. *Report of the Interagency Review Group on Nuclear Waste Management. Hearings Before the Energy, Nuclear Prolif. and Federal Services Subcomm. of the Senate Gov. Affairs Comm.*, 96th Cong., 1st Sess., 5 & 11 (1979).

466. *Id.* 5-6 & 11 (1979).

467. M. Willrich, et al., "Radioactive Waste Management Regulation" at 1-5 (Dec. 1976) (report prepared for ERDA) [hereinafter M. Willrich].

468. *Id.* 1-4 to 1-5.

Energy Act, facilities owned by, or operated under contract with and for the account of, the Commission, such as the facilities generating defense waste, were not required to have an Atomic Energy Act license.[469] In addition, it was anticipated that the repositories contemplated for nuclear waste would also be owned by the Commission and thus would not be subject to license requirements. As a result, there was little emphasis given to the problem of devising standards and requirements to govern the disposal of such material. Third, the National Environmental Policy Act [NEPA], whose environmental impact statement requirement[470] has tended to focus attention on environmental issues associated with a variety of activities, was not adopted until 1969. Fourth, the civilian nuclear power industry originally developed under the assumption that spent fuel would be reprocessed to extract re-useable uranium and plutonium. Under that assumption, high-level waste would be the only waste material and it would have been a responsibility of the reprocessing industry.

This situation began to shift in the late 1960s and early 1970s. First, more vocal opposition to nuclear power emerged. One of the focal points of opposition was the lack of provision for the safe disposal of nuclear waste.[471] This in fact resulted in state moratoria on new nuclear power plants.[472] Second, the federal regulatory picture also began to change. Reorganization Plan No. 3 of 1970,[473] which created EPA, vested the new agency with the authority of the Commission under the Atomic Energy Act to promulgate generally applicable standards for radiological safety in areas accessible to the general public.[474] EPA's new authority (if ever exercised) arguably embraced off-site emissions from previously unregulated Commission activities, including projected waste disposal facilities for both civilian and defense-related wastes. Even more significant, Congress in 1974 abolished the Atomic Energy Commission,[475] and in its stead established the Nuclear Regulatory Commission, to which was transferred the AEC's regulatory duties, and the Energy Research and Development Administration, to which was transferred the AEC's responsibilities to promote and to develop nuclear power. As part of the same statute, Congress amended the general exemption of Atomic Energy

469. 42 U.S.C. § 2140(a).

470. 42 U.S.C. § 4332(2)(C).

471. *See, e.g.*, J. Gofman & A. Tamplin, *Poisoned Power* 189-203 (1971).

472. *See generally* Murphy & La Pierre, *Nuclear "Moratorium" Legislation in the States and the Supremacy Clause: A Case of Express Pre-emption*, 76 COLUM. L. REV. 392 (1976) (cataloging a number of such moratoria and arguing that they are preempted). The Supreme Court has upheld state moratoria on new nuclear plants so long as the states assert that the reason for the prohibition is the economic uncertainty of waste disposal. *See* Pacific Gas and Electric Co. v. State Energy Resources Conservation & Development Comm'n, 461 U.S. 190 (1983).

473. 42 U.S.C.A. § 4321 note, 35 Fed. Reg. 15,623, 84 Stat. 2086.

474. *Id.*, § 2(b).

475. 42 U.S.C. § 5814(a).

Commission facilities from license requirements. In particular, Section 202 of the Energy Reorganization Act of 1974 provided that the new NRC would have licensing jurisdiction over:

> [F]acilities used primarily for the receipt and storage of high-level radioactive wastes resulting from activities licensed under [the Atomic Energy Act] [and] . . . Retrievable Surface Storage Facilities and other facilities authorized for the express purpose of subsequent long-term storage of high-level radioactive waste generated by the [Energy Research and Development] Administration, which are not used for, or are part of, research and development activities.[476]

The provision was basically intended to provide for NRC licensing of all disposal facilities for civilian high-level nuclear waste and for facilities (other than research and development facilities) employed for long-term disposal of military high-level nuclear waste.[477] This situation was further clarified by Section 8(b) of the Nuclear Waste Policy Act [NWPA], signed into law on January 7, 1983. That Act provided for the President to evaluate whether a defense-only repository was "required." If a separate repository was not required, defense wastes were to be disposed of in the civilian facilities provided under the NWPA. If a separate repository was required, disposal of defense-related high-level radioactive waste in that repository would escape NRC licensing only if the repository did not include high-level waste and was exclusively devoted to defense-related waste.[478]

The NWPA confirmed earlier assumptions of ultimate federal responsibility for spent fuel by requiring the Secretary of Energy to take title to spent nuclear fuel and high-level waste "following commencement of operation of a repository . . . as expeditiously as practicable upon the request of the generator or owner of such waste or spent-fuel."[479] The new statute also confirmed the regulatory authority of EPA and NRC. Consonant with Reorganization Plan No. 3, EPA was required to promulgate "generally applicable standards for protection of the general environment from off-site releases from radioactive material in repositories."[480] NRC was required to promulgate technical requirements and criteria governing construction, operation, and closure of such repositories.[481]

476. 42 U.S.C. § 5842(c) and (d). The provision did not require licensing of facilities employed by ERDA for short-term storage of wastes. *See* Natural Resources Defense Council v. NRC, 606 F.2d 1261 (D.C. Cir., 1979).

477. S. REP. NO. 93-980, *reprinted in* U.S. CODE CONG. & AD. NEWS, at 5,521 (1974).

478. 42 U.S.C. § 10,107(b) & (c).

479. 42 U.S.C. § 1022(a)(5)(A).

480. 42 U.S.C. § 10,141(a).

481. 42 U.S.C. § 10,141(b).

The NWPA gives essentially no guidance to the standards to be issued by EPA. The Act is little more informative as to NRC. The only direct constraints are that NRC's criteria are to "provide for the use of a system of multiple barriers in the design of the repository" and "shall include [appropriate] restrictions on the retrievability" of the waste.[482] In a Janus-like fashion, the Act undercuts the latter provision by providing that the repository shall be designed to permit retrieval of the waste for health, safety, environmental, or economic reasons for an appropriate time.[483] The Act also provides that the NRC requirements and criteria "shall not be inconsistent with any comparable [EPA] standards."

The chief guidance for both the EPA standards and NRC requirements and criteria applicable to disposal of high-level radioactive waste and spent nuclear fuel remains the Atomic Energy Act, which authorizes regulation to protect the public health and safety and to provide for national security.[484] The Supreme Court has treated the Atomic Energy Act as an extremely broad grant of authority to the AEC, and its successor, the NRC. In particular, the Court has accorded deference to the decisions of the Commission,[485] requiring only that the regulatory agency consider the relevant factors and articulate a rational connection between the facts and the choice made.[486] Presumably the same deference would apply to EPA when that agency prescribes standards under the Act.[487]

2. *EPA's Disposal Standards for Spent Nuclear Fuel, High-Level Waste, and Transuranic Material*

Although the establishment of detailed requirements seems premature in the absence of standards, such is expressly permitted under the NWPA, and NRC was first off the mark with its requirements for high-level waste repositories. NRC's requirements for high-level waste repositories are codified in 10 C.F.R. §60. The bulk of the requirements call for DOE to furnish information for NRC to consider and specify factors to which the Commission will look in evaluating a DOE repository license application. Such provisions provide no guidance on how various factors are to be weighed, if they are to be weighed at all. In terms of actual health

482. *Id.* § 10,141(b)(1)(B).

483. *Id.* § 10,142.

484. *See, e.g.*, 42 U.S.C. § 2201(b) and (p).

485. Power Reactor Development Co. v. International Union of Elec., Radio and Mach. Workers, AFL-CIO, 367 U.S. 396 (1961).

486. Baltimore Gas and Elec. Co. v. NRDC, 462 U.S. 86, 105 (1983).

487. Since EPA does not regulate nuclear energy facilities directly, it arguably lacks some of the expertise of the Commission in that area, which expertise is the presumed grounds for deference. On the other hand, EPA arguably possesses the kind of expertise in health-related issues which the standard setting function demands.

and safety requirements the NRC regulations basically punt, in that they repeatedly incorporate by reference the EPA standards,[488] which at that time had not yet been promulgated. The NRC regulations do provide a few specific requirements, subject however to modification by the Commission on a case-by-case basis. The NRC specific standards included requirements that containment of waste within packages shall be "substantially complete" for at least 300 years;[489] that the release rate of radionuclides shall generally be no greater than 1 in 100,000 of the inventory per year for the first 1,000 years;[490] and that the fastest travel time of a radionuclide from the disturbed zone to the "accessible environment" shall be at least 1,000 years.[491]

EPA published proposed standards for high-level waste, spent nuclear fuel, and transuranic waste (defined as waste containing greater than 100 nCi/gram transuranic material) in late 1982.[492] The proposed standard to govern actual operations of the repository is basically an extension of EPA's 40 C.F.R. § 190. Part 190 limits the annual dose equivalent to maximally exposed members of the public from planned releases (except radon and its daughters) from all nuclear fuel cycle operations (except mining and waste disposal) to 25 mrem to the whole body or to critical organs (except the thyroid for which a 75 mrem limit is prescribed).[493] Simplifying somewhat, EPA in essence proposed to include high-level waste and spent nuclear fuel disposal into § 190.

The agency's proposed standard after closure of the repository was quite different. EPA's post-closure proposal was to limit release of certain radionuclides for a period of 10,000 years.[494] According to the agency, the specified release rates were calculated to limit adverse health effects to 0.1 person per year for "over 10,000 years"[495] for a repository capable of holding all the wastes expected to be generated during the life-time of operation of approximately 100 reactors of the current design.[496] A repository of that size would be sufficiently large to contain virtually all civilian high-level waste and spent nuclear fuel expected to be generated in the United States. EPA indicated that under this approach, the residual risk to future generations would be "no greater than the risks from an

488. 10 C.F.R. § 60.111(a), 60.112, 60.113(b)(1).
489. 10 C.F.R. § 60.113(a)(1)(ii)(A).
490. *Id.* § 60.113(a)(1)(ii)(B).
491. *Id.* § 60.113(a)(2).
492. 47 Fed. Reg. 58,196 (1982).
493. *Id.* proposing § 191.03.
494. *Id.* 58,205, proposing § 191.13.
495. 47 Fed. Reg. 58,200.
496. *Id.* 58,199.

equivalent amount of unmined uranium ore."[497] The EPA proposal also prescribed several "assurance requirements" to provide "confidence" in waste containment. These included reliance on multiple barriers, use of permanent markers, and several other features or control techniques.[498]

EPA's final regulations issued in 1985 were a somewhat modified version of the proposal. The final regulation applied a weakened version of the twenty-five mrem dose equivalent limitation.[499] For example, maximum organ exposures were all moved to seventy-five mrem, in effect tripling allowable exposures. Although the final regulation also called for control of releases of specified radionuclides for 10,000 years,[500] the release rates applicable to some of the radionuclides were altered. The agency nevertheless indicated that it did not intend to change the basic level of protection manifest in its proposed regulations.[501] EPA's final regulation on "assurance requirements" excluded facilities regulated by the Commission under 10 C.F.R. § 60. This impliedly approves the Commission's regulations for the projected civilian high-level waste facilities as providing adequate assurance.

EPA's final regulation added two new standards not previously proposed by the agency. The first standard required the disposal system to be designed to provide a reasonable expectation that the maximum annual dose equivalent to any individual member of the public in the "accessible environment" shall not exceed twenty-five mrem to the whole body or seventy-five mrem to any critical organ "for 1,000 years after disposal."[502] The second standard limits contamination of specified potential drinking water aquifers for 1,000 years after disposal. The limits are (1) 5 pCi/liter radium-226 and radium-228, (2) 15 pCi/liter for alpha-emitters including radium but excluding radon, and (3) combined concentrations of beta- and gamma-emitters such that the annual dose equivalent to the total body or any organ is no greater than four mrem.[503]

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497. *Id.* Comparison to "unmined uranium ore" is somewhat ambigous. Spent nuclear fuel contains a large percentage of uranium-238. Unless that uranium is recovered through reprocessing, the only "unmined uranium ore" to which the spent fuel will ever be comparable is pitchblende, which represents a potential radiation hazard. *Cf.* M. Willrich, *supra* note 467, at 2-9.

498. 48 Fed. Reg. 58,205, proposing § 191.14.

499. 48 Fed. Reg. 38,085 (1985), promulgating 40 C.F.R. § 191.03.

500. *Id.* 38,086, promulgating *id.* § 191.13. EPA's 10,000-year standard notes, however, that:

> . . . because of the long period involved and the nature of the events and processes of interest, there will inevitably be substantial uncertainties in projecting disposal system performance. Proof of the future performance of a disposal system is not to be had in the ordinary sense of the word in situations that deal with much shorter time frames. Instead, what is required is a reasonable explanation, on the basis of the record before the implementing agency, that compliance . . . will be achieved.

40 C.F.R. § 191.13(b).

501. 48 Fed. Reg. 38,075.

502. 50 Fed. Reg. 38,086, promulgating 40 C.F.R. § 191.15.

503. 50 Fed. Reg. 38,087, promulgating 40 C.F.R. § 191.16.

The EPA standards have been criticized on a variety of grounds, including (a) the lack of a specific requirement that doses be reduced "as low as reasonably achievable" [ALARA], (b) the fact that the final standards allegedly increase allowable releases to the accessible environment and the allowable doses to the general public and workers, (c) the belief that groundwater protection requirements are unduly weak, and (d) the view that the criteria for variances from the standards are unduly relaxed.[504] Four states and three private organizations sought judicial review of the agency's standards, and all petitions for review have now been consolidated in the First Circuit.[505]

3. The EPA Standards and the Safe Drinking Water Act

The chief argument[506] directed against the EPA standards in the First Circuit litigation is that they violate the Safe Drinking Water Act [SDWA].[507] The SDWA regulates, among other things, underground injections. This term is broad enough to encompass underground nuclear waste repositories. EPA's underground injection control [UIC] regulations define underground injection to mean "well injection", which in turn is defined to mean "the subsurface emplacement of 'fluids' through a bored, drilled, or driven 'well'; or through a dug well, where the depth of the dug well is greater than the largest surface dimension."[508] EPA's regulations also define a "well" to mean any "bored, drilled, or driven shaft, or a dug hole, when depth is greater than the largest surface dimension."[509]

The contemplated repository for spent nuclear fuel and high-level waste readily fits the definition of "well," since the depth of the repository (at least 300 meters) will be greater than the largest surface dimension. Since the SDWA covers "radioactive" contaminants,[510] and since radioactive material regulated under the Atomic Energy Act is not exempt from the UIC portion of the SDWA,[511] the disposal of such waste in a repository

504. *Mission Plan for the Civilian Radioactive Waste Management Program, Hearing Before the Energy Resources & Dev. Subcomm. of the Senate Energy & Nat. Resource Comm.*, [hereinafter *Mission Plan Hearing*]. 99th Cong., 1st Sess., at 137 (1985) (testimony on behalf of the State of Minnesota). EPA's final standards permit alternative standards to be employed but only after notice and an opportunity for comment. 50 Fed. Reg. 38,087, promulgating 40 C.F.R. § 191.17.

505. Natural Resources Defense Council v. EPA, C.A. No. 85-1915, et al. (1st Cir.). Petitioners included the Conservation Law Institute of New England, the Environmental Policy Institute, and the States of Maine, Vermont, Minnesota and Texas.

506. Brief for NRDC, at 15 in NRDC v. EPA, C.A. No. 85-1915 (1st Cir.) filed Mar. 27, 1986 [hereinafter NRDC Brief].

507. 42 U.S.C. § 300f.

508. 40 C.F.R. § 144.3.

509. *Id.*

510. 42 U.S.C. § 300f(6) (definition of "contaminants").

511. The House Report accompanying the SDWA states that the statutory definition would "of course . . . include any radioactive materials whether or not they originated from any source under the jurisdiction of the Atomic Energy Act." H.R. REP. NO. 118-5, 93rd Cong., 1st Sess., *reprinted in* U.S. CODE CONG. & AD. NEWS, at 6454, 6469 (1974).

constitutes underground injection subject to the SDWA if spent fuel and high-level waste fall within the definition of "fluid."[512] Fluid is defined as "any material or substance which flows or moves whether in a semi-solid, liquid, sludge, gas, or any other form or state."[513] EPA's § 191 regulations anticipate that radionuclides in the waste stored in a repository will "flow" after disposal. Indeed, as NRDC notes in its Brief, EPA expressly states in the preamble to § 191 that its standards are designed to "apply to radionuclides that are projected to move into the 'accessible environment' . . . after disposal."[514] The UIC regulatory program under the SDWA thus arguably applies to the disposal of spent nuclear fuel and highlevel waste in an underground repository. The fact that the disposal facility is constructed and operated by a federal agency [DOE] is irrelevant. The SDWA by its terms unquestionably applies to any federal agency "engaged in any activity resulting, or which may result in, underground injection which endangers drinking water. . . ."[515]

Given the applicability of the SDWA program to the repository, the next question is what constraints follow. The SDWA prohibits the "endangerment" of aquifers by underground injection. The Act broadly defines endangerment to mean "the presence in underground water which supplies, or reasonably can be expected to supply any public water system, of any contaminant" if the presence of the contaminant may result in non-compliance "with any national primary drinking water regulation or may otherwise adversely affect the health of persons."[516]

Under the risk projections of the linear non-threshold model,[517] any amount of any radioactive contaminants in drinking water "may . . . adversely affect the health of persons." This would mean that any radioactive contamination which may affect drinking water is barred by the SDWA. Put another way, in a fashion even more forceful than that employed by Section 112 of the Clean Air Act with respect to hazardous air pollutants, the SDWA in effect states a nondegradation policy with respect to potential carcinogens. This would seem to preclude the "underground injection" (that is, placement in a mined repository) of spent nuclear fuel and high-level nuclear waste if there is any impact on drinking water. The SDWA thus throws into question not only EPA's standards but also

512. Spent nuclear fuel and high-level waste will most likely be placed in the repository in a solidified, encapsulated form. However, the UIC regulations view waste as "fluid" if it "flows" or "moves" and does not condition the concept on matter being in a liquid or gaseous state.

513. 40 C.F.R. § 144.3.

514. NRDC Brief, *supra* note 506, at 20, quoting 50 Fed. Reg. 38,071.

515. 42 U.S.C. § 300j-6(ii).

516. 42 U.S.C. § 300h(d)(2).

517. There seems little doubt that such projections satisfy the statutory intent for what kind of showing is sufficient to indicate that a contaminant "may adversely affect health." *See* Env. Defense Fund v. Costle, 578 F.2d 337, 343-44 (D.C. Cir. 1978).

the entire federal program to develop a mined repository for nuclear waste.

This syllogism, however, is not as simple as the face of the statute seems to indicate. The apparent bar manifest in the SDWA against possible adverse health effects from any contaminants is modified by EPA's regulations implementing the agency's UIC program.

EPA's UIC regulations divide injection wells into five classes. Two of these are relevant here: Classes IV and V. Class IV wells are "wells used by generators of hazardous waste or of radioactive waste . . . to dispose of hazardous waste or radioactive waste into [or above] a formation" which within one-quarter mile of the well contains an underground source of drinking water.[518] EPA has banned any new Class IV wells.[519] If a repository constitutes a Class IV well, it is therefore banned. This would mean that there is a clear inconsistency between EPA's new high-level waste disposal standards and the SDWA. This issue obviously warrants more detailed inquiry.

The starting point to evaluate this question is the definitions given for the various terms employed in the description of Class IV wells. "Hazardous waste" is defined in accordance with EPA's Solid Waste Disposal Act regulations, which currently do not encompass any radioactive waste.[520] Even if they did, the Solid Waste Disposal Act could not define hazardous waste to include Atomic Energy Act materials, such as spent nuclear fuel, because such materials are excluded by statute from the definition of hazardous waste. EPA's UIC regulations, however, define "radioactive waste" as "any waste which contains radioactive material in concentrations which exceed NRC's standards for release into unrestricted areas are listed in 10 C.F.R. §20, Appendix B, Table II, Column 2."[521] Spent nuclear fuel and high-level waste readily meet this definition of "radioactive waste" and will continue to do so essentially in perpetuity. Thus, the proposed nuclear waste repository deals with precisely the same kind of material as do Class IV wells.

The next question concerns the term "underground source of drinking water." This term is defined in the UIC regulations to mean any aquifer (other than an "exempted aquifer"), which either (a) supplies a public water system[522] or (b) contains sufficient water to supply such a system and is currently supplying water for human consumption or contains fewer

518. 40 C.F.R. § 144.6(d) (emphasis added).
519. 40 C.F.R. § 144.13(a)(1).
520. 40 C.F.R. § 144.3.
521. *Id.*
522. A public water system is defined to include any system for the provision of piped water for human consumption if it has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. 42 U.S.C. §300f(4). *See also* 40 C.F.R. § 142.2(k).

than 10,000 mg/liter total dissolved solids."[523] In short, an underground high-level waste repository would appear to be a Class IV well if it resulted in the placement of nuclear waste into or above a formation which, within one-quarter mile, contains sufficient water with less than 10,000 mg/liter total dissolved solids to supply a public drinking-water system.

In contrast, EPA's § 191 standards protect only "special sources of drinking water."[524] These are sources (a) within five miles of the repository, (b) actually serving "thousands of persons," and (c) which are "irreplaceable."[525] This could clearly permit the construction of a repository over or into "underground sources of drinking water" protected under the agency's UIC program from Class IV injection wells, and indeed could permit actual contamination of aquifers protected by EPA's UIC regulations. To the extent that the new EPA standards permit radioactive waste to be placed into or above such formations, they are inconsistent with the agency's UIC regulations, unless the aquifer in question has been exempted from protection. The exemption provision is too narrowly drawn to afford much solace to EPA for purposes of a nuclear waste repository.[526]

If the projected nuclear waste repository is not constructed over or into a formation bearing an underground source of drinking water, it is not a Class IV well but something else. That "something else" is easy to determine. EPA has specifically provided that all "radioactive waste disposal wells other than Class IV" are included in Class V.[527] Class V requirements are applicable to the projected repository so long as it is not covered by the ban on Class IV wells.[528]

523. *Id.* For comparison purposes, ocean water is approximately 30,000 mg/liter total dissolved solids. Thus the SDWA protects any water which is less than one-third as "salty" as the ocean. No one would drink such water absent treatment. Most drinking water has less than 1000 mg/liter total dissolved solids.

524. 40 C.F.R. § 191.16(a).

525. 40 C.F.R. § 191.12(o).

526. Under 40 C.F.R. § 144.7, the criteria for exempt aquifers are set forth in 40 C.F.R. § 146.4. Insofar as germane here, in order to qualify as an exempt aquifer, an aquifer (a) must not currently serve as a source of drinking water, and (b) cannot now and will not in the future serve as such a source because of mineral or energy producing activities; or economic, or technological impracticability. 40 C.F.R. § 146.4(a), and (b)(1), and (2). It is unlikely that an aquifer utilized by a repository would qualify for an exemption under this formula. Alternatively, EPA's UIC regulations provide that a qualifying aquifer must contain more than 3,000 mg/liter total dissolved solids and be "not reasonably expected to supply a public water system." Conceivably a repository-utilized aquifer might qualify for an exemption under this test. The EPA Nuclear Waste Policy Act standards, however, permit contamination of aquifers which would not qualify for an exemption under 40 C.F.R. § 146.4. It is also noteworthy that if radioactive waste were classified as hazardous waste, the ban on injection into or above aquifers would apply even if the aquifer were exempt, because EPA defines Class IV wells to include wells injecting "hazardous waste" into or above exempt aquifers. 40 C.F.R. § 144.6(d)(3).

527. *See* 40 C.F.R. § 146.6(11).

528. But for EPA's express inclusion in Class V of radioactive waste disposal wells other than Class IV, the Class I category might be relevant. Class I wells are defined as wells injecting hazardous

The general requirements applicable to Class V injection wells are relatively limited. As is the case for any underground injection, a Class V well is prohibited unless authorized by permit or rule under the UIC program.[529] EPA's UIC program does not require a specific permit for a Class V well, although EPA reserves authority to do so on a case-by-case basis.[530] Instead, Class V wells are the least regulated category in EPA's UIC program. The agency provides that injection into Class V wells is authorized until further requirements under future regulations become applicable.[531] In essence, Class V wells are currently permitted by regulation, subject to generally applicable requirements. The chief substantive requirement, which is in reality applicable to all classes of injection wells, is that no Class V injection well "allow . . . the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 C.F.R § 142 or may otherwise adversely affect the health of persons."[532]

This brings us in a full circle back to the drinking water standards and the question whether the SDWA requires non-degradation. The primary drinking water standards for alpha-emitters are 5 pCi/liter for combined radium-226 and radium-228 and 15 pCi/liter for gross alpha activity, including radium-226 but excluding radon and uranium.[533] The basic standard for beta and gamma radioactivity is cast in terms of "man-made" radionuclides, and specifies that the annual dose equivalent to the total body or any internal organ from such radionuclides shall be no greater than 4 mrem.[534] EPA's § 191 is in some ways more stringent than the drinking water standards (EPA's waste standard, for example, does not exclude uranium from the 15 pCi/liter limit on gross alpha activity, nor does it restrict the four mrem limit to man-made radionuclides). On the other hand, § 191 is arguably less stringent in several important ways.

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waste "beneath the lowermost formation containing, within one-quarter mile of the well bore, an underground source of drinking water" or, alternatively, "other industrial and municipal disposal wells which inject fluids beneath the lowermost formation containing, within one-quarter mile of the well bore, an underground source of drinking water." 40 C.F.R. § 144.6(a). Although EPA's regulations do not define the term "industrial disposal well," the projected nuclear waste repository on its face seems to fall within the plain meaning of the term, since it will dispose of industrial waste. Thus, to the extent the repository results in injection of wastes beneath a formation containing, within one-quarter mile, an underground source of drinking water, it would arguably be a Class I well for purposes of EPA's UIC program if it is not Class V. Class I wells are not banned, but there are detailed requirements applicable to their construction and monitoring. *See* 40 C.F.R. § 146.12.

529. 40 C.F.R. § 144.11.
530. *Id.* § 144.25(a)
531. *Id.* § 144.24.
532. *Id.* § 144.12.
533. *Id.* § 144.12.
534. *Id.* § 141.16.

For example, it only applies for 1,000 years, whereas the primary drinking water standard is indefinite. Moreover, § 191 applies only to certain special sources of drinking water, whereas any "underground source of drinking water" is protected by EPA's UIC program, unless it is an "exempt aquifer."

The non-degradation interpretation of the SDWA is an even greater challenge to EPA's § 191. Arguably any additional exposure to radionuclides "may otherwise adversely affect the health of persons," notwithstanding the possible compliance with the primary drinking water standards. If the SDWA were interpreted to establish such a non-degradation requirement, any high-level waste repository would arguably be forever banned, unless DOE could find some location free of aquifers. However, the drinking water regulations themselves envision some "man-made" contamination.[535] This could be read to suggest the acceptance of some degradation, so long as it is within standards. In any event, it seems unlikely that the UIC program will be construed to ban *de minimis* levels of contamination so long as they do not result in an infraction of specific radioactivity standards embodied in the primary drinking water standards. If this is so, EPA's § 191 standards are problematic under the Class V well provision of the SDWA not so much because they permit some degradation but because they expressly impose a time limit on the applicability of numerical limits on the amount of drinking water degradation which they would permit due to a repository. The standards would also be problematic because they do not provide for protection of all "underground sources of drinking water," or at least all those not qualifying for an exemption under the SDWA.

The analysis thus far has focused on the minimum requirements applicable to underground injection embodied in EPA's federal UIC regulatory program. States may apply to EPA for approval to conduct their own programs. Indeed, such state regulation of DOE facilities is specifically envisioned in Section 1447 of the SDWA.[536] Under both the SDWA and EPA's regulation, a state may adopt or enforce requirements which are more stringent or more extensive than that required by EPA.[537] A state which is a candidate site for a nuclear waste repository could accordingly regulate DOE's conduct in constructing and operating a repository simply by adopting an appropriately designed state UIC program. State regulation of a DOE waste repository under a UIC program could be more stringent than either EPA's § 191 standards or EPA's UIC regulations. Presumably the only constraints are (1) that the state program must comply with

535. *Id.*
536. 42 U.S.C. § 300j-6(a).
537. 42 U.S.C. § 300h-2(a); 40 C.F.R. § 145.1(g).

whatever state equivalent exists to the federal Administrative Procedure Act requirements for procedural and substantive validity of the state regulation, and (2) that the state regulation (for example, an outright ban on the repository) not be subject to a constitutional flaw, such as an undue burden on interstate commerce or an undue interference with an otherwise lawful activity.[538]

B. Solutions to the Problem of Siting Nuclear Waste Repositories under the Nuclear Waste Policy Act

After four years of travail, Congress in December 1982 sent to the President the Nuclear Waste Policy Act [NWPA] which he signed on January 7, 1983.[539] That statute was widely billed as a "road-map" to assure the timely availability of facilities for the disposal of spent nuclear fuel and high-level waste.[540] It is an expensive roadmap. DOE estimates that the total cost of the program over a fifty year period will be $20 billion.[541] Other estimates suggest that that amount will cover the cost of only one of the program's envisioned two repositories.[542]

Federal authorities have long viewed a mined geologic repository as the preferred solution for disposal of high-level waste and spent nuclear fuel.[543] President Carter so declared in 1980[544] and DOE in fact issued a

538. For example, in People of the State of Illinois v. General Electric Co., 683 F.2d 206 (7th Cir. 1982), the court invalidated a ban on importation of spent nuclear fuel into the state for storage. The court explained that, "to pass laws that arbitrarily burden interstate commerce by forbidding shipments merely because they originate out of state violates the commerce clause . . . and it is irrelevant that the traffic is in 'bads' rather than in goods." 683 F.2d at 213. The court rejected Illinois' contention that it enjoyed such plenary power under the Clean Air Act: "We cannot believe that Congress in promulgating the Clean Air Act Amendments meant the states to have carte blanche to enact any statutes, and to promulgate any regulation, that might as a side-effect reduce the level of radioactive emissions . . . , regardless of how much the statute or regulation disrupted the federal atomic energy program, which includes . . . a program for disposing of nuclear wastes." *Id.* 216. *See also* Washington State Bldg & Const. Trades Union v. Spellman, 684 F.2d 627 (9th Cir. 1982), *cert. denied*, 103 S.Ct. 1891 (1983).

539. 42 U.S.C. §§ 10,101-10,226 (1982).

540. *See, e.g.*, H.R. REP. No. 491, § I, 97th Cong., 2d Sess. 47 (1982); 128 CONG. REC. H 8165 (daily ed. Sept. 30, 1982).

541. *See Department of Energy Authorization for Fiscal Years 1986 and 1987 Before the Energy and Env. Subcomm. of the House Interior and Insular Affairs Comm.*, 99th Cong., 1st Sess. 2 (1982) (GAO statement).

542. *See, e.g.*, Memorandum from Staff to Members, Subcomm. on Energy Cons. and Power, House Energy and Commerce Comm., Apr. 17, 1986, at 4 ($15 to $30 billion per repository) [hereinafter Memorandum from Subcomm. Staff to Members].

543. *See* M. Willrich, *supra* note 467, at 1-6 and *passim*. Some alternatives to mined geologic disposal include the following: geologic disposal using conventional mining techniques, placement in sediment beneath the deep ocean, disposal in very deep holes, disposal by injection of liquid waste into underground cavities, geologic disposal on islands, disposal by melting into continental ice sheets, injection into porous strata beneath the earth's surface, transmutation in reactors and disposal by rocket transport into space. 46 Fed. Reg. 26,677 (1981).

544. II DOE, FINAL ENV. IMPACT STATEMENT, WASTE ISOLATION PILOT PLANT, App. C., at C-3 (Oct., 1980) [hereinafter WIPP EIS].

"record of decision" in this regard in 1981.[545] The NWPA embraces this approach. The statute sets a deadline for the construction of a mined geologic repository such that it will begin receiving waste for disposal by January 31, 1998.[546] Moreover, the statute provides that the environmental impact statement for the initial repository need not consider alternative disposal technologies.[547] However, as Mr. Rusche, the Director of DOE's Office of Civilian Radioactive Waste Management, has nevertheless observed "this program is controversial. There are, indeed, many constituencies with widely varying views of how, when and whether elements of the program should be carried out . . . . Contingency plans, therefore, must be considered."[548]

The NWPA in fact does provide several "contingency plans." For example, the Act envisions the possible construction of a Monitored Retrievable Storage [MRS] facility. If the first mined geologic repository is unavailable in a timely manner, the MRS facility could accept waste material until the first repository is operational, or, if that repository is not constructed, until the "second" repository envisioned by the Act is operational. Moreover, if an MRS has not been approved by Congress or is not operational when needed, utilities may continue to employ on-site storage capacity. In addition, the NWPA authorizes DOE to provide up to 1,900 metric tons of interim storage for utilities which run out of storage space prior to the availability of an MRS or repository.

According to Mr. Rusche, this exhausts the options available to DOE and, "should no repository be constructed and an MRS facility not be approved . . . the Nation would return to the situation where it had no viable assured method for the permanent disposal of spent-fuel and high-level waste."[549] The situation is in reality not so limited, for DOE as a practical matter has in effect retained one major additional fallback position. This position is totally outside the provisions of NWPA: it is the Waste Isolation Pilot Plant [WIPP] facility located near Carlsbad, New Mexico. Before turning to the complex regime established by the NWPA for the siting and construction of two repositories and possibly an MRS, it is appropriate to take a detour from the NWPA for a visit to the WIPP facility in New Mexico.

545. 46 Fed. Reg. 26,677 (1981).

546. *Mission Plan Hearings, supra* note 504, at 27 (statement of DOE).

547. 42 U.S.C. § 10,134(f).

548. *Mission Plan Hearings, supra* note 504, at 32.

549. *Mission Plan Hearings, supra* note 504, at 34. DOE also may develop a civilian facility for research and development for waste disposal pursuant to the streamlined provisions of §§ 211-21 of NWPA. 42 U.S.C. § 10,191-10,201. This facility might later be expanded into repository.

1. WIPP

DOE's WIPP facility is located in bedded salt formations in southeastern New Mexico. Attention has been focused on this area as a potential repository site since at least 1974.[550] WIPP's role in the nuclear waste disposal puzzle has taken several twists and turns since the inception of the project. The WIPP facility was originally envisioned for disposal of defense-generated transuranic wastes and as a research and development project to demonstrate the safe disposal of high-level waste and up to 1,000 spent-fuel canisters.[551] Because WIPP was billed as defense-related (or to the extent civilian-related) as a research and development facility, it did not fall under the requirement of the Energy Reorganization Act of 1974 that it be constructed and operated under an NRC license.

President Ford in 1976 directed that "the first demonstration depository for high-level wastes . . . be submitted for licensing by the independent NRC. . . ."[552] In an evident effort to avoid licensing but to conform to President Ford's policy, the mission of WIPP shifted toward use only for transuranic material. President Carter in February of 1980 announced a policy in favor of licensing "all repositories for highly radioactive waste" and "that they accept both defense and commerical wastes."[553] He accordingly announced a decision that the WIPP project "shall be cancelled," but he instructed that the WIPP site continue to be evaluated along with other sites for the Nation's first waste repository.[554] Congress nevertheless continued to authorize and appropriate funds for WIPP; a final environmental impact statement was issued in the same year President Carter thought he cancelled the project; DOE announced a decision to proceed with construction in 1981;[555] and construction got underway.[556] The facility is now largely completed and may be ready to begin receiving transuranic waste for disposal and spent fuel for research on disposal by 1988.[557]

The basic authority under which DOE is constructing WIPP is the

550. *Report of the Interagency Review Group on Nuclear Waste Management, Hearings Before the Energy, Nuclear Proliferation and Fed. Services Subcomm. of the Govt. Affairs Comm.*, 96th Cong., 1st Sess. at 154 (1979).

551. *Id.*

552. M. Willrich, *supra* note 467, at 4-11.

553. President Carter's Message to Congress, Feb. 12, 1980, *reprinted in* WIPP EIS *supra* note 544, at C-3.

554. *Id.*

555. The EIS indicated that the "authorized alternative" was to construct a defense transuranic waste facility although the "preferred alternative" was to dispose of defense transuranic wastes in a civilian high-level waste repository. *See* WIPP EIS, *supra* note 553, at 3-16.

556. DOE, SECRETARY'S ANNUAL REPORT TO CONGRESS 103-04 (Sept. 1983).

557. DOE, SECRETARY'S ANNUAL REPORT TO CONGRESS 173-74 (Dec. 1985).

Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980.[558] Section 213(a) of that Act requires the Secretary of Energy to "proceed" with the WIPP facility "to demonstrate the safe disposal of radioactive wastes resulting from the defense activities and programs of the United States exempted from regulation by the Nuclear Regulatory Commission."[559] Section 213 (b)(1) requires DOE to consult with the State of New Mexico with respect to health and safety concerns of the project, and to give consideration of those concerns "consistent" with the purpose of the facility.[560] The Act further provides for a written agreement with the state.[561] Finally, the Act provides a relatively unique shield against subsequent statutory enactments. It expressly states that no law enacted subsequent to it shall be construed to amend, supercede, or modify Section 213 "unless such law does so by specifically and explicitly amending, repealing, or superceding this section."[562]

The written agreement called for by Section 213 was fulfilled in conjunction with a Stipulated Agreement in *State of New Mexico ex rel. Bingaman v. United States Department of Energy*.[563] The Stipulated Agreement, which was filed under a court order, provides for the transfer of information by DOE and for various other actions by DOE for the benefit of New Mexico. The Stipulated Agreement was signed at the same time that DOE and New Mexico signed an "Agreement of Consultation and Cooperation." The latter Agreement allowed the state to conduct "reasonable independent monitoring and testing of on-site activities"[564] and provided for a "conflict resolution officer" to resolve disputes.[565]

DOE subsequently entered into a "Supplemental Stipulated Agreement Resolving Certain State Off-Site Concerns over WIPP." The Supplemental Stipulated Agreement clarified the application of the federal indemnifi-

558. P.L. 96-164, 93 Stat. 1259 (Dec. 29, 1979). *See* DOE, SECRETARY'S ANNUAL REPORT TO CONGRESS 174 (Dec. 1985):

> WIPP's mission—to demonstrate transuranic waste disposal and to conduct experiments with defense high-level waste—is consistent with the Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980, its Conference Report . . . , and subsequent budget authorization legislation. The WIPP facility is not being designed for the permanent disposal of high-level waste, nor has the site been characterized for such permanent disposal.

559. 93 Stat. 1265.

560. 93 Stat. 1265-66.

561. Section 213(b)(3), 93 Stat. 1266. The prescribed agreement shall, in general, not be effective except after 45 days of review by the Armed Services Committee of the House and Senate.

562. Section 213(c), 93 Stat. 1266.

563. *See* Order filed July 1, 1981, State of New Mexico *ex rel* Bingaman v. United States Department of Energy, D.N.Mex. C.A. No. 81-0363 (JB).

564. Agreement for Consultation and Cooperation, by Gov. King and Sec. Edwards, 1981, art. VIII.C.

565. *Id.*, art. IX. The state did not, however, waive rights to judical review. *Id.*, art. IX.N.

cation provisions of the Price-Anderson Act to WIPP, provided for DOE cooperation and back-up financial assistance with respect to state emergency planning costs, provided for DOE cooperation and financial assistance with respect to transportation and environmental monitoring and for DOE to pay for certain transportation improvements, if necessary. The Supplemental Stipulated Agreement provided that it and the previous July 1, 1981 document, settled the State's WIPP litigation and "are binding contractual agreements the compliance with which is subject to the appropriate oversight jurisdiction of [the District] Court."[566] The state and DOE have subsequently entered into a "First Modification" of the "Agreement for Consultation and Cooperation" (but not the Stipulated Agreements) on WIPP.[567] The Modification expressly noted that WIPP was intended for permanent disposal of defense transuranic waste and temporary storage of high-level defense waste. It also limited the volume of 100 rem/hour transuranic waste which could be disposed at the facility and barred disposal of waste exceeding 1,000 rem/hour.[568]

Although the NWPA does not specifically override WIPP's authorizing statute, it places some further constraints on the project and further erodes its rationale. First, under Section 8(c) of the NWPA, in order to continue to avoid the procedural regime applicable to civilian spent nuclear fuel, the facility must be used "exclusively for the disposal of high-level radioactive waste or spent nuclear fuel resulting from atomic energy defense activities, research and development activities of the Secretary, or both."[569] This on its face does not pose a problem for the facility, because DOE had much earlier entered into a memorandum of understanding with the state of New Mexico restricting WIPP solely to defense wastes.[570] However, President Reagan, like President Carter before him, has recently determined that a separate defense-related repository for high-level waste and spent nuclear fuel is not required.[571] Under the terms of the NWPA, this means that defense-related wastes in general will be disposed in an NRC-licensed facility. This in turn casts a cloud on the basic defense-only rationale for WIPP.

EPA's standards for management and disposal of spent nuclear fuel and high-level waste by their terms are applicable to WIPP.[572] In particular,

566. *Id.*, art. II. 567. First Modification, dated Nov. 1984.

568. *Id.*

569. 42 U.S.C. § 10,107(c). Similarly, a research and development facility is not subject to NRC licensing under 42 U.S.C. § 10,192, or to the consultation and other requirements of the research and development portion of the NWPA if the facility is devoted solely to waste "resulting from atomic energy defense activities." *Id.*

570. DOE, SECRETARY'S ANNUAL REPORT TO CONGRESS 115 (Aug. 1982).

571. DOE, SECRETARY'S ANNUAL REPORT TO CONGRESS 170 (Dec. 1985) decision issued Apr. 30, 1985).

572. *See* 40 C.F.R. §§ 191.01, 191.03, and 191.11.

EPA's standards apply generally to transuranic wastes—the principal wastes for which WIPP is supposedly being constructed. But the WIPP facility therefore must conform to standards of protection equivalent to those required for spent nuclear fuel and high-level waste. This in turn means that WIPP is being designated such that it can serve as a repository for high-level waste and spent nuclear fuel.[573]

DOE projects that the WIPP facility will be operational in 1988.[574] In the event that WIPP is completed but the NWPA fails to spawn a repository, it is only reasonable to project that there will be considerable pressure to make WIPP available for civilian nuclear waste. This is particularly so when one recognizes that the "Stipulated Agreement" in New Mexico's WIPP lawsuit implicitly recognizes this possibility by providing, among other things, that DOE "shall . . . provide to the State of New Mexico and the public ". . . a reasonable review period prior to any decision to change the nature or scope of the WIPP project to that of a permanent, high-level waste repository, or a decision not to retrieve the high-level waste placed in the repository. . . ."[575]

There are several factors supporting this hypothesis in addition to the erosion of the original rationale for WIPP as a facility devoted to defense-related transuranic waste. First, reliance on WIPP for waste disposal is now much more feasible given the fact that current projections of the amount of civilian nuclear waste for which disposal must be provided are much lower than those employed when the NWPA was passed. This makes expanding WIPP to provide for such wastes not only more practicable but also potentially extremely attractive economically.[576] Second, there is considerable interest in development of a federal facility for so-called "intermediate" level civilian waste. This is waste, such as transuranic waste with a concentration greater than 100 nCi/gram, which does not meet NRC's standards for Class C waste suitable for land disposal at low-level radioactive waste repositories. The current purpose of WIPP is to serve as a disposal facility for that type of waste, so long as it is defense-related, as well as for much more heavily contaminated transuranic material. It would be economically foolish to develop another re-

573. *See* 40 C.F.R. §§ 191.01 and 191.11.

574. DOE, SECRETARY'S ANNUAL REPORT TO CONGRESS 173 (Dec. 1985).

575. *See* Stipulated Agreement ¶6 dated July 1, 1981 in State of New Mexico *ex rel.* Bingaman v. United States Department of Energy, D.N.Mex. C.A. No. 81-0363 (JB).

576. The EIS for the WIPP facility indicates that WIPP will contain 100 acres of space for TRU waste and 7.5 acres of space for research on high-level waste. This is deemed adequate for all existing and expected TRU waste through the year 2003. WIPP EIS, *supra* note 544, at 8-16 to 17 and 3-13. WIPP, however, can be expanded to provide 2000 acres for waste disposal; *id.* at 3-13, which is roughly the size of the projected high-level waste repository. *Id.* at 3-16. In short, so far as the WIPP EIS discloses, expansion of WIPP into a full-fledged repository for spent nuclear fuel and high-level waste is entirely feasible.

pository for the same purpose, especially since the quantity of civilian transuranic waste is believed to be relatively limited.

Many questions will be posed if WIPP is converted into the nation's repository for spent nuclear fuel and high-level waste, or if it becomes a repository devoted at least in part to civilian "intermediate" (that is, transuranic) waste. For one thing, such a conversion would make Atomic Energy Act licensing requirements applicable, but those requirements ordinarily apply before an applicant for a license even begins construction of a facility.[577] Furthermore, although the conversion would appear to be consistent with the Stipulated Agreement of July 1, 1981 (which, as noted, anticipated possible conversion of the facility to serve as a permanent repository for high-level waste), as well as the Supplemental Stipulated Agreement, neither of these Agreements preclude the State of New Mexico from seeking further judicial review. More significantly, conversion of the WIPP facility to a permanent repository for high-level waste or spent-fuel might be a breach of the First Modification to the 1981 Agreement for Consultation and Cooperation which specified that WIPP is for transuranic waste. That document provides that it "is a binding enforceable agreement" and that it also shall not be construed to limit any rights to judicial review.[578] The conversion of WIPP to supplant all or a portion of the NWPA regime would likely require an Act of Congress in order to cut through the resultant litigation. Fortunately or unfortunately (depending on one's view), Congress' track record in cutting through nuclear waste litigation has thus far not proved to be very formidable.

2. The First Two Repositories

The NWPA envisions a four-stage process leading to the operation of a repository:

a. The nomination and subsequent selection by DOE of several potential repository sites for more detailed analysis (site characterization);
b. The completion of site characterization activities to support a Presidential site recommendation;
c. Preparation of an EIS and a license application for the site deemed preferable;
d. Completion of licensing activities and the construction of a repository.[579]

577. *See, e.g.*, 10 C.F.R. § 60.3(b) (construction authorization from NRC required before repository may be constructed).

578. Agreement for Consultation and Cooperation, Gov. King & Sec. Edwards, 1981, art. XI.B.

579. *See* Montange, *The Initial Environmental Assessments for the Nuclear Waste Repository under Section 112 of the Nuclear Waste Policy Act*, 4 UCLA J. ENV. LAW & POLICY 187, 19-90 (1985).

The entire program is supposed to take place under "guidelines" issued by DOE. State participation is authorized. Indeed, an affected state may veto a Presidential site selection, but the state veto is subject to Congressional override through a resolution adopted within ninety calendar days of continuous sessions after Congress receives notice of the state action.

The NWPA does not require, and indeed does not provide, for the selection of the optimum repository site. Indeed, it arguably does not require the selection of even an obviously superior site. It is aimed solely at the selection of an adequate site—one that meets applicable standards and does not present insurmountable political or legal obstacles.[580]

DOE nominated nine sites for consideration for the first repository in December, 1984.[581] The agency has recommended three of the sites (Yucca Mountain, Nevada; Deaf Smith, Texas; and Hanford, Washington) to the President for site characterization.[582] The affected states and several environmental organizations have instituted litigation against DOE, alleging numerous transgressions of provisions of the Act relating to state participation in the decisionmaking process.[583] Some of the litigation has been dismissed as premature.[584] Other aspects of the state claims have now resulted in invalidation of portions of DOE's guidelines for siting of repositories.[585] DOE announced the President's approval of its initial recommendation on May 28, 1986.[586] This announcement was immediately greeted with additional litigation or threatened litigation by the affected states.[587]

In a kind of political compromise reflecting the fact that the first re-

580. *See id.* at 219-21. *E.g.*, under the statute, DOE's basic guidelines are not required to apply to the selection or the nomination of initial locations for site-characterization, largely to accommodate the fact that DOE had already identified a number of western sites for more detailed investigation for the first repository.

581. 49 Fed. Reg. 47,801 (1984); *id.* at 49,590 (1984).

582. *See, e.g., DOE, Draft Environmental Assessment, Yucca Mountain site, Nevada Research Development Area, Nevada* (Dec. 1984).

583. *See, e.g.*, Env. Policy Inst. v. Hodel, No. 84-7854 (9th Cir. filed Dec. 18, 1984).

584. Texas v. Department of Energy, 764 F.2d 278 (5th Cir.) *cert. denied*, 106 S. Ct. 531 (1985) (challenge of Texas to DOE designation of two sites as potentially acceptable for nuclear waste repositories was neither final nor ripe for judicial review).

585. Nevada v. Herrington, F.2d ___, 23 ERC 1617 (9th Cir. 1985).

586. DOE Press Release entitled *DOE Announces Decisions on High-Level Waste Repository Program*, May 28, 1986.

587. *DOE Facing Multiple Lawsuits over Selection of Three Potential Waste Sites*, NUCLEAR FUEL, 9 (June 2, 1986); (five by Nevada, one by Texas, one contemplated by Washington and Yakima Indian Nation). Within a few weeks, more than a dozen suits had been filed. *See, e.g.*, Nevada v. Herrington, 9th Cir. No. 86-7307 (filed May 28, 1986); Nevada v. Herrington, 9th Cir. No. 86-7308 (filed May 28, 1986); Nevada v. Herrington, 9th Cir. No. 86-7309 (filed May 28, 1986); Nevada v. Herrington, 9th Cir. No. 86-7311 (filed May 28, 1986); Nuclear Waste Force v. DOE, D.C. Cir. No. 86-1309 (filed May 29, 1986); Texas v. DOE, D.C. Cir. No. 86-1310 (filed May 29, 1986). Legislation effectively suspending elements of the first repository program was also promptly introduced. *See, e.g.*, H.R. REP. No. 4959, 99th Cong. 2d Sess. (Yucca Mountain).

pository was anticipated in the West, Congress at the instigation of the Senate adopted language barring the first repository from disposing more than 70,000 metric-tons of waste until a second repository "is in operation."[588] This prohibition if left intact would virtually assure a need for the construction of a second repository. DOE's efforts to identify sites for a second repository have concentrated on crystalline rock formation in the Midwest and East,[589] although the agency indicated that it would also consider sites examined for the first repository in making its selection of a site for the second.[590]

DOE's effort to produce a second repository has stirred intense opposition from two basic directions: first, critics have charged that the selection process is arguably propelled by regional political considerations as opposed to technical considerations relating to site desirability;[591] and second, the additional repository is arguably unneeded[592] and therefore a costly waste of money.[593] A second repository under the NWPA is even more superfluous in the event WIPP becomes operational and is suitable for disposal of spent nuclear fuel.

The question whether to construct a second repository is obviously intensely controversial. Legislation has been introduced by the congressional delegations of the eastern states affected by DOE's Crystalline Rock Project to amend the NWPA to delete any such requirement as

588. 42 U.S.C. § 10,134(d).

589. As part of the Crystalline Repository Project, DOE issued a Draft Area Recommendation Request [DAPR] which identified 12 sites for possible development as repositories. The sites are located in Georgia (1), Maine (2), Minnesota (3), New Hampshire (1), North Carolina (2), Virginia (2), and Wisconsin (1).

590. Testimony of Mr. Rusche [DOE], *Hearings Before the Subcommittee on Energy Cons. and Power, House Commission Energy and Comm.*, 99th Cong., 2d Sess., § 1 (1986).

591. "States . . . believe that western crystalline rock structure were unfairly excluded. . . . Some suggest that the West was excluded for regionality reasons (most first round repository sites are in the West). . . ." Memorandum from Subcomm. Staff to Members, Subcomm. on Energy Cons. & Power, House Energy and Commerce Comm., Apr. 17, 1986, at 5.

592. According to Memorandum from Subcomm. Staff to Members, *supra* note 542, at 3, ". . . debate on the decision to build two repositories was influenced in part by DOE projections of waste made in 1980. Those projections showed that by the year 2020, commercial waste would total 167,000 metric tons (MT) using middle case assumptions. The low case assumption was 150,300 MT, and the high case was 204,000 MT. . . . However, since 1980, projections of waste have declined signficantly . . . The latest projects of commercial waste in the year 2020 indicates a middle case of only 106,404 MT, a low case of 87,397 MT, and no new orders case of 74,635 MT. Defense waste is estimated to add another 8,000 to 10,000 MT." *See also* Statement of Wisconsin Gov. Tony Earl *Hearings Before the Subcomm. on Energy Cons. & Power, House Comm. on Energy and Comm.*, (1986), Response to Written Question 2; Testimony of Mr. Rusche (DOE); *id.* at 2-5; Testimony of Gregg S. Larson (Minnesota), *id.* (chart annexed at end of statement).

593. A second repository would cost $16 to 30 billion. *See* Memorandum from Subcomm. Staff to Members, *supra* note 542, at 4. DOE; *id.* at 2-5; Minnesota Governor Perpich testified bluntly that "rate payers are funding a program that is unnecessary and wasteful." Testimony of Gov. Perpich *Hearings Before the Energy Cons. & Power Subcomm. of the House Energy and Commerce Comm.*, 99th Cong. 2d Sess., 5 (1986).

unnecessary and wasteful.[594] In order to mitigate the political firestorm, on the same day that the President had approved its initial site recommendations for the first repository, DOE announced that it was postponing indefinitely site-specific work for a second repository "because of progress in siting the first repository and the uncertainty of when a second repository might be needed."[595] The decision to postpone the second repository "met a mixed reaction on Capitol Hill," causing "at least some concern among waste program watchers that the decision may destroy the delicate balance between eastern and western states' interests that allowed passage of the Nuclear Waste Policy Act in 1982."[596] Indeed, eleven senators and two congressmen, including Morris Udall, James McClure, Alan Simpson, and Bennett Johnson, wrote Secretary Herrington that DOE's decision was illegal and thwarted the intent of Congress in adopting the NWPA.[597] The reaction in the states targeted for the first repository was similarly stark. Governor Bryan of Nevada testified that "with nearly every action taken, every document published and with every decision made, DOE has systematically unraveled the finely crafted fabric of the Nuclear Waste Policy Act. The unilateral decision to drop the second repository program is the final straw."[598]

Secretary Herrington initially took the position that postponement of the required nomination of sites for a second repository was within the law if Congress accepted DOE's revised "mission plan."[599] On August 21, 1986, Chairman Udall reiterated in writing an earlier oral request that DOE supply a memorandum from legal counsel supporting the Secretary's view.[600] Secretary Herrington responded with a Memoran-

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594. H.R. REP. No. 4668, 99th Cong., 2d Sess. § 2383, 99th Cong., 2d Sess. *See* 130 CONG. REC. H 2160 (daily ed. Apr. 21, 1986); *id.* § 5018.

595. DOE Press Release entitled *DOE Announces Decisions on High-Level Waste Repository Program*, May 28, 1986. *See also* Statement by John S. Herrington entitled *Nuclear Waste Repository*, May 28, 1986.

596. *DOE Decision to Halt Second Repository Program Could Derail Entire Waste Act*, NUCLEAR FUEL 7 (June 2, 1986).

597. Letter from Cong. Udall, *et al* to Secretary Herrington, June 11, 1986. The letter flatly stated that "The requirement to proceed with a program for the siting of a second repository is firmly established throughout the Act. . . . The decision on whether to proceed with a second repository is a matter that the Congress, not the Department, must ultimately decide." The signators requested the Secretary to submit "a detailed memorandum of law" stating the basis for the Department's decision, proposed legislation to modify the NWPA, and an explanation of how DOE intends to comply with the Act.

598. Statement of Gov. Richard Bryan, at 2, *Hearings Before the Energy Res. and Dev. Subcomm. of the Senate Energy and Nat. Resources Comm.*, 99th Cong., 1st Sess. (1986).

599. *See* transcript attached to letter from Chairman Udall to Secretary Herrington, Aug. 21, 1986. The "mission plan" is a document required under § 301 of the NWPA, 42 U.S.C. § 10,221.

600. Letter from Chairman Udall to Secretary Herrington, Aug. 21, 1986. Chairman Udall noted in his letter that:

> My colleagues and I have stated individually and together our profound displeasure with the unilateral and politically inspired reorientation of the nation's nuclear waste disposal program. It only adds to my concern to find that the Department either will

dum[601] from the DOE's General Counsel,[602] dated September 5, 1986, indicating that an amendment to the "mission plan" cannot supplant the requirements of the NWPA pertaining to the second repository. Chairman Udall, noted that the General Counsel's memorandum "reinforces" the conclusion that DOE had acted unlawfully, stated that "the Department's site selection process not only must be fair but . . . must appear fair if the waste program is to succeed. Your decision to postpone indefinitely an integral part of the siting program has seriously harmed the credibility of the process."[603]

However this political logjam turns out, the effort to site a second repository is likely to be troublesome. Although the NWPA provides that the need for a repository and alternative technologies need not be considered with regard to the initial repository, no such dispensation is granted with respect to the need for a second repository, or for that matter, with respect to alternatives to geological disposal with respect to the projected second facility.[604] Thus, a full analysis of the question of need and alternatives will be required in any EIS for the projected second repository.[605]

The NWPA in many ways is a disappointment. Rather than providing institutional arrangements for disposal of spent nuclear fuel and clear rules of decision, the Act codified a complex "road map" for states and federal agencies to interact on the issue. The new law is virtually devoid of rules of decision. It is not clear that the Act will advance the repository siting process any further than it was under pre-existing law.[606] Already political concerns have led to the purported and evidently unlawful

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not or can not provide a legal rationale for its pre-emptory action in mothballing the second repository program. For all practical purposes, mothballing is tantamount to cancellation and, in my view, it is in direct violation of the intent and letter of the NWPA.

601. Letter from Secretary Herrington to Chairman Udall, Sept. 9, 1986 (noting that, contrary to testimony, DOE had no legal memorandum on the subject prior to the mothballing decision).

602. Memorandum for B.C. Rusche from J.M. Farrell, entitled *Relationship Between the Mission Plan and Second Repository Recommendation Requirements of the Nuclear Waste Policy Act of* 1982, dated Sept. 5, 1986. The memorandum noted that the requirements pertaining to a second repository "remain intact until repealed, amended, or supplanted by new legislation adopted through consitutionally-required procedures of bicameralism and presentment to the President," citing I.N.S. v. Chadha, 42 U.S.C. § 919 (1983). Memorandum, at 3.

603. Letter from Chairman Udall to Secretary Herrington, Sept. 18, 1986.

604. 42 U.S.C. § 10134(f); *see also id.* § 10134(a)(1)(D).

605. The fact that the statute currently places a limit on the first repository effectively precluding it from handling all U.S. spent-fuel and high-level waste does not obviate the controversy over need. It is well-established that an agency must analyze a reasonable alternative (reliance on the first repository) even if that alternative would require legislative action to accomplish. *See, e.g.*, EDF v. Corps of Engineers, 492 F.2d 1123, 1135 (5th Cir. 1974).

606. Indeed, most nuclear utilities reportedly lack confidence that a repository will be available within the deadline specified by the Act (1998). *See GAO, Monitored Retrievable Storage of Spent Nuclear Fuel* 21 (May 1986) (70% have no confidence; 9% have little confidence; and most believe that a repository will not be available before 2003).

postponement of one of the repositories called for in the Act. Major opposition has been mounted to the first repository as well. The provision for state vetos augments the ability of states to frustrate repository siting efforts.

There are two basic techniques available to obviate institutional difficulties with respect to high-level waste disposal. The first is to provide some non-arbitrary rule of decision. In other words, politics and political pressure should be excluded or at least minimized in the siting process. An obvious rule would be for DOE to seek an optimal site,[607] but this may be too much to ask, unless some guidance is given concerning what factors are to be used in the optimization and some leeway is given to the agency so the second-guessing of its decision does not continue ad infinitum. An important thing is that some guidance be given to public input and that a logical, non-arbitrary decisionmaking process be pursued. Unfortunately, asking that politics be excluded from nuclear waste may be akin to King Canute's attempt to roll back the sea.

The second possible technique, which may be much more feasible in the United States, is a market-oriented approach. Under a market-oriented approach, a number of acceptable sites would be identified and the federal government would offer affected states and localities financial inducements in return for their consent to harbor the repository. So long as the cost of the payments, construction expenses and operational outlays, were less than $20 billion (the estimate for a repository under the current program), everyone (and especially the selected state for the repository) would be financially better off. The estimated cost for a repository under the NWPA is about $20 billion. The estimated cost to construct WIPP, including all monitoring and environmental costs, is about $1 billion.[608] An expanded WIPP capable of acting as a repository would presumably cost no more than two or three times that amount. The difference between $20 billion and roughly $3 billion is some $17 billion. This $17 billion—a figure roughly six times the true engineering, construction, and overhead expense for the repository—approximates the administrative and transaction cost of the NWPA per repository. Instead of spending this $17 billion on political consultants, lawyers, Beltway Bandits and bureaucratic trench warfare, federal authorities might use it to try to strike a bargain.

607. Governor Gardner of Washington, for example, has asserted that his State mistakenly assumed that DOE would choose a site "based on science" rather than politics and that "only the *safest* . . . site would be selected. . . . " Statement of Gov. Booth Gardner, at 1 *Hearings Before the Energy Research and Dev. Subcomm. of the Senate Energy and Nat. Resources Comm.*, 99th Cong., 1st Sess. (1986) (emphasis in original).

608. WIPP's estimated cost, including overhead, was $497 million (1979 dollars) for construction and $26 million for operation. *See WIPP EIS, supra* note 514, at 3-13 and -15. This works out to about $1 billion in more current dollars.

For example, DOE might offer to endow the state and local educational and park systems with $5 billion and perhaps to create a perpetual care fund under the affected state's control for another $1 billion in return for state and local consent to harbor a repository. The total amount of the endowment could move up or down depending on the market. After payment of the endowment as well as construction costs, it is entirely possible that many billions would still be left over as a savings to utility ratepayers and, to the extent defense wastes go to the repository, to federal taxpayers as well. These billions of savings would be in addition to the billions in savings which would result from cancelling an unneeded second repository. Additional savings could be realized by expanding, and relying upon WIPP, or by cancelling it in favor of the NWPA repository. Senators Johnston and McClure, the Chair and Ranking Member respectively of the Senate Energy of Natural Resources Committee, recently proposed legislation calling for a contribution of up to $100 million per year to any state or Indian tribe willing to accept the repository.[609] Although roundly criticized for appearing to "bribe" opponents of the siting process,[610] Ford's basic notion of providing economic benefit to the depository state in return for its hosting the disposal facility won uniform support at a public hearing.[611]

C. Monitored Retrievable Storage.

Section 141 of the NWPA[612] contains a potentially major alternative to a mined geologic repository for purposes of management of spent nuclear fuel or high-level radioactive waste; namely a monitored retrievable storage [MRS] facility.[613] Such a facility would permit continuous monitoring of stored waste "for the foreseeable future," provide for the "ready retrieval" of the waste "for further processing or disposal" and "safely store" the waste "for as long as may be necessary."[614] In adopting the MRS provision, Congress specifically found that, "long-term storage

609. S. 839, 100th Cong., 1st Sess.

610. Senator Reid and Rep. Bilbray of Nevada have promptly denounced the money offer as a "bribe." *The Carrot: $100 Million; The Stick: Atomic Dumps*, Wash. Post, Mar. 25, 1987, at A25.

611. *See, e.g.*, Statements of Gov. Bryan of Nevada *Hearings Before the Senate Energy and Nat. Resources Comm.*, 100th Cong., 1st Sess., 42-43 (1987) ("additional compensation is a valuable concept").

612. 42 U.S.C. § 10,161.

613. Legislators differed dramatically over the desirability of an MRS. *E.g.*, Senator Johnston was a strong advocate, viewing an MRS as potentially preferable to a repository. S. REP. 97-282, 97th Cong., 1st Sess. at 63-64 (1981). Congressman Udall reluctantly supported MRS as a back-up technology. 128 CONG. REC. H 8525 (daily ed. Nov. 29, 1982). Congressman Markey opposed MRS as precluding a permanent solution to the waste disposal problem. *Id.*, at 10,521 (daily ed. Dec. 20, 1982).

614. 42 U.S.C. § 10161(b)(1)(B)-(d). *See also* DOE, SECRETARY'S ANNUAL REPORT TO CONGRESS 88-89 (Dec. 1985).

of high-level radioactive waste or spent nuclear fuel in monitored retrievable storage facilities is an option for providing safe and reliable management of such waste or spent-fuel. . . ."[615]

Section 141 required DOE to prepare a detailed study of the need for and feasibility of an MRS and to "submit to . . . Congress a proposal for . . . the construction of one or more monitored retrievable storage facilities for high-level radioactive waste and spent nuclear fuel, by June 1, 1985."[616] The proposal must include at least three alternative sites.[617] It must be accompanied by an environmental assessment, but no environmental impact statement is required.[618]

Under subsection (c) of Section 141, Congress must authorize construction of an MRS "by law."[619] If Congress does so, an environmental impact statement must be prepared, but it need not consider the need for the facility or alternative design criteria.[620] The facility is subject to NRC licensing authority.[621]

All this seems clear enough. However, Subsection (h) of Section 141, like the thirteenth chime of a clock, throws everything into doubt.[622] Subsection (h) provides that any MRS "authorizing pursuant to this section" shall be subject among other things, to the provisions of Sections 115[623] and 116(b)[624] (authorized a state veto of a repository subject to congressional override), Section 116(a)[625] (requiring notification of states harboring potential candidate sites within 90 days of January 7, 1983), and Sections 117[626] and 118[627] (consultation with states and Indian tribes).

Subsection (h) creates a number of ambiguities. First, it may mean that the Secretary's initial proposal to Congress, which must be approved "by law" in order to authorize construction of an MRS,[628] in fact will be deemed approved without any actual legislative action. In this event,

615. 42 U.S.C. § 10,161(a)(1).
616. 42 U.S.C. § 10,161(b)(1).
617. 42 U.S.C. § 10,161(b)(4).
618. 42 U.S.C. § 10,161(c)(1).
619. 42 U.S.C. § 10,161(c)(2).
620. *Id.*
621. 42 U.S.C. § 10,161(d).
622. 42 U.S.C. § 10,161(h). Subsection (h) was added at the last minute as a result of a conference between Senate and House managers. *C.f.* 128 CONG. REC. S. 15,640-41 (daily ed. Dec. 20, 1982) *with id.*, at H 10,517.
623. 42 U.S.C. § 10,135.
624. 42 U.S.C. § 10,136(b).
625. 42 U.S.C. § 10,136(a).
626. 42 U.S.C. § 10,137.
627. 42 U.S.C. § 10,138.
628. *See e.g.*, 128 CONG. REC. H 10,522 (daily ed. Dec. 20, 1982) (statement of Cong. Lujan—D-NM); *id.* H 10,524 (statement of Cong. Dingell); *id.* S. 15,642 (statement of Senator McClure); *id.* S. 15,664 (statement of Senator Johnston).

the only method to place the issue before Congress is by a veto and by the host state, in which case a congressional override would be necessary for work to proceed. The alternative construction would give the state two bites at the apple: first to dissuade Congress from authorizing the MRS and second to force Congress to override. This latter alternative seems more than a little strained. Second, Subsection (h) may mean that DOE must begin consultation with all potential host states before receiving authorization "by law" to construct an MRS and even before deciding whether to propose an MRS. This arguably puts the cart before the horse. Not surprisingly, subsection (h) has been a legal disaster to the MRS program.

The Secretary of Energy identified eleven potentially acceptable sites by applying a brief list of screening factors[629] and an additional list of suitability factors.[630] The Secretary eventually identified three sites in Tennessee as "candidate sites" and the Clinch River Breeder Reactor site near Oak Ridge, Tennessee as most preferable.[631] DOE on April 25, 1985 announced its decision to propose to Congress by January 1986 the construction of an MRS as part of "an integrated nuclear waste disposal system, by January, 1986."[632] DOE indicated that it was "prepared to work closely with the state[s]" to prepare documentation with respect to the proposal.[633]

Subsequent to DOE's April 25 announcement, Tennessee "scrambled" to "catch up," with DOE.[634] Dissatisfied with DOE's failure to provide data and studies in a fashion which would permit the state to prepare its position prior to DOE's submission of an MRS proposal to Congress, Tennessee sued in federal district court for declaratory relief. Tennessee argued that DOE was obligated to consult and cooperate with the State prior to making an MRS proposal to Congress, and sought injunctive relief barring the agency from submitting its proposal. The district court sided with the state.[635] Interpreting the initial MRS proposal to Congress as equivalent to a repository site recommendation, the district court ruled that the proposal became effective without further congressional action

629. These factors were location in the southeast region, ownership by DOE or docketing with NRC, and containment of at least 1,100 acres. *See* Tennessee v. Herrington, 626 F. Supp. 1345, 1349 n.12 (M.D. Tenn. 1986).

630. These factors included ease of regulatory compliance, environmental setting, site characteristics, socioeconomic setting, institutional and administrative structure of state, transportation, access to utilities, and capital cost. *Id.*, at 1996 n. 12.

631. *Id.* The two alternatives are the Oak Ridge Reservation itself and the cancelled Tennessee Valley Authority Hartsville nuclear reactor site. 50 Fed. Reg. 16,537 (1985).

632. 50 Fed. Reg. 16,536 (1985).

633. *Id.* 16,537.

634. Tennessee v. Herrington, 626 F. Supp. 1345, 1349 (M.D. Tenn. 1986).

635. *Id.*

absent a state veto, which in turn would be subject to a congressional override.[636] The Court further construed the consultive requirements of the NWPA to apply at the inception of DOE's MRS site-selection process and ruled that DOE's failure to consult with Tennessee violated the Act. When DOE nevertheless threatened to submit its proposal to Congress,[637] the Court permanently enjoined DOE "from making any proposal to Congress or filing any documents with Congress which rely on siting studies developed prior to consultation and cooperation" with Tennessee pursuant to Section 117 of the NWPA.[638]

After ruling that the district court lacked jurisdiction over the dispute,[639] the Sixth Circuit on appeal split two-to-one in favor of DOE's construction of the MRS provision.[640] Judge Kennedy viewed the statute and legislative history as ambiguous. Noting that, although the state had support for its views, the statute embodied conflicting policies, he deferred to the agency's resolution.[641] Judge Wellford in dissent argued that the agency's construction was inconsistent with "the clear intendment" of the Act "to give the states a meaningful and timely role in the site selection process."[642] The basic role of the state is not the only point of confusion spawned, as to the projected MRS facility by the NWPA. The application of NEPA to the facility may also provoke a confrontation. The chief point of contention is likely to surround the need to consider alternative sites in the EIS eventually prepared for the MRS and during the course of the licensing process. The original version of Section 141(c) in both the House and Senate bills expressly provided that the EIS proposed for the MRS did not have to consider alternative sites.[643] This made sense because Congress anticipated approving a site for the MRS in the course of approving (if it did) DOE's MRS proposal. However, this provision was dropped in the version of the bill ultimately enacted by Congress. Senators McClure and Johnston specifically noted that NRC and the EIS should now consider alternative sites.[644] Senator Johnston suggested that the alternatives analysis was principally for "comparative purposes" and was not intended "to delay the program."[645]

The analysis of alternatives is at the heart of an EIS.[646] In order to be

636. *Id.*, at 1351.
637. *Id.*, at 1359.
638. *See* Tennessee v. Herrington, 806 F.2d. 642, 647 (6th Cir. 1986).
639. Tennessee v. Herrington, 806 F.2d, 642, 647-51 (1986).
640. *Id.*, at 651-53.
641. *Id.*, at 643.
642. *Id.*, at 654-55.
643. *See* § 311(c) of H.R. REP. No. 6598 97th Cong., 2d Sess. (1982); § 505(b) of S. 1662, 97th Cong., 2d Sess (1982).
644. 128 CONG. REC. S 15,642 (daily ed. Dec. 20, 1982); *id.* § 15,664. *But see id.* S 15,664 (contrary representation in written summary of House-passed legislation).
645. *Id.* § 15,664.
646. *See, e.g.*, Natural Resources Defense Council v. Callaway, 524 F.2d 79, 92 (2d Cir. 1975); Calvert Cliffs' Coordinating Committee v. AEC, 449 F.2d 1109, 114 (D.C. Cir. 1971).

useful in the decisionmaking process, it must be presented to the decisionmakers before their decisions are made.[647] If the alternatives analysis for the MRS is an after-the-fact piece of window dressing, presented chiefly for academic value as suggested by Senator Johnston, the whole exercise is not only largely superfluous but contrary to the thrust of NEPA. But if the alternatives analysis is not so treated, then NRC must have the right to reject DOE's site, even if it has been approved by Congress. How this will ultimately play out is difficult to judge, as it always is when Congress nimbly and without explanation imposes a requirement out-of-step with the framework in which it is to reside.

VI. ORDERING CHAOS

Despite enormous effort and occasional paeans of praise to landmark legislation and so forth, the struggle over nuclear waste management is far from over. Regulation of radioactive mine waste is arguably not even in its infancy. Elements of the environmental community are seriously displeased with uranium mill tailings regulations. The new congressional scheme for spawning low-level waste repositories is complex, costly, and likely to provoke at least some regional controversies and crises. The program for spent nuclear fuel and high-level waste has created confusion, mistrust, and litigation. The picture that emerges is something like World War I trench warfare: huge forces grimly pushing each other back and forth a few hundreds of yards after a tremendous expenditure of effort.

There are many reasons offered for this dilemma. The "anti-nuclear" camp suggests the problem is merely a reflection of the allegedly inescapable fact that nuclear energy is a fundamentally unsafe technology.[648] A more refined version of this position is that advanced technology (such as nuclear energy) is so complex that its safety cannot be entrusted to human hands, as witnessed by the disaster at Chernobyl or the loss of the space shuttle Challenger. Advocates of nuclear energy tend to attribute the malaise to difficult psychological obstacles in the nature of a nuclear phobia,[649] or a knee-jerk aversion to any waste in one's state, let alone one's vicinity. It is certainly true that nuclear waste is an emotional issue, but proponents and opponents have tended to aggravate this problem by failing to channel debate into rational channels. Perhaps the greatest breakdown in the debate concerns the word "safe." All agree that nuclear waste disposal should be "safe." However, the fact is that no one can demonstrate perfect safety with respect to a particular waste disposal technology, any more than one can achieve a demonstration of perfect

647. *See* National Wildlife Federation v. Snow, 561 F.2d 227 (D.C. Cir. 1976).

648. *See, e.g.*, J. Gofman and A. Tamplin, *Poisoned Power* (1971).

649. *See, e.g.*, R. DuPont, *Nuclear Phobia—Phobic Thinking About Nuclear Power* (Mar. 1980); J. Kearney, *Anti-Nuclear Scare Tactics*, Wash. Post, Nov. 8, 1982, at A14.

safety with any other technology, or with no technology at all.[650] What is needed is content for the term "safety"—some reasonable concensus as to what it means, some shared understanding of how safe is safe enough.

Congress has generally avoided this issue. Legislators shun substantive health and safety standards in preference to frequently complicated procedures involving virtually total delegation of the safety issue to administrative agencies. Where specific standards are stated, they tend to smack of non-degradation. But such zero risk standards are frequently so draconian in effect that the pressure to somehow circumvent them is enormous.

The lack of legislative direction on how safe is safe enough is compounded by a lack of direction on how agencies should set standards. There is no generally accepted approach to setting safety standards.[651] As a result, agency standards tend to be arbitrary in the sense that they are arrived at after an unstructured and subjective review of numerous factors.

This is not to say that such standards violate the law. To the contrary, the Administrative Procedures Act [APA] at the substantive level requires only that health and safety standards not be "arbitrary and capricious."[652] The APA requirement is an extremely deferential one, and it usually results in judicial approval of agency conduct so long as the agency has considered all the relevant factors and made some effort to explain how it got where it is. However, the fact that a standard survives judicial review under the APA hardly means that it is optimal, or even obviously superior

650. *See, e.g.*, Nader v. NRC, 513 F.2d 1045, 1050 (D.C. Cir. 1975) (guarantee that a technology is risk-free is "unattainable" and not compatible with "modern technical societies"); North Anna Environmental Coalition v. NRC, 533 F.2d 655, 665 (D.C. Cir. 1976) (same). *See also* Industrial Union Dept. v. American Petroleum Institute, 448 U.S. 607, 642 (1980) ("safe" is not the equivalent of "risk-free").

651. Some variant of cost-benefit analysis is the most frequently proferred "objective" approach to the setting of standards. There are two basic objections to cost-benefit analysis. The first objection is that some of the costs and benefits which should weigh in the analysis are not easily quantified, or perhaps more precisely, there is a strong aversion to quantifying them. Examples of such costs and benefits include the "cost" of a premature cancer death and the benefit of maintaining a scenic or "undeveloped" setting. Nevertheless, cost-benefit analysis offers some progress in rendering the standard-setting process explicable. The second objection is that the whole cost-benefit doctrine "is immoral" because "there is no benefit to society that can justify the forcible imposition of risks or the threats to life upon individuals." Gofman, *The Top 10 Pronuclear Arguments . . . Answered*, THE MOTHER EARTH NEWS (Jan./Feb. 1981). It is doubtful, however, that any society could exist which did not impose some risks on individuals. Even Dr. Gofman, for example, would permit the United States to forcibly impose individual risks in order to resist domination by authoritarian regimes and ideologies. The moral question turns on such factors as manner, degree, compensation, consent, and the nature and distribution of benefits.

Another approach to safety regulation is to pick some level of risk (either arbitarily or by comparative risk analysis) as safe enough (such as the chance of being struck by lightening—about 1 in 1,000,000 per year) and then employ cost-effectiveness techniques to implement it. Cost-effectiveness seeks the least-cost method of attaining a particular level of safety. The choice of safety goal under this approach, however, remains relatively subject to the charge of "immorality" noted above in the context of cost benefit analysis.

652. 5 U.S.C. § 706(2)(A).

to some alternative formulation, and it certainly does not mean that it in fact will reduce overall health risks.

The confused nature of the standard setting process is reflected in the various standards governing radioactive waste disposal discussed above. EPA states that mill tailings must be stabilized for 200 to 1,000 years, yet transuranic waste, which poses similar hazards for a time span approximately one-quarter as long, must be stabilized for 10,000 years. Very high risks to hypothetical nearby residents are tolerated in connection with radon from operating underground uranium mines; on the other hand, risks to nearby residents from operating low-level and high-level waste disposal facilities are presumably kept to very low levels through application of a variant of EPA's 25 mrem rule.

The confusion is compounded by the fact that the whole standard-setting process for radioactive waste is taking place largely in isolation from the standard-setting for other potential human health hazards. This is troubling from a resource allocation standpoint. To the extent that a radioactive waste regulation imposes a burden to reduce a risk, it may prompt increased reliance on some technological alternative to nuclear energy, but if that alternative poses a greater health hazard, society is worse off.[653] This is no hypothetical possibility. Reliance on coal is the major alternative to nuclear energy for electrical energy needs. Yet acid rain, carbon dioxide buildup, and other adverse effects are associated with coal.[654] The point is that there is no *a priori* reason to expect that a standard-setting process for nuclear waste disposal which takes place in isolation from the rest of the regulatory environment to reach a result which optimizes health protection, much less to reach a result that optimizes health protection against other interests, such as the societal interests in economic growth and technological development.[655]

William Ruckelshaus, twice Administrator of EPA, has voiced many of these same concerns. Writing in *Science* magazine, Mr. Ruckelshaus has called for regulatory agencies to:

> Be given . . . a common statutory formula . . . The formula should

653. *See, e.g., Nuclear Waste: What to Do with It?*, at 11 (1979) (Prof. Kenneth Arrow: "it would be pointless to demand a safety level for nuclear waste disposal that is so high as to prevent it from being achieved and then go to another cycle that has higher health hazards").

654. *See, e.g.*, OTA, ACID RAIN AND TRANSPORTED AIR POLLUTANTS (1984); GAO, COAL AND NUCLEAR WASTES—BOTH POTENTIAL CONTRIBUTORS TO ENVIRONMENTAL AND HEALTH PROBLEMS (Sept. 1981).

655. *See, e.g.*, Okrent, *Comment on Societal Risk*, 208 SCIENCE (1980) at 312, 374 ("Resources for the reduction of risks to the public are not infinite. At some point, a greater improvement in health and safety is to be expected from a stable and viable economy than from a reduction in pollution or the rate of accidents"); Industrial Union Dept., AFL-CIO v. American Petroleum Institute, 448 U.S. 607, 670 (1985) (Powell, J., concurring "A standard-setting process that ignored economic considerations would result in a serious misallocation of resources and a lower effective level of safety than could be achieved under standards set with reference to the comparative benefits available at a lower cost").

> be as precise as possible and should include a responsibility to assess the risk and to weigh that, not only against the benefits of the continued use of the substance under examination, but against the risks associated with substitute substances and the risks associated with the transfer of the substance from one environmental medium to another via pollution control practices.[656]

As it is with standards, so it is with respect to siting nuclear waste disposal facilities. In essence, Congress has given no real guidance on this issue with respect to any waste. As to spent nuclear fuel and high-level waste, Congress has elaborated an amorphous process involving the consideration of a variety of factors in an unspecified way. With respect to defense transuranic waste, Congress has in effect ratified a particular site which DOE somehow has managed to pluck out of a potential political conundrum. The problem has otherwise been shunted to a hodge-podge of federal agencies, state officials, and interstate compact commissions.

Until Congress or the agencies begin to make some sense out of the standard-setting and site-selection process, there is no technically satisfactory explanation for either the standards or site-selection. The best defense one can muster for the current process is to claim that there are many factors to consider and many politically powerful forces involved, and the agencies involved are attempting to reach a result which is not "arbitrary and capricous" under the circumstances. That is not very reassuring. It basically amounts to saying, "trust me" when the agency asking for trust, although it may be genuinely sincere, is enmeshed in an inherently irrational decisionmaking process. It may be that that process, and that agency, on occasion will generate a correct result, but such occasions will be purely serendipitous.

A recent opinion poll indicates that a clear majority of American adults believe that nuclear waste cannot be safely disposed.[657] To the extent that this suggests a belief that safe disposal is technically impossible, the opinion is arguably misguided, at least in the sense that the scientific concensus is that nuclear waste can be disposed as readily as other equally hazardous materials. To the extent that the poll suggests a healthy skepticism with the current system for disposal of nuclear waste, it is much more difficult to pick an honest quarrel. And whether or not nuclear waste "can" or "will" be safely disposed, the current system for that purpose appears to be costing billions of dollars, and probably tens of billions, more than it should.

656. Ruckelshaus, *Science, Risk and Public Policy*, 221 SCI. 1026-27 (1983).

657. *78% of Americans Balk at New Nuclear Reactors*, Wash. Post, May 24, 1986, at A6, col. 2. (Fifty-eight percent "says radioactive waste from nuclear plants cannot be disposed of safely.")