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NOTE FOR: Seth Coplan

FROM: Dan Fehringer

SUBJECT: POTENTIAL FOR SIGNIFICANTLY MORE STRINGENT EPA HLW STANDARDS

In this note I will argue that, contrary to popular folklore within the technical community, EPA's current HLW standards are not particularly stringent in terms of the degree of isolation required for most of the constituents of spent nuclear fuel. I will also argue that the individual dose rates that might occur at Yucca Mountain could be quite high, even if EPA's release limits are met. Thus, the potential exists for a significant revision to EPA's standards which would require much better waste isolation than is required by the current (1985) standards.

Derivation of EPA's containment requirements. To begin, I will cite EPA's own description of the derivation of its HLW standards.

> The Agency assessed the performance of a number of model geologic repositories similar to those systems now being considered by DOE. Potential radionuclide releases over 10,000 years were evaluated, and very general models of environmental transport and a linear, non-threshold dose-effect relationship were used to relate these releases to the incidence of premature cancer deaths they might cause. For the various repository types, these assessments indicate that disposal of the wastes from 100,000 metric tons of reactor fuel would cause a population risk ranging from no more than about ten to a little more than one hundred premature deaths over the entire 10,000-year period, assuming that the existing provisions of 10 CFR Part 60 regarding engineered barriers are met.

⇒ A.D. Little Study

> The Agency also evaluated the health risks that future generations would be exposed to from the amount of uranium ore needed to produce 100,000 metric tons of reactor fuel, if this ore had not been mined to begin with. Population risks ranging between 10 and 100,000 premature cancer deaths over 10,000 years were associated with this much unmined uranium ore, depending upon the analytical assumptions made.

> These analyses, which have been updated from those prepared for the proposed standards, reinforce the Agency's conclusion that limiting radionuclide releases to levels associated with no more than 1,000 premature cancer deaths over 10,000 years from disposal of the wastes from 100,000 metric tons of reactor fuel satisfies two important objectives. First, it provides a level of protection that appears reasonably achievable by the various options being considered within the national program for commercial wastes. Second, the Agency believes that such a limitation would clearly keep risks to future populations at acceptably small levels, particularly because it appears to limit risks to no more than the midpoint of the range of estimated risks that future generations would have been exposed to if the uranium ore used to create the wastes had never been mined. Thus, because mined geologic

& update unavailable [illegible]

repositories appear capable of providing such good protection, the Agency has decided to establish containment requirements that meet these two objectives. (50 FR 38071).

EPA did not try to conceal the fact that its standards were based on population risks and that doses to individuals could be significant. EPA provided the following discussion.

> The Agency believes that the containment requirements in 191.13 will insure that the overall population risks to future generations from disposal of these wastes will be acceptably small. However, the situation with regard to potential individual doses is more complicated. Even with good engineering controls, some waste may eventually (i.e., several hundreds or thousands of years after disposal) be released into any ground water that might be in the immediate vicinity of a geologic repository. Since ground water generally provides relatively little dilution, anyone using such contaminated ground water in the future may receive a substantial radiation exposure (e.g., several rems per year or more). This possibility is inherent in collecting a very large amount of radioactivity in a small area. (50 FR 38077).

EPA went on to discuss its decision to emphasize limitation of population risks as the primary basis for the standards, and to provide only limited protection of individuals during the first 1,000 years after disposal.

EPA Could extend individu. protection Criteria to 10,000 yr.

<u>How stringent are EPA's standards (I)</u>? One way to evaluate the stringency of EPA's standards is to compare the release limits of the standards to the inventory of a repository. Table 1 below provides such a comparison.

Table 1 clearly indicates that EPA's release limits are significantly restrictive only for the isotopes of Am and Pu. Moderate restrictions are imposed on releases of Np, U and maybe C-14 (its inventory is uncertain), while releases of all other radionuclides may approach or exceed the entire repository inventory. Table 1 suggests that EPA's release limits are not especially stringent since they allow ample margins for uncertainties in projected releases of most nuclides. Only releases of the Am and Pu isotopes must be projected in detail.

<u>How stringent are EPA's standards (II)</u>?

Another perspective on the stringency of EPA's release limits can be gained by estimating the individual dose rates that might result from releases allowed by the standards. In Table 2, it is assumed that the maximum allowable quantity of each nuclide is released to groundwater at a uniform rate over 10,000 years. Groundwater provides dilution of $10^5$ $m^3/yr$. Contaminated groundwater is then withdrawn through a well to be used for drinking water at the rate of 2 L/day. The resulting doses are displayed in Table 2.

TABLE 1. COMPARISON OF RADIONUCLIDE INVENTORIES OF A 100,000 MTHM REPOSITORY WITH THE RELEASE LIMITS OF EPA'S HLW STANDARDS.

| NUCLIDE | REPOSITORY INVENTORY (CI) @ 1,000 YR | EPA RELEASE LIMIT (CI)* | % ALLOWED TO BE RELEASED |
|---|---|---|---|
| Am-241 | 9.24E7 | 10,000 | 1.1E-2 |
| Am-243 | 1.57E6 | 10,000 | 6.4E-1 |
| C-14 (A.D.Little) | 1.35E3 | 10,000 | 740 |
| C-14 (Park & Pflum) | 1.55E5 | 10,000 | 6.5 |
| Cs-135 | 2.23E4 | 100,000 | 450 |
| Cs-137 | 1.00 | 100,000 | ---- |
| I-129 | 3.8E3 | 10,000 | 290 |
| Np-237 | 1.0E5 | 10,000 | 10 |
| Pu-238 | 9.8E4 | 10,000 | 10 |
| Pu-239 | 3.2E7 | 10,000 | 3.1E-2 |
| Pu-240 | 4.4E7 | 10,000 | 2.3E-2 |
| Pu-242 | 1.7E5 | 10,000 | 5.9 |
| Ra-226** | 2.84E2 | 10,000 | 3500 |
| Sr-90 | 1.5E-1 | 100,000 | ---- |
| Tc-99 | 1.4E6 | 1,000,000 | 71 |
| Th-230** | 1.6E3 | 1,000 | 62 |
| Th-232 | 1.3E-3 | 1,000 | ---- |
| Sn-126 | 5.6E4 | 100,000 | 180 |
| U-233** | 3.3E2 | 10,000 | 3000 |
| U-234 | 1.9E5 | 10,000 | 5.3 |
| U-235 | 2.0E3 | 10,000 | 500 |
| U-238 | 3.1E4 | 10,000 | 32 |

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under Part 60.113 $1 \times 10^{-5}$/yr ≈ .09 or 9% over 9000 yrs of inventory @ 1000 yrs is allowable

*The EPA standards require that a "sum-of-the-fractions" rule be applied if more than one radionuclide is released. "Unlikely" releases are allowed to be ten times larger than the limits listed here.

**Inventory increases after 1,000 years.

Part 60 release rate criterion significantly more stringent than EPA

significantly less stringent

TABLE 2. RADIATION DOSES ASSOCIATED WITH THE RELEASE LIMITS OF EPA'S HLW STANDARDS (100,000 MTHM REPOSITORY INVENTORY).

| NUCLIDE | REPOSITORY INVENTORY (CI) @ 1,000 YR | EPA RELEASE LIMIT (CI)* | WELL WATER DOSE RATE (REM/YR)*** |
|---|---|---|---|
| Am-241 | 9.24E7 | 10,000 | 16 |
| Am-243 | 1.57E6 | 10,000 | 16 |
| C-14 (A.D.Little) | 1.35E3 | 10,000 | -- |
| C-14 (Park & Pflum) | 1.55E5 | 10,000 | -- |
| Cs-135 | 2.23E4 | 100,000 | 0.5 |
| Cs-137 | 1.00 | 100,000 | 3.6 |
| I-129 | 3.8E3 | 10,000 | 2.0 |
| Np-237 | 1.0E5 | 10,000 | 29 |
| Pu-238 | 9.8E4 | 10,000 | 2.9 |
| Pu-239 | 3.2E7 | 10,000 | 3.2 |
| Pu-240 | 4.4E7 | 10,000 | 3.2 |
| Pu-242 | 1.7E5 | 10,000 | 3.1 |
| Ra-226** | 2.84E2 | 10,000 | 9.7 |
| Sr-90 | 1.5E-1 | 100,000 | 10 |
| Tc-99 | 1.4E6 | 1,000,000 | 1.0 |
| Th-230** | 1.6E3 | 1,000 | 0.4 |
| Th-232 | 1.3E-3 | 1,000 | 2.0 |
| Sn-126 | 5.6E4 | 100,000 | 1.4 |
| U-233** | 3.3E2 | 10,000 | 2.1 |
| U-234 | 1.9E5 | 10,000 | 2.1 |
| U-235 | 2.0E3 | 10,000 | 1.9 |
| U-238 | 3.1E4 | 10,000 | 1.9 |

*The EPA standards require that a "sum-of-the-fractions" rule be applied if more than one radionuclide is released. "Unlikely" releases are allowed to be ten times larger than the limits listed here.

**Inventory increases after 1,000 years.

***Committed effective whole body dose equivalent assuming uniform release rate over 10,000 years, aquifer dilution of $10^5$ $m^3/yr$ (following Pigford, LBL-17248), and 2 L/day water consumption.

Table 2 indicates that potential dose rates associated with EPA's release limits are significantly higher than any reasonable standard for individual protection, and are roughly three orders of magnitude higher than EPA's drinking water standards. (Note that the individual and groundwater protection requirements of EPA's 1985 standards did not significantly protect individuals since they were limited to "undisturbed performance" during the first 1,000 years -- conditions for which releases are unlikely to occur.)

How can this be? EPA's standards have been widely criticized for being excessively stringent. However, Tables 1 and 2 suggest the opposite -- that the standards allow significant fractions of most radionuclides to be released and that the resulting doses to individuals can be quite high. How are the two views to be reconciled?

EPA's critics have focused their attention on the 1,000 health effects basis for the release limits without giving serious consideration to the size of the population within which these health effects might occur. In some cases, this is reasonable. If releases are diluted in a river before humans are exposed to them, individual doses are likely to be quite small, and EPA's standards might be more stringent than other accepted safety standards. However, a very different situation exists at Yucca Mountain where there is no river to provide dilution. Dilution in groundwater seems to be inadequate to prevent significant individual doses via drinking water. If Table 2 is at all accurate, at Yucca Mountain it will be necessary to do one of three things: 1) accept the possibility of large individual doses via groundwater consumption, 2) impose more stringent standards for releases than the current release limits of EPA's HLW standards, or 3) eliminate the potential for doses via groundwater consumption by changing our assumptions about the long-term effectiveness of institutional controls.

Is Table 2 bogus? Maybe. The key assumption in translating releases into doses is the amount of water available for dilution of the released activity. The figure used here ($10^5$ $m^3/yr$) is rounded off from Pigford's figure of 9.9 X $10^4$ $m^3/yr$ used in his analyses for the National Academy's Waste Isolation Systems Panel. (Summary paper presented in "Scientific Basis for Nuclear Waste Management VII," 1983.) Accordingly, the individual dose rates of Table 2 are similar to Pigford's estimates. However, it would be a good idea for our hydrologists to try to support or refute this estimate since it is such a critical assumption.

Potential changes to the standards. When EPA developed its standards, a deliberate policy decision was made to emphasize protection of populations rather than individuals. This policy decision was never especially popular within the technical community because of its departure from traditional standards-setting practices, its inconsistency with the recommendations of international advisory organizations, and perceptions that it resulted in excessively stringent standards. Recently, EPA's decision has come under renewed attack as we heard at the September 17-18 symposium hosted by the National Academy of Sciences. If criticism of EPA's standards continues to build, it is possible that EPA will supplement, or replace, its containment requirements with a substantive individual protection requirement more comparable to other radiation protection standards. As indicated in Table 2, for a site like Yucca Mountain, such a standard might be more stringent than the current release limits by two or three orders of magnitude.

Could more stringent standards be implemented? Table 1 illustrates one reason for my optimism about the workability of EPA's probabilistic containment requirements -- a repository really does not have to perform very well to meet EPA's release limits. If EPA were to significantly reduce its release limits, I would need to reexamine my views on the probabilistic standards. However, I think that changes to the containment requirements (191.13) are unlikely. It is more likely that EPA's individual protection requirements (191.15) would be revised to provide a meaningful level of protection. This could easily be done by extending the period of applicability to 10,000 years and/or by applying the requirement to conditions other than undisturbed performance. As long as the revised requirements were not stated probabilistically, I see no reason why such changes would cause us implementation problems comparable to those that have plagued us regarding EPA's containment requirements.

Could more stringent standards be met? Probably. The simplest, but most controversial, solution would be to assume continued effectiveness of institutional controls beyond 100 years. It might also be possible to show that either the waste package lifetime or the radionuclide travel time exceeds 10,000 years. Finally, a combination of low groundwater flux through the unsaturated zone and low solubility limits for key radionuclides might provide sufficiently low engineered barrier release rates to meet more stringent release limits. However, all of these are likely to have accompanying costs, either in improved engineered barrier design or in more thorough site characterization and laboratory testing.

Is this NRC's problem? Generally not. EPA has been assigned the task of determining how safe is safe enough, and I think it is appropriate for the NRC to continue to stay out of that debate. We have our hands full trying to do our own job without taking on EPA's job too. The major effect of more stringent standards on our program would be the increased demands on site characterization and performance assessment. We might also need to reexamine the subsystem performance objectives of Part 60 to see if they need to be revised. However, as we have discussed, we will probably need to review the performance objectives anyway when we propose our conforming amendments to Part 60. Thus, I see few impacts on our program if EPA's standards are revised in a way that makes them significantly more stringent.

D Fehringer

D. Fehringer

cc: R. Ballard
R. Browning
R. Bernero

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# NOTICE

## WARNING CONCERNING COPYRIGHT RESTRICTIONS

# Water-Short Las Vegas Ignites Conflict as Old as the American West

By Lou Cannon
Washington Post Staff Writer

LAS VEGAS—This thirsty, [illegible] gambling oasis is laying claim to vast reserves of underground water throughout Nevada in a [illegible] that its adversaries call [illegible] greatest attempted water [illegible] in history and a menace to the fragile environment of the [illegible].

The application by the Las Vegas Valley Water District to gain control of water supplies in an area twice the size of Maryland is a classic western struggle over the region's most precious [illegible]. But because of the [illegible] threat to rare plants and [illegible] hundreds of miles away, the 146 Las Vegas applications for underground supplies from 26 Nevada [illegible] have implications far beyond the state's borders.

Las Vegas developers, backed by Nevada's gambling industry, say the new water is needed for this booming desert metropolis, which during the last five drought years has received only half of its normal annual [illegible] of four inches.

[illegible] ranchers, conservationists, federal agencies and rural politicians from the three gigantic counties where Las Vegas would take the water warned at an informal hearing here last week by the Interior Department that approval of the applications could dry up natural springs in the Death Valley National Monument in California, kill rare fish species that have survived since the Ice Age and destroy verdant valleys throughout the West.

Under Nevada law, applications can be approved by the state water engineer alone, and approval is expected after hearings that probably will be held early next year. But it is widely agreed that state approval is likely to face a federal court challenge by the Nevada counties or federal agencies that have protested the applications. Most of the applications affect federal lands.

Supporting the opposition from the Nevada counties was Inyo County in California, where in the early decades of the century, Los Angeles tricked farmers in the fertile Owens River Valley into surrendering their water rights.

[illegible] the Inyo County [illegible] pointed out that Owens Valley became a barren dust bowl [illegible] a major source of airborne pollution in Southern California and warned that the same thing [illegible]

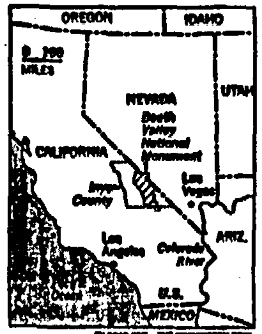
A congressional tour group examines water and vegetation problems in Moapa National Refuge in southern Nevada.

duce 26 Owens Valleys," said Steve Bradhurst, a planning consultant for Nevada's Nye County and coordinator of opposition to the Las Vegas applications.

Nearly a decade ago, Bradhurst led a coalition of ranchers and environmentalists in a successful effort to prevent deployment of the MX missile in Nevada. But he believes that odds against victory are longer now.

"No one predicted that we could stop the MX, but we had [former senator] Paul Laxalt with us in that fight," said Bradhurst. Laxalt, with close ties to then-President Ronald Reagan, helped to kill desert deployment of the MX, which subsequently was placed in existing Titan missile silos.

But Las Vegas and the gambling industry control the levers of political power in the water battle. With more than 800,000 people in the Clark County metropolitan area and a projected population of 1 million by the year 2000, Las Vegas has become one of the nation's fastest-




ly from gambling and related tourism.

"We need more water," said Patricia Mulloy, general manager of the Las Vegas Valley Water District, who said the city is growing at the rate of 6,000 people a month while 90 percent of the state's current water supplies are used by 6,000 farmers. Mulloy said tapping underground

*Opposition from the Nevada counties to the Las Vegas Valley Water District proposal is being supported by Inyo County, Calif.*

new jobs and billions of dollars in revenue to Nevada.

But Mike O'Callaghan, a former Nevada governor who is executive editor of the Las Vegas Sun, has argued in front-page columns that the city has taken an unfair and heavy-handed approach to needs of rural counties. He also has proposed that the state prepare a comprehensive

O'Callaghan appears to be a lonely voice of caution in this optimistic city of illusion, which is defying both the national economic downturn and drought fears that have inspired strict conservation measures and soaring water rates in other Southwest communities.

Golf is the most popular outdoor sport here, and the Las Vegas valley boasts a score of golf courses, each using as much as two million gallons of water a day. Las Vegas water consumption is among the highest in the West—380 gallons per person daily compared with a little more than 200 gallons in Phoenix and Los Angeles.

Residential areas are dotted with fountains, swimming pools, artificial lakes and rich, green lawns. A waterfall flows constantly at the entrance of the Mirage, one of the Las Vegas gambling strip's most glittery hotels, although the waterfall uses undrinkable and recycled water.

The waterfall nonetheless suggests to visitors that water, the most precious resource in Nevada, is abundant in this arid valley. The gambling industry has expressed concern that suggestions of scarcity might scare away tourists. Business leaders disdain building moratoriums and say finding alternative sources of water supplies is preferable to limiting growth.

Las Vegas takes most of its water from the Colorado River, where Nevada's share is small compared with those of neighboring California and Arizona. Mulloy said it would be unrealistic for Las Vegas to base long-term growth on the unlikely possibility that Nevada would receive additional shares of already over-allocated Colorado River water.

The Las Vegas alternative has been to lay claim to 864,000 acre-feet of water in underground basins as far as 250 miles away from the city and as much as 1,000 feet below the earth's surface. An acre-foot is the amount of water needed to cover an acre a foot in depth.

The basins, remnants from prehistoric times when most of Nevada was a lake, are scattered throughout 20,000 square miles of central Nevada and fed by subterranean rivers in carbonate rock formations extending through half of Nevada, one-third of Utah and an area of southeastern California that includes Death Valley.

U.S. geologists said it is difficult to measure the long-term impact of withdrawing this underground wa-

Department, compared the interlocking system of underground basins to a huge bathtub in which many of the environmental resources depend on waters near the tub's edge.

"We just don't know what will happen if the level of water in the bathtub is lowered appreciably," she said.

Representatives of the National Park Service and the Fish and Wildlife Service are protesting many of the 146 applications. They said fragile wildlife and plant species in the national parks and other environmental havens are likely to suffer most from lowering the tub. Among these are the Moapa dace, a small fish that survived the Ice Age in warm springs east of Las Vegas.

A better-known endangered species—the inch-long pupfish living in Devil's Hole in the Death Valley National Monument—also could be affected. A report by National Park Service scientists contends that use of the underground water sought by Las Vegas might dry up natural springs in the national monument, one of the largest units in the national park system.

Mulloy said last week that both sides have engaged in preliminary "posturing" and acknowledged that compromises may be necessary. But she also reiterated the prevailing view here that using the untapped underground water in the valleys to the north is the key to unabated growth of Las Vegas.

## CORRECTIONS

The obituary yesterday of David J. Galvin, a retired Patent Office official, should have said he was a supervisory patent examiner. His age also was misstated. He was 88.

Due to an editing error, a homicide victim was misidentified Tuesday in Courtland Milloy's column. The victim was Andre Reese Jr.

## CLARIFICATION

The caption of a photograph that appeared in some editions yesterday and showed James Bias leaving his home with a friend implied that Bias was in front. He was in the rear.