

**THE PROPOSED AMENDMENTS TO THE USEPA ENVIRONMENTAL STANDARDS
FOR THE MANAGEMENT AND DISPOSAL OF SPENT NUCLEAR FUEL, HIGH-LEVEL AND
TRANSURANIC RADIOACTIVE WASTES (40 CFR PART 191)**

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ABSTRACT

The United States Environmental Protection Agency (EPA) has proposed revised standards for the management and disposal of spent nuclear fuel, high-level and transuranic radioactive wastes (40 CFR Part 191). These standards have been under development since 1987 when the disposal standards (Subpart B) were vacated and remanded by a Federal court. However, the scope of the proposed revisions to the standards and the schedule for promulgation have been significantly changed within the past year as a result of the enactment of Public Law 102-579, the *Waste Isolation Pilot Plant Land Withdrawal Act* (WIPP LWA). These legislatively mandated changes will be outlined and a schedule for promulgation will be presented.

In addition, three other events in the past year which could impact upon future considerations will be summarized. These events are a review, by the EPA's Science Advisory Board, of gaseous releases from unsaturated media and a review, by the Board on Radioactive Waste Management of the National Research Council (BRWM), of technical material submitted to EPA by the Department of Energy in support of comments made prior to proposal, and the enactment of the Energy Policy Act of 1992.

BACKGROUND

In September 1987, a Federal court in Boston, Massachusetts, ruled that insufficiencies in Sections 191.15 and 191.16 of Subpart B (*Disposal Requirements*), individual and ground-water protection requirements, respectively, were sufficient to vacate and remand the entirety of Subpart B. In the intervening years, EPA had been updating its technical analyses and had been consulting with interested parties in an attempt to reach as much consensus as possible. Changes were being contemplated for Subpart A (*Management and Storage*) as well as Subpart B. To assist in this effort, two studies were undertaken. One was conducted by the EPA's Science Advisory Board (SAB) and the other by the Board on Radioactive Waste Management of the National Research Council (BRWM). The SAB study focused on gaseous releases from deep geologic repositories while the NAS study was an examination of technical analyses presented to EPA by the Department of Energy (DOE) to support comments they made on a working draft of the standards. The results of these studies will be discussed later.

On October 30, 1992, the President signed the *Waste Isolation Pilot Plant Land Withdrawal Act* (WIPP LWA) which has made a significant change in the scope and process of repromulgating Part 191. The WIPP LWA reinstated the majority of Subpart B; only Sections 191.15 and 191.16 were not reinstated. In addition, the WIPP LWA requires that the new sections be finalized by April 30, 1993. The Act also exempts all sites which are characterized under Section 113(a) of the Nuclear Waste Policy Act. At this time, the only site affected is the proposed site at Yucca Mountain, Nevada.

The WIPP LWA does not forbid changes to the reinstated sections, the short time frame imposed effectively does. The course the Agency has followed is proposal of only the replacements for Sections 191.15 and 191.16 while leaving the remainder of Subpart B unchanged with the exception of some necessary changes in definitions. Neither are there any changes to Subpart A being proposed.

With the reinstatement of the majority of Subpart B of Part 191, the changes necessary to meet the intent of the WIPP LWA were narrowed to the two sections upon which the court remand was based, viz., the *Individual and Ground-Water Protection Requirements*. The questions which needed to be addressed for both sections were the level of protection and the length of time which must be analyzed to demonstrate compliance. Another question dealing with the court remand was whether deep geologic repositories are a form of underground injection.

**PROPOSED CHANGES TO THE INDIVIDUAL
PROTECTION REQUIREMENTS**

In the remanded version of the standards, Section 191.15, *Individual Protection Requirements*, imposed an annual limit of 25 millirem (250 μ Sv) to the whole body as received from radionuclides released, as a result of undisturbed performance, from the repository and traveling through all applicable pathways to the receptor.

The recently proposed version maintains the "all pathways" and "undisturbed performance" approaches but has an annual limit of 15 millirem (150 μ Sv) committed effective dose (CED); this dose presents an increased risk that an individual would develop fatal cancer of about 5×10^{-4} over a lifetime. Because of revised risk-to-dose estimates, this risk is roughly equivalent to the lifetime risk that was associated with 25 mrem (250 μ Sv) per year in 1985. The Agency also believes that 15 millirem CED is sufficiently protective for situations where no more than a few individuals are likely to receive the maximum dose. The Agency believes that it is reasonable to allow a slightly higher level of risk when the dose is being received through multiple exposure pathways rather than a single pathway or via a single medium, e.g., the annual 10-millirem-CED limit for emissions of radionuclides into the air.

The other change in the *Individual Protection Requirements* is an extension of the regulatory period. In 1985, the standards were to apply for 1,000 years following disposal. In the recently proposed standards, that period is 10,000 years.

The main reasons for the choice of 1,000 years in the 1985 standards were that the use of good engineered barriers would be encouraged while avoiding what appeared at that time to be an overly burdensome task of demonstrating compliance because of the uncertainties involved. In addition, there was concern that very expensive engineered barriers would be necessary at some sites.

However, in reconsidering this issue, the Agency has changed its position. First, the Agency's generic analyses have shown that, for most of the geologic media analyzed and using reasonable parameter values (the Agency's base cases), there are estimated to be no releases over the first 10,000 years. In fact, only in the basalt base case were releases projected before 10,000 years. In this case, doses rapidly rose to the rem level. Therefore, it was concluded that the use of 10,000 years, assuming "undisturbed behavior" and considering that the media at some sites may not be efficient enough to contain the radionuclides, is not unreasonable and will encourage the selection of "good" sites and robust engineered barrier systems. In addition, it is consistent with the Subpart B Containment Requirements and the "no-migration" determinations made under the Resource Conservation and Recovery Act, as amended.

PROPOSED CHANGES TO THE GROUND-WATER PROTECTION REQUIREMENTS

In the 1985 standards, a complex system of ground-water classification was employed which protected certain, limited underground sources of drinking water. This was based upon a proposed strategy and classification scheme which the Agency later withdrew from consideration.

For the 1993 proposed Part 191 standards, the Agency has decided to adopt the Safe Drinking Water Act (SDWA) regulations which are in effect at the time that compliance is demonstrated. At the moment, this consists of a four-millirem ($40 \mu\text{Sv}$) per year limit from beta and gamma emitters and several concentration limits for alpha emitters (each of these limits is a maximum contaminant level or MCL). In July, 1991, the Agency proposed amendments to the Safe Drinking Water Act regulations. These proposed regulations limit exposure from beta- and gamma-emitting radionuclides to four millirem ($40 \mu\text{Sv}$) CED per year and several concentration levels for alpha-emitting radionuclides.

The Agency believes that these proposed amendments fulfill the Court's charge to make Part 191 consistent with the SDWA. It will also discourage potential endangerment of underground sources of drinking water since endangerment is triggered by exceeding the MCLs.

As has been done for the individual protection requirements, the length of the regulatory period is proposed to be lengthened from 1,000 to 10,000 years and, of course, assumes "undisturbed" performance. The discussion in the previous section is also applicable here.

APPROACH TO THE ISSUE OF UNDERGROUND INJECTION

Part of the Court ruling included a finding that deep geologic repositories would "likely" constitute a form of underground injection. EPA has addressed this issue by proposing to amend the Underground Injection Control (UIC) program regulations to establish that compliance with the proposed Subpart C of Part 191 would constitute compliance with the UIC program requirements if it is determined that

such requirements would apply to a particular disposal system.

EPA has not found convincing technical or policy reasons for proposing a level of protection for ground water less stringent than would apply under the SDWA. The Agency has determined that proposed Subpart C of Part 191 and the SDWA regulations have essentially the same environmental and public health protection goal, *i.e.*, prevention of endangerment of underground sources of drinking water. The Agency also believes that the procedural aspects which take place prior to licensing disposal systems subject to Part 191 is at least equivalent to that which would occur under the SDWA. Overall, then, EPA believes that Subpart C comprehensively requires disposal of radioactive wastes to which it applies to be accomplished in a manner that protects underground sources of drinking water resources present outside the controlled area around a disposal system as effectively as the SDWA regulations.

THE RESULTS OF THE SCIENCE ADVISORY BOARD STUDY

Prior to the WIPP LWA reinstatement, EPA asked its Science Advisory Board to examine the issue of gaseous releases from repositories located in unsaturated zones. At the time of this writing, the EPA Science Advisory Board (SAB) had not approved a final report. However, a review draft had been released which contains major conclusions which are not likely to change substantially. Such change is, of course, possible and this should be considered a caveat. It is also noted that with the enactment of the WIPP LWA, this report is not considered relevant to the current rulemaking for Part 191. However, this report could play a role in future considerations.

The Agency presented a contractor-prepared report to the SAB for purposes of discussion. There were then six questions asked of the SAB. These questions dealt with: (1) the source term, (2) the accuracy of the report in characterizing release mechanisms and rates, (3) proper description of the effectiveness of engineered barriers, (4) the adequacy of the description of retardation and radionuclide transport, (5) the completeness and accuracy of the release magnitudes, and (6) adequacy of the uncertainty assessment.

In general, the SAB found the report to be inadequate but recognized that this is more the fault of a lack of research and data than the methods used in the report.

1. Source term. There was agreement that a source term of approximately one curie per metric ton of heavy metal (MTHM) is reasonable. This agreement was tempered by differences in judgment such as 100% oxidation of carbon atoms is probably too high and that pretreatment to remove potential gaseous radionuclides did not look promising.
2. Release mechanisms and rates. The SAB found that the report did not adequately describe mechanisms and release rates from the waste. However, given the current state of knowledge, "it is not clear that these mechanisms and release rates can be more accurately characterized." Also, the assumed release rate, 10^{-4} per year, is not solidly scientific and could indicate larger releases than actually happen; although they noted that they know of no solid justification for any particular value. Another critique was that the model used for

container corrosion in which a small percent of the containers fail at 300 years and the rest at 1,000 years does not cover the entire range of uncertainty in that parameter. And finally, the assumption that 5% of the carbon-14 inventory is released promptly is probably too high.

3. Effectiveness of engineered barriers. The SAB faulted the lack of research that has been done in the area and urged that more should be done. They could not agree on "the technical feasibility and effectiveness of improved barriers to impede or retard" any releases.
4. Retardation and transport model. The SAB found it conceptually valid. However, the choice of parameters and the ranges of their values leads to "higher releases and underestimated uncertainties. They determined that using a site with flat terrain would not significantly reduce potential releases as was asserted in the report. The major reason for this was a factor not examined in the report, temperature-driven convection. They identified another issue which was believed to deserve further attention. In the EPA report, it was assumed that an aquifer would essentially eliminate gaseous releases. The SAB took issue with this and said that it should be analyzed further. Potentially the most important conclusion was that not enough is known about the travel of gases through the unsaturated zone to either support or rule out the possibility of finding a site where geologic barriers could contain carbon-14.
5. Magnitude of releases. The SAB decided that the base case used in the assessment probably leads to high estimates of the amount of carbon-14 which could be released. In addition, to provide a greater understanding of the nature of the risks, the SAB believes that there should be multiple endpoints, e.g., annual releases as a function of time, collective dose over 10,000 years, and individual doses and dose rates, in addition to the reported normalized release rates. With each of these endpoints there should be uncertainty and sensitivity analyses.
6. The uncertainty analysis. The SAB felt that some uncertainties were underestimated and some were not discussed. Also, they judged that the selected, limited range of parameter values predetermined the outcome of the sensitivity analyses. They stated that using the broader ranges, as recommended in their report, would result in an estimated-to-allowable release ratio of zero to 10.

The SAB also noted that site selection based upon this single criterion, i.e., gaseous releases, may not necessarily result in overall optimal disposal conditions. It should be noted that the Agency has never intended to do this but wanted to narrow the scope of the SAB study to just gaseous releases from unsaturated media.

THE RESULTS OF THE BOARD ON RADIOACTIVE WASTE MANAGEMENT REVIEW

In late 1991, DOE submitted comments to EPA regarding a working draft of Part 191. At that time it was planned to propose the entirety of Subpart B of Part 191. EPA requested DOE to provide further technical bases for several of those comments. DOE completed this effort in August 1992. Shortly

prior to this, EPA and DOE had requested, through the National Research Council, for the BRWM to review, on a technical basis, the results of the DOE work. The BRWM examined the issues and published its findings in December 1992. The subject areas reviewed were: (1) human intrusion; (2) uncertainty propagation; (3) the transuranic waste equivalent unit; (4) multi-mode release limits; and (5) collective dose. It should be noted that these areas were focused on the containment requirements which have been reinstated by the WIPP LWA and are, therefore, not as directly relevant to the current rulemaking on Part 191 as they were prior to the WIPP LWA. However, the findings could be employed in future deliberations. A synopsis of the findings on each area follows.

1. Human intrusion. The BRWM agreed "with DOE that establishing the probability of human intrusion will be difficult," although it could be just as difficult for some natural processes and events. However, the finding also states that "there is a reasonable likelihood of inadvertent human intrusion" and, therefore, risk assessments should be based upon the consequences of human intrusion rather than its probability. Nonetheless, the BRWM states that an analysis of the probability should be done to aid in discriminating among potential disposal sites and to devise disposal system designs capable of mitigating the consequences. The BRWM also encouraged EPA to provide guidance which designates specific assumptions and parameters to be used.

DOE had proposed comparing the results of human intrusion analyses with ten times the release limits. In Part 191, the comparison to be made with ten times the limits is for processes and events with likelihoods of less than one chance in 10 of occurring over 10,000 years. The BRWM found no technical support for the DOE's position and, in fact, stated, "the proposal would permit greater releases from human intrusion than from natural processes." This portion of the DOE proposal was rejected for that reason.

This finding concludes with the BRWM stating "that human intrusion should be a significant factor in site selection" and that the DOE approach would reduce that significance. They note that this is similar to DOE proposing to compare releases to ten times the release limits. They believe that this would "not encourage the design of disposal systems that are as robust against the consequences of human intrusion as against other release scenarios."

2. Uncertainty Propagation. The DOE submission argued for the use of a 1,000-year applicability period for the individual and ground-water requirements as opposed to 10,000 or 100,000 years. This was based upon their conclusion that "release calculations at 100,000 years are more uncertain than at 10,000 years...." BRWM agrees that uncertainty increases with time but states that the DOE analysis does not support that conclusion.

The appearance of increasing uncertainty in the DOE analysis comes from the use of an absolute measure. The BRWM said that such a measure is usually done in a relative manner using a multiplicative factor

around a mean, e.g., if 3 is the factor of uncertainty, the likely result lies between the mean divided by 3 and the mean multiplied by 3. "On this basis, the DOE analysis does *not* demonstrate increasing uncertainty."

The second finding under this heading concerned the difference between uncertainty in calculating individual doses versus curies released. There was no analysis offered by DOE but the BRWM believes that individual dose calculations may be "either more or less certain than calculations" of releases depending upon the situation.

3. TRU Waste Equivalence Unit. Prompted by comments received on early working drafts, EPA decided to re-examine the 1985 TRU waste equivalence unit which was set at 1,000,000 curies of TRU per 1,000 metric tons of heavy metal (MTHM). The equivalence unit is used as the denominator in the ratio of total TRU curies in the disposal system which is then multiplied by the release limits. DOE suggested using a 20 million-curie TRU repository be set equal to a 100,000 MTHM repository. This would result in an equivalence of 200,000 curies per 1,000 MTHM. EPA was considering proposing use of a system wherein the activity of each radionuclide in a disposal facility was integrated over 10,000 years and multiplied by its specific risk factor and summed over all radionuclides. The EPA method would result in an equivalence of about 3 - 10 million curies per 1,000 MTHM.

The BRWM decided that the choice of a particular value or approach is a policy issue "because it defines the acceptable population risk from a TRU" disposal system and was, therefore, beyond the scope of the review. However, they encouraged continued work to find an equivalency "that would allow general application of the standard to all types of radioactive waste that might go into a" disposal system.

4. Multi-Mode Release Limits. The 1985 release limits were based upon a pathway from the repository to a river via an aquifer. DOE argued that this model is not appropriate at all sites and should be modified to allow consideration of those pathways present at a specific site. In addition, DOE thought that further modification was appropriate which would allow further reductions (termed "site adjustment factors" by DOE) in projected releases by using actual expected points of discharge rather than using the boundary of the accessible environment.

The BRWM agreed that multiple pathways could be an appropriate alternative to the 1985 release limits provided that conservatism is kept consistent with the health goals of the standards. The BRWM left to EPA the question of appropriateness as to the use of site adjustment factors but indicated that their use would require significant analysis beyond that presented by DOE.

The BRWM did not review DOE's suggestion to move regulation of carbon-14 from the containment requirements to the individual protection requirements. However, they did mention that if carbon-14 is kept under

the containment requirements, it would be straightforward to put them under an atmospheric pathway release limit.

5. Collective Dose. The issue which was reviewed was the use of a collective dose limit as an alternative to the release limits. The EPA was considering the conversion of its overall goal of 1,000 health effects over 10,000 years from 100,000 MTHM to person-rem. In this case and at that point in time that was 25,000 person-rem. The BRWM endorsed this approach as "a significant improvement in the technical linkage between the overall health protection objectives of the standard and the implementation of the containment requirements."

THE ENERGY POLICY ACT OF 1992

Another act, the Energy Policy Act of 1992 (Public Law 102-597) was enacted about the same time as the WIPP LWA. It directed EPA to contract with the NAS to do a study of the potential for human intrusion into Yucca Mountain and whether an individual dose limit would protect the public. EPA is then supposed to write Yucca-Mountain-specific standards. This contract has recently been approved. It is expected that NAS will have a report by December 1994. Congress then gave EPA another year to issue these standards.

RELATED PROJECTS UNDERWAY

Besides the six-month deadline given in the WIPP LWA for the finalization of the amendments to Part 191, the Act also assigned portions of the implementation of Part 191 at WIPP. There are currently two projects operating for this purpose. One is in the process of reviewing, for approval or disapproval, the Test Phase Plan. This is the plan that will guide testing of TRU waste at WIPP over the next several years. The WIPP LWA has a deadline of August 1993 for this decision. The other current WIPP-related project involves writing implementing criteria for Part 191. The WIPP LWA deadline for this project is October 1994.

SUMMARY

The amendments to Part 191, which are necessary as a result of the Federal court remand and the Congressional reinstatement and imposed deadline, have been proposed. The amendments apply only to those sections not reinstated by Congress in the WIPP LWA, i.e., the individual and ground-water protection requirements. For individual doses, the limit, 15 millirem (150 Sv), is based upon all possible pathways leading to a person in the accessible environment. Also, the regulatory period has been extended from 1,000 to 10,000 years.

For the ground-water protection requirements, an entirely new subpart has been devised which is consistent with regulations issued under the Safe Drinking Water Act. The regulatory period for these requirements is also proposed to be 10,000 years.

The studies which were done by the EPA SAB and the NAS are generally not applicable to the current rulemaking. However, as EPA proceeds with future rulemakings, particularly, the Yucca-Mountain-specific rulemaking in conjunction with NAS, they will likely be incorporated into those deliberations.