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Risk Considerations for WIPP Passive Institutional Controls

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ABSTRACT

The regulatory assurance measures for the Waste Isolation Pilot Plant (WIPP) include such things as active and passive institutional controls, monitoring, waste retrieval/removal capabilities and engineered barriers. Passive Institutional Controls (PICs) are an assurance measure intended to reduce the likelihood of humans unintentionally intruding the WIPP geologic radioactive waste disposal system for thousands of years after it is closed. The waste repository is designed such that it should not pose a significant risk to future populations if it is left undisturbed. The design has also been demonstrated through a performance assessment (PA) analysis to not pose a significant risk to future generations even if it is intruded upon by an inadvertent drilling intrusion [1, Appendix PA]. Through PA, it has been determined that the overall risk of the disposal system to people and the environment is small. The intent of the regulatory Assurance Requirements and PICs is to provide additional confidence that the repository will perform as expected after closure. However, the actual implementation of the proposed PICs design may pose a greater risk to the current population than they would potentially reduce for future generations. Specifically, the risks due to industrial accidents, construction and transportation risks incurred during the fabrication and construction of the permanent markers system may be greater than the overall reduction in risk to future generations due to the existence of the permanent markers. If this were true, implementation of the current PICs design may be counter to the intention of the regulatory requirement to include such assurance measures. As such, provisions for assurance measures used in geologic radioactive waste disposal facilities, such as PICs, should consider risk impacts. A provision of any disposal program's Regulatory Assurance Requirements should address the impacts of the known risks from all the components of the assurance-related systems. The initial WIPP PICs design was developed as part of the regulatory certification process in 1996 with the intent of being revised when the WIPP closes several decades from now [2, Appendix PIC]. The revised design that will be developed at closure should address the design's potential reduction to long-term risks from the repository and the risks due to the implementation of the final design.

INTRODUCTION

For WIPP, a PA is used to predict the disposal system's radioactive waste containment performance. The results are compared to specific cumulative regulatory release limits over a 10,000-year period. Unlike most international disposal programs and the U.S. high-level waste programs, the WIPP disposal standards limit releases and not potential doses to future populations. To provide additional confidence that the WIPP's disposal system will isolate the waste as predicted by PA, several assurance measures are required by the governing regulations. These assurance measures include:

1. Active Institutional Controls
2. Monitoring
3. Passive Institutional Controls
4. Engineered Barriers
5. Resource Disincentive
6. Waste Removal

The intent of the assurance measures is to provide additional confidence in the overall system's ability to reduce the risk of the repository to future populations. As stated in the WIPP long-term disposal regulations, PA need not provide complete assurance that the containment requirements will be met. Because of the long time period involved, 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 [3]." Because of this, assurance measures were required by the regulator to help provide additional confidence that the repository will isolate the waste from the environment.

The disposal system's containment requirements are based on the potential risk to future populations. The risk of the disposal system should not be greater than the potential risks from a natural ore body the size of which it would take to produce the radioactive waste in the disposal system. As the WIPP's release limits are normalized to the radionuclide inventory in the repository, the actual risk or consequences of the repository are dependent on how much waste is eventually emplaced in the repository. As such, it is difficult to associate the risks of the repository to future generations based on actinide releases to the accessible boundaries without developing scenarios that determine mechanisms allowing future populations to be exposed to these calculated releases. A comparison of the potential dose to man due to a release scenario could be developed that could be compared to the risks of PICs implementation; however, this has not been done.

Need to quantify the risk

As stated earlier, the intent of an assurance measure is to reduce risks to future generations. However, there are inherent risks associated with these measures. Specifically, the current population will incur risks associated with assurance measure construction, transportation of materials, additional environmental impacts from mining, quarrying and emissions. The WIPP Passive Institutional Controls include permanent markers, records archival and government ownership. The current permanent markers design includes a large earthen berm, many large granite monuments and two granite information centers (above ground open structure and a buried room containing duplicate information). The design is documented in the WIPP compliance application (http://www.wipp.energy.gov/library/CRA/BaselineTool/Documents/Appendices/PIC.PDF) [2, Appendix PIC]. These elements will require significant labor to build the earthen berm, and to quarry and engrave the large granite monuments and information center walls. There will be occupational and transportation risks involved with the PICs system construction. Large quantities of salt, caliche and rip rap will need to be transported for the construction of the berm. Quarrying large granite walls and monuments and transporting them significant distances via rail will also incur risks to the current population at that time. The cumulative total of these risks could be significant in that it is possible the risk incurred to implement the PICs may be greater than the potential reduction in risks that the assurance measure is intended to yield. With the exception of selecting the engineered barrier assurance measure, the governing regulations only require that assurance measures be included in the disposal system design, they do not address performance, risk or benefit criteria. Because of this, who should determine acceptable risks to the present population for a perceived and unmeasurable benefit to those of the future?

METHODS

The basic premise of this paper's recommendation is that the risks of the PICs design and implementation should be considered and mitigated prior to actual construction. This can be accomplished by either performing an analysis that assesses the risks imposed by the current design or considering them as part of the final redesign process. The analysis would develop criteria to determine the types of risks that should be considered/compared and an acceptable limit for these risks. Determining these criteria is not straight forward. Direct comparison of risk of PICs against the long-term performance of the repository using the PA results is not possible because the PA results are not specifically risk-based, they are based on radionuclide containment performance. PA determines potential cumulative releases to the accessible boundary over a 10,000 year period. The PA does not directly determine dose-to-man or any other risk metric (i.e., potential fatalities per year). The boundary includes the surface but also the perimeter of the site at depth. If left undisturbed, the PA results do not show any releases at the site's surface and negligible to no releases at the underground boundary [1, Appendix IGP]. Quantifying what the risk to a future population would be for a release at the boundary 2,150 feet below ground level would require specific contaminant pathway assumptions that are highly uncertain and unrealistic. The results may not be a good metric to compare to current construction-related risks. Therefore, the analysis must identify the types of risks that are related to PICs implementation and determine how they may be related to the long-term risks of the repository.

Although PA models a drilling scenario where a driller hits the repository, the scenario was developed per the regulatory requirements. The regulations specify the impact of a release to the surface from drilling would soon be detected by the driller and mitigated such that PA is not required to determine the potential impact to the drillers. PA does determine the cumulative releases from drilling intrusions, specifically cuttings, cavings, spallings and contaminated brine releases. Again comparison of cumulative releases to risks to future populations is not easily compared to PICs implementation risks.

To determine containment performance, the WIPP's regulations also require analysis of potential doses to man (compliance assessment). The regulations describe the assumptions that should be used in this assessment, included where the affected individual is located and how much of a potential contaminated source of drinking water they consumed per day. The project performed this compliance assessment in 1996 which determined the potential dose to be 0.93 mrem per year which is well below the regulatory limit of 15 mrems per year [1, Appendix IGP]. The latest PA shows no releases to the boundary such that there would be no dose-to-man for this scenario. This scenario also conservatively assumes that there is a water well at the WIPP site boundary when in reality, there is no potable water there.

For the reasons discussed above, specific risk limits based on repository risk that is comparable to those due to PICs may not be practical. However a comprehensive risk analysis should determine what potential risks exist for each element and if there is justification to develop criteria for PICs implementation risks. If no justifiable criteria could be determined, the final PICs design should at least quantify the expected risks (identified in the risk analysis) to the current population such that the project and stakeholders can make an informed decision on implementing the PICs design and may make changes that reduce the risk impact of PICs.

DISCUSSIONS

There are several reasons that the risks due to PICs implementation should be considered. It is a regulatory requirement to mark the site with as permanent a marker as practical. Providing additional measures to deter human intrusions into the waste is the basis of this requirement. However, at the time the regulations were developed, the actual impacts from human intrusion had not been thoroughly modeled. Since this time, the containment performance of the WIPP has been modeled and found to meet the regulatory containment limits without any credit for PICs deterring human intrusions. The PA results show that the repository complies with the containment standards even if the PICs are completely ineffective at deterring human intrusion. If PICs are not needed to deter human intrusions as intended then their potential risks of implementation may increase the overall risk of radioactive waste disposal.

PA has also determined that early intrusions into the repository are more significant than later time intrusions. Intrusions in the first few hundred years have a much higher consequence, partly due to radioactive decay. The regulations require active controls for the first 100 years which will prevent intrusions during that time and it is very likely that PICs will be highly effective at deterring intrusions for a least a few hundred years after that [2, Appendix EPIC].

Although they may not be needed to demonstrate containment performance, this paper does not recommend removing passive controls requirements at WIPP. PICs will arguably communicate the existence and hazards of the waste for hundreds to thousands of years. Communicating the existence of WIPP is a responsibility of this generation, introducing additional risks to the current population is not. Therefore it is justifiable to assess the risks of passive controls measures when determining the actual design that will be constructed when WIPP is closed decades from now.

CONCLUSIONS

The regulatory assurance measures for WIPP include such things as active and passive controls, monitoring, waste retrieval/removal capabilities and engineered barriers. PICs are an assurance measure intended to reduce the likelihood of humans intentionally intruding WIPP for thousands of years after closure. The repository is designed to not pose a significant risk to future populations if left undisturbed. The design has also been demonstrated through a performance assessment analysis to not pose a significant risk to future generations even if it is accidently intruded by drilling events. The risk of WIPP to people and the environment is small. The actual implementation of the currently-proposed PICs design may pose a greater risk to the current population than they actually reduce for future generations. During the final evaluation of the PICs design, the risks of PICs implementation should be considered and mitigated prior to their actual construction. This consideration should also apply to other international disposal programs.

REFERENCES

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