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Deep Isolation – Development of the safety case for disposal of Radioactive wastes in horizontal boreholes

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Nuclear power is likely to be a low-carbon source of baseload energy for decades to come. One challenge remains vexing to the continued use of nuclear power, this being the safe management of radioactive wastes.

Deep Isolation has developed a safe, secure, and permanent deep geological disposal method for high-level waste, including spent nuclear fuel as well as sealed sources and other highly radioactive materials. The method uses horizontal drilling techniques and emplaces the disposal canisters in a horizontal orientation. This provides additional safety factors to those found in deep mined repositories or deep vertical boreholes.

The innovative solution uses established directional drilling technology from the oil and gas industry to drill a vertical drill hole hundreds to thousands of meters deep and then transition to a horizontal drill hole that is thousands of meters in length. The target geologic media for our disposal solution is in or below formations that have been out of contact with surface waters for hundreds of thousands to millions of years. These formations are present at various depths throughout much of the world and will ensure the suitability of the geologic environment prior to considering any location.

Work by Deep Isolation has focused on the development of the safety case for its disposal system. This paper will address the dominant features of the Deep Isolation system that establish the demonstrable case for disposal safety.

Siting: Deep Isolation is establishing a list of criteria that are necessary for the candidate site to be acceptable. The criteria include stability, the age of the water in the disposal horizon, the isolation of the water at the disposal horizon from water above and below (determined by isotopic age dating methods), and geochemistry. It should be noted that Deep Isolation is no longer focused on shales and other sedimentary rocks. After being convinced of the drilling and emplacement technology, Deep Isolation is actively considering emplacement locations in deep basement rock, provided all siting conditions are met.

Elimination of Pathways: In other disposal concepts, the process of emplacing nuclear wastes creates a pathway for its release to the biosphere. Deep Isolation is addressing this with horizontal emplacement a considerable distance from the vertical borehole. In addition, the horizontal portion of the borehole is inclined a few degrees above horizontal. These design facets eliminate two pathways for transport of radionuclides in disposal. The first is that analyses have shown that there is essentially no thermal gradient present at the vertical portion of the emplacement borehole, thus eliminating the energy source to move contaminants to the surface. These analyses have considered very high burnup fuel with minimal cooling. The slight incline of the horizontal emplacement borehole creates a preferential path for any gases evolved during the disposal process, noting that the preferential pathway is to a “dead end” – the end of the horizontal emplacement borehole. Analyses are ongoing to determine the quantity of gases expected once wastes are emplaced.

Engineered Barriers: Deep Isolation is mindful of regulatory requirements for engineered barriers as well as the cases for excluding them. Alternative canister materials are being considered for the various geologic environments that might be present in disposal conditions. In addition, Deep Isolation is evaluating alternative backfill and seal materials that would be used to close the disposal boreholes.

A comprehensive safety case is being prepared by Deep Isolation and its progress will be reported in this paper. The

current conclusion is that in a properly sited Deep Isolation disposal system, there is no native nor manmade pathway that would connect the disposal setting to the biosphere.

The stalemate seen across the globe on the disposal of spent nuclear fuel and high-level waste can be broken. Deep Isolation offers options for safe, secure, and permanent deep geological disposal of nuclear waste while reducing the time and cost of licensing, constructing, and transporting nuclear waste.

Speaker Biography

James Voss is a Senior Nuclear Engineer and President of the Terra Verde Group of Companies. He has managed radioactive, solid and toxic waste programs in over 20 countries and has advised governments and companies on decommissioning strategies. He served as the General Manager of the President's State Planning Council on Radioactive Waste Management during the terms of Presidents Carter and Reagan.

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