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Technical and Scientific Reasons
Why Disposal of Radioactive Waste and Spent Nuclear Fuel at Yucca Mountain
Is Unacceptable and Not Adequately Protective of Human Health and Safety

The need to achieve safe disposal of high-level radioactive wastes and spent nuclear fuel is a matter that has to be addressed by any country with a significant nuclear program. Worldwide, there is broad agreement that deep geological disposal is the preferred option, with the intent being that the geological environment will provide long-term protection of the waste packages from degradation, and will limit the transport of radionuclides to the human environment in the event of container failure. Thus, for example, in Sweden and Finland, the proposal is to dispose of spent fuel in copper canisters in a geological environment in which significant degradation of the packages would not be expected on a timescale of one million years or longer.

In contrast, the geological environment at Yucca Mountain provides essentially no protection of the waste packages against degradation and would do little to limit the transport of radionuclides from those packages once they had degraded. Thus, the DOE can only argue for the long-term safety of the proposed facility based on projection of the performance of complex engineered materials and structures over timescales longer than the total duration of human civilization. In contrast, the materials that they rely on have only been used for engineering purposes for, at most, a few decades. Furthermore, although resistant to degradation in some contexts, it has been demonstrated experimentally that these materials would not maintain their physical integrity in the environment that would be present in a repository at Yucca Mountain.

A fundamental problem with the proposed Yucca Mountain facility is that it is positioned above the water table in a location where corrosively aggressive infiltrating water would contact the waste containers. No other country is proposing to locate a repository above the water table, so the problems that arise are unique to the US program and are not being addressed by research and development activities elsewhere in the

world. Safety analyses conducted by the DOE have shown that disposal of waste packages of the proposed design at Yucca Mountain would give rise to radiation doses to members of the local population far in excess of the Federal Standard set by the Environmental Protection Agency to protect public health. Furthermore, this violation of the Standard is projected to occur within a few hundred years of repository closure.

Faced with this fundamental obstacle to demonstrating the safety of the proposed repository, the DOE License Application introduces an additional design feature. It posits the existence of titanium alloy 'drip shields', one 5-ton drip shield over each of the 11,500 waste packages, to ward off the corrosion-promoting water. However, these extremely expensive drip shields are not part of the current waste installation plan, but are intended to be installed by a yet-to-be-designed, remote-controlled robotic mechanism about one hundred years after the wastes have been emplaced. Taking account of the high temperature (above boiling point), high radiation, physically degraded environment that would exist at that time, it seems unlikely that efficient and comprehensive installation of the drip shields could be achieved, even if the political will to undertake that installation could be relied upon. It is not acceptable to base public safety on such a technically risky and politically uncertain proposition.

The problems in developing a safety case for Yucca Mountain arise essentially from selection of an inappropriate site and invalid disposal concept. Although located in a desert region, the unsaturated rock at Yucca Mountain contains large quantities of water that can percolate rapidly downward to the saturated zone, where it is then carried away horizontally toward the residential and agricultural area of Amargosa Valley. The downward seeping water would enter the hot, oxidizing environment of the waste tunnels and there promote rapid waste package corrosion, waste dissolution and the migration of radionuclides to a major pristine aquifer and hence to Amargosa Valley, contaminating groundwater resources there to an unacceptable degree. No other country is considering a repository attaining temperatures as high as those proposed at Yucca Mountain. Nor are other proposed repositories located in unsaturated, oxidizing environments where reliance has to be placed entirely on the predicted performance of complex engineered materials and structures to achieve safety. Indeed, location of a repository in the conditions existing at Yucca Mountain is ruled out by generally accepted international standards. The United States, as a party to the 2001 *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* is obligated to conform to such standards, if this is reasonable.

Not only is the location of the proposed Yucca Mountain repository inconsistent with international standards, but those standards also include the requirement that the design should incorporate redundant barriers. That is, the overall performance of the geological disposal system should not be unduly dependent on a single barrier or function. This is usually called defense-in-depth and is a basic feature of nuclear power reactor safety as regulated by the NRC. Defense-in-depth does not exist in the proposed Yucca Mountain repository design, as compliance with Federal Safety Standards depends entirely on the installation and performance of the drip shields, neither of which can be assured at the time of licensing.

The foregoing general objections apply even if the results of calculations presented by the DOE in the Yucca Mountain License Application are accepted. However, the scientific and technical bases of these calculations are open to question. Three independent panels of NRC lawyers and scientists have determined that the License Application raises over 200 significant safety and environmental issues that would have to be fully and satisfactorily resolved before any license could be issued. These issues include:

- The appropriate representation of future climate in the area;
- The selection of models to characterise water flow;
- The chemical composition of the water that would contact the drip shields (if installed) and waste packages;
- The corrosion resistance of drip shields and waste packages;
- The sorption of radionuclides to minerals in the rock;
- The behaviour of radionuclides in the biosphere.

Further issues relate to vulnerabilities of surface facilities to aircraft crashes and the overall vulnerability of the site to future volcanic events.

The unprecedented number, scope and technical depth of the admitted contentions relating to these issues suggest that, taken together, they cannot reasonably be expected to be resolved in favor of the proposed repository. To date, some ten billion dollars have been expended in investigating the Yucca Mountain site and in developing a grossly inadequate licence application. To proceed with repository construction would result in the expenditure of several times as much over the next decade, but with a high likelihood that the resulting facility would then be found to be unacceptable for disposal of either spent fuel or high-level wastes.