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Please respond to Charles Fairhurst <fairh001@tc.umn.edu>

To: ymp_sr@ymp.gov
cc:

Subject: Yucca Mountain Site Suitability

Part of Records Package / Supplement / Correction

Please replace my earlier comments, sent about 3 hours ago, with those attached below. The earlier note included several typographical and spelling errors and awkward phrasing that I have attempted to correct in the version attached here.

C. Fairhurst

- SiteSuitability.REVdoc.doc

- fairh001.vcf

Suitability of Yucca Mountain as a Repository for High Level Nuclear Waste.

Comments

by

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As someone who has been closely associated with efforts to establish the suitability of various geological rock types and locations for disposal of nuclear waste for thirty years, both in the United States and other countries, I would like to comment on the suitability of the Yucca Mountain site for long-term isolation of high-level nuclear waste.

My first contact with waste isolation came in 1971 when I was appointed as a member of the U.S. National Academy of Science's Committee on the Bedrock Concept, a proposal to place defense waste from the Savannah River Plant in Triassic sandstone deep below the Plant. Since that time I have maintained an active unbroken association with the subject, both in the United States and in other countries. Currently, I am a consultant to the geological isolation programs in Canada, France, Sweden and Switzerland-in addition to the Yucca Mountain program in the United States.

Individual Risk

Before addressing the Yucca Mountain site specifically, I would like to comment on the broad issue of perceived risk associated with geological isolation of nuclear waste.

The U.S Environmental Protection Agency has recently established a Standard of 15 millirems/year [15mrem/y] (equivalent to 0.15 milliSieverts/year [0.15 mSv/y] for the maximum individual radiation dose rate that cannot be exceeded at any time within the first 10,000 years of repository operation at Yucca Mountain. This standard is consistent with that established by other nations. It is more severe than several, where 0.25mSv/y has been adopted.

The radiation protection standards of various countries are based on studies of atomic bomb survivors in Hiroshima and Nagasaki. These studies suggests that the risk of developing a fatal cancer due to exposure to ionizing radiation is 100% if a person is exposed to a total lifetime dose of 20Sv. It is to be noted, however, that radiation exposures at Hiroshima and Nagasaki were all high dose rate-short duration exposures.

In the absence of data for the very small dose rates/long exposure conditions associated with geological isolation, the International Council on Radiological Protection (ICRP) argued that it is prudent to assume that the effects are independent of dose rate levels.

Thus, if a total exposure of 20Sv can be equated to a 100% risk of developing a fatal cancer, then 1Sv total exposure results in a 5% lifetime risk i.e. of 100 people each exposed to a total of 1Sv during their lifetime, 5 would die of radiation-induced cancer. Similarly, a dose rate of 0.15mSv /yr for 100 years [assuming a life-expectancy of 100 years] would result in a risk of (fatal cancer) of $(0.15x\ 10^{-3} \times 100)/\ 20 = 75 \times 10^{-5}$. That is, of 100,000 people each exposed to an annual dose rate of 0.15 mSv/y (or 15 mrem/y) for 100 years, 75 would die of radiation-induced cancer.

The ICRP and corresponding national groups acknowledge that there is little or no data to support the extrapolation of high dose rate data to very low dose rates in the manner just described (referred to as the Linear Non-Threshold, or LNT hypothesis. As noted above, the justification is largely one of prudence- until reliable data becomes available.

It is not possible to extract meaningful results from statistical analysis of epidemiological data since, compared to all cancer deaths in populations, the proportion of radiation-induced cancer deaths is very small (estimated to be about 3%). However, the fact that

i) there appears to be no correlation between cancer fatality rates and the very variable level of natural background (solar and terrestrial) radiation around the globe; and
ii) groups that may have been exposed to above average levels of radiation, e.g. workers in nuclear facilities, do not appear to exhibit higher levels of cancer

has led some to argue that there is probably a lower threshold of exposure, below which there is no adverse (i.e. cancer) risk. This threshold could well be above the 15mRem limit established by the EPA.
Recent advances in fundamental molecular biology have led the U.S. Department of Energy to start a ten-year long program of research to attempt to understand the fundamental biological mechanisms by which ionising radiation affects human organisms. It seems likely, to the writer at least, that a much better basis for establishing radiation protection standards will emerge within the next ten or twenty years-and that the actual risks will be much lower than now assumed. Similarly, major advances are being made in medical research, including the treatment of cancer. This should further reduce the fatality risk.

The lengthy discussion above is presented simply to make the point that the risks of low-level ionizing radiation now assumed are probably overly conservative. The writer does not advocate any changes until better data becomes available, but believes that this will arrive soon, i.e. well before it becomes necessary to decide whether or not to close a repository.

Yucca Mountain
Of approximately 30 repository sites now being considered worldwide, only Yucca Mountain is located in the unsaturated zone (UZ) i.e. above the water table. This was

selected because it was argued that little or no water would contact the waste, and that groundwater transit times through the UZ would be very long. This would result in low release rates to the human environment. More recently, less optimistic assessments have been presented and a greater reliance is being placed on long-lived alloy containers. There is significant public scepticism that this reliance can be scientifically justified for fabricated materials. The writer believes that there is considerable, as yet unexplored potential to develop improved drift layout arrangements and procedures to "engineer" the natural features at the site so as to divert water away from contact with the containers, and considerably enhance overall performance. These may not be required but the fact that these opportunities exist helps this writer feel confident that the site can be made even safer than indicated by the Preliminary Site Suitability Evaluation (PSSE), should this be deemed advisable.

The layout of the Yucca Mountain site, with essentially horizontal access to the underground, is very well suited to the notion of maintaining the containers in a fully retrievable condition for 100 years or more, as additional scientific data on site performance, risks of radiation etc are developed –and the public can become better informed as to the safety of the site.

Underground location of the waste in containers reduces considerably the risk of damage due to earthquake effects that could result if the waste remains indefinitely on the surface.

It is also important to note the potential terrorist target of surface based nuclear facilities (U.S. nuclear power plants were placed on heightened alert in the aftermath of the recent tragic events in New York and Washington). The writer has visited the surface waste handling facilities at Gorleben, Germany-where extraordinary measures have been taken to reduce the danger of attack or accident –including the possibility of a crash by a large plane into the waste handling building. Placing waste underground ay Yucca Mountain would make it much less vulnerable to such events-and would not require the costly extraordinary building designs such as those at Gorleben.

The comments above do not include a detailed analysis of the PSSE but the writer is aware of the main arguments presented in it.

In summary, the writer is confident that a safe high-level nuclear repository can be constructed at Yucca Mountain. Further, a program of studies designed to reduce important uncertainties in current estimates of repository performance, along with phased construction of facilities and attention to effective public communication (profiting from effective programs and experience elsewhere e.g. at WIPP and countries such as Finland and Sweden) can convince the U.S public of the safety of the Yucca Mountain site.

Charles Fairhurst.

September 20 2001.