UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 1 1 1991

MEMORANDUM FOR: Howard J. Larson, Staff Engineer
Advisory Committee on Nuclear Waste

FROM: Paul H. Lohaus, Chief
Low-Level Waste Management Branch
Division of Low-Level Waste Management
and Decommissioning
Office of Nuclear Material Safety
and Safeguards

SUBJECT: RESPONSE TO REQUEST FOR INFORMATION ON LEACHABILITY AND GROUNDWATER PROTECTION

This is in response to your request for information on a possible research project on low-level waste leachability/chemical stability and information on how Nuclear Regulatory Commission (NRC) regulations and guidance address groundwater protection. Each area is discussed below.

Waste leachability/chemical stability:

Office of Nuclear Material Safety and Safeguards (NMSS) and Office of Research (RES) staff has been meeting to explore various approaches to address the question of low-level radioactive waste (LLW) leachability/chemical stability. Although we have not yet prepared a formal user need letter, we have developed a draft scope for the work (Enclosure 1) that can be used as a foundation for a feasibility study to assess the need for and feasibility of additional barriers such as chemical binding to reduce leachability.

Several current RES projects involve studies that are relevant to the questions posed in the draft scope of work. For example, Brookhaven National Laboratory (BNL) is working on LLW source term and burial environment issues, and the Idaho National Engineering Laboratory (INEL) is conducting waste form Technical Position tests (including leaching) on solidified radioactive wastes from nuclear power plants and is obtaining lysimeter measurements from solidified Three Mile Island wastes located in plots at Oak Ridge National Laboratory (ORNL) and Argonne National Laboratory (ANL). In addition, RES is considering holding a one day planning meeting involving (a) personnel from each of these projects, (b) NMSS and RES staff, and (c) a few other RES consultants/ contractors who might be able to bring relevant experience to bear. The issues addressed in Enclosure 1 would provide the basic structure for a meeting agenda (the details of which are being worked out along with a time and location). Following this meeting, we would jointly consider the next steps to be taken such as possible modifications to present or planned projects in this area. Given the Advisory Committee on Nuclear Waste's (ACNW's) expressed interest in this topic, we would like to invite ACNW participation/observation. If the ACNW members or staff would like more information on the meeting, please contact Mel Silberberg at (301) 492-3810. Also, please note that we have not yet had the opportunity to review these ideas fully with our management or assess possible resource impacts.

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NLXP

Groundwater Protection:

A hydrogeologist in the Low-Level Waste Management Branch has examined several "key" 10 CFR Part 61 rulemaking and associated documents to identify specific references pertaining to how environmental (groundwater) protection was considered in the development of the Part 61 rule. Enclosure 2 provides a list of these documents and presents a brief summary of specific sections and pages covering groundwater protection within the documents referenced. In addition, please find enclosed three copies of NUREG-1243, "Ground-Water Protection Activities of the U.S. Nuclear Regulatory Commission." Should more information or questions arise concerning the reference list, please contact Fred Ross at (301) 492-0527.

ORIGINAL SIGNED BY

Paul H. Lohaus, Chief
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Division of Low-Level Waste Management
and Decommissioning
Office of Nuclear Material Safety
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Enclosures: As stated

LLWM 91-043
Distribution: Central File # NMSS r/f RBangart JGreeves
JAustin JSurmeier PLohaus MTokar FRoss
LLWD t/f LLWM r/f MSilberberg
PDR YES
PDR NO X Category: Proprietary ___ or CF Only X
ACNW YES X NO ___
SUBJECT ABSTRACT: RESPONSE TO REQUEST FOR INFORMATION ON LEACHABILITY AND GROUNDWATER PROTECTION

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OFC	:LLWM*	:LLWM*	:LLWM	:RES/WMB
NAME	:FRoss/jj	:MTokar	:PLohaus	:MSilberberg:
DATE	:03/11/91	:03/11/91	:3/11/91	:3/11/91 :

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OFC :LLWM	:LLWM	:LLWM
NAME:FRoss/jj	:MTokar	:PLohaus
DATE:3/11/91	3/12/91	: / /91

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LOW-LEVEL WASTE FEASIBILITY STUDY

Given: 10 CFR Part 61, as it currently exists, provides adequate protection of public health and safety from the potential hazards of low-level radioactive wastes.

(But),

Question 1: Are additional barriers needed? Could the margin of safety be increased via a defense in depth, additional multiple barrier, approach that might involve the use of any of the following strategies (thus improving assurance of protection of groundwater as well as public health and safety)?

1. Putting the radioactive species in question into a chemical form that is relatively insoluble in water? For long-lived radionuclides, in particular, this might help ensure that Part 61 offsite dose limits would not be exceeded at long time periods (after the waste form has disintegrated).

2. Placing the wastes (whether Class A, B, or C) into a more stable chemical form through the use of additives to currently used solidification/stabilization media (such as cement or bitumen) or through the use of some entirely "new" medium; (in the latter case, "new" means some substance that is not currently being used for waste solidification/stabilization/encapsulation). The new or modified chemical form or additive would provide greater leach resistance, thus reducing potential releases.

3. Alternating the near-field environment via the use of some chemical or material substance (e.g., clay) that would chemically retard the migration of radionuclides in groundwater.

4. Adopting some other concepts or strategies that could be used to inhibit or retard radionuclide release and migration through the groundwater to the accessible environment.

Question 2: What would be the cost/benefit of any/all of the above strategies?

It is envisioned that a two-part feasibility study would be conducted to address the above two questions. Part 1 (Question 1) would require a combination of activities including: (a) a literature study; (b) a determination of what is currently being accomplished or contemplated in other countries; and (c) some new innovative thinking and analysis of what is needed and technologically achievable within the current state of knowledge of science and engineering. Part 2 (Question 2) would require some performance assessment, cost/benefit and value/impact analyses that would extend beyond consideration of technical issues alone and that would involve financial and regulatory issues as well.

10 CFR PART 61 REFERENCES ON GROUNDWATER PROTECTION

The technical requirements for land disposal of low-level radioactive waste were developed in recognition that radionuclide transport in groundwater is the most significant long-term migration pathway to individuals residing off-site. They provide for groundwater protection through the performance objective for the protection of the general population (10 CFR 61.41) and the technical requirements in Subpart D. The general population performance objective limits releases of radionuclides to groundwater and other transport media to concentrations that will not yield an annual dose to any member of the public in excess of 25 millirems (whole body), 75 millirems to the thyroid and 25 millirems to any other organ. With respect to this objective, radionuclide concentrations in groundwater are limited at and beyond the site boundary because an individual could consume water from a well located immediately downgradient from the facility. NRC's technical requirements also rely on a combination of siting, design and operating requirements that keep water away from waste. Groundwater protection is achieved through minimization of leachate formation by avoiding prolonged contact between the wastes and infiltrated water. The regulations rely on siting requirements for groundwater protection to keep water away from the waste, to reduce the volume of contaminated water, and to provide long groundwater travel times.

The Statement of Consideration to proposed 10 CFR part 61 (FR 38083-38035), discusses how the performance objective for protection of the environment was arrived at based on the existing numerical standards for releases of radioactivity to the general environment, as well as those anticipated from the Environmental Protection Agency. The Commission analyzed a range of limits from 1 to 25 mrem/yr and selected 25 mrem/yr as a dose limit to an individual at the site boundary. The 40 CFR Part 141 EPA drinking water standard (4 mrem) was selected as the performance objective to be applied to the nearest public drinking water supply. Also provided is background on the development of minimum technical requirements related to assuring that the performance objectives will be met. These technical requirements cover disposal site selection, design, waste form, and operation. Many are intended to eliminate or minimize to the extent practicable contact of waste with water.

The Draft Environmental Statement on 10 CFR Part 61 (DEIS), (Section 3.2.2, pages 3-4 and 5) provides additional background on the development of the 10 CFR Part 61 technical and other requirements. This section describes how the technical requirements were established to provide defense in depth, through "multiple Barriers" of individual components (site characteristics, design and operations, waste form and packaging, and institutional controls) rather than relying solely on natural disposal site characteristics as had been the practice of the past. Section 5.3 (pages 5-74 thru 5-82) of the DEIS provides discussion of the conclusions drawn from the analytical case studies performed to support the performance objectives for migration (groundwater pathway) and long-term stability. The section concludes with a discussion of the relationship between the performance objective for potential exposures to individuals at the disposal facility boundary (25 mrem/yr) and the performance objective corresponding to the EPA primary drinking water standard at the nearest drinking water supply well (4 mrem/yr). In that discussion, the staff concludes that the 25 mrem/yr limit for the site boundary well is based on the expectation of somewhat higher impacts (more than 4 mrem) due to the migration of short-lived radionuclides and only a few individuals would be impacted. The

4 mrem limit to the nearest supply well is achieved through longer travel times and dispersion. DEIS Section 5.5 (pages 5-89 thru 5-92) discusses how the technical requirements relate to eliminating or reducing the contact of water with waste to help achieve the performance objective for off-site migration through the groundwater pathway.

The Final Environmental Impact Statement on 10 CFR Part 61 provides a summary and analyses to public comments on the proposed rule. In consideration of the performance objective for environmental protection (pages B-34 thru B-37), the staff concluded, based partly on comments from EPA, that the 25 mrem (whole body and other organs except thyroid) and 75 mrem (thyroid) is an appropriate performance objective for environmental releases. This limit represents what is achievable at a LLW facility, and was expected to be close to any standard EPA might establish in the future. In response to an EPA comment that the 4 mrem EPA drinking water standard was inappropriately applied, the drinking water performance objective was deleted from the final rule. The FEIS (pages B-47 thru B-51) contains the staff's analysis on comments related to the groundwater siting requirements directed at keeping water out of the waste, reducing volumes released, and providing for long travel times for decay.

The FEIS comment analyses cited above are summarized in the Statements of Consideration for the final rule (FR 57449-574450). In this summary, the Commission states that although the 4 mrem drinking water supply performance objective was not carried over to the final rule, the Commission will assess the potential impact on drinking water supplies as part of its licensing review.

Ground-Water Protection Activities of the U.S. Nuclear Regulatory Commission, NUREG-1243, describes how various NRC regulatory programs provide for groundwater protection. Pages 2-7 through 2-14 give details on how groundwater protection is achieved in 10 CFR Part 61. The discussion includes sections on historical perspective, regulations and guidance, staff technical capabilities, and current staff activities related to groundwater protection.

Statements comparing groundwater protection standards of EPA (RCRA) and NRC (page 2-9, paragraph 4) need further elaboration. In RECRA, EPA has established a specific set of hazardous constituents and concentration limits that, when exceeded, trigger prescribed proceedures for monitoring and corrective actions. By contrast, NRC will establish, in license conditions, site specific action levels for groundwater and other environmental media to provide early warning of radionuclide releases as outlined below.

Environmental Monitoring of Low-Level Radioactive Waste Disposal Facility, NUREG-1388, provides general guidance on what is required by Section 61.53 of 10 CFR Part 61, calling for environmental monitoring during the preoperational, operational and postoperational stages of a low-level waste facility. Section 4.2.3 provides guidance on action levels that should be set on key environmental media to provide early warning of problems and to ensure mitigating measures are taken in a timely manner. The guidance establishes the concept of "triggering level", defined as the level of concentration of radionuclides, radioactivity, or chemical indicators above which an investigation is required, and "reporting level", defined as the concentration of radionuclides, radioactivity, or chemicals that exceed or is about to exceed regulatory standards.

REFERENCES

Licensing Requirements for Land Disposal of Radioactive Waste: Proposed Rule 10 CRF Part 61; Federal Register Vol. 46, No. 142, July 24, 1981; pages 38083 thru 38085

Draft Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste"; NUREG-0782 Vol. 2; pages 3-4 thru 3-5; 5-74 thru 5-82; 5-89 thru 5-92

Final Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste"; NUREG-0945, Vol. 2; pages B-37; B-49

Licensing Requirements for Land Disposal of Radioactive Waste: Final Rule; Federal Register Vol. 47, No. 248, December 27, 1881; pages 57448 thru 57450

Ground Water Protection Activities of the U.S. Nuclear Regulatory Commission; NUREG-1243; pages 2-7 thru 2-14

Environmental Monitoring of Low-Level Radioactive Waste Disposal Facility, NUREG-1388; Section 4.2.3, page 8