Department of Energy
Washington, DC 20585

JAN 7 1993

Mr. Joseph J. Holonich, Director
Repository Licensing & Quality Assurance
Project Directorate
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: Ltr, Roberts to Holonich, dtd 6/5/92

Dear Mr. Holonich:

The transmittal of Study Plan 8.3.1.2.3.2, "Characterization of the Yucca Mountain Saturated-Zone Hydrochemistry," provides the basis to explicitly address the Site Characterization Analysis (SCA) Open Items 21 and 22. The U.S. Department of Energy's (DOE) December 14, 1990, responses to the SCA, and the U.S. Nuclear Regulatory Commission's July 31, 1992, evaluation of these responses (enclosures 1 and 2) represent the administrative record for these open items.

Both SCA comments 21 and 22 expressed general concerns regarding: (1) the sampling programs for the radioisotopes Tc-99, I-129, Tritium, and Cl-36 were not explicitly identified in the Site Characterization Plan for studies intended to characterize groundwater flow and radionuclide background concentrations in both the unsaturated and saturated zones, and (2) how to obtain water samples representative of sampled intervals, especially with respect to perched water.

On the basis of the information in Enclosures 1 and 2, DOE regards these two SCA open items as resolved.

If you have any questions, please contact Mr. Chris Einberg of my office at 202-586-8869.

Sincerely,

John P. Roberts
Acting Associate Director for
Systems and Compliance
Office of Civilian Radioactive
Waste Management

WM-11
102.8
NH03.11

Enclosures:
1. Administrative Record for
   SCA Comment 21
2. Administrative Record for
   SCA Comment 22

cc: w\enclosures
C. Gertz, YMPO
R. Loux, State of Nevada
T. Hickey, Nevada Legislative Commission
M. Baughman, Lincoln County, NV
J. Bingham, Clark County, NV
B. Raper, Nye County, NV
P. Niedzielski-Eichner, Nye County, NV
G. Derby, Lander County, NV
P. Goicoechea, Eureka, NV
C. Schank, Churchill County, NV
F. Mariani, White Pine County, NV
V. Poe, Mineral County, NV
E. Wright, Lincoln County, NV
J. Pitts, Lincoln County, NV
R. Williams, Lander County, NV
J. Hayes, Esmeralda County, NV
B. Mettam, Inyo County, CA
C. Abrams, NRC

ENCLOSURE 1

SCA Comment 21 and DOE Response (12/14/92)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 21 Open Item

ENCLOSURE 1

Section 8.3.1.2.3.2 Study: Characterization of the Saturated Zone Hydrochemistry

Section 8.3.1.2.3.2.1 Activity: Assessment of Saturated-Zone Hydrochemical Data Availability and Needs

Section 8.3.1.2.3.2.2 Activity: Hydrochemical Characterization of Water in the Upper Part of the Saturated Zone

Section 8.3.1.2.3.2.3 Activity: Regional Hydrochemical Characterization

COMMENT 21

Technetium-99 and iodine-129 are not explicitly included in studies to characterize groundwater flow and radionuclide background concentrations in groundwater.

BASIS

- **The study to characterize saturated zone hydrochemistry has three principal objectives: (1) describe the chemical composition of, and spatial compositional variations in, saturated-zone groundwaters using new and existing data; (2) identify the chemical and physical processes that influence ground-water chemistry; and (3) aid in the identification and quantification of fluxes to, from, and within the saturated zone. Existing hydrochemical data from previous sampling will be compiled and evaluated. Additional groundwater samples will be analyzed for inorganic chemical concentrations; activities of selected radioisotopes, including tritium, carbon-14, chlorine-36; and ratios of selected stable isotopes, including those of carbon, hydrogen, oxygen, strontium and sulfur. The radioisotopes to be analyzed do not include the highly mobile and long-lived radioisotopes technetium-99 and iodine-129. These radioisotopes, like tritium and chlorine-36, are potentially of great value as groundwater tracers, and can provide important data about groundwater flow paths and groundwater travel time.**

- **Iodine-129 and technetium-99 are among those radioisotopes identified in Appendix A of EPA (1985) regarding release limits for containment requirements. The background levels and variability of these radioisotopes in the saturated zone at the site should be assessed as part of site characterization to provide baseline information for performance confirmation program at the site. Insofar as perched groundwater represents localized zones of saturation, and perched zones that are discovered during drilling or excavations should likewise be sampled and analyzed for these radioisotopes.**

- **The need for data on technetium-99 and iodine-129 in the saturated flow system is consistent with guidance provided in Regulatory Guide 4.17, Standard Format and Content Guide for HLW SCP's (NRC, 1987). In Section 3.9.1.3 of that document (hydrochemistry), it is stated that "at sites where human activity may have introduced radioactivity into the ground water, analysis should be done for those radioisotopes that are known or suspected to have been added to the system. Using this information, provide assessments of temporal and spatial variations of the**

hydrochemistry." At Yucca Mountain, anthropogenic sources of mobile radioisotopes, such as iodine-129 and technetium-99, would include underground nuclear testing at the nearby Nevada Test Site, and groundwater recharge form precipitation containing contaminants from past atmospheric nuclear tests.

- Analyses of radioisotopes in the saturated zone will be used in interpreting data from the infiltration and transport studies in the vadose zone. The analyses of technetium-99 and iodine-129 at the water table and in perched zones may provide insight about groundwater travel time and rates of migration of these isotopes in the vadose zone.

- Further, characterization of technetium-99 and iodine-129 in the saturated zone may help support modeling work under Section 8.3.1.2.2.5, diffusion tests in the exploratory shaft facility. The objective of this modeling is to determine in situ the extent to which nonsorbing tracers diffuse into the water-filled pores of the tuffs of the Topopah Spring unit. Test results will be used to model the transport of technetium-99 and iodine-129 from the repository to the water table. Evaluation of the concentrations of these radioisotopes at and below the water table and in perched zones can aid in calibration and validation of repository scale models.

RECOMMENDATION

Technetium-99 and iodine-129 should be added to the group of radioisotopes that will be analyzed from water samples collected in the upper part of the saturated zone and in any discovered zones of perched groundwater.

REFERENCES

EPA, 1985. Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes: 40 CFR Part 191, U.S. Environmental Protection Agency, Federal Register 9/19/85.

NRC, 1987. Standard format and Content of Site Characterization Plans for High-level Waste Geologic Repositories: Regulatory Guide 4.17, Revision 1, U.S. Nuclear Regulatory Commission, Washington, D.C.

RESPONSE

In late 1988 Yucca Mountain Project personnel in the geohydrology, geochemistry, and radiological monitoring programs began planning for integration of efforts to characterize the chemical and isotopic constituents in groundwater at and near Yucca Mountain. Sampling and analyses for isotopes that are expected to be present in very small concentrations (if at all) but that, nonetheless, are required for baseline information are within the aegis of the Radiological Monitoring Plan rather than the Site Characterization Plan. The U.S. Department of Energy (DOE) plans to analyze 10-15 percent of the samples acquired by the saturated zone hydrochemistry study for Tc-99 and I-129. Additional analyses will be performed if initial data show them to be appropriate. The Study Plan for saturated zone hydrochemistry (8.3.1.2.3.2) will address the cooperative sampling in Sections 2.1.2 and 3.2.3.3. DOE will remain aware of the Environmental Restoration Program at the NTS to

identify areas where cooperation would be beneficial (i.e., cross-cutting issues regarding radionuclide migration studies in volcanic tuff alluvium).

REFERENCES:

DOE (U.S. Department of Energy), 1988. Radiological Monitoring Plan, DOE/NV-10576-6, Yucca Mountain Project Office, Las Vegas, NV.

Section 8.3.1.2.3.2	Study: Characterization of the saturated zone hydrochemistry
Section 8.3.1.2.3.2.1	Activity: Assessment of saturated-zone hydrochemical data availability and needs
Section 8.3.1.2.3.2.2	Activity: Hydrochemical characterization of water in the upper part of the saturated zone
Section 8.3.1.2.3.2.3	Activity: Regional hydrochemical characterization

SCA COMMENT 21

Technetium-99 and iodine-129 are not explicitly included in studies to characterize groundwater flow and radionuclide background concentrations in groundwater.

EVALUATION OF DOE RESPONSE

- NRC had previously recommended that technetium-99 and iodine-129 be added to the group of radioisotopes that will be analyzed from water samples collected in the upper part of the saturated zone and in any discovered zones of perched groundwater.

- DOE responded that these data will be collected under the Radiological Monitoring Plan (DOE, 1988) rather than the Site Characterization Plan. DOE plans to analyze 10-15 percent of samples acquired by the saturated zone hydrochemistry study for Tc-99 and I-129. Additional analyses will be done if initial data show them to be appropriate. The study plan for saturated zone hydrochemistry (8.3.1.2.3.2) will address the cooperative sampling.

- DOE's response does not adequately address the NRC comment. A key part of NRC's comment was that analyses of Tc-99 and I-129 at the water table and in perched zones may provide insight about groundwater travel time and rates of migration of these radioisotopes in the vadose zone. Both I-129 and Tc-99 are among those radioisotopes for which release limits are specified in Appendix A of EPA's high-level waste standards (EPA, 1985). Data on migration of anthropogenic radioisotopes, including tritium and long-lived radioisotopes like Tc-99, I-129, and Cl-36, will provide important insight about groundwater flow paths and groundwater travel time. These data may provide a tool for the validation of numerical flow and transport models in the vadose and saturated zones.

- The DOE response does not address sampling from perched zones above the water table, and it is not clear that the radiological monitoring program will target perched groundwater for sampling. Any perched groundwater that is discovered during site drilling operations may be transient in nature, and thus perched water should be sampled as it is found. Accordingly, such sampling may have to be done as part of the site characterization program, rather than under the long-term radiological monitoring program.

- The NRC staff considers this comment open. DOE agrees that data on Tc-99 and I-129 need to be collected. However, DOE has planned to collect data

for these radioisotopes under the radiological monitoring program. The staff concludes that DOE's commitment to collect this data through the radiological monitoring program does not in itself resolve the comment. In order to make progress toward resolution, the NRC staff will have to review DOE's Radiological Monitoring Plan (DOE, 1988) and relevant study plans. Relevant study plans include DOE (1989) and plans under the following studies: Unsaturated-Zone Infiltration, Water Movement Tracer Tests, Percolation in the Unsaturated Zone, and Saturated Zone Hydrochemistry.

REFERENCES

DOE (U.S. Dept. of Energy), 1988. Radiological Monitoring Plan, DOE/NV-10576-6, Yucca Mountain Project Office, Las Vegas, NV.

DOE, 1989. Study Plan "Hydrochemical Characterization of the Unsaturated Zone": YMP-USGS-SP 8.3.1.2.2.7 R0, U.S. Dept. of Energy.

EPA (Environmental Protection Agency), 1985. Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes: 40 CFR Part 191, 50 FR 38066, Sep. 19, 1985.

Additional Information Relevant to SCA Comment 21 Open Item

In their evaluation of DOE's SCA response, the NRC stated the need to review the following study plans in relation to Open Item 21: (1) Water Movement Tracer Tests Using Chloride and Chlorine-36 Measurements of Percolation at Yucca Mountain (Study 8.3.1.2.2.2); (2) Characterization of Unsaturated Zone Infiltration (Study 8.3.1.2.2.1); (3) Hydrochemical Characterization of the Unsaturated Zone (Study 8.3.1.2.2.7); (4) Characterization of the Yucca Mountain Saturated Zone Hydrochemistry (Study 8.3.1.2.3.2); and (5) the Yucca Mountain Site Characterization Project Office's (YMPO) Radiological Monitoring Plan (RMP).

The NRC has received all of these study plans. Study Plan 8.3.1.2.2.2 was sent on February 9, 1989 (NRC subsequently informed DOE that a Phase I review was deferred). Study plan 8.3.1.2.2.1 was sent on March 1, 1991 (Phase I review was received on May 31, 1991; no technical concerns with the study were expressed). Study Plan 8.3.1.2.2.7 was sent on May 8, 1991 (Phase I review was received on May 1, 1992; no technical concerns with the study were expressed). Study Plan 8.3.1.2.3.2 was sent on June 6, 1992 (Phase I review is still outstanding). The YMPO RMP has not been sent to the NRC.

The NRC's concern centered on the potential sampling of Tc-99, I-129, Tritium, and Cl-36, as part of site characterization. Table 2.2-1 of Study Plan 8.3.1.2.2.7, Table 3.2-2 of Study Plan 8.3.1.2.3.2, and Study Plan 8.3.1.2.2.2 clearly indicate that sampling of these radioisotopes is intended to be part of the sampling programs for assessing the age and movement of groundwater in the unsaturated and saturated zones. To update the response to SCA Comment 21, DOE is not relying on the RMP to address this open item, and therefore this document should not be relied upon as part of the basis to resolve this open item. The RMP, however, does explain Tc-99 and I-129 sampling that will be done for YMPO environmental program requirements.

Section 3.2.3.3 (Chemical and Isotopic Analyses of Water Samples), p. 3.2-16, of Study Plan 8.3.1.2.3.2 (Characterization of the Yucca Mountain Saturated Zone Hydrochemistry) explains the intended study program for Tc-99 and I-129 in the upper part of the saturated zone. Table 3.2-2 indicates that tritium and Cl-36 will be sampled as part of this study. With respect to perched water sampling, Study Plan 8.3.1.2.2.7 (Hydrochemical Characterization of the Unsaturated Zone), Table 2.1-2, indicates that perched water in the unsaturated zone is to be sampled wherever encountered. Testing for tritium and Cl-36 in water from unsaturated rock is explained on p. 3.2.11-12 of the Study Plan 8.3.1.2.2.7. Hydrochemical sampling of any perched water zone encountered is clearly intended to be part of the site characterization program, in addition to any longer-term radiological monitoring.

ENCLOSURE 2

SCA Comment 22 and DOE Response (12/14/90)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 22 Open Item

ENCLOSURE 2

Section 8.3.1.2.3.2.2 Activity: Hydrochemical Characterization of Water in the Upper Part of the Saturated Zone

COMMENT 22

Use of packers to isolate saturated zone intervals for water sample collection has the potential to compromise sample collection.

BASIS

- **Sampling from the top of the saturated zone below the repository block has the potential to detect the presence of high flux or high velocity pathways. Identification of modern water in the upper portion of the water table may be indicative of rapid groundwater flow from the surface through the unsaturated zone. Hence, data integrity from the hydrochemical tests is potentially very important with respect to groundwater travel time.**

- **Use of packers lessens confidence in the quality of the data collected. Representative data from the partitioned interval could be compromised by failure to prove an adequate seal in the borehole or prior mixing with waters from some depth. Presence of vertical gradients will increase the likelihood of mixing (and dilution). Scalf et al. (1981) discuss the need to avoid vertical intercommunication within wells.**

- **Withdrawal of water samples when the water table is encountered during drilling will increase the confidence level in the representativeness of the water quality data.**

RECOMMENDATION

In order to avoid potential contamination (or modification of the water quality due to mixing), it is recommended that plans be made to collect water samples first in the upper portion of the saturated zone and then in deeper portions (as necessary) as drilling advances into the units beneath the water table.

REFERENCES

Scalf, M.R., J.F. McNabb, W.J. Dunlap, R.L. Cosby, and J.S. Fryberger, 1981. Manual of Ground-Water Quality Sampling Procedures: Office of Research and Development, U.S. Environmental Protection Agency, ADA, Oklahoma, 93 p.

RESPONSE

Yucca Mountain Project investigators recognize that achieving vertical isolation using packers is not certain. The investigators believe, however, that careful examination of caliper logs (and televiewer logs, as appropriate and available) for water-table holes and other boreholes would enable relatively smooth and short (1 to 10 m) borehole sections within which the deployment of sufficiently long packers (about 1.5 to 2 m) would be expected to result in satisfactory vertical isolation. Whether vertical isolation is achieved will be examined during sampling by monitoring heads below, within, and above the sampled intervals, as appropriate. Because pumping rates will

range between 0.5 and 2.0 L/min, the stress imposed on the isolated zones will be significantly less than commonly applied in sampling and hydraulic testing. For this reason sensitive differential-pressure transducers will be used to detect and monitor perturbations.

Data relative to the presence or absence of vertical hydraulic gradients within about the uppermost 100 m of the saturated zone do not exist, but head monitoring associated with the sampling is planned to include a brief period (about 5 to 25 days) to examine relative heads after the packers have been set and before pumping for sampling. Efforts to maximize the representativeness of individual samples are described in Section 3.2.3.1 of Study Plan 8.3.1.2.3.2 (DOE, 1990). Concentrations of drilling tracers and selected cations, anions, and dissolved gases would be monitored to provide a basis for sampling decisions.

The reference cited in the comment (Scalf 1980) is only marginally relevant to YMP plans, because it implicitly addresses only shallow groundwater sampling relevant to pollutant/contaminant-related studies in stratified porous materials. In particular, the sample-collection section is not relevant to deep, fractured rocks, in which considerable penetration may be required to intersect a fracture that is permeable enough to yield a water sample.

Study Plan 8.3.1.2.3.2 addresses the need to investigate the feasibility and utility of discrete samples from several intervals within the uppermost 100 m of the saturated zone. The U.S. Department of Energy believes the methodology selected -- briefly described in the first paragraph responding to this comment -- is the one most likely to yield the best results. The text of the U.S. Nuclear Regulatory Commission's recommendation does not define what is meant by "the upper part of the saturated zone," and indeed seems to imply that the intended definition differs from that in the Site Characterization Plan. Study Plan 8.3.1.2.1.3 (Characterization of the Regional Groundwater Flow System) recommends the use of a multi-layer sampler (MLS) for obtaining discrete geochemical samples from the top of the saturated zone. The potential use of the MLS would also be examined during implementation of Study Plan 8.3.1.2.3.2.

REFERENCES:

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.2.1.3, "Characterization of the Regional Groundwater Flow System." Yucca Mountain Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.2.3.2, "Characterization of the Saturated Zone Hydrochemistry." Yucca Mountain Project Office, Las Vegas, NV.

Scalf, M.R., J.F. McNabb, W.J. Dunlap, R.L. Cosby, and J.S. Fryberger, 1981. Manual of Ground-Water Quality Sampling Procedures: Office of Research and Development, U.S. Environmental Protection Agency, ADA, Oklahoma, 93 p.

Section 8.3.1.2.3.2.2 Activity: Hydrochemical characterization of water in the upper part of the saturated zone

SCA COMMENT 22

Use of packers to isolate saturated zone intervals for water sample collection has the potential to compromise sample collection.

EVALUATION OF DOE RESPONSE

- DOE responded that various methods will be used to provide the hydrologic isolation of borehole intervals for groundwater sampling. Borehole logging techniques will be used to select smooth borehole lengths where packers of sufficient length can attain adequate seals. During sampling, vertical isolation can be tested by monitoring heads below, within, and above the sampled intervals. Sensitive differential-pressure transducers will be used to detect and monitor perturbations in head.

- DOE's intended approach is to drill wells to total depth and then install packers and sampling devices. The sampling procedure described for fully drilled wells appears reasonable for wells that already exist, but does not allow for sampling from perched zones that may be encountered during the drilling of new wells. Perched zones that may be penetrated will drain downward via the borehole, resulting in hydrochemical mixing at the water table and the possible loss of the chance to sample the perched water. For this reason, the first significant water-producing zone that is encountered should be sampled for hydrochemical and radioisotopic analyses. Such an approach will ensure that all significant perched zones will be sampled during drilling operations.

- DOE should be prepared to sample any perched groundwater zones that are encountered during site drilling operations. Perched groundwater should be analyzed for anthropogenic contaminants, including radioisotopes like tritium, iodine-129, chlorine-36, and technetium-99, because the presence of these contaminants deep in the vadose zone would suggest conditions of enhanced infiltration and rapid percolation.

- The NRC staff considers this comment open. In summary, DOE agrees that hydrologic isolation of borehole intervals during groundwater sampling is important. DOE will attempt to collect discrete samples under study plan 8.3.1.2.1.3 (Characterization of the Regional Groundwater Flow System) (DOE, 1990) and study plan 8.3.1.2.3.2 (Characterization of the Saturated Zone Hydrochemistry). The NRC staff concludes that DOE's commitment to collect discrete samples does not in itself resolve this comment. In order to make progress toward resolution, the NRC staff will need to review study plan 8.3.1.2.3.2 (Characterization of the Saturated Zone Hydrochemistry) and other documents that may be relevant to the sampling of perched groundwater (for example, plans for tracer tests, and the study plan for hydrochemical characterization of unsaturated zone).

REFERENCE

DOE, 1990. Study Plan "Characterization of the Yucca Mountain Regional Ground-Water Flow System": YMP-USGS-SP 8.3.1.2.1.3 R0, U.S. Dept. of Energy.

Additional Information Relevant to SCA Comment 22 Open Item

In their evaluation of DOE's SCA response, the NRC stated that it appeared DOE's intent was to drill saturated zone sampling boreholes to total depth, and then undertake any water sampling from packed intervals. Section 3.2.3.1 (Water-Sample, Gas-Sample, and Field-Data Collection), p. 3.2-10, of Study Plan 8.3.1.2.3.2 (Characterization of the Yucca Mountain Saturated Zone Hydrochemistry) states the sequence for drilling and testing in the rock just above and below the water table. After any core/gas sampling in the unsaturated zone directly above the water table has been completed, and after any core near the top of saturated rock has been collected for hydrochemical analysis of water content, the well would then be drilled to total depth, geophysical data would be collected if needed, and then water samples as described for existing wells (p. 3.2-8).

With respect to perched water sampling, Table 2.1-2 of Study Plan 8.3.1.2.2.7 (Hydrochemical Characterization of the Unsaturated Zone), indicates that perched water in the unsaturated zone is to be sampled for hydrochemical characterization wherever it is encountered. Sampling of these zones, as they are encountered, will yield a distinct hydrochemistry for water in them. If perched water zones with high volumes of water are encountered, it is possible that drainage down the borehole could cause mixing at the top of the water table. Although some wet zones have been encountered in drillholes, the drilling experience at the site suggests that the likelihood of encountering perched water in volumes that may present problems like this is very small.