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Building 500-4255
Lawrence Berkeley Laboratory
University of California Berkeley, California 94720

(415) 486-4000 • FTS 451-4000

(415) 486-6536 - FTS 451-6536

26 January 1984

Mr. Everett Wick
Division of Waste Management
Office of Nuclear Materials, Safeguards
and Safety
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Everett:

Attached are my comments on Draft Technical Position, Vol. 2, Subtask 1.2, Post Emplacement Monitoring, NUREG/CR-3219, by S.V. Panno.

Most of my comments on the body of the report are not serious criticisms, though there is the general appearance that the author may not have been working with reference material explaining DOE's latest thoughts on repository design (e.g., horizontal canister emplacement was not mentioned).

I regret that I have read only as far as page B-15 in the appendix before stopping due to time constraints. At that point it became obvious that there were some shortcomings in the appendices, requiring a fair amount of work to properly review and correct. Reviewers from several areas of expertise will also be required. During our phone conversation in early January we discussed my comments on Appendix B through page B-13. This attachment also includes my comments on Appendix B through the section on Temperature, though I do not consider them complete by any means.

Please contact me if you have questions on the comments or would like further assistance. Our project manager, Dr. Edna Didwall, will be in your area on January 30 and 31, and hopes to be in contact with you at that time.

Sincerely yours,

Eugene P. Binnall
Head of Field Systems Group
Department of Instrument Science
and Engineering

pc: E. Didwall, LLNL
EPB/cmj

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January 24, 1984

Memo

TO: Everett Wick, NRC

FROM: Eugene P. Binnall, LBL

RE: Comments on NUREG/CR-3219, Vol. 2, "Draft Technical Position, Subtask 1.2 Post Emplacement Monitoring", S.V. Panno, BNL, 1983.

I. Comments on Report Body, pages 1 - 46.

1. P. 1, para. 2.

The period of time is not clear for the 8 liters of water ingress. I suggest the following changes (Ref., P. 8 of this report).

"Even though the water ingress" during the first 1000 years "is not expected to greatly exceed eight liters for each emplaced package, the water will be a concentrated corrosive brine." Seventy-five percent of the water ingress will occur during the first 100 years.

2. P. 4, para. 4.

The waste package emplacement configurations discussed in paragraphs 4 and 5 do not include horizontal borehole emplacements, such as that under consideration for basalt and tuff. I suggest the following addition:

"- - - floor of the repository drift", or in horizontal boreholes between parallel drifts, "and sealed with more packing material."

3. P. 7, para. 3.

(Bates, R.L., 1980) should be (Bates and Jackson, 1980).

4. P. 11, para. below Table 2.3.

Should the reference (White, D.E., 1963) be (White et al., 1972) to conform with the reference given on page 24? Are these the same references (1963 or 1972)?

5. P. 11, Table 2.3.

(Carpenter, A.B., 1974) should be (Carpenter et al., 1974). Should (Stewart, D.B., 1978) be (Stewart and Potter, 1979)? Are these the same references (1978 or 1979)?

6. P. 12, Table 2.4.

(Schoff, S.L., 1964) should be (Schoff and Moore, 1964). Schoff or Schoff (see page 23)?

7. P. 13, para. 1.
Delete one "contact with".
8. P. 13, line 9 from bottom.
"phenomena" should be "phenomenon".
9. P. 15, para. 1.
See comment 5.
10. P. 15, para. 2.
(Swyler, K. J., 1979) should be (Swyler et al., 1979).
11. P. 16, para. 1.
(Schweitzer, D.C., 1982) should be (Schweitzer and Davis, 1982). No date given on reference on page 23.
12. P. 16, para. 4.
The second sentence states that " - - the effects of radiation on glass - - suggests that the glass may undergo swelling or contraction within a radiation field." This implies that the swelling and contraction is a direct result of radiation. Is this true, or is the expansion and contraction really due to thermal loading (heat generation and subsequent cooling) from the radioactive waste?
13. P. 16, under 2.4 Thermal Effects.
" - - temperatures will be near geologic (?) 1000 years following emplacement." Something seems to be missing here.
14. P. 16, bottom para.
These temperatures (220°C & 185°C) should be checked against those stated in the Rockwell Hanford Operations, Site Characterization Report. As absolute maximums, they may be low.
15. P. 18, top line.
What does the superscript 4 reference?
16. P. 18, top para. .
"- - between 60 and 70°C at repository depth" should probably be "- - between 50 and 60°C at repository depth". Measurements in the Umtanum Flow are 57-58°C, and in the Middle Sentinel Bluffs Flow, about 51°C (Ref., Rockwell Hanford Operations, Site Characterization Report, DOE/RL 82-03, 1982).
17. P. 19, para. 1.
(Broxton, D.E., 1982) should be (Broxton et al., 1982).
18. P. 19, bottom para, and P. 20, top para.
See comment 5.

19. P. 20, under 2.5.3 Tuff, top para.
 - a). (Schoff, S.L., 1964) should be (Schoff and Moore, 1964)
 - b). The selected candidate site in Nevada Test Site (NTS) tuff will probably be above the water table, hence, under negligible hydrostatic pressure. (see NUREG/CR-3065, by Golder Associates).
20. P. 21, top para. (list).

"Waste package movement" should probably be included as a monitored parameter (as stated in section 4.4 on p. 38 of this report). Under certain emplacement configurations (e.g., canisters in boreholes, horizontal or vertical, surrounded by a sealing bentonite type backfill mixture) it is conceivable that very high hydraulic pressures can develop at one end or a side of the canister resulting in considerable unequal forces which can cause canister movement if the canister is not adequately held in place.
21. P. 25, top para.

"(Appendix B)" should be "(Appendix A)"
22. P. 25, under Section 3.2.1.2 Intent of Position.

It is important that those packages selected for monitoring as a representative subset of the total waste package population include packages that may encounter worst case conditions. For example, monitored packages should include those in the most highly fractured and/or most hydrologically active regions of the repository. It is not specifically clear in the text that worst case conditions must be included in the selection of packages for monitoring.
23. P. 25, under Section 3.2.1.3 Technical Analysis of Alternatives.

Third sentence. The uniqueness of the environment surrounding the waste package is due to more factors than simply the waste package design, as stated by the first two sentences of this section. Perhaps the third sentence should be more inclusive, such as: "The environment within and surrounding the waste package will be unique to the specific repository chosen because of the unique waste package designs for each of the host rock candidates", and because of the unique characteristics of the rock media and surrounding environment.
24. P. 25, 3.2.1.3 under comment 1.

This assumes homogeneity throughout the repository, which is unlikely in basalt and tuff (possibly covered adequately on p. 27, para. 3).
25. P. 26, 2nd para. from bottom.
 - a) A random selection of waste packages for monitoring does not necessarily assume that waste packages will be monitored under worst case conditions.
 - b) Should "(Scheaffer, R.L., 1979)" be "(Scheaffer et al., 1981)" as given on P. 36?
26. P. 28, under Radiation.

Radiation can also affect materials used in instrumentation in the vicinity of the waste packages.

27. P. 29, line 4.
Should "effect of" be "affect on" (or, "influence on")?
28. P. 29, para. 3 and 4
The following additional reasons for temperature monitoring should be included in paragraph 3, or Table D.2.
 - o Water influx can influence packaging material and host rock temperature by convective heat transfer, and by heat transfer due to boiling and recondensation cycles (i.e., heat piping).
 - o Temperature around the waste package can also be influenced by rock decrepitation. Decrepitated rock can act like a thermal insulator resulting in increased package temperature.
29. P. 30, top para. under Mechanical Properties.
Hydraulic pressures could result in package movement in a tightly backfill sealed environment.
30. P. 30, 3.2.2.2 Intent of Position.
"representative of the emplaced wastes" [10 CFR 60, Section 60.143 (b)] carries an implication that waste packages in the worst case repository locations must also be represented. This is weakened by the second sentence of 3.2.2.2. Perhaps the addition of something like "including normally expected worst case repository conditions" to that sentence would help.
31. P. 30, lines 3 and 8 from bottom.
"data acquisition facility" is broader and would be better terminology than "data logging facility".
32. P. 32, top sentence.
"Similar hydrological characteristics" should be included with "similar physical and chemical characteristics".
33. P. 32, para. 2, top line
"A logical choice would be a facility (or facilities, in a highly heterogeneous host rock,) within - - - -"
34. P. 34, under Gas Generation, last sentence.
What is meant by "require generation of the packing material"?
Should that be, "generation of gas in the packing material"?
35. P. 34, under 3.2.4.2 Intent of Position.
"retreval" should be "retrieval"
36. P. 34, bottom para.
Should "10CFR60, Subpart E" be "10CFR60, Subpart F"?
37. P. 37, para. 3; and P. 44, para. 2.
Define "DSTP".

38. P. 39, 4th bullet.

What is meant by, "Monitoring instrumentation inputs should be from sensors that directly measure the desired variables"? Should "instrumentation inputs" be "signals"? Can one always directly measure the desired variables with the available sensors?

39. P. 40, para. 2.

a) "simpliest" should be "simplest".

b) "replecement" should be "replacement".

c) Sheath is probably not a good term to use here. A sheath is generally considered as a permanent clad over the instrument and/or wires (e.g., sheathed thermocouples). Perhaps the second sentence should be changed to read: "For example, hollow tubing is currently being successfully used in several repository simulations and instruments have been modified to fit inside the tubing and simply slide into place."

40. P. 41, under 4.9.2 Quality Control.

"Purturbing" should be "Perturbing".

41. P. 41, 2nd para. from bottom.

Should "calculation" be "calibration"?

42. P. 42, para. 3

Where possible, monitoring should begin before emplacement of waste packages to give baseline data.

43. P. 42, 2nd bullet.

Should "radiation resistant" (or "radiation hard") be included with "corrosion resistant or protected wiring - - -"?

44. P. 42, 5th bullet.

The term "data loggers" is a specific class of data acquisition equipment. "Analog-to-digital converters" is a better term for this component as listed here.

45. P. 44, 5.2 Discussion.

"Waste package movement" should be added to the list of six "off normal conditions" already itemized.

46. P. 45, para. 2.

"- - causing an inability to the detector - -" should be "- - causing inability of the detector - -"

47. P. 46, under 5.3 Corrective Actions, line 1.

"out of design" should be "out-of-design".

II. Comments on Appendix B.

I have reviewed the first pages of Appendix B into section B.2.2 on Temperature, a topic with which I have had direct experience in waste isolation experiments. There are a considerable number of errors and misinterpretations of references in that section which will require more than simple comments to properly rectify. After reviewing section B.2.2 I am also suspicious that the preceding section, B.2.1 on Radiation, may suffer from the same problems, or, at best, not be a true representation of "State-of-the-Art Monitoring Instrumentation and Systems"; however, someone more expert in the field of radiation monitoring should make that determination. That expertise is available here at LBL. Due to time considerations, I have not looked at the report beyond page B-15.

During our phone conversation, about 5 January 1984, we discussed in some detail my concerns and comments regarding Appendix B. Though incomplete at this point, I am including the comments that I made notes on. As you will see, our phone conversation included a few additional comments that I have not detailed below.

- B1. P. B-4, 1st bullet.
"dectors" should be "detectors".
- B2. P. B-5, line 8,
"quanity" should be "quantity".
- B3. P. B-7, under Climax spent fuel test, line 2.
"climax" should be "Climax".
- B4. P. B-7, para. 5, line 5.
"hose" should be "hole"
- B5. P. B-8, para. 5, bottom line.
"Table B.1" should be "Table B.2"
- B6. P. B-9, near top of Table B.2.
"Detecable" should be "Detectable"
- B7. P. B-10, bottom para., sentence 3.
 - a) This sentence is a little confusing.
 - b) "to a limited extent" should be omitted. Heat dissipation properties of the host rock are extremely important for model verification.
- B8. P. B-11, Top.
There are basically four types of common temperature sensors available that have been used in simulated repository experiments; the three mentioned (thermocouples, thermistors, and RTDs) and integrated circuit (IC) temperature sensors. For a brief description of IC temperature sensors, see NUREG/CR-3494, "Reliability of Geotechnical, Environmental, and Radiological Instrumentation in Nuclear Waste Repository Studies", by F. Rogue and E. P. Binnall, 1983, page 32. Brief descriptions of thermocouples, thermistors, and RTDs are also included in NUREG/CR-3494.

B9. P. B-11, under B2.2.2 Thermistors.

The two sentences discussing energy transfer to the sensor and energy dissipation have nothing to do with the use of thermistors as temperature measuring devices, other than the fact that the resulting "self-heating" causes an error in the temperature reading. The self-heating characteristic of thermistors (also RTDs and IC temperature sensors) is sometimes used in the measurement of thermal conductivity and thermal diffusivity of the surrounding media, but is a detriment to temperature measurements and must be minimized by keeping electrical current low through the device. (see NUREG/CR-3494 for further discussion).

B10. P. B-11, B.2.2.3 RTDs

It should be pointed out that RTD means Resistance Temperature Device and that the platinum resistance thermometer is only one special type of RTD (see NUREG/CR-3494).

B11. P. 13-12, para. 2.

Should be "Platinum RTDs are the most - - - -, are capable of high precision, and - - -"

B12. P. B-11, B-12, B-13, and B-15.

Remove apostrophes from RTD's and TC's (i.e., use RTDs and TCs). It is probably better to use "thermocouple(s)" rather than "TC(s)".

B13. P. B-13, line 4.

Guide tubes and sheaths are two totally different things. Guide tubes are hollow tubes attached to simulated waste canisters, down-hole instruments, or simply grouted into boreholes to allow the insertion and/or removal of thermocouples. A sheath is the outside protective covering protecting the thermocouple wire and junction, and is an integral part of the thermocouple. There have indeed been corrosion problems with stainless steel sheaths (see NUREG/CR-3494, pp. 29-31), and, to a lesser extent, Inconel sheaths.

B14. P. B-13, line 10.

Is "grouting" the correct word? Should that be "cementing", "epoxying", "attaching", or some other method of attachment; or was grouting material actually used between the container and metal plate?

B15. P. B-13, para. 2, last sentence.

This sentence is not totally correct as it stands. The reference given (LBL-10532) actually states that the desired precision was 0.5% over 10 to 220°C. See NUREG/CR-3494, p. 29, top sentence for a more general statement of thermocouple accuracy.

B16. P. B-13, para. 3.

This whole paragraph is completely misleading:

- a) Free water entering thermocouple wells caused only one of the more minor problems.
- b) Thermocouple wells were not involved in the corrosion or electrical shorting problems.

- c) Unfortunately, the problem was not avoided at Stripa.
- d) The last two sentences refer to stress and deformation measurement instruments, not thermocouples.

B17. P. B-13, bottom para.

- a) "Retail" should be "Retain"
- b) The recommendations given here are from the Stripa experiences. A more up-to-date and general list is given in NUREG/CR-3494.

B18. P. B-14, Figure title.

"Thermocouple well dewatering system" should be "thermocouple borehole dewatering system".

B19. P. B-15, top para.

The first two sentences of this paragraph are totally misleading.

B20. P. B-15, para. 3 and 4.

These two paragraphs need rework. Neither is totally correct.