NUCLEAR REGULATORY COMMISSION

COMMISSION MEETING

In the Matter of: PUBLIC MEETING

DISCUSSION AND POSSIBLE VOTE ON SECY-81-277 TO GER 50 DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN GEOLOGIC REPOSITORIES: TECHNICAL CRITERIA

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1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 DISCUSSION AND POSSIBLE VOTE ON SECY-81-267 -10 CFR 60

5 DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN

6 GEOLOGIC REPOSITORIES: TECHNICAL CRITERIA

7

8 PUBLIC MEETING

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Nuclear Regulatory Commission

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Room 1130
11 1717 H Street, N. W.
Washington, D. C.

12

Tuesday, June 16, 1981

13

The Commission met, pursuant to notice, at

14 10:05 a.m.

15

16 PRESENT:

17 JOSEPH M. HENDRIE, Chairman of the Commission
VICTOR GILINSKY, Commissioner
18 JOHN F. AHEARNE, Commissioner
PETER A. BRADFORD, Commissioner

19

20 STAFF PRESENT:

21 S. CHILK
M. MALSCH
22 J. MARTIN
P. COMELLA
23 W. DIRCKS
D. RATHBUN
24 G. CUNNINGHAM

25 * * *

# DISCLAIMER

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1 P R O C E E D I N G S

2 CHAIRMAN HENDRIE: Why don't we come to order.

3 The Commission meets this morning to continue its

4 discussion of the draft technical criteria rule for

5 high-level waste disposal, SECY-81-267.

6 We have from a staff a June 15th memorandum and

7 attached Enclosure A which, as requested of them, picks up

8 the material we have been through to about page 34. Our

9 principal task this morning will be to start at that point

10 and work on back through picking up people's comments.

11 I think we will be working primarily off two

12 documents, one of them the June 15th staff piece because it

13 presumably represents the best up-to-date version from the

14 staff, and the second one you may want to have in hand is my

15 memorandum of June 9th so that you can see the changes that

16 I want to make in it. There may be other papers the

17 Commissioners have or sections that they are interested in.

18 By way of getting us started I have clipped some

19 pages in the first 34 pages. Let's see, take out a

20 "whether" on page 9 for me, about the middle of the page,

21 "be determinant of when the Commission would decide whether

22 to permit closure of the repository. Couldn't we just say

23 "permit closure of the repository" since we either will

24 decide to permit or not.

25 We find the next one. Commissioners, please leap

1 in as you have found a thing or two coming along.

2 COMMISSIONER BRADFORD: My copy of your draft

3 doesn't have a "whether."

4 CHAIRMAN HENDRIE: I was thumbing through the

5 staff's bringing up to date of those sections, Peter. If

6 you will look at the staff's page 9 of the June 15th memo.

7 How did you get one printed on two sides?

8 MR. CHILK: We printed it on two sides this

9 morning. The copy that was distributed last night came up

10 from the staff with one side.

11 COMMISSIONER BRADFORD: It never pays to read

12 anything too soon, Joe.

13 (Laughter.)

14 CHAIRMAN HENDRIE: I am glad I have the one-sided

15 one.

16 (Laughter.)

17 There is a "whether" over on the left margin,

18 "whether to permit closure." It is just a language thing.

19 COMMISSIONER AHEARNE: I would like to compliment

20 the staff on page 1.

21 (Laughter.)

22 You may recall the day, Peter, where we discussed

23 whether it would be two spaces or three spaces were left.

24 You will notice how they explicitly left three spaces.

25 (Laughter.)

1 COMMISSIONER BRADFORD: I think it should be taken
2 as a move against foreclosing options.
3 (Laughter.)
4 CHAIRMAN HENDRIE: Question. Page 22 of the new
5 one. John, it says "Accessible Environment means" under
6 "Definitions. This is the May 11 rewrite? I had additional
7 language in the page that I used, but I used an earlier
8 version.
9 MS. COMELLA: Right.
10 CHAIRMAN HENDRIE: So you mean precisely what you
11 have got in the current one?
12 MS. COMELLA: Yes.
13 CHAIRMAN HENDRIE: Okay. That is the only
14 question.
15 Over on page 34, which brings us practically up to
16 date, six lines from the top, would you delete "so."
17 COMMISSIONER BRADFORD: How many lines from the
18 top?
19 CHAIRMAN HENDRIE: Six. It is up there where they
20 have "what is required is reasonable assurance that the
21 outcome will be confirmed."
22 Now, having achieved those major pieces of policy
23 decision, there are some upper case, lower cast matters that
24 will have to be completed but I will do those separately.
25 Why don't we embark and start to work our way

1 forward. This then would run from the bottom of page 34 in
2 the staff's new print-up and correspondingly from the middle
3 of page 30 in my memorandum.
4 Other comments on the material are welcomed.
5 This stuff from this point on now is a
6 reproduction essentially of the June 1st version of the
7 rule. So it has underlinings and crossings-out just as that
8 did I think. Isn't that right?
9 MS. COMELLA: Yes. And I think there has been an
10 attempt to provide in comparative text, although it was not
11 caught uniformly. What we have here are some of the changes
12 you made.
13 COMMISSIONER GILINSKY: Well, let's see. Have you
14 conformed it with Joe's version?
15 MS. COMELLA: No. In comparative text to bring
16 into this version what was in the Chairman's earlier version.
17 COMMISSIONER GILINSKY: But you have conformed it
18 indicating what changes you have made?
19 MS. COMELLA: Well, we put it there so you would
20 be able to see what was there and what were the changes
21 suggested. I am not sure I am quite answering your question.
22 COMMISSIONER GILINSKY: That is called conforming
23 it.
24 MS. COMELLA: But we didn't capture it all, I am
25 afraid. So that I think it would be better to work off the

1 two.

2 COMMISSIONER BRADFORD: Yes. For example, the

3 first set of changes on his page 34 don't appear at all on

4 your page 38.

5 MS. COMELLA: Yes.

6 COMMISSIONER GILINSKY: Let me understand. What

7 is the standing of the June 15th text? Is it something you

8 have written to try to capture what Joe was proposing, or is

9 it your proposal? Is it your revised proposal?

10 MS. COMELLA: It is basically what we had in the

11 earlier draft. In some instances we captured in comparative

12 text some of the changes that the Chairman had in his June

13 9th memorandum, but because of haste we could not do a

14 complete job.

15 COMMISSIONER GILINSKY: I understand that. But is

16 this a text which you support or recommend?

17 MS. COMELLA: Yes. It is the staff's text.

18 COMMISSIONER GILINSKY: So you have made revisions

19 which you are satisfied with?

20 MS. COMELLA: No, no.

21 CHAIRMAN HENDRIE: We will have to hear from the

22 staff on the changes that I proposed.

23 COMMISSIONER BRADFORD: Up to page 38 it is

24 something that everyone ---

25 COMMISSIONER GILINSKY: Well, let me just jump

1 ahead to give an example. Let's look at page 43,
2 "Potentially Adverse Conditions." You originally had "any
3 such conditions will give rise to a presumption" and so on.
4 You now have "will require analysis and such measures as are
5 necessary to compensate for them."
6 CHAIRMAN HENDRIE: Vic, I understand they have
7 made that change, and in some ways I am sorry they did it,
8 by way of trying to provide for our use my changes. But I
9 think when we get there we will have to see what the staff
10 thinks of the changes.
11 COMMISSIONER GILINSKY: That is what I was trying
12 to find out.
13 CHAIRMAN HENDRIE: I cannot regard them as
14 endorsing any of my changes they may have incorporated in
15 this part on.
16 MS. COMELLA: That is correct. That is what I
17 thought you were asking, whether we had actually reviewed
18 the language and then said well this is how the staff would
19 change it. No, that is not the case at all.
20 COMMISSIONER GILINSKY: That leaves me more
21 confused than before.
22 (Laughter.)
23 CHAIRMAN HENDRIE: Since I don't have any changes
24 until we get to 60.111, let's get at least that far and then
25 60.111 where ---

1 COMMISSIONER BRADFORD: (2), subpart (i). It is
2 the one headed "Containment of wastes."
3 CHAIRMAN HENDRIE: "Performance of the engineered
4 system."
5 COMMISSIONER BRADFORD: Right.
6 CHAIRMAN HENDRIE: This is the first of a couple
7 of places where I think the ALARA language is not the way to
8 handle the area requirement. As I say in the memorandum, I
9 think we ought to phrase it "the waste packages will contain
10 all radionuclides for at least for the first 1,000 years
11 after permanent closure," and take out the phrase "and for
12 as long thereafter as is reasonably achievable" because I am
13 not sure how you are going to cut off litigation on what is
14 reasonably achievable.
15 COMMISSIONER BRADFORD: But, Joe, isn't this
16 precisely the same problem that we run into anywhere where
17 we use ALARA type answer and the answer turns out to be that
18 if something is in effective a gold plated way of doing the
19 same thing then it is not said to be reasonably achievable
20 and that the benefits in fact don't outweigh the costs?
21 CHAIRMAN HENDRIE: Yes, and if repository
22 technology were as well developed as radiation health
23 technology, the techniques as frequently practiced, so that
24 a professional in the field, you know, has an immediate
25 sense of how often and to what extent he takes alpha swipes

1 in an area in order to get a reasonable coverage and what
2 practice constitutes just ridiculous running around in
3 circles in effect, then I think you would be on much
4 stronger ground in using an ALARA condition here.
5 But what you are talking about in each of these
6 cases is a piece of technological development in which you
7 are trying to drive this system to achieve a pretty decent
8 level of performance, at least if I measure by the complaint
9 level from the folk who presumably are going to supply the
10 data that supports the 1,000 year container and the part in
11 a hundred thousand leach rate engineering system.
12 So to attach to that new piece of technology an
13 ALARA sort of objective is going to end up taking you far
14 beyond the place the staff wants to be or I think the place
15 the staff wants to be, which is that they want to maintain
16 some degree of technology forcing posture. And as the
17 development work goes along if you see a good and reasonable
18 and practicable way, why you are working on the 1,000 year
19 container to make it a 2,000 year container and you can do
20 that for another five percent of the cost, why how about
21 that, that is a pretty good buy. But that isn't the way it
22 is going to be gone at in the adjudicatory format. The
23 designer's and the DOE's side will be mustering their
24 arguments to have a reasonable basis for claiming to have a
25 1,000 year design. There will be substantial argument over

1 that proposition.

2 Then beyond that, even if it appears that the

3 preponderance of the records supports the 1,000 year

4 proposition, you haven't met the regulations, because

5 somebody is going to come in and the people that come in

6 aren't going to have to show you a lot of engineering data

7 and erosion results and so on. They are just going to have

8 to make the proposition that if you put the whole thing in

9 four-inch wall thickness copper containers, that is

10 certainly readily reasonably achievable although expensive

11 and that is what the regulation requires.

12 As I say, once you have got the four-inch copper

13 container, then it can be gold plated. After it is gold

14 plated it can be gold plated inside as well as out. You

15 know, for a new technology like this where you can't foresee

16 all the details, you are going to end up with NRC staff

17 members trying to decide eventually in the midst of an

18 adjudicatory proceeding where they think too expensive is.

19 COMMISSIONER BRADFORD: It won't be in the midst

20 of. It will be before.

21 CHAIRMAN HENDRIE: I doubt it because there will

22 be some initial positions on that and then there will be a

23 whole series of contentions about you could have done it

24 this way and at least in principle that would last longer or

25 possibly last longer and you have to go away and investigate

1 that.

2 What I worry about here is the inability to in any
3 reasonable way close off and settle on a design and say that
4 is good enough. I think what in fact is good enough is if
5 you get reasonable assurance of a 1,000 year container and
6 reasonable assurance of a part in 100,000 leach rate from
7 the engineered system.

8 You have in fact reduced the isolation burden on
9 then the geologic setting, assuming the thousand year water
10 travel time which would be easily achievable, and you have
11 then reduced the isolation requirement on the geologic
12 setting now. Well, you have speculated on what you know of
13 where EPA is going on the general standard and factors of
14 like, oh, 10, 100 and probably not more than 1,000 was the
15 way I read it. So that you in fact have got very good
16 performance from those first barriers, performance which
17 certainly must be good enough.

18 My view is that because of what I can foresee as
19 the difficulties then in defining the design so that DOE can
20 go ahead and be confident that they have got, you know, one
21 that meets what we think of as the ALARA principle and will
22 stand up under that language of the adjudication because of
23 that difficulty and because in fact if you say at least
24 1,000 years you are still pressing the technology and are
25 providing a damn good barrier. I think it is good enough

1 and I think we ought to be able to cut it at that.

2 Now, it is certainly true from a technical

3 standpoint that if you say at least a thousand the precision

4 with which you can design life into a waste package is not

5 such that that means no, it would have been easy to achieve

6 1,400 years and they cut it back on you. No, no.

7 They are going to have to push and the canister

8 will probably be good for a good deal more than a thousand

9 for the great majority of the canisters. I think the ALARA

10 proposition just leaves things too open and too undefinable

11 for the designer. It is simply an unnecessary barrier that

12 we are forced to erect here.

13 That is the argument that I make on the point and,

14 you know, it applies to the canister and it applies to the

15 leach rate. There is also the same language in the TRU and

16 that sort of comes with the other. If you wouldn't have it

17 in the first two places you wouldn't have it in the other.

18 COMMISSIONER BRADFORD: Yes.

19 CHAIRMAN HENDRIE: Comments are welcomed.

20 MR. DIRCKS: We agree if we get a 1,000 year

21 canister, "at least." That would satisfy your requirements,

22 right John?

23 MR. MARTIN: What we had in mind here was to

24 provide some incentives to the few people in the national

25 labs working on this problem to think. There are some

1 incentives to do more than the minimum. I think adding "at
2 least" pretty much satisfies my concern.
3 CHAIRMAN HENDRIE: Well, it isn't as good as long
4 as "reasonably achievable" is clear, but it certainly gives
5 the sense that, you know, if you just manage to gasp over
6 the 1,000 year line with your evidence, why, you know, we
7 would like to see people going past a thousand years in good
8 philosophy.
9 MR. MARTIN: Of course, a great deal of our
10 argument about having these performance objectives is it
11 does add more certainty to the whole licensing process and I
12 think "as low as reasonably achievable" probably runs
13 counter to that.
14 CHAIRMAN HENDRIE: Well, I will tell you, I
15 certainly don't have any objection to going back into the
16 supplementary information section in the appropriate place
17 where one talks about the performance criteria or about the
18 multiple barriers and say there one notes that the rule
19 establishes a requirement of at least a thousand years and
20 then note in the supplementary information that the
21 Commission considers it highly desirable that the waste
22 package lasts as long as is reasonably achievable, that is,
23 you know, the same kind of language. But that is putting it
24 back there rather than making it a requirement of the rule
25 that will get adjudicated.

1 COMMISSIONER BRADFORD: Your suggestion was to put
2 back in there that the Commission seeks comment on an ALARA
3 proposition?
4 CHAIRMAN HENDRIE: That is an alternative
5 proposition. What I was saying here was that if I could
6 talk you all into taking the ALARA language out of the rule
7 I would certainly have no objection to putting a couple of
8 sentences on ALARA, you know, the Commission thinks it
9 highly desirable that canisters last as long as reasonably
10 achievable or equivalent language, putting that back in the
11 supplementary considerations.
12 Now, obviously, that means that it is not a
13 requirement in the regulations of the Commission. Obviously
14 if I could get you to take it out of the rule language and
15 make a concession to me and people who think they would not
16 like to lose the thought in the language hopefully out of
17 the package for comment, you know, if I can get you to take
18 it out of one place, why it is certainly not unreasonable to
19 put it in back up in the front end in a sentence or two or
20 however the people might want to phrase it.
21 I urge that strongly on you.
22 Down under the "Control of Releases" the 1,000
23 year one, in the same sense in my editing it was too easy to
24 strike a line right down there at the bottom of the page,
25 and I didn't get "as a minimum" in and I would think to go

1 with "at least", why one would want again that sense of "at
2 least" or "as a minimum."
3 COMMISSIONER BRADFORD: So you would keep that "As
4 a minimum, the design shall provide"?
5 CHAIRMAN HENDRIE: As a matter of fact, it is an
6 inconsistency between the waste package "at least" and this
7 one that I had contended.
8 COMMISSIONER BRADFORD: I understand the point you
9 are making and certainly there is an appeal in trading the
10 ALARA for the "at least" or "as a minimum" principle.
11 I wonder though whether the ALARA concept wasn't
12 in there originally because it was intended to provide the
13 staff with the ability in the event that they saw a
14 relatively inexpensive path that provided either greater
15 assurance that the particular criteria were being met or
16 else the opportunity to meet a little more than the criteria
17 at relatively low cost to insist that that be the path
18 chosen.
19 If we take the ALARA principle out here, how does
20 the staff then have the ability to do that? Supposing, for
21 example, that they seem to have skated in with a proposal
22 that just does seem to do it as to the past years and part
23 in a hundred thousand, but for a little bit more could
24 substantially strengthen one of the two, isn't it useful for
25 the staff to be able to insist that they enforce it?

1 CHAIRMAN HENDRIE: Certainly it is true that if
2 this kind of language were in the rule the staff would be
3 supported directly by the rule language going into the
4 hearing and saying, you know, we think the design proposed
5 isn't "as long as reasonably achievable" and that another
6 would be. Indeed, you would give that regulatory muscle up
7 in what I propose.
8 I think, however, that the chance that that might
9 be the case, that there might be, you know, a very small
10 incremental cost in difficulty proposition which had a
11 substantially longer containment time and that would not be
12 an option followed by DOE, I think the chance of that
13 occurring and leaving you in a configuration in which it was
14 all apparent that it was there and you could see how you
15 could make the showings and then DOE wouldn't take it and
16 the staff would have to compel them to do it, I think the
17 chance that you will find that configuration is really
18 diminishing the small.
19 I agree that you give up a certain amount of clout
20 in compelling a solution on DOE. If we stop to consider how
21 things lie at the moment in putting an at least a thousand
22 year requirement on the waste package and we compel DOE in
23 certain research directions aimed at a waste package which
24 is a little tougher than they had been planning in fact so
25 they have got to frame their research against the longer

1 requirement time than they had planned, as far as I can
2 judge, that research will develop, you know, certainly
3 information which presumably would support a thousand year
4 plus package.
5 If there is a readily achieveable, you know, not a
6 large incremental cost or a large development problem option
7 that shows up, I think the chance that DOE won't take it is
8 not very high. You know, from the thrust they get out now
9 it will have had to have launched this research program and
10 if it generates, if it throws up out of its bowels, you
11 know, a good looking proposition, it is just very hard to
12 see them not taking advantage of the additional containment
13 time in terms of the relief that offers on other aspects of
14 the repository, you know, to meet the overall standards.
15 You know, I don't think you are giving up very
16 much, you see.
17 COMMISSIONER BRADFORD: Let me make a suggestion.
18 If it were just you and me voting, my sugestion would be
19 that we just put a footnote under this section saying that
20 as to (b)(ii) or (1)(ii) and whatever the two section is,
21 2(a) and (b), the Commission also seeks comment on the
22 wisdom and feasibility of applying an ALARA concept and
23 leave it at that. That is, use your language as the
24 proposed version but also seek comment on an ALARA
25 proposition.

1 CHAIRMAN HENDRIE: We have done that in other
2 places and I certainly wouldn't have objection to that. One
3 of my aims here is to try to keep it flexible.
4 But you would be willing to go with my version of
5 the language and then call for an ALARA comment on
6 achievable?
7 COMMISSIONER BRADFORD: Yes.
8 CHAIRMAN HENDRIE: I guess a footnote could point
9 out that earlier versions or earlier drafts had an "as long
10 as reasonably achieveable" additional requirement in.
11 COMMISSIONER BRADFORD: I would just ask for a
12 comment on an ALARA proposition.
13 CHAIRMAN HENDRIE: On how one could best frame and
14 what the practicality would be of the "as long as reasonably
15 achievable."
16 COMMISSIONER BRADFORD: Yes.
17 CHAIRMAN HENDRIE: I wouldn't object to that. I
18 think that would accommodate my aim.
19 COMMISSIONER AHEARNE: You would also do that on
20 all of these?
21 CHAIRMAN HENDRIE: Yes. There are these three
22 ALARA type places, one for the waste package, one for
23 control of releases and then for TRU. I think the staff
24 could find an appropriate way to asterisk and reference the
25 three sections to a single footnote then.

1 MR. MARTIN: In using your words I presume we
2 would then also go back to the statement of considerations
3 of add a couple of sentences?
4 CHAIRMAN HENDRIE: I would think so, yes, because
5 then in the rule language it says you are calling for sort
6 of a special interest area, a comment on it and I think yo
7 would normally want to note those up front.
8 MR. MARTIN: Well, we had talked earlier about
9 adding a couple of sentences in the statement of
10 considerations which reflect that we would really like to
11 see this "as long as you can" but not have it in the rules.
12 So we would like to add a couple of sentences there.
13 COMMISSIONER BRADFORD: What do those sentences
14 say again, Jack, that you like the concept of "as long as
15 you can" but don't want it litigable?
16 CHAIRMAN HENDRIE: No, I don't think you would say
17 you don't want it in the rule. Those were the sentences I
18 was suggesting I wouldn't have any objection to, to put back
19 in the supplementary information the thought that we
20 consider it highly desirable ---
21 COMMISSIONER BRADFORD: ---that even under the
22 non-ALARA formulation that this be ---
23 CHAIRMAN HENDRIE: Yes.
24 COMMISSIONER AHEARNE: Then you will have to
25 somewhat smooth the language under "Control of Releases" to

1 pick up the phrase "as a minimum." The sentence structure
2 will have to be smoothed out.
3 CHAIRMAN HENDRIE: Everybody I guess will have a
4 favorite place to put "at a minimum." My own would be after
5 you get along in it a little bit "assuming anticipated
6 processes and events, the annual release from the engineered
7 systems into the geologic setting of any radionuclide does
8 not at a minimum exceed" -- "does not exceed at a minimum"
9 -- "at a minimum does not exceed" -- I don't know.
10 COMMISSIONER AHEARNE: I would say "is no greater
11 than."
12 CHAIRMAN HENDRIE: "Is no greater than." Isn't
13 that the same as "does not exceed."
14 MR. MARTIN: More people would understand it.
15 CHAIRMAN HENDRIE: That is a desirable attitude.
16 (Laughter.)
17 I would advise them to work it as they think the
18 language should be and we will see a version. I thought
19 that was going to turn out great, but when I got to reading
20 it and got to the place, why I realized I tread upon a
21 bridge of sand.
22 If we turn two pages forward, comments on Section
23 112, 121, 122, "Favorable Conditions"?
24 COMMISSIONER AHEARNE: There you have picked up
25 the change.

1 CHAIRMAN HENDRIE: When we get to 123 we come to
2 another one of my complaints here.
3 You had a suggestion there.
4 COMMISSIONER AHEARNE: My suggestion was trying to
5 get half way between where I guess the staff originally was
6 and you were.
7 COMMISSIONER GILINSKY: I would suggest coupling
8 both versions. I would run the staff language and follow it
9 with "unless the condition is carefully analyzed and
10 adequately compensated." I just made this up. Essentially
11 just tack your substitution on at the end.
12 CHAIRMAN HENDRIE: I will tell you what got my
13 ruff up about the framing of the unfavorable conditions
14 section. If you have got some favorable conditions, why
15 good, you know those. You know, that is dandy, but it
16 doesn't get you a license in their list of favorable
17 conditions. The repository applicant can note that he has
18 got all the odd ones and that is great and fine and it is on
19 the positive side of the evidence to be sure, but it doesn't
20 get him down the line and it doesn't get him a license
21 certainly or a permit.
22 Now we have got a list of unfavorable conditions.
23 Instead of saying now have you got any these, why, you know,
24 we will have to analyze them and see what should be done
25 about them, are they of a nature where something needs to be

1 done and, if so, what can be done. We don't say it that
2 way. We frame it and say if you have got any one of these,
3 then the presumption is that the repository is unlicenseable.
4 All I can say is that in a regulation whose intent
5 is to establish the technical safety requirements for a
6 repository I am not sure I see the advantage in constructing
7 that formal barrier which having erected it you are then
8 going to have to try to climb over in a hearing.
9 Perhaps somebody can tell me about rebuttable
10 presumption and so on. I just didn't understand why the
11 language was useful and helpful, you know, the way in which
12 these things were framed. You know, the change that I had
13 proposed, and John does better with it than my proposal I
14 think, was not to strike any adverse condition or to strike,
15 you know, saying what you ought to do about it if you got
16 one of these, but rather just to relieve that what seemed to
17 me peculiar framing.
18 COMMISSIONER GILINSKY: Well, these are more than
19 potentially adverse conditions. It seems to me they are
20 potentially serious adverse conditions.
21 COMMISSIONER BRADFORD: Somehow the adverse
22 conditions are more adverse than the position conditions are
23 position. That is, you just couldn't say about the position
24 conditions that their presence or the presence of any one of
25 them in and of itself gives rise to a presumption that you

1 will meet the criterion. But I think it is true of the
2 adverse conditions that they really would, if you found
3 them, that they would weight more heavily on the negative
4 side than the positive would weigh on the positive side.
5 CHAIRMAN HENDRIE: But if you are going to say
6 that, Peter and Vic, then you are going to have to say let's
7 start out on No. 1. It is not the potential for failure of
8 man-made surface water impoundments that would cause the
9 repository to be rejected but, you know, some basis for
10 believing that there will be failure of specific man-made
11 impoundments.
12 As these things are phrased, "potential for," et
13 cetera, you know, I come at you and you have got the
14 proposition for a repository at Hanford. I say, listen,
15 either four generations hence our children will decide to
16 damn the Columbia and return the Hanford Basin to the lake
17 condition which it enjoyed at one point in geologic history
18 or there will be a landslide or a volcano will leap up in
19 the bed of the river and damn it and what are you going to
20 do about that? By George, that is certainly the potential
21 for flooding, impoundment and all sorts of these things.
22 Good, I have not erected an adverse condition and, you know,
23 tear up the paper on the Hanford repository.
24 You are going to say, wait, you know, you have
25 cited a hypothetical events here and let me show you why

1 these just aren't likely or certainly not likely enough to
2 rule out the Hanford Basin. But, you know, the way they are
3 framed ---
4 COMMISSIONER GILINSKY: Supppose we simply tack on
5 "unless the condition is carefully analyzed and adequately
6 compensated." It seems to me to be in fact almost the exact
7 words that you are using.
8 CHAIRMAN HENDRIE: Good. Why do these things once
9 identified in some form or other in a contention in the
10 hearing, why does that have to throw the proceeding into a
11 configuration in which it is then presumed the repository is
12 unsuitable? Why can't those issues as they come into
13 contention be like any other set of issues, that is, you
14 know, the guy has got an argument that you won't meet all
15 your objectives and regulations on account of this here
16 problem and now we will analyze it?
17 COMMISSIONER BRADFORD: The problem seems to be
18 coming out of the word "presumption" which I don't think
19 would work quite as severely as you think it would. But in
20 fact I gathered a moment ago that John's language had some
21 appeal for you and I just say it seems to me to convey the
22 same basic thought. So it is okay with me.
23 I would add at the tail of his points one, two and
24 three just the words "pursuant to Section 60.124" which is
25 where you really lay out the method. But that aside, I can

1 live with that language.

2 CHAIRMAN HENDRIE: I think that would do it for me

3 as I read what you have written.

4 COMMISSIONER AHEARNE: Fine.

5 COMMISSIONER GILINSKY: Let's hear from you, Jack.

6 MR. MARTIN: We think Commissioner Ahearne's words

7 are just right.

8 (Laughter.)

9 COMMISSIONER AHEARNE: You have no problem.

10 (Laughter.)

11 CHAIRMAN HENDRIE: Great. Let's do it that way

12 with that addition that Peter made at the end of John's

13 words. Those would be his words on 123, right?

14 COMMISSIONER BRADFORD: Yes.

15 COMMISSIONER GILINSKY: I would like to add "and

16 necessary to adequately compensate for them." Put in the

17 word "adequately."

18 CHAIRMAN HENDRIE: I will go with that if you will

19 agree to put it after the infinitive rather than splitting

20 it.

21 (Laughter.)

22 COMMISSIONER GILINSKY: Yes.

23 COMMISSIONER BRADFORD: I would hang firm on that

24 one, too.

25 CHAIRMAN HENDRIE: I have got a couple of other

1 questions I would like to raise with regard to the adverse
2 conditions section but they are of a lower order than the
3 point we have just settled.
4 In my copy you will find a couple of places I
5 chucked in "planned" or "existing" or something like that,
6 No. 1, No. 2 and No. 3, and I guess I ran out of places
7 after that.
8 COMMISSIONER AHEARNE: They put those in.
9 CHAIRMAN HENDRIE: Well, I know, but that was not
10 that they thought that was just great language but rather
11 as ---
12 COMMISSIONER BRADFORD: Does the "planned" in No.
13 3 change significantly the thought that was already there?
14 CHAIRMAN HENDRIE: I don't know. I needed some
15 discussion with the staff on the point, Peter. It sort of
16 depends on what they had in mind.
17 What I had in mind was, for instance, for these
18 first several, what would you do with a contention that
19 there is no way to guarantee that future generations won't
20 damn the Columbia and flood the Hanford plateau and thus
21 lead to flooding the repository and changes in groundwater
22 flow, et cetera? Would you argue that you don't think that
23 is very sensible?
24 MR. CUNNINGHAM: I think you would have to
25 litigate it in terms of reasonable foreseeability which is

1 akin to what you are accomplishing by putting in the word
2 "planned" here. Without the word "planned" obviously you
3 can't reflect that contention in an absolute sense. It has
4 to be in terms of reasonable probability or foreseeability.
5 CHAIRMAN HENDRIE: I guess that is what, without
6 being able to put it in those words, I was perhaps sensing
7 and why I felt the need for "planned" or "existing" or
8 something like that. It seemed to me that once you got
9 beyond activities in the human realm of this kind that
10 "reasonably foreseeable" or it could be on the basis of our
11 present society "reasonably projected" to be "planned," then
12 you sort of get into the same area you are with regard to
13 some future race, you know, some 5,000 years from now
14 drilling into the repository.
15 What you have said about that is, come on, what we
16 are going to do is mark it as well as we can and keep
17 records as well as we can and contain and isolate the waste
18 pretty and then we are just not going to argue about whether
19 some 5,000 year hence citizen drills the repository. If he
20 does he will have the technology we think to detect that he
21 is getting an interesting load of transuranics off the end
22 of the drill bit and he will take provisions and not that
23 many people will get hurt, if any, and we just aren't going
24 to argue endlessly about it in the hearings.
25 Now, it seems to me that in these things there

1 ought to be some way to put the same reasonable kind of
2 bound on the way you are going to treat and argue
3 contentions and that was the thrust behind these word
4 additions.
5 COMMISSIONER BRADFORD: How would you feel about
6 just adding "or reasonably likely" wherever you put in
7 "planned" so that you are not confined solely to things that
8 are actually in blueprint form?
9 CHAIRMAN HENDRIE: I think anyway that you or the
10 legal people I think would provide the sort of framework
11 that I am talking my way around here somewhat
12 inarticulately.
13 I think with regard to the deliberate human
14 intrusion aspect, that I think it has been handled very
15 well. I think it is clear from the rule what the
16 protections and the bases for the way of setting them up are.
17 Here, it seems to me, is a very much related area
18 and all I am looking for is some way to carry the same kind
19 of thought.
20 COMMISSIONER BRADFORD: How about "planned" or
21 "reasonably likely," does that cause anyone any problem?
22 MR. MARTIN: "Planned" might be better.
23 CHAIRMAN HENDRIE: It is narrow. It means
24 somebody comes in and says I think they are going to damn
25 the Hanford Basin and you say, produce, you know, show me

1 the evidence that there is a plan. He says, no, I can't
2 show you a specific plan but let me tell you why I think it
3 is likely.
4 MR. MARTIN: If you said "planned" it seems to me
5 that that would narrow the kinds of things discussed in the
6 hearing yet still permit you to examine the tradeoffs in the
7 environmental analysis. You still have to look for
8 competition, you know, whether does the site compete with
9 some sort of a hydroelectric project that might be
10 constructed and get that out of the way of the environmental
11 analysis.
12 It seems to me that if it was reasonably
13 foreseeable that you would still have an awful lot left to
14 argue about.
15 COMMISSIONER BRADFORD: Well, drop "reasonably" if
16 you would like. The difficulty with doing it all in the
17 environmental analysis is that that doesn't in itself give
18 you a clear regulatory tool. That is, that the NEPA
19 statement is in the end a description and you can regulate
20 on the basis of it but it is not as clear cut a path as the
21 regulation itself.
22 CHAIRMAN HENDRIE: You would propose something
23 like "planned" or "likely"?
24 COMMISSIONER BRADFORD: "Planned" or "likely."
25 CHAIRMAN HENDRIE: Let's try "planned." The first

1 one, instead of "existing," "planned" or "likely." If it is
2 existing, why I think it is both likely and planned.
3 There is one other place over in 12 under (b)
4 where I suggested "expected" instead of "potential." Now,
5 this is not a human proposition but I worry about how you
6 were going to deal again with a geologic process which you
7 would argue is not likely and is not to be expected on the
8 basis of the geologic history but which you have some
9 difficulty in being able to throw out as a potential
10 geologic scenario out there in the future. If you can't
11 throw it out, you know, by the virtue of the way these
12 things were framed, I worry that you then had fallen into a
13 tiger trap from which you couldn't climb out.
14 COMMISSIONER GILINSKY: You might be concerned
15 about changes that have a 10 percent probability or even
16 less than that, particularly since you weakened the general
17 statement.
18 CHAIRMAN HENDRIE: I accept advice. I seek advice
19 on ---
20 COMMISSIONER AHEARNE: That is a more accurate
21 description.
22 CHAIRMAN HENDRIE: --- whether the changes to the
23 overall framing of this section relieves the difficulty.
24 COMMISSIONER GILINSKY: I would think so. You
25 might want something a trifle narrower than "potential" but

1 I think "expected" goes too far since you have got
2 "potential" elsewhere.
3 CHAIRMAN HENDRIE: Yes, there are a lot of
4 "potentials" in there and I wasn't sure what to do about
5 them. I felt inadequate to attack them all.
6 COMMISSIONER GILINSKY: Well over here in No. 7,
7 your "Potential for creating new pathways for radionuclide
8 migration" and so on.
9 It seems to me that by softening the introduction
10 you have pretty well achieved what you wanted to.
11 CHAIRMAN HENDRIE: That may be the case. I don't
12 know.
13 MR. CUNNINGHAM: I am inclined to think so.
14 MR. DIRCKS: You are already asking for the
15 analysis and we can pick it up there.
16 COMMISSIONER GILINSKY: You are way ahead already,
17 Bill.
18 CHAIRMAN HENDRIE: You think I ought to quit while
19 I am winning.
20 COMMISSIONER GILINSKY: Yes.
21 CHAIRMAN HENDRIE: You may be right.
22 (Laughter.)
23 CHAIRMAN HENDRIE: With regard to Section 124 ---
24 MR. MARTIN: How did we leave that one?
25 COMMISSIONER GILINSKY: Leave it the way it was.

1 CHAIRMAN HENDRIE: Yes, I think so. You know, you
2 have got some language to work in in earlier pages and then
3 the final adjustment on these last pages. So you are going
4 to have to churn another version. As you churning if you
5 think of a word that we might consider as an alternate to
6 "potential," why, you know, I would glad to consider it but
7 I will leave that up to you.
8 CHAIRMAN HENDRIE: Now with regard to 124, John,
9 does your language then leave the text of 124 reading the
10 way it was, or does it mean that the changes in the verbs
11 that I have in there?
12 COMMISSIONER AHEARNE: What it does is it just
13 picks up after "demonstrated:"
14 COMMISSIONER BRADFORD: Yours would go back to the
15 original I think, John.
16 COMMISSIONER GILINSKY: John, you say, "may be
17 shown to not significantly impair the ability of the
18 geologic repository." Now it may or may not be possible to
19 show. I think you mean an attempt can be made.
20 COMMISSIONER AHEARNE: Well, in order to show
21 these are what have to be demonstrated.
22 COMMISSIONER GILINSKY: Well, that is clear from
23 the following sentence, but I wonder if one oughtn't to
24 change the "may be shown" and perhaps combine the two
25 sentences.

1 CHAIRMAN HENDRIE: You need something like the
2 last phrase in order to lead into the rest of the text
3 without having to change all of the verbs.
4 COMMISSIONER GILINSKY: I wonder if you don't want
5 to start with "In order to show that a potentially adverse
6 condition or combination of so and so does not significantly
7 impair the abilities of the geologic repository that the
8 following must be demonstrated:" I am a little bothered by
9 the "may be shown" which I think is intended to mean the
10 attempt may be made in order to demonstrate the following.
11 CHAIRMAN HENDRIE: Sounds find to me. It would
12 read then "In order to show that a potentially adverse
13 condition or combination of conditions cited in Section
14 61-23 of this subpart does not impair significantly the
15 ability of the geologic repository to isolate the
16 radioactive waste the following must be demonstrated:" I
17 guess that is all right.
18 COMMISSIONER GILINSKY: Maybe we had better ask
19 Jack before we all nod.
20 MR. MARTIN: Then leave the rest of the paragraph
21 the way it was.
22 CHAIRMAN HENDRIE: Then it does need the verb
23 changes.
24 COMMISSIONER BRADFORD: Except for the place where
25 Joe cured the split infinitive.

1 (Laughter.)

2 CHAIRMAN HENDRIE: Oh, yes, to affect

3 significantly. You notice I unsplit one when I reread

4 John's.

5 COMMISSIONER BRADFORD: Right. Well, what they

6 did was did it in. There isn't an infinitive there any more.

7 CHAIRMAN HENDRIE: Doesn't it end up with "to

8 impair" in there?

9 COMMISSIONER BRADFORD: No. "It does not

10 significantly impair."

11 CHAIRMAN HENDRIE: Okay. Let me down in (c)(i)

12 there my unsplitting of the infinitive.

13 Peter, I sometimes feel that you and I struggle

14 valiantly ---

15 COMMISSIONER BRADFORD: Well, it is very much

16 against the tide.

17 CHAIRMAN HENDRIE: --- pushing this dumb ball up

18 hill. I am not even sure you on occasion ---

19 (Laughter.)

20 I think that ran me out, didn't it?

21 I have a page 46 extracted from some place.

22 COMMISSIONER GILINSKY: I am sorry, this is yours.

23 (Laughter.)

24 CHAIRMAN HENDRIE: You know my papers are your

25 papers. This is a collegial body.

1 (Laughter.)

2 COMMISSIONER GILINSKY: I read that speech on the

3 back.

4 (Laughter.)

5 COMMISSIONER AHEARNE: Ask him what he did for it.

6 (Laughter.)

7 CHAIRMAN HENDRIE: You just have to be sure which

8 side you read when you get on the podium.

9 (Laughter.)

10 COMMISSIONER AHEARNE: Make a few changes.

11 Now, is it correct that in your revised version

12 you sent up there is no page 46?

13 MS. COMELLA: That got left out.

14 COMMISSIONER AHEARNE: The text seems to flow but

15 it is just the pagination.

16 MS. COMELLA: Yes, that is right.

17 CHAIRMAN HENDRIE: It is just a page number. The

18 text flows along.

19 The rest of the June 15th text is up to date in

20 the sense that as far as you know it is the most recent

21 staff proposal for the language for the latter sections of

22 the rule?

23 MS. COMELLA: That is right, yes.

24 CHAIRMAN HENDRIE: As I recall it, I didn't have

25 any marks on those pages so you haven't as a courtesy

1 included mine.

2 MS. COMELLA: Right.

3 CHAIRMAN HENDRIE: So it is the staff proposed

4 language. I would be glad to thumb through it. Does anyone

5 feel the need for that?

6 COMMISSIONER AHEARNE: I will pass.

7 CHAIRMAN HENDRIE: You pass.

8 Pass?

9 COMMISSIONER GILINSKY: (Nodding affirmatively.)

10 CHAIRMAN HENDRIE: Pass?

11 COMMISSIONER BRADFORD: Pass.

12 CHAIRMAN HENDRIE: There is great enthusiasm for

13 passing these sections.

14 (Laughter.)

15 All right, why don't we go back to page 1 since it

16 is only a quarter after 11 and haggle at length over a

17 comment period.

18 (Laughter.)

19 COMMISSIONER BRADFORD: I forgot about that.

20 (Laughter.)

21 CHAIRMAN HENDRIE: I will tell you what. I think

22 it is best from my point of view to start from a position of

23 strength.

24 (Laughter.)

25 Since three spaces have been provided, my strong

1 recommendation to you is 999 days.

2 (Laughter.)

3 COMMISSIONER BRADFORD: Let's see, I can't get

4 below minus 99, can I?

5 (Laughter.)

6 CHAIRMAN HENDRIE: I don't think you can go below

7 the law so I think you are stuck with 15 days.

8 (Laughter.)

9 Now, I am willing to split it half way.

10 (Laughter.)

11 What could be more reasonable than that?

12 COMMISSIONER GILINSKY: Having won out all these

13 points, Joe, why don't you just gracefully go on with 90

14 days.

15 CHAIRMAN HENDRIE: I could, but I tell you, I

16 really think they ought to have at least a little more time.

17 COMMISSIONER GILINSKY: Well, we talked about this

18 before. The point really isn't that they need more time.

19 If they have something in the works they really need an

20 opportunity to let us know at some high level and they

21 certainly have that. If they did, there is no question that

22 it would receive a great deal of weight here.

23 COMMISSIONER AHEARNE: Would you people be willing

24 to count mine at 120?

25 COMMISSIONER GILINSKY: If there is no other

1 choice, yes. I mean, why fool around when we can quit early.
2 (Laughter.)
3 I think the concerns which Joe has, which I think
4 I understand, really aren't so much -- well, let me put it
5 this way. The possibility that DOE may want to go in some
6 different direction or produce some new program or do
7 something or other is something they can communicate to us
8 in 90 days as well as they can communicate in 120 or 150.
9 COMMISSIONER AHEARNE: The one difference I guess
10 is assuming there were other people other than DOE who were
11 going to comment. Let's say we put 90 days in there and
12 they wait until 80 days are up and then they come in and say
13 we are going to need an extra 60 days to do our comments.
14 You are absolutely correct, we will give them an extra 60
15 days, but they probably would have reached that conclusion
16 that they wanted the extra time many days earlier, whereas
17 the other people who would be commenting might be trying to
18 make the 90-day deadline.
19 If we believe there is a reasonably good chance
20 that it is going to take longer to get DOE's comments in, I
21 think we ought to give everybody that same advance situation.
22 COMMISSIONER GILINSKY: Well, are we really
23 talking about DOE taking longer to comment? I didn't think
24 that was really the situation. After all, they have been
25 following this very closely and we put this out in an

1 earlier version. Everyone who is interested in the subject
2 is pretty well ready to comment and has assembled all his
3 references and index cards and everything else and is ready
4 to go I would imagine.
5 CHAIRMAN HENDRIE: But that is one of the aspects
6 of it that makes a longer comment period desirable. I would
7 just as soon that DOE didn't come back to us with a set of
8 comments which were essentially drafted as they looked at
9 Jack Martin's versions of this document of, you know, two,
10 three or four months ago. We have been hearing kind of a
11 steady stream of comments about, oh, this is going to create
12 a great problem and, you know, you are setting unnecessary
13 difficulties in the licensing and so on.
14 It seems to me that what we have now got framed
15 here is a proposition that is at the same time both more
16 practical as a licensing regulation and as a rule proposed
17 for comment also has, I guess the word is flexibility and
18 elbow room built into it for accommodation of comments than
19 the original version.
20 I would like to think that they will try to sit
21 down with it and think through from scratch the sort of
22 positions they have been taking about the multiple barriers
23 and how they would approach things just with the rule and so
24 on. You know, one of the aspects of a shorter comment
25 period is the pressure, you know, it would be the kind of

1 memorandum that SECY sends out, you know, staff is to have
2 the first draft of this to the Division Deputy Director by,
3 you know, next Tuesday or whatever.
4 So what is going to come up from the working ranks
5 I am afraid is something which will be sort of a not all
6 that carefully rethought retread of the kind of comments we
7 have been getting for the last, I don't know, since spring.
8 So that is one of the things I had in mind when I said I
9 think that I wanted to leave DOE enough time so that there
10 could be some policy evolution in their thinking.
11 Now, if on balance the rest of you would just as
12 soon go ahead and call it 90 days, why I guess I will quit
13 fighting about it. But in that case what I would suggest to
14 you is that down in the background under supplementary
15 information background I would put in a sentence or two
16 along the lines that the Commission seeks, what will we call
17 it, seeks comment on these technical criteria.
18 I would start out and say the Commission has asked
19 for comment on these technical criteria within 90 days for
20 publication in the Federal Register. If an interested
21 person feels that they would need more time than that they
22 should let us know or something like that.
23 What I am anticipating is if you are going to get
24 more than just sort of I need your response to this from DOE
25 and the principal contractors who are carrying forward the
high-level waste program, they are going to have to come to

1 you for more time than say 90 days. Now, I don't know but
2 what they won't come to you for more time if you say 120 or
3 even my 150. So I don't propose that my number is the
4 golden alternative. I think they really need to sit down
5 and rethink how they may carry the case.
6 COMMISSIONER GILINSKY: Will this proposed rule
7 that appears in the Federal Register indicate how it differs
8 from the previous version?
9 CHAIRMAN HENDRIE: I don't think you planned to
10 publish it in comparative text form because I think it does
11 now have a number or differences of some substance. You
12 know, the text would be really clogged up if you did it in
13 comparative form I would think.
14 MS. COMELLA: One of the problems with the draft
15 version that appeared in the advance notice was the fact
16 that structurally it made it very, very difficult to follow
17 everything that was there and a lot of the comments that
18 came back to us on the advance notice suggested that we just
19 hadn't communicated well enough with them. So we have spent
20 a lot of time trying to clarify what we meant. A lot of the
21 seeming changes are really an attempt at better
22 communication of what we were trying to accomplish.
23 COMMISSIONER GILINSKY: Shall we put in some
24 statement such as please read carefully before writing
25 comments?

1 (Laughter.)

2 CHAIRMAN HENDRIE: At one point I was actually

3 groping as I sat down and tried to go through this from the

4 beginning when I was doing my memo. We got to the

5 background and I was trying to frame a sentence saying, come

6 on, Shelley, knock off dragging the drafts of old letters

7 out of the files and sit down and, you know, give it a good

8 kick from scratch here.

9 (Laughter.)

10 Then I decided I couldn't find a way to frame that

11 in Federal Register language.

12 (Laughter.)

13 MR. CUNNINGHAM: Make available the transcript

14 page.

15 (Laughter.)

16 MR. MARTIN: This has been a problem with this

17 rulemaking where we have tried to do it all out in the open

18 and have had at least 14 drafts of this thing circulating.

19 Inevitably you will find somebody still arguing about draft

20 10 and we have long since fixed that and are off on draft

21 14.

22 I think there is some unsorting to do and

23 refocusing on what is in front of us here. You know, many

24 of the groups that will comment on this sort of act as

25 collegial bodies as well where they have to organize

1 committees and plan travel schedules and get people together
2 two or three times to focus on and debate the issues. I
3 guess 120 days doesn't sound really that ---
4 COMMISSIONER GILINSKY: That is what John
5 suggested. Why don't we all agree to that?
6 CHAIRMAN HENDRIE: That is more or less in the
7 middle and a long way down from 999.
8 (Laughter.)
9 I want you to know I am really rolling over here.
10 (Laughter.)
11 As I say, I wouldn't be surprised even at that and
12 say, look, I think we need some longer time to get organized.
13 COMMISSIONER GILINSKY: I think with the 120 I
14 wouldn't encourage requests for extensions.
15 CHAIRMAN HENDRIE: Once you get into using the
16 three spaces I quit.
17 (Laughter.)
18 COMMISSIONER BRADFORD: Sold.
19 COMMISSIONER GILINSKY: Break out the champaign.
20 (Laughter.)
21 MR. CHILK: Now you have to vote.
22 COMMISSIONER GILINSKY: Now we have to vote.
23 Formalities.
24 (Laughter.)
25 CHAIRMAN HENDRIE: Steady now.

1 (Laughter.)

2 CHAIRMAN HENDRIE: How fast can you turn the thing

3 around?

4 MS. COMELLA: As you can see, we haven't caught

5 everything when we turned it around so rapidly. We could

6 turn it around -- before I can write something in concrete,

7 when can we get it?

8 MR. COSTANZI: Probably three days from the

9 receipt of the transcript.

10 MS. COMELLA: So if we can have a transcript

11 tomorrow we could by COB Friday have it here.

12 COMMISSIONER BRADFORD: Let's see, there is strong

13 merit for pushing that back a little.

14 COMMISSIONER GILINSKY: At this point you are just

15 talking about having a clean text and making sure that it

16 has caught the changes that we have agreed to.

17 CHAIRMAN HENDRIE: Yes.

18 MS. COMELLA: Yes.

19 COMMISSIONER GILINSKY: It seems to me we could ---

20 COMMISSIONER BRADFORD: COB Thursday maybe.

21 COMMISSIONER GILINSKY: I mean, I would vote on

22 the thing now. I am perfectly happy to leave it to the

23 efficient system we have here to catch all these items and I

24 am sure you will look at it carefully, Joe.

25 CHAIRMAN HENDRIE: Okay. A configuration that we

1 indeed have used before, as you say, is to hold a vote of
2 the Commission on the intrinsic proposition which in this
3 case is that we have agreed on language for a proposed rule
4 for comment on these technical criteria.
5 There are some final wordings to be completed by
6 staff and issuance of the document to the Federal Register
7 would await Commissioner office agreement on the words as
8 produced by the staff here at the end of the week, but the
9 Commission would be voting on the proposition to go forward
10 with public comment on the technical criteria as we have
11 discussed them and modified them here at the table.
12 We can have that vote now and that would
13 constitute the formal action of the Commission in deciding
14 to put this language out for comment.
15 If we wait until later in the week in the hopes of
16 having, you know, all of the words in hand in a separate
17 document it raises the chance that either the staff will
18 drop a page on the floor in the hurry of producing it so we
19 wouldn't even then have, you know, the actual genuine
20 package that is going to go word for word to the Federal
21 Register and we might also slip and while three of us might
22 agree to do it the week after, why I think all those present
23 would like to participate in the vote.
24 So we will go ahead and do that vote this
25 morning. Before I ask you to vote Yea or Nay on the

1 proposition as I have stated it, I would like to make a
2 comment for the benefit of that great unseen observing body
3 of people who have suggested to me that human affairs would
4 go better if the proposed rule did not go out for comment at
5 this time.

6 For their benefit then it is my considered opinion
7 that while one can reasonably argue whether this is the best
8 time to put a set of technical criteria out for comment, on
9 balance I think the public interest lies in going ahead with
10 the proposition as we have now agreed to frame it.

11 What we will be putting out in the Federal
12 Register, as I have said, in my view is both a more workable
13 set of proposed criteria than earlier drafts and it is also
14 a more flexible proposal for comment. It points out some
15 alternatives and calls for comment on them in a number of
16 critical places. To my mind that relieves much of the
17 difficulty which people tell me about.

18 I think, as with any rule of the Commission, this
19 one certainly is not a final rule and there are a number of
20 issues to be debated when the comments come back in and are
21 digested. As with any rule of the Commission, changing
22 conditions in the area that is being regulated can always be
23 changed to appropriate adjustments in the regulations. I
24 guess I have to take the view that it is probably better to
25 move forward in these things than doubt some of them than it

1 is to be in a posture of perpetual suspension hoping that
2 tomorrow the world will in fact settle down and become
3 understandable and stable and so on. It just isn't going to
4 do it.
5 So on that basis I intend to vote Aye for this
6 proposition.
7 I will ask my colleagues, those in favor of
8 putting the proposed rule as discussed and modified here at
9 the table out for comment please say Aye.
10 (Chorus of Ayes.)
11 CHAIRMAN HENDRIE: Those opposed?
12 (No response.)
13 CHAIRMAN HENDRIE: The motion carries.
14 Thank you very much.
15 (Whereupon, at 11:35 a.m., the meeting concluded.)
16 * * *
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NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

COMMISSION MEETING

in the matter of: Discussion and Possible Vote on SECY-81-267- 10 CFR 60 Disposal of High-Level Radioactive Wastes in Geologic Repositories: Technica Criteria

Date of Proceeding: June 16, 1981

Docket Number:

Place of Proceeding: Washington, D. C.

were held as herein appears, and that this is the original transcrip thereof for the file of the Commission.

Mary C. Simons

Official Reporter (Typed)

Mary C Simons

Official Reporter (Signature)

NUCLEAR REGULATORY COMMISSION





COMMISSION MEETING

In the Matter of: DISCUSSION AND POSSIBLE VOTE ON SECY-81-[illegible] RE: 10 CFR 60, DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE IN GEOLOGIC REPOSITORIES: TECH[illegible] CRITERIA

PUBLIC MEETING

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1 DISCUSSION AND POSSIBLE VOTE ON SECY-81-267 -
2 10 CFR 60, DISPOSAL OF HIGH-LEVEL RADIOACTIVE
3 WASTES IN GEOLOGIC REPOSITORIES:
4 TECHNICAL CRITERIA
5 - - -
6 PUBLIC MEETING
7 - - -
8 Nuclear Regulatory Commission
9 Room 1130
10 1717 H Street, N.W.
11 Washington, D.C.
12
13 Thursday, June 11, 1981
14 The Commission met, pursuant to notice, at 10:25
15 a.m.
16 BEFORE:
17 JOSEPH M. HENDRIE, Chairman of the Commission
18 VICTOR GILINSKY, Commissioner
19 JOHN F. AHEARNE, Commissioner
20 PETER A. BRADFORD, Commissioner
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22
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24
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1 STAFF PRESENT:

2 SAMUEL J. CHILK, Secretary

3 LEO SLAGGIE, General Counsel's Office

4 WILLIAM J. DIRCKS, Exec. Dir. for Operations

5 MARTY MALSCH, General Counsel's Office

6 GUY CUNNINGHAM

7 J. MARTIN

8 PAT COMELLA

9 D. RATHBUN

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# DISCLAIMER

This is an unofficial transcript of a meeting of the United States Nuclear Regulatory Commission held on 6-11-81 in the Commission's offices at 1717 H Street, N. W., Washington, D. C. The meeting was open to public attendance and observation. This transcript has not been reviewed, corrected, or edited, and it may contain inaccuracies.

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1 P R O C E E D I N G S

2 CHAIRMAN HENDRIE: The Commission will come to
3 order. We are behind schedule, I am afraid, on my account.
4 We meet this morning to continue our discussion on
5 SECY-81-267, the proposed technical criteria for disposal of
6 high-level radioactive wastes in geologic repositories.
7 There are several recently-issued documents, one
8 of them is a complete Enclosure "A" of the paper that I have
9 put together with mark-ups on it. I recommend that be
10 convenient at hand. The other one is a memorandum from the
11 staff.
12 COMMISSIONER AHEARNE: They have learned well,
13 their neither date or nor sign it now.
14 CHAIRMAN HENDRIE: Yes. There is apparently a
15 shadow organization with your name, Bill.
16 MR. DIRCKS: If it works. If it does not, I will
17 disavow it.
18 CHAIRMAN HENDRIE: I guess one would refer to this
19 as the June 10 memo from ETO which has applicable pages in
20 it. There may be some others which I am not as learned
21 about. There have been assorted memoranda. Peter had
22 several. I do not remember one from you, John.
23 Oh, yes, but yours is in both of these versions.
24 What I suggest we do to try to sweep through this in an
25 orderly way is to start on my mark-up, simply because it is

1 the only one since the original paper that has all of the
2 pages in it.
3 COMMISSIONER BRADFORD: I do not think it does.
4 CHAIRMAN HENDRIE: Well, it has some extra pages
5 that I have stuck in.
6 COMMISSIONER BRADFORD: I think you put your
7 inserts into the original SECY paper.
8 COMMISSIONER AHEARNE: Mixture.
9 CHAIRMAN HENDRIE: What I did was the following:
10 I took the original SECY paper and then I took the staff's -
11 what was it, June 1st or 2nd - replacement pages for
12 Enclosure "A" which came to us. I put all of those pages
13 in, replacing original paper pages.
14 COMMISSIONER BRADFORD: Right, but meanwhile the
15 staff had replaced the original paper with its second
16 version. So, I do not think what you put into the original
17 quite tracks what the staff has done in its.
18 CHAIRMAN HENDRIE: It should.
19 MR. MARTIN: I think it does. The version the
20 chairman used was "the" paper we used for discussion at the
21 last meeting.
22 CHAIRMAN HENDRIE: You now have some more
23 replacement paper.
24 MR. MARTIN: Right, that sort of takes care what
25 we discussed at the last meeting, but it is separable.

1 CHAIRMAN HENDRIE: Well, those I regard as current
2 discussions and inclusions as appropriate. But as I worked
3 through it, it seemed to me that where there was a second
4 version or a third version of a page, why, I used the latest
5 one. As far as I know, up to the point I did it, the thing
6 that I started to mark up would have represented what the
7 staff would have said was their version as of that moment.
8 MS. COMELLA: We replaced the entire version on
9 May 11 when we sent in a transmittal of DOE's comments.
10 COMMISSIONER BRADFORD: That is what I think is
11 causing the trouble. Joe used the pre-May 11 version for
12 his, and there are times when that resulted in not the same
13 as if he had used the May 11th. I have not been able to
14 catch up with it.
15 It is perfectly possible to work from yours, Joe,
16 but I think somebody is going to have a job once we are
17 going back to see if every page really is the current page.
18 CHAIRMAN HENDRIE: Where is May 11th?
19 MS. COMELLA: Here is a copy of the May 11th one.
20 CHAIRMAN HENDRIE: I see. You are quite right, I
21 used April 27th plus June 1st, rather than May 11th.
22 MS. COMELLA: We will keep track of it.
23 CHAIRMAN HENDRIE: Keep track of it as we go
24 through. My intent was to work with the mark-up the latest
25 staff version.

1 MS. COMELLA: Do you want a copy of May 11th?

2 COMMISSIONER BRADFORD: It is headed "Transmittal

3 of DOE Comments."

4 CHAIRMAN HENDRIE: There we are, very good.

5 Why don't we start to scan and just go from front

6 to back, picking up points as we go? As I said, I do not

7 think I have all yours, Peter, and I will have to ask you to

8 watch for them to come along, and holler.

9 COMMISSIONER BRADFORD: Let's see, that is going

10 to be a challenge.

11 CHAIRMAN HENDRIE: Well, we can always go back

12 across again. I see some problems right off the bat. The

13 first item I have starts practically in the beginning. I

14 think we ought to crank up the comment period substantially.

15 COMMISSIONER BRADFORD: Well, I would not go to

16 150 days. I must say, if the DOE program is changing and

17 that has to be taken account of, it is really going to be a

18 separate matter altogether.

19 It seems to me that what we are doing is putting

20 out what we think the technical rule ought to look like.

21 That really is not a function of the DOE program one way or

22 another. They will be able to give us plenty of indication

23 within 90 days if they need an extension of the comment

24 period. The 90 days is about as long a comment period as we

25 normally run, even in large cases.

1 I don't see any reason to add 60 more days to it.
2 CHAIRMAN HENDRIE: Since Vic is not here, I won't
3 comment that we are split on the point. I mean, we won't
4 vote and I conclude that we could be split on the point.
5 I continue to feel that for this sort of a rule on
6 this sort of a proposition an extensive comment period is
7 certainly necessary and would be helpful, rather than
8 setting everybody off on a 90-day period and then having the
9 Department either inform us after the comment period is
10 over, or various policy evolution matters on their side
11 which have made their previous comments obsolete, or
12 whatever.
13 I think you are not going to go anywhere, I don't
14 think, with a final rule that fast anyway because I think a
15 final rule is certainly going to have to wait for a clear
16 enunciation of the administraton's high-level waste
17 initiatives and another 60 days or so for comment is not
18 going to make much different.
19 Vic, you arrived on page 1. I tell you, we have a
20 whole batch of things that we are looking at. I am working
21 along on that one because I thought it represented a
22 complete base package with all the pages in it. Now it
23 turns out that I did not get the right base package to mark
24 up. So, there is going to be a certain amount of difficulty.
25 There is a May 11th thing from the staff which I

1 should have combined with their June 1st, or whatever it is;
2 instead I used the original paper with the June 1st. So, as
3 we go along, we will have to do a certain amount of
4 shuffling back and forth.
5 COMMISSIONER GILINSKY: You are talking about the
6 comment period now?
7 CHAIRMAN HENDRIE: Yes. We just reached page 1,
8 and the only thing I added on was the comment period. John
9 and I extended it; Peter would not.
10 COMMISSIONER GILINSKY: John would go with 150
11 days, too?
12 CHAIRMAN HENDRIE: Yes.
13 COMMISSIONER GILINSKY: Well, do you consider this
14 part of the comment period?
15 CHAIRMAN HENDRIE: No.
16 COMMISSIONER GILINSKY: It seems to me it would
17 have been a comment period for some time.
18 COMMISSIONER BRADFORD: It is like a jail sentence
19 in which you count time already served.
20 COMMISSIONER GILINSKY: That's right.
21 (Laughter.)
22 COMMISSIONER GILINSKY: I guess I would go with
23 the shorter period.
24 COMMISSIONER AHEARNE: I will point out to two of
25 my colleagues that 150 days from June is less than --

1 COMMISSIONER BRADFORD: Ninety days from September.
2 COMMISSIONER AHEARNE: Yes.
3 COMMISSIONER BRADFORD: That does not come as a
4 revelation.
5 COMMISSIONER AHEARNE: I am not sure.
6 COMMISSIONER GILINSKY: September being what?
7 COMMISSIONER AHEARNE: Many months later.
8 (Laughter.)
9 COMMISSIONER GILINSKY: Why September?
10 COMMISSIONER AHEARNE: The end of the summmer.
11 COMMISSIONER GILINSKY: What is our practice on
12 comment periods, are there any rules?
13 COMMISSIONER AHEARNE: The practice is to put it
14 out and then take three, to four, to five times as long as
15 the comment period provided for comments.
16 MR. CUNNINGHAM: We have no rules. Customarily,
17 we range between 30 and 90 days. I think I have some
18 recollection of 120.
19 COMMISSIONER GILINSKY: Have we put something out
20 for 120?
21 MR. CUNNINGHAM: I believe so, I think we have.
22 COMMISSIONER GILINSKY: Did this guide go out with
23 an early notice of rulemaking?
24 COMMISSIONER BRADFORD: There has been an advance
25 notice.

1 COMMISSIONER GILINSKY: And how long was the
2 comment period on that? I think it is still continuing,
3 really, we are still receiving communications.
4 CHAIRMAN HENDRIE: It went out last may.
5 COMMISSIONER BRADFORD: May 13.
6 CHAIRMAN HENDRIE: I would assume it would have
7 been 90 to 120 days, or something lik that.
8 COMMISSIONER GILINSKY: It sounds like your
9 concern is not so much that we have adequate time for
10 comment, but that we do not go final until the
11 administration has decided what it wants to do. Is that not
12 really the point?
13 CHAIRMAN HENDRIE: Yes.
14 COMMISSIONER GILINSKY: Because there has been a
15 lot of discussion with DOE, and to the extent that they want
16 to comment further, it seems to me they are primed to
17 comment further if they need an extra 60 days to comment.
18 CHAIRMAN HENDRIE: They are certainly primed to
19 comment further at the staff level. Whether the sort of
20 comments that you would get from the DOE staff which I
21 presume would reflect the sorts of comments that we have
22 gotten to late, would represent the administration's thrust
23 on high-level waste as reflected down into this kind of rule
24 detail, I don't know.
25 My thought was, it would be useful to give them a

1 chance to let their nuclear sub chiefs settle down in August
2 over there, get their desks full of pencils and pads and one
3 thing or another, and consider whether there is anything of
4 a policy nature which would impact from their standpoint on
5 certain comments they would like to make on this rule.
6 COMMISSIONER GILINSKY: Well, it seems to me that
7 does not have to be accomodated by lengthening the period,
8 which just puts the whole thing off for us.
9 If the DOE feels that way, then the Secretary of
10 Energy can send us a note during the 90-day period and say,
11 "We ask you not to go final with this rule because we have
12 things in the works." Now, that is clearly a statement that
13 would affect the judgment of this agency.
14 I do not think you need a longer comment period
15 for that.
16 CHAIRMAN HENDRIE: We are split two-two on the
17 comment period. Why don't we go on to page 2?
18 Now, at this point I already begin to have trouble
19 with the May 11th proposition. The May 11th simply adds a
20 sentence at the end, right?
21 COMMISSIONER GILINSKY: Yes.
22 CHAIRMAN HENDRIE: And the only thing I want to do
23 for you is to explain what an ANPR is. I assume that would
24 be accepted without major debate. Since it would have been
25 my intention to work from the latest draft, if I realized

1 what the May 11th was and got my hands on it, why, that page
2 would have been in there. I think in fact what I will do is
3 to try to patch it together as I go along.
4 COMMISSIONER GILINSKY: Why does it say, "For
5 further information contact Frank Arsenault?
6 CHAIRMAN HENDRIE: They were sitting around
7 drawing straws one day, and Frank got the short one.
8 MR. DIRCKS: That is the Standards' writing.
9 COMMISSIONER GILINSKY: Oh, I see, it is now over
10 there.
11 COMMISSIONER AHEARNE: Pat is sitting in the
12 opposite chair.
13 CHAIRMAN HENDRIE: Standards is now in Research.
14 What I do is take page 2 out of May 11th and put it into my
15 package.
16 COMMISSIONER GILINSKY: Well, you are not going to
17 get any argument - chalk that up as one on your side.
18 CHAIRMAN HENDRIE: One for me.
19 COMMISSIONER GILINSKY: One page approved in
20 toto. Page 3 looks pretty good, too.
21 CHAIRMAN HENDRIE: Page 3 looks pretty good, too.
22 Now, when we get to page 4 I do not have anything except a
23 couple of minor language things. I do not much care, they
24 are not worth talking about.
25 Let me ask the staff. I now have a June 1st and a

1 June 10th -- I see, you have deleted "Other processes and
2 events," but added some other stuff.
3 MS. COMELLA: What is here on page 4 responds to
4 Commissioner Bradford's request to give particular examples
5 of what an "anticipated process or event" might be, and what
6 an example of an "unlikely event" might be.
7 CHAIRMAN HENDRIE: All right, and this change,
8 then, carries on to the top of the next page. An example
9 would be "reactivation" etc., etc. Fine, I do not see any
10 problem with that.
11 COMMISSIONER BRADFORD: In fact, their change
12 picks up your change on page 5.
13 CHAIRMAN HENDRIE: That was your change.
14 COMMISSIONER BRADFORD: Which is actually my
15 change, in your handwriting.
16 CHAIRMAN HENDRIE: Yes. Now, there is a batch of
17 pages in your May 10th. Where does the next substantive
18 change occur, or do we have all these pages, 5, 6, 7, 8, 9,
19 etc. simply because the addition at the top of page 5 pushed
20 the text down and slid it along?
21 COMMISSIONER BRADFORD: Let's see, what you are
22 asking really is whether the May 11th changes were all
23 shown, as compared to the earlier text.
24 MR. DIRCKS: If we have fallen behind.
25 COMMISSIONER AHEARNE: He is asking the question

1 on the one that you just sent out. You have incorporated
2 there pages 6, 7, 8, 9. Now, is that in here because you
3 have changes on them, or because you added something extra
4 back on page 5 that it shifted the text on all those other
5 pages?
6 MS. COMELLA: Yes, I have just gotten a nod. We
7 have shifted the text.
8 COMMISSIONER AHEARNE: Just the text.
9 COMMISSIONER BRADFORD: I see. The error was not
10 in the 10, but in the month. You had May 10, Joe.
11 COMMISSIONER AHEARNE: So, there is no change.
12 CHAIRMAN HENDRIE: So, if I take starting with
13 page 4 in the June 10 proposition and pick up all the way,
14 5, 6, 7, 8, 9, 10, 11, 12, 13 --
15 COMMISSIONER AHEARNE: You do not want to do that,
16 though because you have substantial changes.
17 CHAIRMAN HENDRIE: Well, I thought I would pick up
18 mine as we went along. As I go along through those pages,
19 why, holler. Other people holler as appropriate.
20 COMMISSIONER BRADFORD: I just don't have enough
21 hands.
22 CHAIRMAN HENDRIE: It is not easy.
23 COMMISSIONER GILINSKY: Why don't we talk about
24 changes instead of pages?
25 CHAIRMAN HENDRIE: Well because I am having

1 trouble tabulating. Without paging through it, I do not
2 know whether I am catching changes or not.
3 COMMISSIONER GILINSKY: Well, if we go through
4 your version, we catch every one of the changes.
5 CHAIRMAN HENDRIE: Well, unfortunately my version
6 is a compound of April 27 and June 1, and it should have
7 been a compound of May 11 and June 1. Furthermore, there is
8 a new set of staff pages . I am just trying to see if there
9 are places where the staff is changing the language and it
10 is news to us, or other people want to get in.
11 COMMISSIONER GILINSKY: I am just reading yours.
12 CHAIRMAN HENDRIE: The next place, I hit one as
13 far as I know is on my page 8, where I knocked out "hundreds
14 of" and said "many."
15 COMMISSIONER GILINSKY: Sold.
16 CHAIRMAN HENDRIE: Now the question is, why can't
17 I find it in the June 10 thing?
18 COMMISSIONER BRADFORD: Because the staff did not
19 have it.
20 CHAIRMAN HENDRIE: Oh, yes, there it is, in line
21 5; line 5 of the June 10.
22 COMMISSIONER BRADFORD: Line 5 of what page?
23 CHAIRMAN HENDRIE: Eight.
24 COMMISSIONER BRADFORD: I see. You just needed a
25 place to put it, you don't mean your change.

1 CHAIRMAN HENDRIE: Right. What has happened to
2 this point in the staff June 10 issuance is that the text is
3 just sort of five lines down the page.
4 Good, we finally got to something substantive,
5 page 9, "retrievability." If you are really going to make
6 this stuff retrievable for 110, or whatever it is, years,
7 maybe that is necessary.
8 But what I means to me is, I suspect that the
9 thermo design of the depository, that probably means a lot
10 of the mechanical designs, are going to be dominated by
11 retrievability and not by what would necessarily give you
12 the best containment and isolation. I am not sure that the
13 balance comes out right.
14 First of all, Jack, why don't we see if yo have
15 comments on retrievability. You want to argue with me, for
16 instance, about the way I read it.
17 COMMISSIONER GILINSKY: Is it correct to add the
18 30 to 50?
19 CHAIRMAN HENDRIE: Well, it seems to me so.
20 MR. MARTIN: I think that is basically correct.
21 CHAIRMAN HENDRIE: There are actually two periods
22 of 30.
23 COMMISSIONER GILINSKY: I mean the last.
24 MR. MARTIN: What we are saying here is that we do
25 not want -- let me start over.

1 If you can imagine, 30 years from now people are
2 going to be faced with a choice of what kind of testing or
3 monitoring, or observation do we have to do before we decide
4 to close this up permanently.
5 We do not want to bequeath them a repository that
6 essentially becomes self-closing, wether they want to close
7 it or not. On the other hand, the regulation does not
8 require that the repository be maintained open; it does not
9 require that it be readily retrievable, or even easy to
10 retrieve, just so long as the designers go into it with the
11 idea that if they had to, it could be retrieved.
12 It does not preclude back filling; it does not
13 preclude closing up the repository as long as you could make
14 the case you could get back in there and retrieve the waste
15 if you wanted to.
16 COMMISSIONER GILINSKY: What is your reaction to
17 Joe's comments?
18 MR. MARTIN: Well, I guess my reaction is, I am
19 not sure he read our intent properly. I think perhaps he
20 had more in mind that we visualize a repository that will be
21 sort of held open and readily retrievable for 50 years, and
22 that is just not the case.
23 But, for excample, we would not want the thermal
24 design to be such that it is so hot that there is no way you
25 could get in there and re-establish ventilation paths, or it

1 is just too hot for people to get in and take corrective
2 action. Indeed, that is what we are trying to preclude.
3 COMMISSIONER GILINSKY: What did you have in mind
4 when yo said were there other ways than overall
5 retrievability requirements to preserve options before
6 permanent closure?
7 CHAIRMAN HENDRIE: Nothing by way of a specific
8 alternative, or I would have cited it one way or another.
9 The configuration is that where we get a facility
10 constructed and then reach a point where we say, "OK, you
11 can put waste in it, start putting waste in it now," we by
12 that time will have had looked in considerable detail on a
13 performance confirmation program plan. In fact, some of the
14 base line measurements would already have been taken during
15 the construction phase.
16 What you are really looking for, as Jack says, is
17 as the emplacement goes along on that performance
18 confirmation program, as the data begins to come in because
19 I assume we will be monitoring right at the beginning, you
20 would like to be able to get all the wastes in place and be
21 confident enough from your performance data to that point
22 that things were going to go along about as you planned
23 before you do a permanent closure.
24 What they are trying to do is to preserve
25 retrievability long enough so that you could come up to the

1 point where you are ready to close, and you still had the
2 engineering design which still was such that you could start
3 at that point and take 30 years to take everything back out.
4 Now, that is nice, it sure preserves options, but
5 it is not clear to me that that much option needs to be
6 preserved. You might, for instance, decide that you
7 designate a subsection of the repository which would be the
8 first chambers loaded, and want to be able to get into those
9 things for an extended period and do the bulk of your
10 performance confirmation data-taking around that section,
11 and plan to be able to make a permanent closure decision
12 relatively soon after the completion of the placement of
13 wastes and then close it up and go away and leave it.
14 You know, I can poke holes in that as well as the
15 next one. But it worries me that you are going to make a
16 proposition, that you are going to try to build a
17 proposition which will have high integrity for a long time,
18 but the governing elements of the design will turn out in
19 fact to have more to do with whether or not you could mine
20 the stuff in the first hundred years, than about whether the
21 stuff will have a low leak rate thereafter.
22 Now, indeed, you have to meet the containment and
23 isolation criteria, to be sure, so it is not that designing
24 for retrievability degrades that below the performance
25 criteria.

1 COMMISSIONER GILINSKY: I don't have any problems.

2 CHAIRMAN HENDRIE: I am not sure, it just bothers

3 me. My guess is that retrievability will compel a much

4 larger repository area than would be the case for

5 containment and isolation provisions alone because I think

6 thermo loadings will have to be taken way down.

7 COMMISSIONER AHEARNE: I have no problem with

8 Joe's request. I don't think you do, either.

9 COMMISSIONER BRADFORD: No, I don't have any

10 problem with it.

11 COMMISSIONER GILINSKY: Well, I thought in some

12 way it did not accurately reflect the rest of the rule.

13 MR. MARTIN: No. I just thought it might have

14 been reflected. This has been a difficult thing to explain

15 to people.

16 COMMISSIONER GILINSKY: Is the description of the

17 requirements correct?

18 MR. MARTIN: Yes.

19 COMMISSIONER GILINSKY: Now, we want to say we are

20 concerned with retrievability. "Unnecessarily complicates"

21 sounds reasonable, or "dominate." What if it did turn out

22 to dominate?

23 CHAIRMAN HENDRIE: Well, if it has to, it has to,

24 "unnecessarily" applies to both.

25 COMMISSIONER GILINSKY: Oh, I see, "unnecessarily

1 complicated."

2 COMMISSIONER AHEARNE: If you are concerned that

3 it is not completely clear what we are requiring, there is

4 probably some sort of language that could be dug out of that

5 backup material, a paragraph or something stuck in to

6 explain what the staff has in mind.

7 CHAIRMAN HENDRIE: I am having trouble with the

8 page structure, sort of a mechanical problem. Let me go

9 back and get myself sorted out, sorry.

10 Peter, you have been silent.

11 COMMISSIONER BRADFORD: I have no problem with

12 including your section, your page 9a and your changed

13 position on it; for that matter, with the staff's page 9 of

14 June 10.

15 CHAIRMAN HENDRIE: There isn't any change in the

16 June 10 version.

17 COMMISSIONER BRADFORD: There is a one-word change.

18 CHAIRMAN HENDRIE: Is there?

19 COMMISSIONER BRADFORD: Yes.

20 MS. COMELLA: That is in the one page number.

21 COMMISSIONER BRADFORD: Right.

22 CHAIRMAN HENDRIE: Eleven, I have an insert. If

23 you do not hear a specification on a page number, I just say

24 page something-or-other, why, I am talking about my version.

25 COMMISSIONER BRADFORD: Let's see, Joe, as you are

1 going through and saying, 10, 11, or whatever, is that only
2 your 10 and 11? There are changes on staff 10.
3 CHAIRMAN HENDRIE: New staff 10.
4 COMMISSIONER AHEARNE: There are? You mean the
5 underlined piece?
6 MS. COMELLA: No, at the bottom of the page. On
7 page 9 of the chairman's mark-up, that last sentence is
8 there.
9 COMMISSIONER BRADFORD: OK.
10 CHAIRMAN HENDRIE: Pat is on notice that you are
11 to tell us when in the June 10 we hit anything other than
12 just the rolling forward down the page of the text.
13 COMMISSIONER AHEARNE: This can be tested.
14 MS. COMELLA: That is going to be very interesting
15 because who will know whether I missed something?
16 CHAIRMAN HENDRIE: God will know it, Pat.
17 (Laughter.)
18 MS. COMELLA: That will keep me on my toes, then.
19 CHAIRMAN HENDRIE: My page 11, I think we ought to
20 stick in Howard's -- I think the staff did too, right?
21 MS. COMELLA: Yes. Now, on page 12 of the June 10
22 memorandum there was some further elaboration on the human
23 intrusion question along the lines we thought of the
24 concerns you had voiced in the last meeting. That is just
25 about the relation to other parts of the regulation.

1 CHAIRMAN HENDRIE: So, we should look at the June
2 10 one. Do you have one handy?
3 COMMISSIONER GILINSKY: Is this the same as what
4 we have?
5 CHAIRMAN HENDRIE: It is the same as what I have.
6 This is the rest of the human intrusion stuff, and the
7 underlying things here down to this would be the things. It
8 seems to me to be good stuff.
9 COMMISSIONER GILINSKY: This is what the staff put
10 in?
11 CHAIRMAN HENDRIE: Yes, they were amplifying human
12 intrusion.
13 COMMISSIONER GILINSKY: They are good ones, I will
14 go along with it.
15 CHAIRMAN HENDRIE: OK, then the relations to other
16 parts of the NRC regulations. I don't know whether you took
17 the paragraph right out of Howard's memo or not, I did.
18 MS. COMELLA: Yes.
19 CHAIRMAN HENDRIE: I assume they are pretty much
20 the same.
21 If the staff would put John's alternative approach
22 section in at this point. I had it further over. John,
23 what is your preference?
24 COMMISSIONER AHEARNE: I don't care. I will leave
25 it up to the Standards people, where they think it fits in

1 best.

2 CHAIRMAN HENDRIE: Any comment on one place or the

3 other from staff?

4 MS. COMELLA: Well, we put it in where we thought

5 it made sense to put it. So, we have put it before we got

6 into the discussion of the major features of the rules.

7 COMMISSIONER BRADFORD: Let's see, John, I at one

8 point suggested some modifications. I guess Joe had too. I

9 never sent them to anyone other than you, though.

10 COMMISSIONER AHEARNE: I thought I could get Joe

11 on board with the version. I leave it there.

12 COMMISSIONER BRADFORD: Joe made some changes,

13 also.

14 CHAIRMAN HENDRIE: If we go back to 16a in my

15 version, you will find that this is "it" and my mark-ups are

16 there. If the staff thinks it would go better into the

17 supplementary information at the end of the general remarks

18 section rather than the end of the whole proposition, why

19 don't we consider that to be the intent of the body and take

20 a look at some of the edits on it, see how those strike

21 people.

22 Now, you will have to tell me what yours were,

23 Peter. I guess I do not have this. Anything in the front

24 part of it?

25 COMMISSIONER BRADFORD: Well, there were some that

1 were just grammatical and I am trying just to scan through
2 and jettison those in the interest of saving time.
3 COMMISSIONER AHEARNE: I noticed the staff changed
4 "presumption" to "observatin."
5 COMMISSIONER GILINSKY: This is "staff
6 presumption?"
7 COMMISSIONER BRADFORD: I was going to take the
8 word "staff" out altogether.
9 COMMISSIONER AHEARNE: Yes. Peter would change it
10 to say, "believe the proposition."
11 COMMISSIONER GILINSKY: Well, isn't it "should
12 consistent" rather than "would consistent?"
13 CHAIRMAN HENDRIE: I would think so.
14 COMMISSIONER AHEARNE: Yes.
15 COMMISSIONER BRADFORD: In the sentence before
16 that I thought that the problem here is not just the
17 adjudicatory process. What we are saying is that reliance
18 on the geological setting alone, at least in our current
19 view, does not in fact provide the level of assurance that
20 we would like to have. I would prefer to say something
21 about the uncertainties inherent in reliance on the
22 geological setting alone are too great, either to provide
23 reasonable assurance or to be reconciled in an adjudicatory
24 process.
25 I do not think the point is solely that relying on

1 the EPA standard would get us in trouble in an adjudicatory
2 context.
3 CHAIRMAN HENDRIE: I guess we are going to tinker
4 with it. Let me introduce a further complication. I tried
5 to leave the language alone so that it could carry the
6 thrust at John wrote it. But if we want to try to improve
7 it and so on, I must say that unwillingness to depend on the
8 geological setting alone in isolation, for the isolation of
9 waste is not my reason for thinking it is a good idea to
10 have engineers' waste packages and engineered portion of the
11 facility, backfill and so on.
12 Rather, it is a feeling that while the geologic
13 setting might be all right, you are going to dig a hole,
14 then you have to fill it up again, and the waste is going to
15 have to come in some kind of a package that keeps the
16 radioactivity inside and provides some modest containment.
17 I see no reason why thiose elements which have to
18 be gone through anyway cannot be done in a way which
19 contributes substantially to the containment and the
20 isolation capability of the repository.
21 I have rather different reasons.
22 COMMISSIONER BRADFORD: Let me revise my
23 suggestion and just suggest we put a period after "grade.".
24 COMMISSIONER GILINSKY: Isn't the question whether
25 you would do it differently if there were no hearing? It

1 seems to me we wouldn't, at least as far as these
2 requirements go. I would think you would not do it any
3 differently if there wasn't any regulatory overlay here.
4 You were just sitting down and designing the repository. I
5 think this is the way to go about it.
6 CHAIRMAN HENDRIE: I think probably that is
7 right. I am willing to agree that with the thrust of the
8 original language, rather than having to lay it out and to
9 argue about it in the adjudictory framework does not
10 necessarily, in my mind, improve the practicability of the
11 whole process as a technical and political decision in the
12 process.
13 But I think there are reasons for the multiple
14 barrier approach, apart from the uneasiness about depending
15 on the geology alone.
16 COMMISSIONER GILINSKY: John, couldn'd we drop
17 Alternative 3 which you just dismiss out of hand anyway?
18 What is the point of including that?
19 CHAIRMAN HENDRIE: It is in Appendix J.
20 COMMISSIONER AHEARNE: Yes. The way they approach
21 it in the staff description in reaching their conclusion,
22 they listed three approaches. They came down on one, and
23 this alternative was just trying to pick up that language
24 and that description and then say, "We come down on one, but
25 here is an alternative."

1 CHAIRMAN HENDRIE: Well, let's see, are there
2 suggestions for alternatives with this language at the
3 beginning of the alternative approach?
4 COMMISSIONER BRADFORD: Where are you? My
5 suggestion in the second sentence was to put a period after
6 "grade."
7 CHAIRMAN HENDRIE: That kind of gives me a problem.
8 COMMISSIONER BRADFORD: Well, see, what I am
9 trying to do is mask the set of differences that I guess
10 exist between John and me. John primarily saw the
11 adjudicatory process as being a problem, and I am pointing
12 more to the uncertainties inherent in the performance of the
13 geologic setting as the single route to the EPA standard.
14 Your problem, it seems to me, exists really with
15 either formulation, although it may not stand out quite as
16 clearly.
17 COMMISSIONER GILINSKY: What about just saying
18 that the Commission believes that considerable
19 uncertainties are inherent in reliance on the geological
20 setting alone, period?
21 COMMISSIONER BRADFORD: That is also all right.
22 COMMISSIONER GILINSKY: "Considerable" being one
23 of those vague words.
24 COMMISSIONER BRADFORD: Maybe this is the point
25 Victor was trying to make. If you threw away the

1 adjudicatory process I take it, John - happy though you
2 might be - you still would not find yourself content to rely
3 on the geological setting alone.
4 COMMISSIONER AHEARNE: Well, what we are trying to
5 say here is, we are going out for comment on two alternative
6 regulatory processes.
7 COMMISSIONER BRADFORD: Right.
8 COMMISSIONER AHEARNE: And what I have tried to do
9 is to describe the alternative and then to give some
10 indication of why the alternative is there in a way that
11 would let us get out with the rule.
12 COMMISSIONER GILINSKY: But this would be true
13 whatever the decisionmaking process. If someone is going to
14 seriously want to decide which is the right approach, he is
15 going to want to have some confidence in whatever course he
16 is deciding on. The uncertainties that attach to depending
17 on the geological setting are going to cloud reliance on
18 that alone, no matter how you approach the problem.
19 COMMISSIONER BRADFORD: The sentence seems to be
20 causing a lot of trouble - would we lose anything if we just
21 dropped it altogether?
22 COMMISSIONER GILINSKY: Or you could say, in view
23 of the uncertainties that attach to reliance on the
24 geological setting alone, the Commission believes that a
25 repository should consist of."

1 Isn't that what you would say if you had to write
2 a report as a professional engineer?
3 CHAIRMAN HENDRIE: Maybe, but I could also write
4 it, rather than muttering darkly about the geology, I might
5 prefer to take the approach that since you are going to have
6 waste packages and an engineered part of the repository,
7 that your confidence in the ability of the repository to
8 function successfully can be increased by utilizing those.
9 Hence, we decide that there ought to be multiple, various --
10 I don't much care how we come to that in the language here.
11 I gueses I would want to just put the period after "grade"
12 and then say, you know, the geology can't cut it, no matter
13 what.
14 COMMISSIONER GILINSKY: Well, that was why I was
15 trying to drop that part of it.
16 CHAIRMAN HENDRIE: Dropping it might be a way.
17 John?
18 COMMISSIONER AHEARNE: Joe, I will defer to what
19 is acceptable to you.
20 COMMISSIONER GILINSKY: How about saying, "In view
21 of the uncertainties that attach to reliance on the
22 geological setting alone, the Commission believes that..."
23 and then go on with the rest of the next sentence
24 Or, you can turn around and say, "In view of the
25 opportunities to attain greater confidence" - that amounts

1 to saying the same thing - "gives you the opportunity to
2 attain greater confidence in the isolation of the waste by
3 relying on a package and the depository. We would like to
4 emphasize those elements."
5 CHAIRMAN HENDRIE: I think that would go well.
6 Why don't you jot that down and let us move on? Is that OK
7 with you, John?
8 COMMISSIONER AHEARNE: Sure.
9 CHAIRMAN HENDRIE: The next page.
10 COMMISSIONER BRADFORD: Well, in the next line on
11 that page, what have we wound up settling on? I would have
12 preferred something like, "The Commission further believes
13 that the proposition," and then on.
14 COMMISSIONER GILINSKY: I would say, "That a
15 repository should consist of two..."
16 COMMISSIONER BRADFORD: That's fine, too. My real
17 concern is that I don't think anywhere else in the document
18 up to this point we have talked about something as being a
19 staff position or assumption. I don't think we ought to do
20 it here.
21 COMMISSIONER GILINSKY: Yes. I would say, "The
22 Commission believes a repository should consist of two major
23 engineering barriers in addition to the natural barriers,"
24 etc.
25 COMMISSIONER AHEARNE: That does not speak to any

1 requirement on that.

2 COMMISSIONER GILINSKY: Right.

3 CHAIRMAN HENDRIE: All right, I will leave it to

4 the staff to fix up the footnote.

5 MS. COMELLA: Yes.

6 COMMISSIONER GILINSKY: What about your changes

7 about Alternative 1, the principle advantage one? That is

8 on the next page. We are going to have to go back and pick

9 up another change you made earlier.

10 CHAIRMAN HENDRIE: What is that?

11 COMMISSIONER GILINSKY: The business of putting

12 things in regulatory guidance. As far as I am concerned,

13 that is OK.

14 CHAIRMAN HENDRIE: Yes.

15 COMMISSIONER GILINSKY: That's the only thing.

16 CHAIRMAN HENDRIE: We will be going back to page

17 11 or something like that.

18 COMMISSIONER GILINSKY: Page 15. I think it is

19 the only thing you have back there and I am happy to just

20 approve it.

21 CHAIRMAN HENDRIE: Let's pick up the rest of

22 this. If we can sort out the rest of this section.

23 COMMISSIONER GILINSKY: Sure.

24 CHAIRMAN HENDRIE: It seems to me that my changes

25 of what John meant had not expressed it as well as drafted

1 originally.

2 COMMISSIONER AHEARNE: I have no problem with your

3 changes.

4 CHAIRMAN HENDRIE: That is a satisfactory answer,

5 although a different one. Comments?

6 COMMISSIONER BRADFORD: I don't have difficulty

7 with any of your changes in the paragraph that begins, "The

8 Alternative 1."

9 CHAIRMAN HENDRIE: Right.

10 COMMISSIONER BRADFORD: I would add a sentence at

11 the end. It is not essential, but I think it might help

12 focusing a bit to the effect that commenters espousing this

13 alternative should specifically address ways in which the

14 Commission might find reasonable assurance that the ultimate

15 standards are met without prescribing standards for the

16 major elements.

17 CHAIRMAN HENDRIE: I have no objection.

18 COMMISSIONER AHEARNE: Fine.

19 CHAIRMAN HENDRIE: And then down at the bottom,

20 and at the top of the next one, John, it just doesn't grab

21 me.

22 COMMISSIONER AHEARNE: Fine.

23 CHAIRMAN HENDRIE: I don't think we can very well

24 say, "Does in view of the three numerical..." when we go

25 ahead and propose the rule that says they do.

1 I knew what you meant, I thought. Is that OK with
2 you others?
3 COMMISSIONER AHEARNE: Yes.
4 COMMISSIONER BRADFORD: I had suggested - I am
5 just trying to track it through your changes, John, most of
6 which go in the same direction mine had anyway.
7 I guess, John, the last sentence in that paragraph
8 now reads, "Therefore, the proposed technical rule is
9 established on this approach." My preference would be to
10 change that to the active voice and just say, "Therefore the
11 Commission prefers a technical rule established on this
12 approach."
13 I would put the last sentence in the active voice
14 and say, "Therefore, the Commission prefers a technical rule
15 established upon this approach."
16 COMMISSIONER GILINSKY: I would prefer the active
17 voice. It sounds like there is less hanging back on the
18 Commission's part.
19 COMMISSIONER AHEARNE: Do you go with that?
20 CHAIRMAN HENDRIE: I guess so. Do you have
21 objection to it?
22 COMMISSIONER AHEARNE: If you go with it, I have
23 no objection to it.
24 COMMISSIONER BRADFORD: Am I right in thinking
25 that it is wise to add at the end of the last paragaraph the

1 sentence, "In all probability further public comment would
2 have to be sought." I thought our conclusion when we
3 discussed this last time was that there would be --
4 COMMISSIONER GILINSKY: Not in all probability,
5 but definitely.
6 COMMISSIONER BRADFORD: OK, if that is the case.
7 COMMISSIONER AHEARNE: Why definitely?
8 COMMISSIONER GILINSKY: Because if you went to a
9 completely different approach which is not laid out here,
10 you are going to have to go with a new comment period.
11 COMMISSIONER BRADFORD: The approach is laid out,
12 but you would have to change so much.
13 COMMISSIONER AHEARNE: It depends on how much has
14 to be changed.
15 MR. MALSCH: Well, that is true. If all you did,
16 if our rulemaking had an approach there would not be any
17 problem because the approaches would have been laid out.
18 The question is how many details would yu want to add.
19 COMMISSIONER AHEARNE: I guess I would not want to
20 commit to an additional public comment period. I have no
21 problem with saying have it possibly revised with the
22 possibility of an additional comment period.
23 COMMISSIONER BRADFORD: That's fine. Why don't
24 you just make the sentence then, "It is possible that
25 further public comment would have to be sought?"

1 CHAIRMAN HENDRIE: All right. Major features of
2 the proposed rule. Are there changes, Pat?
3 MS. COMELLA: That is what I am trying to find out.
4 CHAIRMAN HENDRIE: I think there are.
5 MS. COMELLA: Oh, yes, on page 14b of the June
6 10th memo. Remember, there had been an inconsistency when
7 you weere talking about the 10,000 year period.
8 CHAIRMAN HENDRIE: Yes.
9 MS. COMELLA: We have modified language there.
10 CHAIRMAN HENDRIE: I got that. Is there any
11 problem with those?
12 COMMISSIONER BRADFORD: No.
13 CHAIRMAN HENDRIE: All right. There is also,
14 under 14c, there is a trunk that goes in, there are several
15 factors, several changes in this Siting Requirement
16 section. I hear no objection.
17 Then, the Design and Construction, I had a comment
18 about too much stuff in the rule and what do people think
19 about that, do we take it out of the rule?
20 COMMISSIONER BRADFORD: Where are you now?
21 CHAIRMAN HENDRIE: This would be my page 15, down
22 at the bottom where my handwritten stuff goes in.
23 ELD said, "Watch out, you almost sound as though
24 you did define those rate guides."
25 MR. CUNNINGHAM: It was a minor concern that the

1 particular word used here would suggest that part of the
2 rules were in the Reg Guide. The Reg Guide is going to
3 remain what Reg Guides always have been, staff guidance.
4 CHAIRMAN HENDRIE: Let's use your language.
5 MR. CUNNINGHAM: What we would have done would put
6 a semicolon after "form,", the next to the last line on the
7 page, and then have a second clause there that says, "These
8 may be supplemented, of course, with more details in staff
9 guidance documents, such as Regulatory Guides."
10 CHAIRMAN HENDRIE: Now, let's see, I do not pick
11 up a change although I may have, by virtue of not having the
12 May 11 pages in it, have a problem. I do not have any
13 change in my text until you get to page 27.
14 COMMISSIONER GILINSKY: That looks OK.
15 CHAIRMAN HENDRIE: That is talking about estimates
16 as to undiscovered deposits.
17 COMMISSIONER GILINSKY: Sold. Twenty-eight looks
18 good, too.
19 CHAIRMAN HENDRIE: I am going to have to ask the
20 staff how we get through a major piece of goods, and before
21 we look at mine, there is a June 10 change from the staff.
22 This does what, just reflect Peter's version of it?
23 MR. MARTIN: I think that is totally overtaken by
24 yours.
25 CHAIRMAN HENDRIE: So, there is not anything in

1 your June 10 which is not available one way or another;
2 there are the words in mine.
3 COMMISSIONER BRADFORD: Except that you did spell
4 "purpose" correctly.
5 CHAIRMAN HENDRIE: Yes. I am pleased to say that
6 of all of the commenters I am the only objector to the
7 "purpso" of the subpart.
8 I think my memo attempted to outline the rationale
9 for the addition, the change that I think is necessary here.
10 COMMISSIONER GILINSKY: Are you talking about page
11 29?
12 CHAIRMAN HENDRIE: Yes, 29a. Let me stand back.
13 COMMISSIONER GILINSKY: It looks fine, except the
14 last "probable." What do you want, two "probables" in
15 effect. Why is not just "reasonable assurance" enough? "It
16 is probably true that it probably will happen."
17 CHAIRMAN HENDRIE: When you talk about what the
18 leach rate will be in 100,000 years, 10,000 years or
19 whatever, or what the waste canister is going to do in a
20 thousand years, by the time you get through you are going to
21 have a record in which you are going to have people who
22 said, "Yes, we think it will last in our judgment," that it
23 will. It is based on the following experiments which have
24 been done over the past two and-a-half years. We have used
25 the accelerated rates, and so on," and a lot of detail about

1 that.

2 You have other people who are going to be saying,
3 "It is my judgment that you cannot say anything definitive
4 about what is going to happen in a thousand years because
5 you cannot track in any reasonable way the local chemical
6 conditions of the container wall," and all sorts of things
7 like that.

8 I think the most you can hope for in trying to
9 decide what your finding, then, is going to be, say, on a
10 canister, is that the people that say, "We think it is going
11 to last a thousand years," have made reasonable arguments
12 that it will; and that those are not totally overcome by the
13 folks that do not think it will.

14 About all you can say is, out of those two arrays
15 of conflicting data is, "Well, I think the probable outcome
16 will be all right."

17 COMMISSIONER GILINSKY: That is where the
18 "reasonable assurance" comes in. How is that different?

19 CHAIRMAN HENDRIE: When we talk about reasonable
20 assureance in regulatory practice of this agency for 25
21 years in terms of reactor things. Staff requires pretty
22 high standards of proof in order to reach reasonable
23 assurance findings about reactors. If you come in and, say,
24 have a circuit design which will do a certain function and
25 therefore meets this requirement or that and the staff wants

1 to know, "Show me the design. What about this if you
2 analyze that?"
3 When they are all through, the staff engineers are
4 able to stand up and say, "By George, that circuit will
5 perform," executed the the way they are committed to execute
6 it.
7 After all that great positive stuff, guess what
8 the finding is? There is reasonable assurance.
9 What I am saying is, you cannot apply that to
10 repository matters where you are talking about things that
11 go out a thousand years or more. You are going to have to
12 find a way to frame a standard which simply does not require
13 that kind of variable.
14 Now, I do not know that I have the words that we
15 need for that purpose, but the point I am making to you is,
16 you cannot license on the sort of reasonable basis assurance
17 that we license everything else we deal with.
18 COMMISSIONER BRADFORD: Let me speak to this for a
19 second, for once it is an area I know a little about.
20 First of all, you are going to have to start with
21 the standard in the Administrative Procedures Act, which I
22 think is that our findings have to be supported with
23 reliable, probative, and substantial evidence.
24 Now, it is from that, that we have evolved the
25 language "reasonable assurance." But the fact is, nothing

1 we can say in the regulation is going to undercut the
2 statutory requirement.
3 I think one way to deal with it would just be to
4 quote the statutory language.
5 COMMISSIONER AHEARNE: You feel that Joe's
6 language undercuts the statutory language?
7 COMMISSIONER BRADFORD: I think by the time you
8 get down to tellling people that rigorous proofs are not
9 expected, and then also the point Vic made, the double
10 counting reasonable and probably, we run that risk.
11 I do not disagree with Joe's fundamental point
12 which is that in this kind of a proceeding you cannot get
13 the same degree of assurance that you are going to require
14 regarding the circuit in a reactor over that number of
15 years. But I would not go quite as far as this language
16 seems to in trying to take that into account.
17 My difficulty - I have two different difficulties,
18 one in the beginning and one at the end of Joe's proposed
19 language. One is, the sentence about rigorous proofs seems
20 to me to mix up the finding that we have to make with the
21 nature of the evidence that we would like to have come in.
22 I would rather substitute some phrase like, "complete
23 assurance," in there.
24 The difficulty with saying we do not expect
25 rigorous proofs is that it seems to invite the parties to

1 come in casually. What we expect them to do is the best
2 they can. If they can be rigorous they ought to be rigorous.
3 CHAIRMAN HENDRIE: "Complete assurance" would do
4 nicely there.
5 COMMISSIONER AHEARNE: How would you phrase that,
6 "is not expected?"
7 COMMISSIONER BRADFORD: It is not expected that
8 complete assurance that they will be met can be presented.
9 COMMISSIONER AHEARNE: Well, you don't "present"
10 assurance, do you?
11 COMMISSIONER BRADFORD: Well, you present it and
12 hope that the finder will ultimately adopt it.
13 COMMISSIONER GILINSKY: It seems to me, Joe, in
14 this paragraph you are saying that reasonable assurance in
15 this context is not going to be the same.
16 CHAIRMAN HENDRIE: As in others.
17 COMMISSIONER GILINSKY: That seems to me to be
18 good enough. This finding will still be reasonable
19 assurance, rather than introducing a new finding. If you
20 want to make that point more explicit, that will be fine,
21 too.
22 CHAIRMAN HENDRIE: Let me ask the counsel. Let's
23 see, what you would would be to take "probable" out, take
24 the "probable" out of the last sentence.
25 MR. MALSCH: I have no problem with taking the

1 "probable" out. The statutory standard is still that there
2 will be no undue risk, which we say there is reasonable
3 assurance.
4 COMMISSIONER GILINSKY: Where do you get this
5 statutory standard there being no undue risk from?
6 MR. MALSCH: I do not have the section off-hand.
7 COMMISSIONER GILINSKY: It is in one place on
8 construction permits. But I thought the statutory standard
9 was adequate protection.
10 MR. MALSCH: It is stated variously in different
11 parts of the Act, "undue risk" in one place; "adequate
12 protection" is there.
13 COMMISSIONER GILINSKY: Somehow "no undue risk" is
14 something that everybody has latched onto, and the ACRS has
15 latched onto. Everybody always cites that one.
16 MR. MALCH: I think "undue risk" appears both in
17 the materials licensing and in facilities licensing section,
18 but "adequate protection" appears only in the facilities
19 licensing section. But they have all been used
20 interchangeably.
21 MR. CUNNINGHAM: That is the principal one.
22 Reasonable assurance has been used by us to mean the same as
23 no undue risk, the same as adequate protection. What we
24 will have to do is come up with a context for the use of
25 that term in the context of depository licensing. It is a

1 different context in facilities licensing. The standard is
2 still going to be the same.
3 COMMISSIONER GILINSKY: And this would just
4 recognize that we are dealing with something over long
5 periods of time that is inherently uncertain, and so on.
6 That just states the obvious. That is fine.
7 COMMISSIONER AHEARNE: I have no problem with
8 "reasonable assurance".
9 CHAIRMAN HENDRIE: But the language as I have laid
10 it down appears to conflict with APA.
11 MR. MALSCH: I don't think so. The APA standards
12 went for judicial review.
13 CHAIRMAN HENDRIE: Say that again?
14 MR. MALSCH: The APA standard is the one that the
15 courts apply on judicial review. Usually, you cannot apply
16 that as a guide to decision because you can have substantial
17 evidence on both sides of the same question.
18 So, it is conceivable that you could have a record
19 developed in which there was substantial evidence both that
20 the standards were met, and substantial evidence that they
21 were not met. Then all you said was substantial evidence as
22 a possibility that could lead to impacts. Usually you have
23 to make some further statement.
24 COMMISSIONER BRADFORD: Well, "substantial" does
25 not necessarily mean "majority," it means of substance.

1 MR. MALSCH: Right. But if all you said was, make
2 a decision based on substantial evidence, it is conceivable
3 that there is substantial evidence on both sides of the
4 question and the adjudicatory tribunal would not know which
5 way to tilt.
6 So, the words we have always used to show which
7 way to tilt is "reasonable assurance" which, curiously
8 enough, is the only term among all those various phrases
9 that does not appear - undue risk, unreasonable risk
10 appears, reasonable assurance does not.
11 It has historically acquired almost a statutory
12 role. "Probably" means the same as "proponderance of the
13 evidence" in a legal burden of proof sense.
14 COMMISSIONER GILINSKY: Probably.
15 COMMISSIONER BRADFORD: What was troubling me
16 about "probable" is that it invites discussion over whether
17 that means a 51 percent likelihood, a 90 percent likelihood.
18 COMMISSIONER GILINSKY: What you are saying is, it
19 is probable that the mean of whatever the performance
20 characteristic is will be over some line.
21 CHAIRMAN HENDRIE: That is exactly right, that is
22 what it means. But I sure would not want them to be
23 developing probability distributions and mucking around the
24 adjudicatory format trying to prove and disprove one
25 another's probability distributions.

1 COMMISSIONER GILINSKY: I would be a lot more
2 comfortable with saying that reasonable assurance in this
3 case is going to have to take into account the uncertainties
4 inherent in the decision, and may have a different meaning
5 than it does in licensing a reactor.
6 COMMISSIONER BRADFORD: I would be less
7 comfortable with it. The first part of it was all right. I
8 think I once suggested to Joe that to use a phrase like
9 "reasonable assurance" in light of the time periods and
10 hazards involved, that the outcome would be conforming.
11 COMMISSIONER GILINSKY: I was going to say at the
12 start that I am not sure that conceptually there is a lot of
13 difference between this and making findings on a reactor on
14 the basis of semi-scale tests. It is a difference of
15 degree, but I do not think a difference in kind.
16 CHAIRMAN HENDRIE: I think it is a qualitative
17 difference. But let me not try to justify the feeling.
18 Peter, say that again. "For such long-term objective" -
19 this is the last sentence - "what is required is reasonable
20 assurance, taking --
21 COMMISSIONER BRADFORD: Reasonable assurance in
22 light of the time periods and hazards involved. I don't
23 know if you need it based on the record before the
24 Commission; I take it that is implicit in the nature of the
25 proceeding.

1 CHAIRMAN HENDRIE: I guess it is.

2 COMMISSIONER BRADFORD: That the probable outcome

3 will be in conformance with those objectives and criteria.

4 CHAIRMAN HENDRIE: You would take "probable" out,

5 would you not?

6 COMMISSIONER GILINSKY: I would.

7 COMMISSIONER BRADFORD: I am sorry. Yes, I meant

8 to take it out; that is what I get for just reading along.

9 Reasonable assurance in light of the time periods

10 and hazards involved.

11 CHAIRMAN HENDRIE: That might be a formulation

12 which would do it. Any comments from staff, counsel's

13 office that you want to make?

14 MR. ~~CUMMINGS~~ Cunningham: I find that acceptable.

15 CHAIRMAN HENDRIE: How does it strike you, John?

16 COMMISSIONER AHEARNE: Peter, let me ask, when you

17 say, "In light of the time periods and hazards involved," in

18 your mind, does that mean that you would ask for more or

19 less in the sense of conviction that this is the right

20 solution than you would in a reactor licensing case?

21 COMMISSIONER BRADFORD: I don't consider that

22 phrase really to carry it beyond the word "reasonable." It

23 seems to me a reasonable person is going to consider in a

24 reactor the level of assurance they are going to require is

25 going to be in some measure commensurate with what being

1 wrong on that particular point can lead to. I think the
2 same is true here.
3 It is clear to me that when you get out to
4 thousands of years you are talking about greater levels of
5 uncertainty than you would be in most aspects of reactor
6 performance. But that just arises from comparing 30 years
7 to a thousand.
8 COMMISSIONER AHEARNE: Are you saying then that in
9 your mind that phrase would carry with it the idea that the
10 degree of certainty you would have to reach for probable
11 assurance is less in licensing a repository than in
12 licensing a reactor?
13 COMMISSIONER BRADFORD: As a general proposition,
14 John, the chances are none of us will be here to do it.
15 COMMISSIONER AHEARNE: The record will exist.
16 COMMISSIONER BRADFORD: If it were me, as a
17 general proposition I think that the level of assurance one
18 can hope to attain is going to decline with time, and the
19 hazard, of course, is also going to decline with time. So,
20 it is going to be acceptable, is going to have to be
21 acceptable. In the period of thousands of years you are
22 talking about a much greater level of uncertainty.
23 COMMISSIONER AHEARNE: With the understanding,
24 Peter, it carries with it something like the recognition
25 that there is going to have to be less certainty in reaching

1 a reasonable assurance in licensing a repository than in
2 licensing a ractor, which I thought was inherent in Joe's
3 statement. I would accept it.
4 COMMISSIONER GILINSKY: Uncertainty, as you look
5 further ahead.
6 COMMISSIONER AHEARNE: Uncertainty in reaching
7 your conclusion
8 CHAIRMAN HENDRIE: It certainly seems to me
9 directed to the direction that I think you are agreeing it
10 was meant. How about, "What is required is reasonable
11 assurance, making allowance for the time periods and hazards
12 involved, but the outcome will be conformance?"
13 COMMISSIONER BRADFORD: I think that is fine,
14 too. The only caveat I would introduce into my pact with
15 John, that there of course are some activities that go on at
16 the very beginning of transportation and capability
17 concerns, which would be roughly comparable to reactors.
18 CHAIRMAN HENDRIE: I don't know, I think it would
19 carry this insert if we put it in, the kind of language we
20 have adjusted to here is at least a step in the direction
21 that I think things have to be turned to to make it a
22 practical proposition. I suspect it is not practical to go
23 too much farther than this in terms of trying to define the
24 proposition because one is limited by certain legal
25 precedents, statutory requirements on a couple of

1 boundaries; what formulates an ability to agree on another
2 boundary.
3 As it stands, to go through it once to see if we
4 are in agreemewnt. The insert would be the one on my page
5 29a. In the second line we would strike "rigorous proof",
6 substitute "complete assurance." In the third line, strike
7 "or will," and the last sentence would read, "For such
8 long-term objectives and criteria what is required is
9 reasonable assurance, making allowance for the time periods
10 and hazards involved, that the outcome" - strike the
11 "probable" - "will be in conformance with those objectives
12 and criteria."
13 It seems to me that if you allowed me --
14 COMMISSIONER BRADFORD: I think you are right, it
15 is not a matter of allowance.
16 CHAIRMAN HENDRIE: -- what I thought we needed
17 here. So, that would be fine with me. If it is agreeable
18 with others, why, let us put it in.
19 Then, back on page 29, down in Part "b" of this
20 thing, it seems to me that you want to reflect that having
21 discussed what "reasonable assurance" ment in "a", that when
22 you refer to it in "b", you want to say, "What we mean here
23 is what we said up above."
24 COMMISSIONER BRADFORD: Yes.
25 CHAIRMAN HENDRIE: I tell you, since you have to

1 go and since it is ten after twelve, this would be a good
2 time for us to stop.
3 Now, we have to save some time on the agenda to
4 continue this discussion early next week. What I would
5 propose to do is to continue from this point, pick up the
6 discussion at this point on Tuesday afternoon, the 16th at 2
7 o'clock.
8 MR. DIRCKS: We are going up to the hearing on
9 uranium mill tailing the afternoon of the 16th.
10 COMMISSIONER BRADFORD: Can you switch with
11 whatever is on Tuesday morning?
12 CHAIRMAN HENDRIE: Yes. On Tuesday morning I have
13 an export licensing briefing. Can anybody tell me whether
14 that involves people from outside the agency?
15 MR. DIRCKS: That is that Criterion 1?
16 CHAIRMAN HENDRIE: Yes.
17 MR. DIRCKS: That was Shehy and myself. Shehy can
18 do that.
19 CHAIRMAN HENDRIE: Would you prefer to do that, or
20 would you prefer to shuffle Wednesday at 10 o'clock, the
21 ATWS discussion?
22 MR. DIRCKS: I would like to get out of ATWS.
23 (Laughter.)
24 CHAIRMAN HENDRIE: Gee, I am cut to the quick.
25 What do you think of that?

1 COMMISSIONER BRADFORD: It does not matter a lot
2 to me one way or the other. My only concern is a desire to
3 vote on this one if we can. Since we have to by the end of
4 the week, there is a little bit of a risk in shoving it
5 forward if there are any substantial revisions and retyping
6 to be done. It is nice to have the extra day in there.
7 MR. DIRCKS: Move this to Tuesday morning, and
8 move the Tuesday morning one to the next day.
9 COMMISSIONER BRADFORD: For the sole purpose of
10 getting you out of ATWS.
11 (Laughter.)
12 CHAIRMAN HENDRIE: That is all right with me. The
13 ATWS group can come any time.
14 MR. MARTIN: Should we in the meantime revise all
15 this up to page 34?
16 COMMISSIONER BRADFORD: I think if you can stand
17 it, it would be wise, yes.
18 MR. MARTIN: Printed pages, bring us up to the
19 present.
20 CHAIRMAN HENDRIE: Yes.
21 COMMISSIONER BRADFORD: Let's see, does it make
22 sense to try and come up with a single version for
23 discussion from 39 forward as well?
24 MR. DIRCKS: A combination of the May 11 version?
25 MR. MARTIN: Well, there really are not any

1 changes beyond that, to speak of.

2 COMMISSIONER BRADFORD: Not other than those Joe

3 has proposed.

4 MR. DIRCKS: I think the chairman's changes are

5 the only substantive ones.

6 COMMISSIONER AHEARNE: Probably, to speed us on,

7 if you could take his changes and put them in as marked

8 changes in a version that would make sure you picked up all

9 of the June's to avoid the difficulty of trying to shuffle

10 them. That would probably speed us along.

11 CHAIRMAN HENDRIE: Yes, that is right. We still

12 have some substantive things because I am attacking the LERA

13 pieces of the first two barriers, and that needs substantial

14 discussion. Once we get past that an back into these other

15 things, then I had the grump about the adverse conditions.

16 I think from there on I have not touched it. I don't even

17 recall edits I made.

18 So, with that much to go it would be useful. Now,

19 let me ask Commissioners, those present, as they prepare

20 that version, why don't we ask them to prepare it on a clean

21 basis? It does not seem to me to make sense to sort out the

22 most recent set of changes and underline, and do comparative

23 text; do you think so?

24 COMMISSIONER BRADFORD: Let's see, this is the

25 whole thing, or the part up to?

1 CHAIRMAN HENDRIE: The part up to here.

2 COMMISSIONER BRADFORD: Yes, that can be clean.

3 COMMISSIONER AHEARNE: Fine.

4 CHAIRMAN HENDRIE: From here on, were there things

5 I missed in May 11th, using the old one, which were

6 significant? My impression was that from here on, May 11th

7 is sort of irrelevant because I thought your June 1st memo

8 ran solid new pages from about 28 on, or something like that.

9 MS. COMELLA: That's right.

10 CHAIRMAN HENDRIE: So, I think by the time we have

11 gotten this far, there is no longer that problem that I

12 missed things out of May 11th.

13 So, if they would do it as a clean copy up to this

14 point, maybe it would relieve them a little bit from a major

15 typing job to just go ahead and work from mine from here on.

16 COMMISSIONER AHEARNE: And of course that one open

17 item on the first page.

18 COMMISSIONER BRADFORD: The typist can handle that

19 one.

20 CHAIRMAN HENDRIE: When you retype that, if you

21 put in parentheses and three spaces --

22 COMMISSIONER BRADFORD: I was going to say, ten.

23 (Laughter.)

24 COMMISSIONER AHEARNE: Why don't you say three,

25 granting that you may compromise?

1 COMMISSIONER BRADFORD: That's right, an extra
2 space.
3 COMMISSIONER AHEARNE: If you compromise off of
4 nine in his direction, more than nine days.
5 CHAIRMAN HENDRIE: I will have a new proposal by
6 Tuesday morning.
7 (Laughter.)
8 CHAIRMAN HENDRIE: I think it still can be
9 accomodated within three digits. Thus, it will be less than
10 three years, to be sure.
11 Now, does everybody know what they are going to do?
12 MR. MARTIN: Yes.
13 (Whereupon, at 12:15 p.m. the meeting of the
14 Commission was adjourned.)
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NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

COMMISSION MEETING

in the matter of: Discussion and Vote on SECY-81-267 -- PUBLIC MEETING
10 CFR 60

Date of Proceeding: June 11, 1981

Docket Number:

Place of Proceeding: Washington, D. C.

were held as herein appears, and that this is the original transcript thereof for the file of the Commission.

M. E. Hansen

Official Reporter (Typed)

M.E. Hansen

Official Reporter (Signature)

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

OFFICE OF THE SECRETARY

IN RESPONSE, PLEASE REFER TO: M810616A

June 22, 1981

MEMORANDUM FOR: William J. Dircks, Executive Director for Operations

FROM: Samuel J. Chilk, Secretary

SUBJECT: STAFF REQUIREMENTS - BRIEFING ON SECY-81-267, 10 CFR PART 60, DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE IN GEOLOGIC REPOSITORIES: TECHNICAL CRITERIA, 10:05 A.M., TUESDAY, JUNE 16, 1981, COMMISSIONERS' CONFERENCE ROOM, D.C. OFFICE (OPEN TO PUBLIC ATTENDANCE)

The staff continued its discussion with the Commission on the proposed rule on Technical Criteria for High-Level Waste (HLW) Repositories. The Commission agreed on a number of changes to the proposed rule including:

a. The public comment period should be 120 days.

b. The addition of a footnote on page 38 (staff June 15, 1981 version of the rule) noting that the Commission is also seeking public comment on the desirability of the inclusion of an ALARA type concept to the waste packages and engineered system. The Statement of Consideration should include discussion of the desire for public comment on this topic.

c. The introductory paragraphs to Section 60.123 and 60.124 should be revised as follows:

Section 60.123 Potentially adverse conditions

The following are potentially adverse conditions. The presence of any such conditions may compromise site suitability and will require careful analysis and such measures as are necessary to compensate for them adequately pursuant to Section 60.124.

Section 60.124 Assessment of potentially adverse conditions

In order to show that a potentially adverse condition or combination of conditions cited in Section 60.123 of this subpart does not significantly impair the ability of the geologic repository to isolate the radioactive waste, the following must be demonstrated.

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The Commission, by a vote of 4-0, approved:

1. Publication of the proposed rule in the Federal Register subject to review of the final wording by the Commissioners' offices. The staff was directed to prepare the proposed rule and forward it to the Commission. (EDO) (SECY Suspense: 7/8/81)

2. The staff conclusions set forth in Enclosure H to SECY-81-267 for the Analysis with Respect to the Periodic Systematic Review of Regulations and Criteria.

3. Certification that the rule will not have a significant economic impact on a substantial number of small entities.

An advance copy of the Final Rule was subsequently distributed to the Commissioners Offices on June 22, 1981.

cc: Chairman Hendrie
Commissioner Gilinsky
Commissioner Bradford
Commissioner Ahearne
Commission Staff Offices
Public Document Room

Proposed Rule - Technical



were reviewed and published, in summary form, on March 31, 1980 (45 FR 21168). In general, the comments were supportive of the agency's efforts.

It was also at this time, March 1980, that Packers and Stockyards printed its timetable for review anticipating the publication of a specific set of regulations for review every 6 months until all regulations were considered or a total time period of approximately 5 years. Fourteen specific regulations, six policy statements and various report forms were selected for review, and comments were again solicited.

In response to the March request, 21 additional comments were received concerning the specific areas targeted for review, *i.e.:* (1) Current levels of required bonding; (2) proper maintenance of custodial accounts; (3) packer sales promotion policies; and (4) required annual reporting for market agencies and dealers. The agency's third Federal Register publication, dated December 31, 1980 (45 FR 87002), discussed these comments and detailed specific changes in these target areas designed to be responsive to suggestions by the industry, to lessen regulatory burdens on the industry, and to encourage competitive markets within the industry.

### Present Activities

The agency has decided to accelerate the regulatory review and reform process which it has already begun. To assist the agency in achieving this end, the Deputy Administrator, Packers and Stockyards, AMS, established an internal task force in January 1981 to review each rule and regulation and to suggest changes thereto which would lessen or eliminate any regulatory burden imposed without restricting the agency's ability to enforce the Packers and Stockyards Act. An interim report of the task force has been prepared and a final report is expected by the Administrator of Packers and Stockyards Administration on August 1, 1981.

### Revised Plan

Packers and Stockyards Administration will not follow its previously published plan for regulatory review. Rather, the agency will review all currently effective regulations, policy statements and reporting requirements by the close of fiscal year 1983 (September 30, 1983). As a part of this review, effort will be made to obtain input from the affected industries, State Departments of Agriculture, and other interested persons prior to formal publication of proposals. Proposed changes and deletions will then be published in the Federal Register for comments prior to final adoption. Additionally, by September 30, 1981, the agency will publish, pursuant to the requirements of the Regulatory Flexibility Act, a listing of all rules having a significant economic impact on a substantial number of small business entities which will be reviewed during the succeeding 12 months. the proposed regulations published December 31, 1980, in the Federal Register will be reconsidered by the agency to incorporate, where appropriate, the recommendations of the task force and comments filed by the industry, and where necessary, such regulations will be republished for comment.

Done at Washington, D.C., this 1st day of July 1981.

James L. Smith,

*Acting Administrator, Packers and Stockyards Administration.*

[FR Doc. 81-20950 Filed 7-7-81; 8:45 am]
BILLING CODE 3410-02-M

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## NUCLEAR REGULATORY COMMISSION

## 10 CFR Part 60

## Disposal of High-Level Radioactive Wastes in Geologic Repositories

**AGENCY:** Nuclear Regulatory Commission.

**ACTION:** Proposed rule.

**SUMMARY:** The NRC is publishing proposed amendments which specify technical criteria for disposal of high-level radioactive wastes (HLW) in geologic respositories. The proposed criteria address siting, design, and performance of a geologic repository, and the design and performance of the package which contains the waste within the geologic repository. Also included are criteria for montoring and testing programs, performance confirmation, quality assurance, and personnel training and certification. The proposed criteria are necessary for the NRC to fulfill its statutory obligations concerning the licensing and regulating of facilities used for the receipt and storage of high-level radioactive waste.

**DATE:** Comments received after November 5, 1981 will be considered if it is practical to do so, but assurance of consideration cannot be given except for comments received on or before this date.

**ADDRESS:** Written comments or suggestions on the proposed amendments should be sent to the Secretary of the Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch. Copies of comments may be examined in the U.S. Nuclear Regulatory Commission Public Document Room, 1717 H Street NW, Washington, D.C. Comments may also be delivered to Room 1121, 1717 H Street NW, Washington, D.C., between 8:15 a.m. and 5:00 p.m.

**FOR FURTHER INFORMATION CONTACT:** Frank J. Arsenault, Director of the Division of Health, Siting and Waste Management, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Telephone (301) 427-4350.

**SUPPLEMENTARY INFORMATION:**

### Background

On December 6, 1979 the Nuclear Regulatory Commission (Commission or NRC) published for comment proposed procedures for licensing geologic disposal of high-level radioactive wastes. The licensing procedures were published in final form on February 25, 1981 (46 FR 13971). On May 13, 1980 (45 FR 31393) the Commission published for comment an Advance Notice of Proposed Rulemaking (ANPR) concerning technical criteria for regulating disposal of high-level radioactive wastes (HLW) in geologic respositories. Included with the advance notice was a draft of the technical criteria under development by the staff. The public was asked to provide comment on several issues discussed in the advance notice and to reflect on the draft technical criteria in light of that discussion. The comments received were numerous and covered the full range of issues related to the technical criteria. The tecnhical criteria being proposed here are the culumination of a number of drafts, and were developed in light of the comments received on the ANPR. It is the Commissions's belief that the regulation proposed here is one which is both practical for licensing and this notice provides a flexible vehicle for accommodating comments in that it points out alternatives and calls for comment in a number of critical plans. The Commission has prepared an analysis of the comments which explains the changes made from the ANPR, and intends to publish soon the comments and the analysis as a NUREG document. A draft of this NUREG has been placed in the Commission's Public Document Room for review. In addition, the staff has begun a program to develop guidance as to the methods that it regards as satisfactory for demonstrating compliance with the requirements of the proposed rule.

The technical criteria being set forth here as proposed rulemaking are a result of the Commission's further effort in regulating geologic disposal of HLW by the Department of Energy (DOE). The rationale for the performance objectives and the Environmental Impact Assessment supporting this rulemaking are also being published separately and are available free of charge upon written request to Frank Arsenault at the above address. In developing these criteria we have not reexaminated DOE's programmatic choice of disposal technology resulting from its Generic Environmental Impact Statement, inasmuch as the Commission has expressly reserved until a later time possible consideration of matters within the scope of that generic statement (44 FR 70408). Accordingly, the technical criteria apply only to disposal in geologic respositories and do not address other possible or potential disposal methods. Similarly, in that DOE's current plans call for dispoal at sufficient depth to be in the area termed the saturated zone, these criteria were developed for disposal in saturated media. Additional or alternative criteria may need to be developed for regulating disposal in the unsaturated or vadose zone.

### Authority

Sections 202 (3) and (4) of the Energy Reorganization Act of 1974, as amended, provide the Commission with licensing and regulatory authority regarding DOE facilities used primarily for the receipt and storage of high-level radioactive wastes resulting from activities licensed under the Atomic Energy Act and certain other long-term HLW storage facilities of DOE. Pursuant to that authority, the Commission is developing criteria appropriate to regulating geologic disposal of HLW by DOE. The requirements and criteria contained in this proposed rule are a result of that effort.

### Relation to Generally Applicable Standards for Radiation in the Environment Established by the Environmental Protection Agency

The Environmental Protection Agency (EPA) has the authority and responsibility for setting generally applicable standards for radiation in the environment. It is the responsibility of the NRC to implement those standards in its licensing actions and assure that public health and safety are protected. Although no EPA standard for disposal of HLW yet exists, these proposed technical criteria for regulating geologic disposal of HLW have been developed to be compatible with a generally applicable environmental standard. Specifically, the performance objectives and criteria speak to the functional elements of geologic disposal of HLW and the analyses required to give confidence that these functional elements will perform as intended.

### Disruptive Processes and Events

The NRC's implementing regulations assume that licensing decisions will be based, in part, on the results of analysis of the consequences of processes and events which potentially could disrupt a repository. Thus, throughout the criteria are requirements that the design basis take into account processes and events with the potential to disrupt a geologic repository. If the process or event is anticipated, i.e., likely, then the design basis requires barriers which would not fail in a way that would result in the repository not meeting the performance objectives. Anticipated processes and events would include such items as waste/rock interactions that result from emplacement of the wastes or the gradual deterioration of borehole seals. If the process or event is unlikely, then the overall system must still limit the release of radionuclides consistent with the EPA standard as applied to such events. An example of an unlikely event would be reactivation of a fault within the geologic setting which had not exhibited movement since the start of the Quaternary Period. In general, both likely and unlikely processes and events are expected to be site and design specific and would be identified by DOE in its license application.

### Multiple Barriers

The proposed technical criteria were developed not only with the understanding that EPA's generally applicable environmental standard would need to be implemented, at least in part, by performing calculations to predict performance, but also with the knowledge that some of those calculations would be complex and uncertain. Natural systems are difficult to characterize and any understanding of the site will have significant limitations and uncertainties. Those properties which pertain to isolation of HLW are difficult to measure and the measurements which are made will be subject to several sources of error and uncertainty. The physical and chemical processes which isolate the wastes are themselves varied and complex. Further, those processes are especially difficult to understand in the area close to the emplaced wastes because that area is physically and chemically disturbed by the heat generated by those wastes.

However, a geologic repository consists of engineered features as well as the natural geologic environment. Any evaluation of repository performance, therefore, will consider the waste form and other engineering factors which are elemental to the performance of the repository as a system. By partitioning the engineered system into two major barriers, the waste package and the underground facility, and establishing performance objectives for each, the Commission has sought to exploit the ability to design the engineered features to meet specific performance objectives as a means of reducing some of the uncertainties in the calculations of overall repository performance.

In addition, the requirements for containment, controlled release rate, and 1,000-year groundwater transit time are three criteria which act independently of the overall repository performance to provide confidence that the wastes will be isolated at least for as long as they are most hazardous.

### Containment and Isolation

During the first several hundred years following emplacement of the wastes, both the radiation from and the heat generated by the wastes are attributable mainly to the decay of the shorter-lived nuclides, primarily fission products. At about 1,000 years after emplacement both the radiation from and heat generated by decay of the wastes have diminished by about 3 orders of magnitude. As the decay of the longer-lived nuclides, primarily actinides, begins to dominate, both the radiation from and thermal output of the wastes continue to fall until almost 100,000 to 1,000,000 years after emplacement. By that time both have diminished by about 5 orders of magnitude and both heat and radiation become roughly constant due to the ingrowth of daughter nuclides, primarily Ra-225, Ra-226 and their decay products.

The technical criteria would require the engineered system to be designed so that the wastes are contained within the waste package for the first thousand years following emplacement. Following this period, containment is no longer assumed and the function of the waste package and underground facility is to control the release of radionuclides from the underground facility. By requiring containment during the period when the thermal conditions around the waste packages are most severe, evaluation of repository performance is greatly simplified to considerations of the degree of conservatism in the containment design relative to events

and processes that might affect the performance during the containment period.

Although both the radiation from and heat generated by the decay of the wastes have diminished about 3 orders of magnitude during the containment period, the area surrounding the emplaced wastes will not return to temperatures near those before the wastes were emplaced until after about 10,000 years. As mentioned earlier, the thermal disturbance of the area near the emplaced wastes adds significantly to the uncertainties in the calculation of the transport of the radionuclides through the geologic environment. The technical criteria are intended to compensate for uncertainties by imposing further design requirements on the waste package and underground facility, thereby limiting the source term by controlling the release rate.

Role of the Site

The Commission neither intends nor expects either containment to be lost completely at 1,000 years following emplacement or the engineered system's contribution to the control of the release of wastes to cease abruptly at some later time. However, the Commission recognizes that at some point the design capabilities of the engineered system will be lost and that the geologic setting—the site—must provide the isolation of the wastes from the environment, and has translated this requirement into a performance objective for the geologic setting. The Commission also recognizes that isolation is, in fact, a controlled release to the environment which could span many thousands of years, and that the release of radionuclides and the potential exposures to individuals which could result, should be addressed in the evaluation of a repository. A complement to the evaluation of the effects of design basis processes and events which might disrupt the repository is a projection of how the repository, unperturbed by discrete external events, will evolve through the centuries as a result of the geologic processes operating at the site. Hence, an amendment is being proposed to that portion of Subpart B of 10 CFR Part 60 which describes the contents of the Safety Analysis Report of DOE's application for geologic disposal of HLW which would require DOE to project the expected performance of the proposed geologic repository noting the rates and quantities of expected releases of radionuclides to the accessible environment as a function of time.

Retrievability

The licensing procedures of 10 CFR Part 60 were written assuming that there would be a program of testing and measurement of the thermal, mechanical, and chemical properties of the major engineered barriers to confirm their expected performance. The Commission would like to tie the requirement for retievability of the wastes to the expected time needed to execute the performance confirmation program. However, at present it appears to the Commission that neither the specific nature nor the period needed for execution of the performance confirmation program will be certain until construction of the repository is substantially complete; that is, until the actual licensing to receive wastes at a geologic repository. Hence it is difficult at this time to use the performance confirmation program as a basis for establishing a period of retrievability. Nonetheless, DOE is now making critical decisions regarding the design of geologic repositories which will have a direct effect upon how long the optio to retrieve wastes can be maintained, and upon the difficulty which will be encounted in exercising that option, should that be necessary for protection of public health and safety. Therefore, to provide a suitable objective in this regard, the proposed rule sets forth a requirement that the engineered system be designed so that the option to retrieve the waste can be preserved for up to fifty years following completion of emplacement. Thus, the waste package and the underground facility would be designed so that the period of retrievability would not be the determinant of when the Commission would decide to permit closure of the repository. Rather, the Commission would be assured of the option to let the conduct of the performance confirmation program indicate when it is appropriate to make such a decision. In particular, the Commission is concerned that the thermo-mechanical design of the underground facility be such that access can be maintained until the Commission either decides to permit permanent closure of the repository or to take corrective action, which may include retrieval.

As it is now structured, the rule would require in effect that the repository design be such as to permit retrieval of waste packages for a period of up to 110 years. The components of this total period are as follows: the first waste packages to go in the repository are likely to be in place about thirty years before all wastes are in place; thereafter, a 50-year period is required by the rule; finally, a retrieval schedule is suggested of about the same time as the original construction plus emplacement operations—another 30-odd years. Since it is probably not practical to adjust the retrievability design aspects of the repository according to the order of emplacement of the waste packages, the 110-year requirement will apply to all of the waste. The Commission is particularly interested in comments on the degree to which this requirement will govern the thermal and mechanical design of the repository and on whether some shorter period would be adequate or whether there are other ways than an overall retrievability requirement to preserve options before permanent closure. The Commission does not want to approve construction of a design that will foreclose unnecessarily options for future decisionmakers, but it is also concerend that retrievability requirements not unnecessarily complicate or dominate repository design.

The retrievability requirement does not specify the form in which the wastes are to be retrievable or that wastes are "readily retrievable." The requirement is simply that all the wastes be retrievable during a period equal to the period of construction and emplacement. DOE's plans for retrieval are specifically requested as part of its license application and the practicability of its proposal will be considered by the Commission. Waste may be retrieved upon NRC approval of a DOE application or upon order by NRC, or otherwise, where authorized by DOE's license.

Human Intrusion

Some concern has been raised on the issue of human intrusion into a geologic repository. Human intrusion could conceivably occur either inadvertently or deliberately. Inadvertent intrusion is the accidental breaching of the repository in the course of some activity unrelated to the existence of the repository, e.g., exploration for or development of resources. For inadvertent intrusion to occur, the institutional controls, site markers, public records, and societal memory of the repository's existence must have been ineffective or have ceased to exist. Deliberate or intentional intrusion, on the other hand, assumes a conscious decision to breach the repository; for example, in order to recover the high-level waste itself, or exploit a mineral associated with the site.

Historical evidence indicates that there is substantial continuity of

information transfer over time. There are numerous examples of knowledge, including complex information, being preserved for thousands of years. This has occurred even in the absence of printing and modern information transfer and storage systems. Furthermore, this information transfer has survived disruptive events, such as wars, natural disasters, and dramatic changes in the social and political fabric of societies. The combination of the historical record of information transfer, provisions for a well-marked and extensively documented site location, and the scale and technology of the operation needed to drill deeply enough to penetrate a geologic repository argue strongly that inadvertent intrusion as described above is highly improbable, at least for the first several hundred years during which time the wastes are most hazardous. Selecting a site for a repository which is unattractive with respect to both resource value and scientific interest further adds to the improbability of inadvertent human intrusion. It is also logical to assume that any future generation possessing the technical capability to locate and explore for resources at the depth of a repository would also possess the capability to assess the nature of the material discovered, to mitigate consequences of the breach and to reestablish administrative control over the area if needed. Finally, it is inconsistent to assume the scientific and technical capability to identify and explore an anomalous heat source several hundred meters beneath the Earth's surface and not assume that those exploring would have some idea of either what might be the cause of the anomaly or what steps to take to mitigate any untoward consequence of that exploration.

The above arguments do not apply to the case of deliberate intrusion. The repository itself could be attractive and invite intrusion simply because of the resource potential of the wastes themselves. Intrusion to recover the wastes demands (1) knowledge of the existence and nature of the repository, and (2) effort of the same magnitude as that undertaken to emplace the wastes. Hence intrusion of this sort can only be the result of a conscious, collective societal decision to recover the wastes.

Intrusion for the purpose of sabotage or terrorism has also been mentioned as a possibility. However, due to the nature of geologic disposal, there seems to be very little possibility that terrorists or saboteurs could breach a repository. Breach of the repository would require extensive use of machinery for drilling and excavating over a considerable period of time. It is highly improbable that a terrorist group could accomplish this covertly.

In light of the above, the Commission adopted the position that commonsense dictates that everything that is reasonable be done to discourage people from intruding into the repository. Thus, the proposed technical criteria are written to direct site selection towards selection of sites of little resource value and for which there does not appear to be any attraction for furure societies. Further, the proposed criteria would require reliable documentation of the existence and location of the repository and the nature of the wastes emplaced therein, including marking the site with the most permanent markers practical. However, once the site is selected, marked, and documented, it does no use to argue over whether these measures will be adequate in the future, or to speculate on the virtual infinity of human intrusion scenarios and whether they will or will not result in violation of the EPA standard. Of course, the Commission recognizes that there are alternative approaches to the Human Intrusion question. Accordingly, comment on this and alternative approaches is welcome.

### Relation to Other Parts of NRC Regulations

The proposed rule contemplates that DOE activities at a geologic repository operations area may in appropriate cases be licensed under other parts of NRC regulations and would then not be governed by these technical criteria. We note, in this connection, that the scope section of the procedural rule specifically provides that Part 60 shall not apply to any activity licensed under another part. This allows an independent spent fuel storage installation to be licensed under Part 72, even though located at a geologic repository operations area (provided, of course, it is sufficiently separate to be classified as "independent"). Other DOE activities of the geologic repository operations area could be licensed under Parts 30 or 70 if an exemption from Part 60 is determined to be appropriate.

### Alternative Approach

In the course of the Commission's deliberation, it becomes evident that in order to have confidence in the ability of a geological repository to contain and isolate the wastes for an extended period of time, the repository must consist of multiple barriers. In view of the uncertainties that attach to reliance on the geologic setting alone, the Commission believes that a repository should consist of two major engineered barriers (waste packages and underground facility) in addition to the natural barrier provided by the geological setting. The Commission is emphasizing these elements to take advantage of the opportunity to attain greater confidence in the isolation of the waste. Having reached these conclusions, the Commission considers next whether or not and to what level of detail the performance criteria for a geological repository should be prescribed. In this regard, the Commission considers the following 3 alternatives:[1]

1. Prescribe a single overall performance standard that must be met. The standard in this case would be the EPA standard;

2. Prescribe minimum performance standards for each of the major elements, in addition to requiring the overall system to meet the EPA standards; and

3. Prescribe detailed numerical criteria on critical enginneering attributes of the repository system.

Alternative 3 is considered overly restrictive on the design flexibility and judged to be inappropriate at this stage of technological development. Therefore, this alternative is quickly eliminated as a viable regulatory approach.

Alternative 1 has as its principal advantage the fact that it provides maximum flexibility in apportioning credit for containment and isolation to the several elements of the repository. It also allows the designer to incorporate and apply new technological developments and knowledge from the site characterization phase to the repository design. Notwithstanding some concern over its practicality in the regulatory framework, the Commission cannot at this time eliminate it from further consideration. The Commission is, therefore, specifically requesting the general public, particularly those from the technical communities, to comment on this point. In addition, the Commission requests commentors espousing this alternative to address specifically ways in which the Commission might find reasonable assurance that the ultimate standards

[1] Detailed discussions on the advantages and disadvantages of each of these alternatives are given in Appendix J to Commission Paper SECY-81-287, April 27, 1981, "Rationale for Performance Objectives and Required Characteristics of the Geologic Setting." This appendix is being published separately and is available without charge on request to the Commission's Public Document Room, 1717 H St. NW, Washington, D.C. 20555.

are met without prescribing standards for the major elements of a repository.

In relation to the first and the third alternatives that are briefly discussed above, Alternative 2 appears to offer a reasonable and practical compromise. In addition to retaining the single overall performance standard in Alternative 1 as the final performance objective, this approach establishes the minimum performance objectives for each of the 3 major barriers of the repository. While this approach limits the repository designer's flexibility, it is clear that meeting these minimum design goals would substantially enhance the Commission's confidence that the final EPA standard will be met. Therefore, the Commission prefers a technical rule established upon this approach.

It should be noted that, in the event that the Commission decides to adopt the Alternate 1 approach in the final rulemaking, portions of the proposed rule (e.g., the section on requirements for the geological setting) would have to be further studied and possibly revised. In addition, it is possible that further public comments would have to be sought.

## Major Features of the Proposed Rule

1. *Overall Description.* The proposed technical criteria have been written to address the following: performance objectives and requirements for siting, design and construction of the repository, the waste package, confirmation of repository performance, quality assurance, and the training and certification of personnel. As appropriate, these topics are divided in turn to address separately requirements which apply during construction, waste emplacement, and after permanent closure (decommissioning) of the repository. Although the licensing procedures indicate that there would be separate subparts for siting and design requirements, viz. Subparts E and F, respectively (cf. § 60.31(a)(2)), the NRC now believes that the site and design are so interdependent that such a distinction is artificial and misleading. For example, although the requirement to place the underground facility at a minimum depth of 300 meters is clearly a design requirement, it is manifested as a siting requirement since unless the site has a host rock of sufficient thickness at sufficient depth, the above design requirement cannot be met. Hence the proposed Subpart E to 10 CFR Part 60 contains both site and design requirements.

To enable the Commission to reach a finding as to whether the generally applicable environmental standard for disposal of HLW is met and that public health and safety will be protected, a careful and enhaustive analysis of all the features of the repository will be needed. That analysis necessarily must be both qualitative and quantitative although the analysis can and will be largely quantitative during the period that greatest reliance can be placed upon the engineered system. Thereafter, although the issues of concern, and certainly the physics of a repository itself, do not change, the numerical uncertainties begin to become so large that calulations become a weak indicator of expected repository performance.

In sum, the technical criteria perform two tasks. First they serve to guide DOE in siting, designing, constructing, and operating a repository in such a manner that there can be reasonable confidence that public health and safety will be protected. Second, they serve to guide DOE in those same areas in such a manner that there can be reasonable confidence that the analyses, needed to determine whether public health and safety is protected, can be performed.

2. *Performance Objectives.* The design and operation of the repository are prescribed to be such that during the period that wastes are being emplaced and performance assessed, exposure to workers and releases of radioactivity to the environment must be within limits set by the Commission and the EPA. Further, the repository is to be designed so that the option can be preserved to retrieve the emplaced wastes beginning at anytime up to 50 years following completion of emplacement. Following permanent closure, the repository must perform so that releases are within the limits prescribed by the generally applicable environmental standard which will be set by the EPA. Further, the design of the repository must include a waste package and an underground facility, as well as the site, as barriers to radionuclide migration.

The performance of the engineered system (waste package and underground facility) following permanent closure is specified to require containment of the wastes within the waste package for at least 1000 years following closure, when temperatures in the repository are substantially elevated, and control of the release of nuclides to the geologic environment thereafter.

Transuranic waste (TRU) may be disposed of in a geologic repository. Since transuranic waste does not generate significant amounts of heat, there is no advantage to containment for any specified period. Hence, the requirement for TRU waste is simply a controlled release equivalent to that for HLW, provided they are physically separted from the HLW so that they will not experience a significant increase in temperature.

Although a minimum 1,000-year containment and a maximum one part in 100,000 release rate will satisfy these criteria, the Commission considers it highly desirable that wastes be contained as long thereafter as is reasonably achievable, and that release rates be as far below one part in 100,000 as is reasonably achievable.

3. *Siting Requirements.* Although no specific site suitability or exclusion requirements are given in the criteria, stability and minimum groundwater travel times are specified as required site characteristics. ALARA (as low as reasonably achievable) principles have not been applied to the natural features of a site because they are not amenable to modification once a site is chosen. However, the technical criteria do identify site characteristics considered favorable for a repository as well as characteristics which, if present at the site, may compromise site suitability and which will require careful analysis and such measures as may be necessary to compensate for them adequately. The impact of these characteristics on overall performance would be site specific. Thus, the Commission has judged that these should not be made absolute requirements. Presence of all the favorable characteristics does not lead to the conclusion that the site is suitable to host a repository. Neither is the presumption of unsuitability because of the presence of an unfavorable characteristic incontrovertible. Rather, the Commission's approach requires a sufficient combination of conditions at the selected site to provide reasonable assurance that the performance objectives will be achieved. If adverse conditions are identified as being present, they must be thoroughly charaterized and analyzed and it must be demonstrated that the conditions are compensated for by repository design or by favorable conditions in the geologic setting.

The Commission has not included any siting requirements which directly deal with population density or proximity to population centers. Rather, the issue has been addressed indirectly through consideration of resources in the geologic setting. The Commission believes this to be a more realistic approach given the long period of time involved with geologic disposal. Nonetheless, the Commission invites comment on whether population related siting requirements should be included in the final rule and how they might be implemented.

4. *Design and Construction.* In addition to the requirements on designing for natural phenomena, criticality control, radiation protection, and effluent control, the proposed technical criteria require the design of the repository to accommodate potential interaction of the waste, the underground facility, and the site. Requirements are also placed upon the design of the equipment to be used for handling the wastes, the performance and purpose of the backfill material, and design and performance of borehole and shaft seals. Further, there are requirements related to the methods of construction. The Commission believes such requirements are necessary to assure that the ability of the repository to contain and isolate the wastes will not be compromised by the construction of the repository.

The proposed technical criteria would require that the subsurface facility be designed so that it could be constructed and operated in accordance with relevant Federal mining regulations, which specify design requirements for certain items of electrical and mechanical equipment and govern the use of explosives.

These criteria are a blend of general and detailed prescriptive requirements. They have been developed from Commission experience and practice in the licensing of other nuclear facilities such as power plants and fuel cycle facilities. While there are differences in the systems and components addressed by these criteria from those of power plants or fuel cycle facilities, and the criteria have been written to be appropriate for a geologic repository, the proposed criteria represent a common practice based on experience which has shown that the above items need to be regulated. The level of detail of these criteria reflects the Commission's current thinking on how to regulate effectively geologic disposal of HLW. However, the Commission continues to examine other possibilities for promulgating the more detailed of these requirements. Comments are invited on formulations for the design and construction criteria in the rule, perhaps in a more concise form; these may be supplemented, of course, with more details in staff guidance documents such as Regulatory Guides.

5. *Waste Package.* The proposed requirements for the design of the waste package emphasize its role as a key component of the overall engineered system. Besides being required to contribute to the engineered system's meeting containment and controlled release performance objectives, both compatibility with the underground facility and the site and a method of unique identification are required of the waste package. Included in the section of the proposed technical criteria which deals with the waste package are requirements that the waste form itself contained within the package be consolidated and non-pyrophoric.

6. *Performance Confirmation.* The proposed technical criteria include requirements for a program of testing and measurement (Subpart F). The main purpose of this program is to confirm the assumptions, data, and analyses which led to the findings that permitted construction of the repository and subsequent emplacement of the wastes. Further, the performance confirmation program includes requirements for monitoring of key geologic and hydrologic parameters throughout site characterization, construction, and emplacement to detect any significant changes in the conditions which supported the above findings during, or due to operations at the site. Also included in the program would be tests of the effectiveness of borehole and shaft seals and of backfill placement procedures.

**Regulatory Flexibility Certification**

In accordance with the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission hereby certifies that this rule will not, if promulgated, have a significant economic impact on a substantial number of small entities. This proposed rule affects only the Department of Energy, and does not fall within the purview of the Act.

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, the National Environmental Policy Act of 1969, as amended, and sections 552 and 553 of title 5 of the United States Code, notice is hereby given that adoption of the following amendments to Title 10, Chapter I, Code of Federal Regulations is contemplated.

## PART 60—DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN GEOLOGIC REPOSITORIES

1. The authority citation for Part 60 reads as follows:

Authority: Secs. 51, 53, 62, 63, 65, 81, 161b., f., i., o., p., 182, 183, Pub. L. 83-703, as amended, 68 Stat. 929, 930, 932, 933, 935, 948, 953, 954, as amended (42 U.S.C. 2071, 2073, 2092, 2093, 2095, 2111, 2201, 2232, 2233); Secs. 202, 206, Pub. L. 93-438, 88 Stat. 1244, 1246 (42 U.S.C. 5842, 5846); Sec. 14, Pub. L. 95-601 (42 U.S.C. 2021a); Sec. 102(2)(c), Pub. L. 91-190, 83 Stat. 853 (42 U.S.C. 4332)

2. Section 60.2 is revised to read as follows:

**§ 60.2 Definitions.**

For the purposes of this Part—

"Accessible Environment" means those portions of the environment directly in contact with or readily available for use by human beings.

"Anticipated Processes and Events" means those natural processes and events that are reasonably likely to occur during the period the intended performance objective must be achieved and from which the design bases for the engineered system are derived.

"Barrier" means any material or structure that prevents or substantially delays movement of water or radionuclides.

"Candidate area" means a geologic and hydrologic system within which a geologic repository may be located.

"Commencement of construction" means clearing of land, surface or subsurface excavation, or other substantial action that would adversely affect the environment of a site, but does not include changes desirable for the temporary use of the land for public recreational uses, site characterization activities, other preconstruction monitoring and investigation necessary to establish background information related to the suitability of a site or to the protection of environmental values, or procurement or manufacture of components of the geologic repository operations area.

"Commission" means the Nuclear Regulatory Commission or its duly authorized representatives.

"Containment" means the confinement of radioactive waste within a designated boundary.

"Decommissioning," or "permanent closure," means final backfilling of subsurface facilities, sealing of shafts, and decontamination and dismantlement of surface facilities.

"Director" means the Director of the Nuclear Regulatory Commission's Office of Nuclear Material Safety and Safeguards.

"Disposal" means the isolation of radioactive wastes from the biosphere.

"Disturbed zone" means that portion of the geologic setting that is significantly affected by construction of the subsurface facility or by the heat generated by the emplacement of radioactive waste.

"DOE "means the U.S. Department of Energy or its duly authorized representatives.

"Engineered system" means the waste packages and the underground facility.

"Far field" means the portion of the geologic setting that lies beyond the disturbed zone.

"Floodplain" means the lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of offshore islands and including at a minimum that area subject to a one percent or greater chance of flooding in any given year.

"Geologic repository" means a system for the disposal of radioactive wastes in excavated geoligic media. A geologic repository includes (1) the geologic repository operations area, and (2) the geologic setting.

"Geologic repository operations area" means an HLW facility that is part of a geologic repository, including both surface and subsurface areas, where waste handling activities are conducted.

"Geologic setting" or "site" is the spatially distributed geologic, hydrologic, and geochemical systems that provide isolation of the radioactive waste.

"High-level radioactive waste" or "HLW" means (1) irradiated reactor fuel, (2) liquid wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel, and (3) solids into which such liquid wastes have been converted.

"HWL facility" means a facility subject to the licensing and related regulatory authority of the Commission pursuant to Sections 202(3) and 202(4) of the Energy Reorganization Act of 1974 (88 Stat. 1244).[8]

"Host rock" means the geologic medium in which the waste is emplaced.

"Important to safety," with reference to structures, systems, and components, means those structures, systems, and components that provide reasonable assurance that radioactive waste can be received, handled, and stored without undue risk to the health and safety of the public.

"Indian Tribe" means an Indian tribe as defined in the Indian Self-Determination and Education Assistance Act (Public Law 93-638).

"Isolation" means inhibiting the transport of radioactive material so that amounts and concentrations of this material entering the accessible environment will be kept within prescribed limits.

[8] These are DOE "facilities used primarily for the receipt and storage of high-level radioactive wastes resulting from activities licensed under such act (the Atomic Energy Act)" and "Retrievable Surface Storage Facilities and other facilities authorized for the express purpose of subsequent long-term storage of high-level radioactive wastes generated by (DOE), which are not used for, or are part of, research and development activities."

"Medium" or "geologic medium" is a body of rock characterized by lithologic homogeneity.

"Overpack" means any buffer material, receptacle, wrapper, box or other structure, that is both within and an integral part of a waste package. It encloses and protects the waste form so as to meet the performance objectives.

"Public Document Room" means the place at 1717 H Street NW., Washington, D.C., at which records of the Commission will ordinarily be made available for public inspection and any other place, the location of which has been published in the Federal Register, at which public records of the Commission pertaining to a particular geologic repository are made available for public inspection.

"Radioactive waste" or "waste" means HLW and any other radioactive materials other than HLW that are received for emplacement in a geologic repository.

"Site" means the geologic setting.

"Site characterization" means the program of exploration and research, both in the laboratory and in the field, undertaken to establish the geologic conditions and the ranges of those parameters of a particular site relevant to the procedures under this part. Site characterization includes borings, surface excavations, excavation of exploratory shafts, limited subsurface lateral excavations and borings, and in situ testing at depth needed to determine the suitability of the site for a geologic respository, but does not include preliminary borings and geophysical testing needed to decide whether site characterization should be undertaken.

"Stability" means that the nature and rates of natural processes such as erosion and faulting have been and are projected to be such that their effects will not jeopardize isolation of the radioactive waste.

"Subsurface facility" means the undergound portions of the geologic repository operations area including openings, backfill materials, shafts and boreholes as well as shaft and borehole seals.

"Transuranic wastes" or "TRU wastes" means radioactive waste containing alpha emitting transuranic elements, with radioactive half-lives greater than five years, in excess of 10 nanocuries per gram.

"Tribal organization" means a Tribal organization as defined in the Indian Self-Determination and Education Assistance Act (Public Law 93-638).

"Underground facility" means the undergound structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals.

"Unrestricted area" means any area, access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters.

"Waste form" means the radioactive waste materials and any encapsulating or stabilizing materials, exclusive of containers.

"Waste package" means the airtight, watertight, sealed container which includes the waste form and any ancillary enclosures, including shielding, discrete backfill and overpacks.

3. Section 60.10 is revised to read as follows:

**§ 60.10 Site characterization.**

(a) Prior to submittal of an application for a license to be issued under this part the DOE shall conduct a program of site characterization with respect to the site to be described in such application.

(b) Unless the Commission determines with respect to the site described in the application that it is not necessary, site characterization shall include a program of in situ exploration and testing at the depths that wastes would be emplaced.

(c) As provided in § 51.40 of this chapter, DOE is also required to conduct a program of site characterization, including in situ testing at depth, with respect to alternative sites.

(d) The program of site characterization shall be conducted in accordance with the following:

(1) Investigations to obtain the required information shall be conducted to limit adverse effects on the long-term performance of the geologic repository to the extent practical.

(2) As a minimum the location of exploratory boreholes and shafts shall be selected so as to limit the total number of subsurface penetrations above and around the underground facility.

(3) To the extent practical, exploratory boreholes and shafts in the geologic repository operations area shall be located where shafts are planned for repository construction and operation or where large unexcavated pillars are planned.

(4) Subsurface exploratory drilling, excavation, and in situ testing before and during construction shall be planned and coordinated with repository design and construction.

4. Paragraphs (c)(1), (c)(3), and (c)(13) of § 60.21 are revised to read as follows:

**§ 60.21 Content of application.**

* * * * *

(c) The Safety Analysis Report shall include:

(1) A description and assessment of the site at which the proposed geologic repository operations area is to be located with appropriate attention to those features of the site that might affect facility design and performance. The description of the site shall identify the limits of the accessible environment with respect to the location of the geologic repository operations area.

(i) The description of the site shall also include the following information regarding subsurface conditions in the vicinity of the proposed underground facility—

(A) The orientation, distribution, aperture in-filling and origin of fractures, discontinuities, and heterogeneities;

(B) The presence and characteristics of other potential pathways such as solution-features, breccia pipes, or other permeable anomalies;

(C) The bulk geomechanical properties and conditions, including pore pressure and ambient stress conditions;

(D) The bulk hydrogeologic properties and conditions;

(E) The bulk geochemical properties; and

(F) The anticipated response of the bulk geomechanical, hydrogeologic, and geochemical systems to the maximum design thermal loading, given the pattern of fractures and other discontinuities and the heat transfer properties of the rock mass and groundwater.

(ii) The assessment shall contain—

(A) An analysis of the geology, geophysics, hydrogeology, geochemistry, and meteorology of the site;

(B) Analyses to determine the degree to which each of the favorable and adverse conditions, if present, has been characterized, and the extent to which it contributes to or detracts from isolation.

(C) An evaluation of the expected performance of the proposed geologic repository noting the rates and quantities of expected releases of radionuclides to the accessible environment as a function of time. In executing this evaluation DOE shall assume that those processes operating on the site are those which have been operating on it during the Quaternary Period and superpose the perturbations caused by the presence of emplaced radioactive waste on the natural processes.

(D) An analysis of the expected performance of the major design structures, systems, and components, both surface and subsurface, that bear significantly on the suitability of the geologic repostory for disposal of radioactive waste assuming the anticipated processes and events and natural phenomena from which the design bases are derived. For the purposes of this analysis, it shall be assumed that operations at the geologic repository operations area will be carried out at the maximum capacity and rate of receipt of radioactive waste stated in the application.

(E) An explanation of measures used to confirm the models used to perform the assessments required in paragraphs (A) through (D). Analyses and models that will be used to predict future conditions and changes in the geologic setting shall be confirmed by using field tests, in situ tests, field-verified laboratory tests, monitoring data, or natural analog studies.

* * * * *

(3) A description and analysis of the design and performance requirements for structures, systems, and components of the geologic repository which are important to safety. This analysis shall consider—(i) the margins of safety under normal and conditions that may result from anticipated operational occurrences, including those or natural origin; (ii) the adequacy of structures, systems, and components provided for the prevention of accidents and mitigation of the consequences of accidents, including those caused by natural phenomena; and (iii) the effectiveness of engineered and natural barriers, including barriers that may not be themselves a part of the geologic repository operations area, against the release of radioactive material to the environment. The analysis shall also include a comparative evaluation of alternatives to the major design features that are important to radionuclide containment and isolation, with particular attention to the alternatives that would provide longer radionuclide containment and isolation.

* * * * *

(13) An identification and evaluation of the natural resources at the site, including estimates as to undiscovered deposits, the exploitation of which could affect the ability of the site to isolate radioactive wastes. Undiscovered deposits of resources characteristic of the area shall be estimated by reasonable inference based on geological and geophysical evidence. This evaluation of resources, including undiscovered deposits, shall be conducted for the disturbed zone and for areas of similar size that are representative of and are within the geologic setting. For natural resources with current markets the resources shall be assessed, with estimates provided of both gross and net value. The estimate of net value shall take into account current development, extraction and marketing costs. For natural resources without current markets, but which would be marketable given credible projected changes in economic or technological factors, the resources shall be described by physical factors such as tonnage or other amount, grade, and quality.

* * * * *

5. Paragraph (a)(2) of § 60.31 is revised to read as follows:

**§ 60.31 Construction authorization.**

* * * * *

(a) * * *

(2) The site and design comply with the criteria contained in Supart E.

* * * * *

6. Paragraph (a)(2) of § 60.51 is revised to read as follows:

**§ 60.51 License amendment to decommission.**

(a) * * *

(2) a detailed description of the measures to be employed—such as land use controls, construction of monuments, and preservation of record—to regulate or prevent activities that could impair the long-term isolation of emplaced waste within the geologic repository and to assure that relevant information will be preserved for the use of future generations. As a minimum, such measures shall include—

(i) Identification of the geologic repository operations area by monuments that have been designated, fabricated, and emplaced to be as permanent as is practicable; and

(ii) Placement of records of the location of the geologic repository operations area and the nature and hazard of the waste in the archives of local and Federal government agencies, and archives elsewhere in the world, that would be likely to be consulted by potentional human intruders.

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7. New Subpart E, "Technical Criteria," Subpart F "Performance Confirmation," Subpart G, "Quality Assurance" and Subpart H, "Training and Certification of Personnel" are added to 10 CFR Part 60.

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## Subpart E—Technical Criteria

### § 60.101 Purpose and nature of findings.

(a)(1) Subpart B of this part prescribes the standards for issuance of a license to receive and possess source, special nuclear, or byproduct material at a geologic repository operations area. In particular, § 60.41(c) requires a finding that the issuance of a license will not constitute an unreasonable risk to the health and safety of the public. The purpose of this subpart is to set out performance objectives and site and design criteria which, if satisfied, will support such a finding of no unreasonable risk.

(2) While these performance objectives and criteria are generally stated in unqualified terms, it is not expected that complete assurance that they will be met can be presented. A reasonable assurance, on the basis of the record before the Commission, that the objectives and criteria will be met is the general standard that is required. For § 60.111, and other portions of this subpart that impose objectives and criteria for repository performance over long times into the future, there will inevitably be greater uncertainties. Proof of the future performance of engineered systems and geologic media over time periods of a thousand or many thousands of years is not to be had in the ordinary sense of the word. For such long-term objectives and criteria, what is required is reasonable assurance, making allowance for the time period and hazards involved, that the outcome will be in conformance with those objectives and criteria.

(b) Subpart B of this part also lists findings that must be made in support of an authorization to construct a geologic repository operations area. In particular, § 60.31(a) requires a finding that there is reasonable assurance that the types and amounts of radioactive materials described in the application can be received, possessed, and disposed of in a repository of the design proposed without unreasonable risk to the health and safety of the public. As stated in that paragraph, in arriving at this determination, the Commission will consider whether the site and design comply with the criteria contained in this subpart. Once again, while the criteria may be written in unqualified terms, the demonstration of compliance may take uncertainties and gaps in knowledge into account, provided that the Commission can make the specified finding of reasonable assurance as specified in paragraph (a) of this section.

### § 60.102 Concepts.

(a) *The HLW facility.* NRC exercises licensing and related regulatory authority over those facilities described in section 203 (3) and (4) of the Energy Reorganization Act of 1974. Any of these facilities is designated an *HLW facility.*

(b) *The geologic repository operations area.*

(1) This part deals with the exercise of authority with respect to a particular class of HLW facility—namely a *geologic repository operations area.*

(2) A *geologic repository operations area* consists of those surface and subsurface areas that are part of a geologic repository where radioactive waste handling activities are conducted. The underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals, is designated the *underground facility.*

(3) The exercise of Commission authority requires that the geologic repository operations area be used for *storage* (which includes *disposal*) of *high-level radioactive wastes (HLW).*

(4) HLW includes irradiated reactor fuel as well as reprocessing wastes. However, if DOE proposes to use the geologic repository operations area for storage of *radioactive waste* other than HLW, the storage of this radioactive waste is subject to the requirements of this part. Thus, the storage of *transuranic-contaminated waste (TRU),* though not itself a form of HLW, must conform to the requirements of this part if it is stored in a geologic repository operations area.

(c) *Areas adjacent to the geologic repository operations area.* Although the activities subject to regulation under this part are those to be carried out at the geologic repository operations area, the licensing process also considers characteristics of adjacent areas. First, there is to be an area within which DOE is to exercise specified controls to prevent adverse human actions. Second, there is a larger area, designated the *geologic setting* or *site* which includes the spatially distributed geologic, hydrologic, and geochemical systems that provide isolation of the radioactive waste from the accessible environment. The geologic repository operations area plus the geologic setting make up the *geologic repository.* Within the geologic setting, particular attention must be given to the characteristics of the host rock as well as any rock units surrounding the host rock.

(d) *Stages in the licensing process.* There are several stages in the licensing process. The *site characterization* stage, though begun before submission of a license application, may result in consequences requiring evaluation in the license review. The *construction stage* would follow, after issuance of a construction authorization. A *period of operations* follows the issuance of a license by the Commission. The period of operations includes the time during which *emplacement* of wastes occurs; and any subsequent period before permanent closure during which the emplaced wastes are *retrievable;* and *permanent closure,* which includes final backfilling of subsurface facilities, sealing of shafts, decontaminating and dismantling of surface facilities. Permanent closure represents the end of active human activities with the geologic repository operations area and engineered systems.

(e) *Containment.* Early during the repository life, when radiation and thermal levels are high and the consequences of events are especially difficult to predict rigorously, special emphasis is placed upon the ability to contain the wastes by waste packages within an engineered system. This is known as the *containment period.* The *engineered system* includes the waste packages as well as the underground facility. A *waste package* includes:

(1) The *waste form* which consists of the radioactive waste materials and any associated encapsulating or stabilizing materials.

(2) The *container* which is the first major sealed enclosure that holds the waste form.

(3) *Overpacks* which consist of any buffer material, receptable, wrapper, box or other structure, that is both within and an integral part of a waste package. It encloses and protects the waste form so as to meet the performance objectives.

(f) *Isolation.* Following the containment period special emphasis is placed upon the ability to achieve isolation of the wastes by virtue of the characteristics of the geologic repository. *Isolation* means the act of inhibiting the transport of radioactive material to the accessible environment in amounts and concentrations within limits. The *accessible environment* means those portions of the environment directly in contact with or readily available for use by human beings.

## Performance Objectives

### § 60.111 Performance objectives.

(a) *Performance of the geologic repository operations area through permanent closure.*—(1) *Protection against radiation exposures and releases of radioactive material.* The geologic repository operations area shall be designed so that until permanent closure has been completed, radiation exposures and radiation levels, and releases of radioactive materials to unrestricted areas, will at all times be maintained within the limits specified in Part 20 of this chapter and any generally applicable environmental standards established by the Environmental Protection Agency.

(2) *Retrievability of waste.* The geologic repository operations area shall be designed so that the entire inventory of waste could be retrieved on a reasonable schedule, starting at any time up to 50 years after waste emplacement operations are complete. A reasonable schedule for retrieval is one that requires no longer than about the same overall period of time than was devoted to the construction of the geologic repository operations area and the emplacement of wastes.

(b) *Performance of the geologic repository after permanent closure.*—(1) *Overall system performance.* The geologic setting shall be selected and the subsurface facility designed so as to assure that releases of radioactive materials from the geologic repository following permanent closure conform to such generally applicable environmental radiation protection standards as may have been established by the Environmental Protection Agency.

(2) *Performance of the engineered system.*—(i) *Containment of wastes.*[a] The engineered system shall be designed so that even if full or partial saturation of the underground facility were to occur, and assuming anticipated processes and events, the waste packages will contain all radionuclides for at least the first 1,000 years after permanent closure. This requirement does not apply to TRU waste unless TRU waste is emplaced close enough to HLW that the TRU release rate can be significantly affected by the heat generated by the HLW.

(ii) *Control of releases.*[a]

(A) For HLW, the engineered system shall be designed so that, after the first 1,000 years following permanent closure, the annual release rate of any radionuclide from the engineered system into the geologic setting, assuming anticipated processes and events, is at most one part in 100,000 of the maximum amount of that radionuclide calculated to be present in the underground facility (assuming no release from the underground facility) at any time after 1,000 years following permanent closure. This requirement does not apply to radionuclides whose contribution is less than 0.1% of the total annual curie release as prescribed by this paragraph.

(B) For TRU waste, the engineered system shall be designed so that following permanent closure the annual release rate of any radionuclide from the underground facility into the geologic setting, assuming anticipated processes and events, is at most one part in 100,000 of the maximum amount calculated to be present in the underground facility (assuming no release from the underground facility) at any time following permanent closure. This requirement does not apply to radionuclides whose contribution is less than 0.1% of the annual curie release as prescribed by this paragraph.

(3) *Performance of the geologic setting.*—(i) *Containment period.* During the containment period, the geologic setting shall mitigate the impacts of premature failure of the engineered system. The ability of the geologic setting to isolate wastes during the isolation period, in accordance with paragraph (b)(3)(ii) of this section, shall be deemed to satisfy this requirement.

(ii) *Isolation period.* Following the containment period, the geologic setting, in conjunction with the engineered system as long as that system is expected to function, and alone thereafter, shall be capable of isolating radioactive waste so that transport of radionuclides to the accessible environment shall be in amounts and concentrations that conform to such generally applicable environmental standards as may have been established by the Environmental Protection Agency. For the purpose of this paragraph, the evaluation of the site shall be based upon the assumption that those processes operating on the site are those which have been operating on it during the Quaternary Period, with perturbations caused by the presence of emplaced radioactive wastes superimposed thereon.

### § 60.112 Required characteristics of the geologic setting.

(a) The geologic setting shall have exhibited structural and tectonic stability since the start of the Quaternary Period.

(b) The geologic setting shall have exhibited hydrogeologic, geo-chemical, and geomorphic stability since the start of the Quaternary Period.

(c) The geologic repository shall be located so that pre-waste emplacement groundwater travel times through the far field to the accessible environment are at least 1,000 years.

## Ownership and Control of the Geolocghic Repository Operations Area

### § 60.121 Requirements for ownership and control of the geologic repository operations area.

(a) *Ownership of the geologic repository operations area.* The geologic repository operations area shall be located in and on lands that are either acquired lands under the jurisdiction and control of DOE, or lands permanently withdrawn and reserved for its use. These lands shall be held free and clear of all encumbrances, if

[a] The Commission specifically seeks comment on whether an ALARA principle should be applied to the performance requirements dealing with containment and control of releases. In particular, the Commission has considered whether the technical criteria should explicitly require containment to be for "as long as is reasonably achievable" and the release rate to be "as low as is reasonably achievable." Comments should address the merits of such a requirement, how to best frame it, and the practicality of its implementation.

significant, such as: (1) rights arising under the general mining laws; (2) easements for right-of-way; and (3) all other rights arising under lease, rights of entry, deed, patent, mortgage, appropriation, prescription, or otherwise.

(b) *Establishment of controls.* Appropriate controls shall be established outside of the geologic repository operations area. DOE shall exercise any jurisdiction and control over surface and subsurface estates necessary to prevent adverse human actions that could significantly reduce the site or engineered system's ability to achieve isolation. The rights of DOE may take the form of appropriate possessory interests, servitudes, or withdrawals from location or patent under the general mining laws.

Additional Requirements for the Geologic Setting

**§ 60.122 Favorable conditions.**

Each of the following conditions may contribute to the ability of the geologic setting to meet the performance objectives relating to isolation of the waste. In addition to meeting the mandatory requirements of § 60.112, a geologic setting shall exhibit an appropriate combination of these conditions so that, together with the engieered system, the favorable conditions present are sufficient to provide reasonable assurance that such performance objectives will be met.

(a) The nature and rates of tectonic processes that have occurred since the start of the Quaternary Period are such that, when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(b) The nature and rates of structural processes that have occurred since the start of the Quaternary Period are such that, when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(c) The nature and rates of hydrogeological processes that have occurred since the start of the Quaternary Period are such that, when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(d) The nature and rates of geochemical processes that have occurred since the start of the Quaternary Period are such that when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(e) The nature and rates of geomorphic processes that have occurred since the start of the Quarternary period are such that, when projected they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(f) A host rock that provides the following groundwater characteristics—(1) low groundwater content; (2) inhibition of groundwater circulation in the host rock; (3) inhibition of groundwater flow between hydrogeologic units or along shafts, drifts, and boreholes; and (4) groundwater travel times, under pre-waste emplacement conditions, between the underground facility and the accessible environment that substantially exceed 1,000 years.

(g) Geochemical conditions that (1) promote precipitation or sorption or radionuclides; (2) inhibit the formation of particulates, colloids, and inorganic and organic complexes that increase the mobility of radionuclides; and (3) inhibit the transport of radionuclides by particulates, colloids, and complexes.

(h) Mineral assemblages that, when subjected to anticipated thermal loading, will remain unaltered or alter to mineral assemblages having increased capacity to inhibit radionuclide migration.

(i) Conditions that permit the emplacement of waste at a minimum depth of 300 meters from the ground surface. (The ground surface shall be deemed to be the elevation of the lowest point on the surface above the disturbed zone.)

(j) Any local condition of the disturbed zone that contributes to isolation.

**§ 60.123 Potentially adverse conditions.**

The following are potentially adverse conditions. The presence of any such conditions may compromise site suitability and will require careful analysis and such measures as are necessary to compensate for them adequately pursuant to § 60.124.

(a) *Adverse conditions in the geologic setting.*

(1) Potential for failure of existing or planned man-made surface water impoundments that could cause flooding of the geologic repository operations area.

(2) Potential, based on existing geologic and hydrologic conditions, that planned construction of large-scale surface water impoundments may significantly affect the geologic repository through changes in the regional groundwater flow system.

(3) Potential for human activity to affect significantly the geologic repository through changes in the hydrogeology. This activity includes, but is not limited to planned groundwater withdrawal, extensive irrigation, subsurface injection of fluids, underground pumped storage facilities, or underground military activity.

(4) Earthquakes which have occurred historically that if they were to be repeated could affect the geologic repository significantly.

(5) A fault in the geologic setting that has been active since the start of the Quaternary Period and which is within a distance of the disturbed zone that is less than the smallest dimension of the fault rupture surface.

(6) Potential for adverse impacts on the geologic repositroy resulting from the occupancy and modification of floodplains.

(7) Potential for natural phenomena such as landslides, subsidence, or volcanic activity of such a magnitude that large-scale surface water impoundments could be created that could affect the performance of the geologic repository through changes in the regional groundwater flow.

(8) Expected climatic changes that would have an adverse effect on the geologic, geochemical, or hydrologic characteristics.

(b) *Adverse conditions in the disturbed zone.* For the purpose of determining the presence of the following conditions within the distrubed zone, investigations should extend to the greater of either its calculated extent or a horizontal distance of 2 km from the limits of the underground facility, and from the surface to a depth of 500 meters below the limits of the repository excavation.

(1) Evidence of subsurface mining for resources.

(2) Evidence of drilling for any purpose.

(3) Resources that have either greater gross value, net value, or commercial potential than the average for other representative areas of similar size that are representative of and located in the geologic setting.

(4) Evidence of extreme erosion during the Quaternary Period.

(5) Evidence of dissolutioning of soluble rocks.

(6) The existence of a fault that has been active during the Quaternary Period.

(7) Potential for creating new pathways for radionuclide migration due to presence of a fault or fracture zone irrespective of the age of last movement.

(8) Structural deformation such as uplift, subsidence, folding, and fracturing during the Quaternary Period.

(9) More frequent occurrence of earthquakes or earthquakes of higher

magnitude than is typical of the area in which the geologic setting is located.

(10) Indications, based on correlations of earthquakes with tectonic processes and features, that either the frequency of occurrence or magnitude of earthquakes may increase.

(11) Evidence of igneous activity since the start of the Quaternary Period.

(12) Potential for changes in hydrologic conditions that would significantly affect the migration of radionuclides to the accessible environment including but not limited to changes in hydraulic gradient, average interstitial velocity, storage coefficient, hydraulic conductivity, natural recharge, potentiometric levels, and discharge points.

(13) Conditions in the host rock that are not reducing conditions.

(14) Groundwater conditions in the host rock, including but not limited to high ionic strength or ranges of Eh-pH, that could affect the solubility and chemical reactivity of the engineered systems.

(15) Processes that would reduce sorption, result in degradation of the rock strength, or adversely affect the performance of the engineered system.

(16) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

(17) Geomechanical properties that do not permit deisign of stable underground openings during construction, waste emplacement, or retrieval operations.

**§ 60.124 Assessment of potentially adverse conditions.**

In order to show that a potentially adverse condition or combination of conditions cited in § 60.123 does not impair significantly the ability of the geologic repository to isolate the radioactive waste, the following must be demonstrated:

(a) The potentially adverse human activity or natural condition has been adequately characterized, including the extent to which the condition may be present and still be undetected taking into account the degree of resolution achieved by the investigations; and

(b) The effect of the potentially adverse human activity or natural condition on the geologic setting has been adequately evaluated using conservative analyses and assumptions, and the evaluation used is sensitive to the adverse human activity or natural condition; and

(c)(1) The potentially adverse human activity or natural condition is shown by analysis in paragraph (b) of this section not to affect significantly the ability of the geologic setting to isolate waste, or

(2) The effect of the potentially adverse human activity or natural condition is compensated by the presence of a combination of the favorable characteristics cited in § 60.122, or

(3) The potentially adverse human activity or natural condition can be remedied.

## Design and Construction Requirements

**§ 60.130 General design requirements for the geologic repository operations area.**

(a) Sections 60.130 through 60.134 specify minimum requirements for the design of, and construction specifications for, the geologic repository operations area. Requirements for design contained in §§ 60.131 through 60.133 must be considered in conjunction with the requirements for construction in § 60.134. Sections 60.130 through 60.134 are not intended to contain an exhaustive list of design and construction requirements. Omissions in §§ 60.130 through 60.134 do not relieve DOE from providing safety features in a specific facility needed to achieve the performance objectives contained in § 60.111. All design and construction criteria must be consistent with the results of site characterization activities.

(b) Systems, structures, and components of the geologic repository operations area shall satisfy the following:

(1) *Radiological protection.* The structures, systems, and components located within restricted areas shall be designed to maintain radiation doses, levels, and concentrations of radioactive material in air in those restricted areas within the limits specified in Part 20 of this chapter. These structures, systems, and components shall be designed to include—

(i) Means to limit concentrations of radioactive material in air;

(ii) Means to limit the time required to perform work in the vicinity of radioactive materials, including, as appropriate, designing equipment for ease of repair and replacement and providing adequate space for ease of operation;

(iii) Suitable shielding;

(iv) Means to monitor and control the dispersal of radioactive contamination;

(v) Means to control access to high radiation areas or airborne radioactivity areas; and

(vi) A radiation alarm system to warn of increases in radiation levels, concentrations of radioactive material in air, and of increased radioactivity released in effluents. The alarm system shall be designed with redundancy and in situ testing capability.

(2) *Protection against natural phenomena and environmental conditions.*

(i) The structures, systems, and components important to safety shall be designed to be compatible with anticipated site characteristics and to accommodate the effects of environmental conditions, so as to prevent interference with normal operation, maintainence and testing during the entire period of construction and operations.

(ii) The structures, systems, and components important to safety shall be designed so that natural phenomena and environmental conditions anticipated at the site will not result, in any relevant time period, in failure to achieve the performance objectives.

(3) *Protection against dynamic effects of equipment failure and similar events.* The structures, systems and components important to safety shall be designed to withstand dynamic effects that could result from equipment failure, such as missle impacts, and similar events and conditions that could lead to loss of their safety functions.

(4) *Protection against fires and explosions.*

(i) The structures, systems, and components important to safety shall be designed to perform their safety functions during and after fires or explosions in the geologic repository operations area.

(ii) To the extent practicable, the geologic repository operations area shall be designed to incorporate the use of noncombustible and heat resistant materials.

(iii) The geologic repository operations area shall be designed to include explosion and fire detection alarm systems and appropriate suppression systems with sufficient capacity and capability to reduce the adverse effects of fires and explosions on structures, systems, and components important to safety.

(iv) The geologic repository operations area shall be designed to include means to protect systems, structures, and components important to safety against the adverse effects of either the operation or failure of the fire suppression systems.

(5) *Emergency capability.*

(i) The structures, systems, and components important to safety shall be designed to maintain control of radioactive waste, and permit prompt termination of operations and

evacuation of personnel during an emergency.

(ii) The geologic repository operations area shall be designed to include onsite facilities and services that ensure a safe and timely response to emergency conditions and that facilitate the use of available offsite services (such as fire, police, medical and ambulance service) that may aid in recovery from emergencies.

(6) *Utility services.*

(i) Each utility service system shall be designed so that essential safety functions can be performed under both normal and emergency conditions.

(ii) The utility services important to safety shall include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform their safety functions.

(iii) The emergency utility services shall be designed to permit testing of their functional operability and capacity. This will include the full operational sequence of each system when transferring between normal and emergency supply sources, as well as the operation of associated safety systems.

(iv) Provisions shall be made so that, if there is a loss of the primary electric power source or circuit, reliable and continued emergency power is provided to instruments, utility service systems, and operating systems, including alarm systems. This emergency power shall be sufficient to allow safe conditions to be maintained. All systems important to safety shall be designed to permit them to be maintained at all times in a functional mode.

(7) *Inspection, testing, and maintenance.* The structures, systems, and components important to safety shall be designed to permit periodic inspection, testing, and maintenance, as necessary, to ensure their continued functioning and readiness.

(8) *Criticality control.* All systems for processing, transporting, handling, storage, retrieval, emplacement, and isolation of radioactive waste shall be designed to ensure that a nuclear criticality accident is not possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. Each system shall be designed for criticality safety under normal and accident conditions. The calculated effective multiplication factor ($k_{eff}$) must be sufficiently below unity to show at least a 5% margin, after allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation.

(9) *Instrumentation and control systems.* Instrumentation and control systems shall be designed to monitor and control the behavior of engineered systems important to safety over anticipated ranges for normal operation and for accident conditions. The systems shall be designed with sufficient redundancy to ensure that adequate margins of safety are maintained.

(10) *Compliance with mining regulations.* To the extent that DOE is not subject to the Federal Mine Safety and Health Act of 1977, as to the construction and operation of the geologic repository operations area, the design of the geologic repository operations area shall nevertheless include such provisions for worker protection as may be necessary to provide reasonable assurance that all structures, systems, and components important to safety can perform their intended functions. Any deviation from relevant design requirements in 30 CFR, Chapter I, Subchapters D, E, and N will give rise to a rebuttable presumption that this requirement has not been met.

**§ 60.131 Additional design requirements for surface facilities in the geologic repository operations area.**

(a) *Facilities for receipt and retrieval of waste.* Surface facilities in the geologic repository operations area shall be designed to allow safe handling and storage of wastes at the site, whether these wastes are on the surface before emplacement or as a result of retrieval from the underground facility. The surface facilities shall be designed so as to permit inspection, repair, and decontamination of such wastes and their containers. Surface storage capacity is not required for all emplaced waste.

(b) *Surface facility ventilation.* Surface facility ventilation systems supporting waste transfer, inspection, decontamination, processing, or packaging shall be designed to provide protection against radiation exposures and offsite releases as provided in § 60.111.

(c) *Radiation control and monitoring.*—(1) *Effluent control.* The surface facilities shall be designed to control the release of radioactive materials in effluents during normal and emergency operations. The facilities shall be designed to provide protection against radiation exposures and offsite releases as provided in § 60.111.

(2) *Effluent monitoring.* The effluent monitoring systems shall be designed to measure the amount and concentration of radionuclides in any effluent with sufficient precision to determine whether releases conform to the design requirement for effluent control. The monitoring systems shall be designed to include alarms that can be periodically tested.

(d) *Waste treatment.* Radioactive waste treatment facilities shall be designed to process any radioactive wastes generated at the geologic repository operations area into a form suitable to permit safe disposal at the geologic repository operations area or to permit safe transportation and conversion to a form suitable for disposal at an alternative site in accordance with any regulations that are applicable.

(e) *Consideration of decommissioning.* The surface facility shall be designed to facilitate decommissioning.

**§ 60.132 Additional design requirements for the underground facility.**

(a) General criteria for the underground facility.

(1) The underground facility shall be designed so as to perform its safety functions assuming interactions among the geologic setting, the underground facility, and the waste package.

(2) The underground facility shall be designed to provide for structural stability, control of groundwater movement and control of radionuclide releases, as necessary to comply with the performance objectives of § 60.111.

(3) The orientation, geometry, layout, and depth of the underground facility, and the design of any engineered barriers that are part of the underground facility shall enhance containment and isolation of radionuclides to the extent practicable at the site.

(4) The underground facility shall be designed so that the effects of disruptive events such as intrusions of gas, or water, or explosions, will not spread through the facility.

(b) *Flexibility of design.* The underground facility shall be designed with sufficient flexibility to allow adjustments, where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.

(c) *Separation of excavation and waste emplacement (modular concept).* If concurrent excavation and emplacement of wastes are planned, then:

(1) The design shall provide for such separation of activities into discrete areas (modules) as may be necessary to assure that excavation does not impair waste emplacement or retrieval operations.

(2) Each module shall be designed to permit insulation from other modules if an accident occurs.

(d) *Design for retrieval of waste.* The underground facility shall be designed to—

(1) Permit retrieval of waste in accordance with the performance objectives (§ 60.111);

(2) Ensure sufficient structural stability of openings and control of groundwater to permit the safe conduct of waste retrieval operations; and

(3) Allow removal of any waste packages that may be damaged or require inspection without compromising the ability of the geologic repository to meet the performance objectives (§ 60.111).

(e) *Design of subsurface openings.*

(1) Subsurface openings shall be designed to maintain stability throughout the construction and operation periods. If structural support is required for stability, it shall be designed to be compatible with long-term deformation, hydrologic, geochemical, and thermomechanical characteristics of the rock and to allow subsequent placement of backfill.

(2) Structures required for temporary support of zones of weak or highly fractured rock shall be designed so as not to impair the placement of permanent structures or the capability to seal excavated areas used for the containment of wastes.

(3) Subsurface openings shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock over the long term. The size, shape, orientation, and spacing of openings and the design of engineered support systems shall take the following conditions into considerations—

(i) natural stress conditions;

(ii) deformation characteristics of the host rock under normal conditions and thermal loading;

(iii) The kinds of weaknesses or structural discontinuities found at various locations in the geologic repository;

(iv) Equipment requirements; and

(v) The ability to construct the underground facility as designed so that stability of the rock is enhanced.

(f) *Rock excavation.* The design of the underground facility shall incorporate excavation methods that will limit damage to and fracturing of rock.

(g) *Control of water and gas.*

(1) Water and gas control systems shall be designed to be of sufficient capability and capacity to reduce the potentially adverse effects of groundwater intrusion, service water intrusion, or gas inflow into the underground facility.

(2) Water and gas control systems shall be designed to control the quantity of water or gas flowing into or from the underground facility, monitor the composition of gases, and permit sampling of liquids.

(3) Systems shall be designed to provide control of water and gas in both waste emplacement areas and excavation areas.

(4) Water control systems shall be designed to include storage capability and modular layouts that ensure that unexpected inrush or flooding can be controlled and contained.

(5) If the intersection of aquifers or water-bearing geologic structures is anticipated during construction, the design of the underground facility shall include plans for cutoff or control of water in advance of the excavation.

(6) If linings are required, the contact between the lining and the rock surrounding subsurface excavations shall be designed so as to avoid the creation of any preferential pathway for groundwater or radionuclide migration.

(h) *Subsurface ventilation.* The ventilation system shall be designed to—

(1) Control the transport of radioactive particulates and gases within and releases from the subsurface facility in accordance with the performance objectives (§ 60.111);

(2) Permit continuous occupancy of all excavated areas during normal operations through the time of permanent closure;

(3) Accommodate changes in operating conditions such as variations in temperature and humidity in the underground facility;

(4) Include redundant equipment and fail safe control systems as may be needed to assure continued function under normal and emergency conditions; and

(5) Separate the ventilation of excavation and waste emplacement areas.

(i) *Engineered barriers.*

(1) Barriers shall be located where shafts could allow access for groundwater to enter or leave the underground facility.

(2) Barriers shall create a waste package environment which favorably controls chemical reactions affecting the performance of the waste package.

(3) Backfill placed in the underground facility shall be designed as a barrier.

(i) Backfill placed in the underground facility shall perform its functions assuming anticipated changes in the geologic setting.

(ii) Backfill placed in the underground facility shall serve the following functions:

(A) It shall provide a barrier to groundwater movement into and from the underground facility.

(B) It shall reduce creep deformation of the host rock that may adversely affect (*1*) waste package performance or (*2*) the local hydrological system.

(C) It shall reduce and control groundwater movement within the underground facility.

(D) It shall retard radionuclide migration.

(iii) Backfill placed in the underground facility shall be selected to allow for adequate placement and compaction in underground openings.

(j) *Waste handling and emplacement.*

(1) The systems used for handling, transporting, and emplacing radioactive wastes shall be designed to have positive, fail-safe designs to protect workers and to prevent damage to waste packages.

(2) The handling systems for emplacement and retrieval operations shall be designed to minimize the potential for operator error.

(k) *Design for thermal loads.*

(1) The underground facility shall be designed so that the predicted thermal and thermomechanical response of the rock will not degrade significantly the performance of the repository or the ability of the natural or engineered barriers to retard radionuclide migration.

(2) The design of waste loading and waste spacings shall take into consideration—

(i) Effects of the design of the underground facility on the thermal and thermomechanical response of the host rock and the groundwater system;

(ii) Features of the host rock and geologic setting that affect the thermomechanical response of the underground facility and barriers, including but not limited to, behavior and deformational characteristics of the host rock, the presence of insulating layers, aquifers, faults, orientation of bedding planes, and the presence of discontinuities in the host rock; and

(iii) The extent to which fracturing of the host rock is influenced by cycles of temperature increase and decrease.

**§ 60.133 Design of shafts and seals for shafts and boreholes.**

(a) *Shaft design.* Shafts shall be designed so as not to create a preferential pathway for migration of groundwater and so as not to increase the potential for migration through existing pathways.

(b) *Shaft and borehole seals.* Shaft and borehole seals shall be designed so that:

(1) Shafts and boreholes will be sealed as soon as possible after they have served their operational purpose.

(2) At the time of permanent closure sealed shafts and boreholes will inhibit transport of radionclides to at least the same degree as the undisturbed units of rock through which the shafts or boreholes pass. In the case of soluble rocks, the borehole and shaft seals shall also be designed to prevent groundwater circulation that would result in dissolution.

(3) Contact between shaft and borehole seals and the adjacent rock does not become a preferential pathway for water.

(4) Shaft and borehole seals can accommodate potential variations of stress, temperature, and moisture.

(5) The materials used to construct the seals are appropriate in view of the geochemistry of the rock and groundwater system, anticipated deformations of the rock, and other in situ conditions.

(c) *Shaft conveyances used in radioactive waste handling.*

(1) Shaft conveyances used to transport radioactive materials shall be designed to satisfy the requirements as set forth in § 60.130 for systems, structures, and components important to safety.

(2) Hoists important to safety shall be designed to preclude cage free fall.

(3) Hoists important to safety shall be designed with a reliable cage location system.

(4) Hoist loading and unloading systems shall be designed with a reliable system of interlocks that will fail safely upon malfunction.

(5) Hoists important to safety shall be designed to include two independent indicators to indicate when waste packages are in place, grappled, and ready for transfer.

**§ 60.134 Construction specifications for surface and subsurface facilities.**

(a) *General requirement.* Specifications for construction shall conform to the objectives and technical requirements of §§ 60.130 through 60.133.

(b) *Construction management program.* The construction specifications shall facilitate the conduct of a construction management program that will ensure that construction activities do not adversely affect the suitability of the site to isolate the waste or jeopardize the isolation capabilities of the underground facility, boreholes, shaft, and seals, and that the underground facility is constructed as designed.

(c) *Construction records.* The construction specifications shall include requirements for the development of a complete documented history of repository construction. This documented history shall include at least the following—

(1) Surveys of underground excavations and shafts located via readily identifiable surface features or monuments;

(2) Materials encountered;

(3) Geologic maps and geologic cross sections;

(4) Locations and amount of seepage;

(5) Details of equipment, methods, progress, and sequence of work;

(6) Construction problems;

(7) Anomalous conditions encountered;

(8) Instrument locations, readings, and analysis;

(9) Location and description of structural support systems;

(10) Location and description of dewatering systems; and

(11) Details, methods of emplacement, and location of seals used.

(d) *Rock excavation.* The methods used for excavation shall be selected to reduce to the extent practicable the potential to create a preferential pathway for groundwater or radioactive waste migration or increase migration through existing pathways.

(e) *Control of explosives.* If explosives are used, the provisions of 30 CFR 57.6 (Explosives) issued by the Mine Safety and Health Administration, Department of Labor, shall be met, as minimum safety requirements for storage, use and transport at the geologic repository operations area.

(f) *Water control.* The construction specifications shall provide that water encountered in excavations shall be removed to the surface and controlled in accordance with design requirements for radiation control and monitoring (§ 60.131(c)).

(g) *Waste handling and emplacement.* The construction specifications shall provide for demonstration of the effectiveness of handling equipment and systems for emplacement and retrieval operations, under operating conditions.

## Waste Package Requirements

**§ 60.135 Requirements for the waste package and its components.**

(a) *General requirements of design.* The design of the waste package shall include the following elements:

(1) *Effect of the site on the waste package.* The waste package shall be designed so that the in situ chemical, physical, and nuclear properties of the waste package and its interactions with the emplacement environment do not compromise the function of the waste packages. The design shall include but not be limited to consideration of the following factors: solubility, oxidation/reduction reactions, corrosion, hydriding, gas generation, thermal effects, mechanical strength, mechanical stress, radiolysis, radiation damage, radionuclide retardation, leaching, fire and explosion hazards, thermal loads, and synergistic interactions.

(2) *Effect of the waste package on the underground facility and the natural barriers of the geologic setting.* The waste package shall be designed so that the in situ chemical, physical, and nuclear properties of the waste package and its interactions with the emplacement environment do not compromise the performance of the underground facility or the geologic setting. The design shall include but not be limited to consideration of the following factors: solubility, oxidation/reduction reactions, corrosion, hydriding, gas generation, thermal effects, mechanical strength, mechanical stress, radiolysis, radiation damage, radionuclide retardation, leaching, fire and explosion hazards, thermal loads, and synergistic interactions.

(b) *Waste form requirements.* Radioactive waste that is emplaced in the underground facility shall meet the following requirements:

(1) *Solidification.* All such radioactive wastes shall be in solid form and placed in sealed containers.

(2) *Consolidation.* Particulate waste forms shall have been consolidated (for example, by incorporation into an encapsulating matrix) to limit the availability and generation of particulates.

(3) *Combustibles.* All combustible radioactive wastes must have been reduced to a noncombustible form unless it can be demonstrated that a fire involving a single package will neither compromise the integrity of other packages, nor adversely affect any safety-related structures, systems, or components.

(c) *Waste package requirements.* The waste package design shall meet the following requirements:

(1) *Explosive, pyrophoric, and chemically reactive materials.* The waste package shall not contain explosive or pyrophoric materials or chemically reactive materials that could interfere with operations in the underground facility or compromise the ability of the geologic repository to satisfy the performance objectives.

(2) *Free liquids.* The waste package shall not contain free liquids in an amount that could impair the structural integrity of waste package components (because of chemical interactions or formation of pressurized vapor) or result in spillage and spread of contamination in the event of package perforation.

(3) *Handling.* Waste packages shall be designed to maintain waste containment during transportation, emplacement, and retrieval.

(4) *Unique identification.* A label or other means of identification shall be provided for each package. The identification shall not impair the integrity of the package and shall be applied in such a way that the information shall be legible at least to the end of the retrievable storage period. Each package identification shall be consistent with the package's permanent written records.

### Performance Confirmation Requirements

#### § 60.137 General requirements for performance confirmation.

The geologic repository operations area shall be designed so as to permit implementation of a performance confirmation program that meets the requirements of Subpart F of this part.

## Subpart F—Performance Confirmation

#### § 60.140 General requirements.

(a) The performance confirmation program shall ascertain whether—

(1) Actual subsurface conditions encountered and changes in those conditions during construction and waste emplacement operations are within the limits assumed in the licensing review; and

(2) Natural and engineered systems and components required for repository operation, or which are designed or assumed to operate as barriers after permanent closure are functioning as intended and anticipated.

(b) The program shall have been started during site characterization and it will continue until permanent closure.

(c) The program will include in situ monitoring, laboratory and field testing, and in situ experiments, as may be appropriate to accomplish the objective as stated above.

(d) The confirmation program shall be implemented so that:

(1) It does not adversely affect the natural and engineered elements of the geologic repository.

(2) It provides baseline information and analysis of that information on those parameters and natural processes pertaining to the geologic setting that may be changed by site characterization, construction, and operational activities.

(3) It monitors and analyzes changes from the baseline condition of parameters that could affect the performance of a geologic repository.

(4) It provides an established plan for feedback and analysis of data, and implementation of appropriate action.

#### § 60.141 Confirmation of geotechnical and design parameters.

(a) During repository construction and operation, a continuing program of surveillance, measurement, testing, and geologic mapping shall be conducted to ensure that geotechnical and design parameters are confirmed and to ensure that appropriate action is taken to inform the Commission of changes needed in design to accommodate actual field conditions encountered.

(b) Subsurface conditions shall be monitored and evaluated against design assumptions.

(c) As a minimum, measurements shall be made of rock deformations and displacement, changes in rock stress and strain, rate and location of water inflow into subsurface areas, changes in groundwater conditions, rock pore water pressures including those along fractures and joints, and the thermal and thermomechanical response of the rock mass as a result of development and operations of the geologic repository.

(d) These measurements and observations shall be compared with the original design bases and assumptions. If significant differences exist between the measurements and observations and the original design bases and assumptions, the need for modifications to the design or in construction methods shall be determined and these differences and the recommended changes reported to the Commission.

(e) In situ monitoring of the thermomechanical response of the underground facility shall be conducted until permanent closure to ensure that the performance of the natural and engineering features are within design limits.

#### § 60.142 Design testing.

(a) During the early or developmental stages of construction, a program for in situ testing of such features as borehole and shaft seals, backfill, and the thermal interaction effects of the waste packages, backfill, rock, and groundwater shall be conducted.

(b) The testing shall be initiated as early as is practicable.

(c) A backfill test section shall be constructed to test the effectiveness of backfill placement and compaction procedures against design requirements before permanent backfill placement is begun.

(d) Test sections shall be established to test the effectiveness of borehole and shaft seals before full-scale operation proceeds to seal boreholes and shafts.

#### § 60.143 Monitoring and testing waste packages.

(a) A program shall be established at the repository for monitoring the condition of the waste packages. Packages chosen for the program shall be representative of those to be emplaced in the repository.

(b) Consistent with safe operation of the repository, the environment of the waste packages selected for the waste package monitoring program shall be representative of the emplaced wastes.

(c) The waste package monitoring program shall include laboratory experiments which focus on the internal condition of the waste packages. To the extent practical, the environment experienced by the emplaced waste packages within the repository during the waste package monitoring program shall be duplicated in the laboratory experiments.

(d) The waste package monitoring program shall continue as long as practical up to the time of permanent closure.

## Subpart G—Quality Assurance

#### § 60.150 Scope.

(a) As used in this part, "quality assurance" comprises all those planned and systematic actions necessary to provide adequate confidence that the repository and its subsystems or components will perform satisfactorily in service.

(b) Quality assurance is a multidisciplinary system of management controls which address safety, reliability, maintainability, performance, and other technical disciplines.

#### § 60.151 Applicability.

The quality assurance program applies to all systems, structures and components important to safety and to activities which would prevent or mitigate events that could cause an undue risk to the health and safety of the public. These activities include: exploring, site selecting, designing, fabricating, purchasing, handling, shipping, storing, cleaning, erecting, installing, emplacing, inspecting, testing,

operating, maintaining, monitoring, repairing, modifying, and decommissioning.

§ 60.152 Implementation.

DOE shall implement a quality assurance program based on the criteria of Appendix B of 10 CFR Part 50 as applicable, and appropriately supplemented by additional criteria as required by § 60.151.

§ 60.153 Quality assurance for performance confirmation.

The quality assurance program shall include the program of tests, experiments and analyses essential to achieving adequate confidence that the emplaced wastes will remain isolated from the accessible environment.

## Subpart H—Training and Certification of Personnel

§ 60.160 General requirements.

Operations that have been identified as important to safety in the Safety Analysis Report and in the license shall be performed only by trained and certified personnel or by personnel under the direct visual supervision of an individual with training and certification in such operation. Supervisory personnel who direct operations that are important to safety must also be certified in such operations.

§ 60.161 Training and certification program.

The DOE shall establish a program for training, proficiency testing, certification and requalification of operating and supervisory personnel.

§ 60.162 Physical requirements.

The physical condition and the general health of personnel certified for operations that are important to safety shall not be such as might cause operational errors that could endanger the public health and safety. Any condition which might cause impaired judgement or motor coordination must be considered in the selection of personnel for activities that are important to safety. These conditions need not categorically disqualify a person, so long as appropriate provisions are made to accomodate such defect.

Dated at Washington, D.C. this 2nd day of July, 1981.

Samuel J. Chilk,

*Secretary of the Commission.*

[FR Doc. 81-20028 Filed 7-7-81; 8:45 am]

BILLING CODE 7590-01-M

## CONSUMER PRODUCT SAFETY COMMISSION

### 16 CFR Part 1700

### Human Prescription Drugs in Oral Dosage Forms; Proposed Exemption From Child-Resistant Packaging of All Unit-Dose Forms of Potassium Supplements Containing Not More Than 50 Milliequivalents of Potassium Per Unit-Dose

**AGENCY:** Consumer Product Safety Commission.

**ACTION:** Proposed rule.

**SUMMARY:** The Commission proposes to amend the current exemption from special packaging under the Poison Prevention Packaging Act of 1970 for potassium supplements in effervescent tablet form, each tablet containing not more than 50 milliequivalents of potassium, to cover all unit-dose forms of the drug containing not more than 50 milliequivalents of potassium per unit-dose. The Commission is taking this action based on the absence of adverse experience from ingestion by children of potassium supplements in all forms, including powdered and liquid potassium.

**DATES:** Comments on this proposed exemption should be submitted by September 8, 1981. If the Commission issues a final regulation concerning the exemption, the Commission proposes that the exemption be effective on the date the final regulation is published in the Federal Register.

**ADDRESS:** Comments should be addressed to the Office of the Secretary, CPSC, 1111 18th St., NW, Third Floor, Washington, D.C. 20207.

**FOR FURTHER INFORMATION CONTACT:** Virginia White, Office of Program Management, Consumer Product Safety Commission, Washington, D.C. 20207, (301) 492-6453.

**SUPPLEMENTARY INFORMATION:**

### Background

Regulations issued under the Poison Prevention Packaging Act of 1970 (PPPA) (15 U.S.C. 1471-1476) establish child-protection packaging requirements for human oral prescription drugs in order to protect children from serious personal injury or illness resulting from handling, using, or ingesting these substances.

On September 30, 1980 the Commission issued a final exemption to the child-resistant packaging regulations for prescription drugs in oral form (16 CFR 1700.14(a)(10)) for potassium supplements in individually-packaged effervescent tablets, each tablet containing not more than 50 milliequivalents (mEq) of potassium (44 FR 34968). The Commission took this action based on the absence of adverse experience with effervescent potassium tablets and on test data indicating that their effervescence inhibits ingestion in dangerous amounts. In the same Federal Register document the Commission also announced its intention to reopen the issue of a possible exemption for all unit dose forms of potassium supplements, including powdered and liquid forms as well as individually-wrapped tablets. The Commission decided to reopen the issue based on correspondence with a manufacturer of powdered potassium (Berlex Laboratories) who contended that there is an inconsistency between denial of its earlier petition (PP 75-11) requesting an exemption from special packaging for powdered potassium chloride in individual packets and the proposal of an exemption for the 50 mEq effervescent tablet.

The Commission denied PP 75-11, along with similar requests from Abbott Laboratories and Mead-Johnson Laboratories for exemption of potassium chloride powder, on August 21, 1975. That denial was based on experimental evidence indicating that potassium chloride powder, administered to rabbits in amounts equivalent to ingestion of one to three packets of the drug by a small child, caused severe gastric irritation and injury in the animals, as well as in the lack of human experience data with this drug.

The Commission also earlier denied a petition from Warren-Teed Pharmaceuticals, Inc. (PP 74-42) for exemption of its liquid potassium supplements in unit dose form. (The liquid form of potassium is used almost exclusively in hospitals and other institutions but is also available for home use.) The Commission denied that petition based on the lack of adequate human experience data, at the time, with which to evaluate childhood ingestion; the fact that the products were highly flavored; and an evaluation of toxicity data indicating that five unit does vials (100 mEq potassium) might produce toxic effects in a small child.

### Grounds for Exemption

Based upon additional information, data, and human experience generated since the 1975 denial of the petitions for exemption of potassium chloride powder and liquid potassium supplements, the Commission is now proposing to exempt from special packaging all unit dose forms of potassium supplements, including unit dose vials of liquid potassium

10-15-81 PDR

ANALYSIS OF PUBLIC COMMENTS ON THE ADVANCE NOTICE OF PROPOSED RULEMAKING--10 CFR PART 60, "TECHNICAL CRITERIA FOR REGULATING GEOLOGIC DISPOSAL HIGH-LEVEL RADIOACTIVE WASTE."

10-15-81 PDR

ANALYSIS OF PUBLIC COMMENTS ON THE ADVANCE NOTICE
OF PROPOSED RULEMAKING--10 CFR PART 60, "TECHNICAL CRITERIA
FOR REGULATING GEOLOGIC DISPOSAL HIGH-LEVEL RADIOACTIVE WASTE."

## Introduction

On May 13, 1980, the Nuclear Regulatory Commission (NRC) published for public comment an Advance Notice of Proposed Rulemaking - 10 CFR Part 60 "Technical Criteria for Regulating Geologic Disposal High - Level Radioactive Waste" and draft technical criteria (45 FR 31393). In response to this request for comments, the NRC received 27 letters (excluding misdocketed and duplicate letters) from other government agencies (6), State officials (2), utility companies or their representatives (7), public interest groups (2), professional societies (1), and interested individuals (9). From these 27 letters, 419 separate comments were extracted and were considered by the NRC staff in the development of the technical criteria set forth in the proposed rule (46 FR 35280).

This document presents the NRC staff's analysis of the public comments. This analysis of the comments is divided into three parts. Part 1 contains an analysis of public comments addressing the Advance Notice. Part 2 sets forth public responses to four questions posed by the NRC at the end of the Advance Notice. Since these responses were solicited by the NRC to aid in its review of specific questions, no NRC staff responses are made to the comments in Part 2. Finally, public comments received on the draft technical criteria are addressed in Part 3.

Appendix A is a copy of the Advance Notice as published in the May 13, 1980 issue of the Federal Register (45 FR 31393). A copy of the proposed rule (46 FR 35280) is presented in Appendix B. Copies of the individual comment letters on the Advance Notice are provided in Appendix C.

PUBLIC COMMENT LETTERS RECEIVED ON THE ADVANCE NOTICE OF PROPOSED RULEMAKING (45 FR 31393)

| PDR No. | Author |
|---|---|
| 1 | Lowenstein, Newman, Reis, Axelrad and Toll |
| 2 | U.S. Arms Control and Disarmament Agency |
| 3 | Hon. Jon Hinson M.C. (comments on proposed 10 CFR Part 60 procedural rule) |
| 4 | National Aeronautics & Space Administration (NASA) |
| 5 | U.S. Department of Energy (comments on proposed 10 CFR Part 60 procedural rule) |
| 6 | Arvin S. Quist |
| 7 | A. E. Wasserbach |
| 8 | B. R. McElmurry |
| 9 | J. G. McCray (University of Arizona) |
| 10 | G. H. Dyer |
| 11 | Robert Abrams, Attorney General, State of New York |
| 12 | U. S. Geological Survey |
| 13 | Bechtel National, Inc. |
| 14 | Atomic Industrial Forum |
| 15 | Exxon Nuclear Corp. |
| 16 | American Institute of Chemical Engineers |
| 17 | Lazlo Toth |
| 18 | U. S. Department of Energy and enclosed comments by<br>- R. Ellison (D'Appolonia)<br>- I. Remson (Stanford University)<br>- H. Ross (University of Utah Research Institute)<br>- G. Pinder (Princeton University)<br>- F. Parker (Vanderbilt University)<br>- N. Cook (University of California)<br>- J. Bird (Cornell University) |
| 19 | Bechtel National, Inc. (duplicate of #13) |

20 Westinghouse Electric Corp.

21 R. Tauke & M. Adam

22 Energy Resources Conservation and Development Commission

23 Environmental Protection Agency

24 R. E. Johnson

25 Duke Power Co.

26 Bureau of Land Management (BLM)

27 A. T. Heubner, Department of Environmental Protection, State of Connecticut

28 Lowenstein, Newman, Reis, Axelrad & Toll (28) with enclosed comments by The Analytic Sciences Corporation (TASC)

29 Everett R. Irish

30 Susan Longenecker (misdocketed)

31 Charles D. Parent (misdocketed)

32 National Resources Defense Council, Inc.

33 State Planning Council on Radioactive Waste Management (comments on the 10 CFR Part 60 procedural rule)

34 U.S. Department of Energy (comments on the 10 CFR Part 60 procedural rule)

PART 1

PUBLIC COMMENTS ON ADVANCE NOTICE OF PROPOSED RULEMAKING 10 CFR PART 60

SUMMARY

Comment 1: Lowenstein, Newman, Reis, Axelrad and Toll (28)

We have noted the statement in the Summary that the published draft criteria "do not necessarily reflect staff positions with respect to rulemaking on this subject." (p. 31394) We assume that this denotes a willingness and a desire by the staff to take into account the numerous constructive comments that it will receive as a result of the Advance Notice and to incorporate into any proposed rule the significant improvements that have been suggested.

Staff Response to Comment 1:

The NRC has considered the numerous comments received on the Advance Notice of Proposed Rulemaking (ANPR) and draft technical criteria and has incorporated a number of the suggested changes into the proposed rule.

SUPPLEMENTARY INFORMATION - GENERAL COMMENTS

Comment 2: Bechtel National Inc. (13)

The discussion contained in this section approaches the development of a HLW repository from a very negative point of view. The section portrays a lack of confidence on the part of the NRC to deal with uncertainties, and emphasizes potential shortcomings of geologic repositories by statements like such disposal of HLW is separable into five distinct problem areas" when not all of the areas identified may be problems, "waste undoubtedly will have a significant interaction with the rock" which we would not expect to be true over the time frames of interest, "no way to reasonably limit the variety of human activities which might compromise a forgotten repository", "engineering against human intrusion is impossible practically", "the site should be geologically simple... so that the site can be easily understood", "mistakes will occur", and "human intrusion cannot be prevented." Such absolute statements are negatively oriented and could lead to public misunderstanding and lack of confidence. Both overly negative and overly positive statements that tend to prejudge the concept of geologic disposal should be avoided.

Staff Response to Comment 2:

It was NRC's intent to develop a cautious and conservative approach to HLW disposal in geologic repositories, not a negative one. The language of the ANPR simply reflected the realities of licensing in which "aspects that can go wrong" must be addressed.

Comment 3: Atomic Industrial Forum (14)

The AIF Subcommittee on High-Level Radioactive Waste offers the following comments on the Advance Notice of Proposed Rulemaking regarding the Technical Criteria for Regulating Geologic Disposal of High-Level Radioactive Waste (10 CFR 60), as published in the Federal Register of May 13, 1980. We recognize the desirability of establishing an appropriate regulatory framework for the timely disposal of high-level wastes in geologic respositories; however, we are concerned by the approach being taken by NRC as well as by the lack of a basis for the quantitative values suggested in the Advance Notice.

While it is noted in the Supplementary Information that bases and rationale are being prepared by the NRC staff, the working draft became available for review only recently. Specific or detailed comments on the suggested numerical criteria cannot be made until a thorough review of this draft is completed. At that time we shall offer additional comments.

Because of the importance of such technical criteria, we suggest that NRC publish their bases and rationale, along with appropriate critiques by DOE and other cognizant agencies, and then reissue the Advance Notice of Proposed Rulemaking for comment and review by the public. A period of 120 days would permit thorough evaluation and comment by all interested reviewers.

Staff Response to Comment 3:

Quantitative criteria were set forth in the ANPR and draft technical criteria in order to solicit public comment on the proposed values. The bases and rationale for the staff's judgment on certain numerical criteria are provided in the technical support document for the proposed rule. This document is available upon request from the NRC.

Comment 4: U.S. Geological Survey (12)

The entire Supplemental Information section stresses geologic simplicity as a very important characteristic of a site without clearly explaining what is meant by the term. While we agree that geologic simplicity is a desirable characteristic, it is not the most important attribute of a site. The most important attribute of a natural barrier is that it works, not that it is mechanistically or descriptively simple. The prime purpose of the geologic setting is to contain the waste, and not to facilitate the licensing process. The geologic complexity of a site is based on two factors: (1) the real geologic system and (2) the apparent complexity created by our own inability to comprehend the system. As we learn about these systems the perceived complexity will change. In addressing this problem in the development of criteria, it is critical that the capability of the geologic setting to contain the waste be given a higher priority than the simplicity of the system.

The requirement in 60.122(a)(1) does put geologic simplicity in its proper perspective and that approach should be reflected in the supplemental information.

Staff Response to Comment 4:

The ability of the geologic and hydrologic systems of a site to effectively retard the migration of radionuclides to the accessible environment has always been a primary consideration in the development of NRC regulations for the licensing of HLW geologic repositories. The term "geologic simplicity" was used in the ANPR to denote that the geologic and hydrologic systems would not be so complicated as to preclude a thorough investigation and evaluation of the important site characteristics.

Comment 5: Ross enclosure in U.S. Department of Energy (18)

The Supplementary Information developed as Background, Nature of the Problem, Underlying Principles, and Considerations would appear to adequately identify the key issues involved in the disposal of HLW. The underlying conservative evaluation of repository sites is appropriate to the importance of the problem, but should not be so rigidly applied that reasonably acceptable sites are eliminated without full consideration of offsetting favorable factors. Predictions of future site stability for the long term (i.e. 10,000 years or more) will be impossible to demonstrate. Thus well reasoned, competent judgement based on the geologic record of the last millions of years must be an acceptable substitute for demonstrated future stability. One point not adequately addressed is that the risk and economics of timely geologic storage must ultimately be compared with the risk and economics of no geologic storage -- the alternative which could result from the ultimate in conservative site evaluations.

Staff Response to Comment 5:

The NRC is acutely aware of the impossibility of demonstrating stability. Rather, future stability of a site is inferred from the geologic history of the area since the start of the Quaternary period.

The Congress has given the Department of Energy (DOE) the responsibility for managing the nation's HLW. Geologic disposal is a means DOE is pursuing and

therefore NRC is responsible for licensing. The economic viability of geologic disposal, or any option, including no disposal of HLW, is a question to be addressed by DOE, not NRC.

Comment 6: Westinghouse Electric Corp. (20)

Westinghouse has the following general comments on the specific questions raised in the "Supplementary Information" section:

a. Instead of focusing on performance of the repository system (NRC Consideration 1), the draft criteria specify performance standards for major components of the system (NRC Consideration 2). These component performance standards should be eliminated. We believe it is essential that the criteria focus on performance of the overall system and on protecting current and future generations.

b. The list of considerations should be expanded to acknowledge that the draft technical criteria apply to a repository which will not be operational before 1997, according to latest Administration schedules. The initial rule should develop performance goals and requirements for the overall system. The current draft criteria incorrectly specify engineering design requirements. Instead, the criteria should provide the future designer and analyst with guidelines that allow the latitude necessary to accommodate repositories in various geologic media, advances in technology, and the influence of complementary regulations such as EPA Standards. We do not believe that these aspects have been thoroughly considered. For instance, paragraph 60.132 "design requirements" are too specific in addressing shaft and borehole sealing, conveyance design, and water control requirements.

   In being so specific, they arbitrarily constrain the benefit of future research and development or suitability of a specific site. Paragraph 60.111 refers to as yet unestablished EPA performance standards but is very specific in defining release rates for the repository. Conversely, the technical criteria also contains words like significant, optimized, reasonable, likely, etc. when addressing other issues. These areas must be kept to a minimum to discourage future conflicts in interpretation.

c. The Commission should consider requiring the Department of Energy to conduct early demonstrations of repository disposal systems in various geologic media such as those proposed in House Bill H.R. 7418. This would allow the Commission to develop the 10CFR60 regulations in conjunction with the design, construction, and operation of the required system demonstrations.

d. Many of the draft technical criteria are not reasonable or realistic, and as such do not deal with the issues in an appropriate manner. In addition to specifying engineering design requirements (see comment b above), many of the numerical criteria appear to be arbitrarily selected. For example, this sense of arbitrary requirements exist in sections dealing

with retrievability and resource assessment. It should also be recognized that numerical criteria apply to unique conditions which may not be generically applicable.

e. The planned NRC environmental impact statement should justify proposed numerical criteria with cost/benefit analyses as required for such statements.

Staff Response to Comment 6:

a. By addressing the performance of and requirements for the multiple barriers comprised by the major components of the system, the NRC seeks to assure the safety of a repository. The barriers and their intended functions are delineated to provide both a minimum of acceptability and a common basis of comparison for potential repository sites and designs, as well as lending confidence that the overall standard of performance - the EPA standard will be met.

b. The staff continues to believe that the level of specificity of the draft technical criteria may be both necessary and appropriate given the novelty and long period of performance of a repository to assure that the repository will adequately protect the public health and safety. However, the Commission has recognized that the level of detail in the draft technical criteria and in the proposed rulemaking may be more than needed. Hence the Commission is asking comment particularly on this point. Further, the staff agrees with the commenter on the use of words such as "optimize", "minimize" etc. which lead to unmeetable requirements. These have been eliminated from the proposed rule.

c. Site characterization and in situ testing at depth should provide ample opportunity for DOE to conduct demonstrations in a various geologic media.

d. See response to Comment No. 3.

e. No response required as stated in introductory remarks to Part 2. See also comments 105-109.

Comment 7: Cook enclosure in U.S. Department of Energy (18)

These comments concerning the technical criteria for regulating geologic disposal of high-level radioactive waste are made in response to a letter from Dr. W. A. Carbiener of ONWI dated May 27, with which were enclosed copies of the the May 13 Federal Register and background information from the USNRC Public Document Room.

The latter information on "Technical Support Documentation for the Siting Requirements in USNRC 10 CFR Part 60: Disposal of High-Level Radioactive Waste in Geologic Repositories", proved to be of particular assistance, and includes a commendably useful list of references.

The treatment of this question in the Federal Register both in the Supplementary Information and in Subpart E is very uneven, reflecting probably the current state of knowledge. However, a more systematic presentation would likely lead to a clearer identification of the problems, and specifications of the criteria.

For example, under the heading "Nature of the Problem" five distinct areas are identified, namely, (1) Lifetime of the Repository, (2) Physical Extent, (3) Waste/Rock Interaction, (4) Treatment of Uncertainties and (5) Human Intrusions. Although these problems are important, they do not seem to define any hierarchial system.

Staff Response to Comment 7:

The proposed technical criteria set forth a more systematic presentation of the performance objectives and requirements. The ANPR identified five distinct problem areas as a means of approaching the regulation of a HLW geologic repository. It was noted in the Supplementary Information at 45 FR 31394 that each of these areas could be further separated into fairly distinct regimes. There was no intent for the five problem areas to define a hierarchial system.

NATURE OF THE PROBLEM

Comment 8: Bird enclosure in U.S. Department of Energy (18)

It is not clear how these "five distinct problem areas", lifetime of the repository, physical extent, waste/rock interaction, treatment of uncertainties, and human intrusions, supercede other, more fundamental questions pertinent to regulation of geologic disposal. Although they are important, there are other questions of equal or greater importance, e.g. the validity of the basic premises of geologic disposal, the existence of appropriate sites, rocks, and limited hydrologic conditions. Also, it can be argued that one or

two large repositories present problems that could be avoided by constructing many small respositories. As more waste is concentrated into a single site, the potential dangers increase significantly. A. E. Ringwood (pers. comm. and pre-print, April, 1980) has argued that deep-drill-hole burial in many si s has significant advantages. Has it been shown that large repositories at a few sites are preferable to many small and therefore dispersed, deep repositories?

Staff Response to Comment 8:

See response to Comment 7. The discussion of these five distinct problem areas does not preclude the existence of problems of comparable importance. However, these are areas of greatest importance with respect to licensing the disposal of HLW in geologic repositories, based on the implicit assumption that geologic disposal is viable. The alternative supported by Ringwood is one which DOE may address, but it is NRC's task to license the method chosen by DOE if such a method will adequately protect the public health and safety.

Comment 9: Duke Power Co. (25)

We believe this discussion serves a useful purpose in that it separates consideration of the problem in time, space, natural processes, and human actions, etc., and thus frames the problem in a form more tractable to solution.

We do, however, take exception to a few of the assertions contained in this section. First, it is stated that "the chemical and thermal properties of the waste undoubtedly will have a significant interaction with the rock unit into which they are emplaced." This is true in the case of thermal properties, and eventually we can expect significant chemical interaction. However, the statement creates the wrong impression in that significant chemical interaction can take place only in the presence of water, which through proper repository siting and design, we can expect to be absent during the time frame most important for protection of the public.

Second, the assertion is made that the very fact that we do not have experience with geologic disposal "poses fundamental difficulties." On the contrary, extensive experimental programs, both in the U. S. and abroad, have validated the concept of geologic disposal. The Atomic Energy Commissions's report regarding Project Salt Vault, ORNL - 4555, stated

> "With the completion of this experiment, it can be concluded that most of the major technical problems pertinent to the disposal of highly radioactive waste in salt have been resolved. Project Salt Vault successfully demonstrated the feasibility and safety of handling highly radioactive materials in an underground environment. The stability of the salt under

the effects of heat and radiation has been shown, as well as the capability of solving minor structural problems by standard mining techniques. The data obtained on the deformational characteristics of salt have made it possible to arrive at a suitable design for a mine disposal facility."

Canadian experiments at Chalk River have provided additional evidence that at least one waste form, glass, can contain waste for long periods of time, even in flowing groundwater. Moreover, this experiment provides additional confidence in our predictive capability regarding the degree of retardation which can be expected in actual geologic settings. In-situ testing conducted by the United States and Sweden at Stripa, in granite formation has provided valuable data on hard, crystalline rock as a disposal medium. Swedish migration experiments at Studsvik have confirmed retardation of two of the most significant fission products, cessium and strontium, provided additional information on sorbent materials which may be used to augment the retardation capability of the natural emplacement medium, and corroborated predictive modeling capability.

We could cite other experimental evidence which points to the acceptability of the geologic disposal concept. However, it is most instructive to point to the Oklo uranium mine site in the Republic of Gabon. Here we have approximately two billion years of "experience" with geologic disposal of about 6 tons of fission products from a natural chain reaction (which, incidentally, took place in an environment saturated, or nearly so, with water. Investigators here concluded that most of the fission products remained essentially immobile over periods of their half-lives and that the actinides, particularly plutonium, were also essentially contained.

Thus, we do not believe the fact that we do not now have an operating, commercial scale repository for high-level radioactive waste should be equated to "no experience...with geologic disposal."

Third, we would take issue with the statement "the problem of human intrusions, intentional or inadvertant moots much of the previous discussions, since there is no way to limit the variety of conceivable human activities which might compromise a forgotten repository." We would emphasize that the primary goal of nuclear waste management is to protect the general public's supplies of air and water. Attainment of this goal is dominated by the fission product content of the waste, the toxicity of which decays to that of the original one body from which the uranium came after only a few hundred years. Viewed in this light, the problem of intrusion becomes much more tractable. Further, safety analyses conducted for waste repositories treat natural events much more severe than that which would reasonably be expected from human intrusion, thereby bounding the problem. Finally, we assess the intrusional scenarios to produce minimal risk since we have to assume two unlikely circumstances with respect to society's continuity: (1) that the location and nature of the repository is lost, <u>and</u> (2) the technology for radiation detection is lost.

<u>Staff Response to Comment 9</u>:

Duke Power Co. is correct in noting that most significant chemical reactions between the waste and the host rock will take place in the presence of water,

and that little, if any, water is expected to be present during the early life of a repository. However, because the range of depths commonly discussed for geologic repositories usually falls below the water table, the NRC assumed a repository located in a saturated medium in the ANPR. Therefore, the presence of water is a parameter that cannot be ignored.

Although several test facilities and experimental programs currently exist that are relevant to HLW disposal in geologic repositories, the NRC believes that the short term nature of such programs (0-20 years), as opposed to the long-term lifetime ($10^4$-$10^6$ years) of a geologic repository renders them of limited use in the planning of HLW disposal in geologic repositories. Moreover, natural analogs such as the processes active at Oklo in the geologic past are certainly not definitively understood. It should be recognized that disposal of HLW in geologic repositories in an entirely new human venture. The evidence cited by the commenter may be a useful background for research and development work and certainly lends confidence that geologic disposal may be achievable, but cannot be categorized as "previous experience" in HLW disposal.

With respect to the commenter's third point, the discussion in the ANPR intended to show that human intrusion is an intrinsically different problem from a regulatory perspective than natural phenomena. The statement with which the commenter took issue stands. There is no way to bound the variety of possible human activities - intentional or otherwise in the way the disruptive effects of natural events can be bound.

(1) LIFETIME OF THE REPOSITORY

Comment 10: Pinder enclosure in U.S. Department of Energy (18)

Pg 31394, Col. 3, Line 23-31: The difference between the two requirements of technical criteria is too subtle for me pick up on first reading. Could this be clarified?

Staff Response to Comment 10:

This section does not present requirements of the technical criteria, but rather explains a need for them. The first point addresses solely the physical parameters of a site, such as geologic, geophysical and hydrologic conditions. The second point recognizes the necessity of using the technical criteria to judge the suitability not only of the physical properties of the site, but also of the integration of geological and engineered settings to effectively retard and isolate the HLW.

Comment 11: Pinder enclosure in U.S. Department of Energy (18)

Pg. 31394, Col. 3, Line 1b*: While I concur with the observation, I suggest some evidence to substantiate this statement is warranted.

* indicates lines counted from bottom.

Staff Response to Comment 11:

The staff is concerned that poor construction techniques, for example, could severely fracture the host rock and result in the creation of significant new water intrusion pathways.

Comment 12: Tauke and Adams (21)

Paragraph 3 states "... construction of repository and emplacement methods will not compromise...protect future populations." In the background info, we find that technical criteria is still under development. How, then, can we determine licensing for technical procedures that are not yet known.

Page 31395, para. 1 states "final protection is achieved by ability of geologic setting to inhibit migration of wastes..." Yet in Area 3 - Waste/ Rock

Interaction, we find that we know there will be a physical effect on the rock, but we do not know the extent of that effect. How, therefore, can we depend on the rock as final protection.

Staff Response to Comment 12:

The scope of the technical criteria was regarded as being sufficiently developed to determine an appropriate licensing procedure for their implementation. This enabled the NRC to publish a final procedural rule even though the technical criteria were still under review.

The extent to which there may be a waste/host rock interaction is a site-specific issue which should be resolved through site characterization. The determined extent of waste/host rock interaction during testing may be one of the parameters used by DOE to evaluate the suitability of a particular site. Waste/host rock interaction would not necessarily reduce the effectiveness of the host rock as a barrier to radionuclide migration since many rock types contain minerals that can capture and incorporate certain radionuclides into their crystal lattice systems.

Comment 13: TASC enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

(a) The delineation of the five distinct problem areas would be more useful if there was at least a brief indication of their interrelationship and relative importance, i.e., how they relate to a systems approach. The second problem might better be identified as "geophysical characteristics pertinent to system performance."

(b) It is important to recognize that the period during which fission products dominate is only a few hundred (300-500) years. This subject is discussed in Section I of Volume 2, The Capability for Disposing of High-Level Wastes Safely, of the Statement of Position filed on behalf of the Utility Nuclear Waste Management Group and the Edison Electric Institute on July 7, 1980, in the NRC Waste Confidence Rulemaking. In the detailed analysis, which is based on the radionuclide retention requirements necessary to achieve an overall system performance (expressed in terms of maximum exposure to individuals), it is demonstrated that after a few hundred years these retention requirements are comparable to those associated with a 2% natural uranium ore body from which the waste originated.

(c) Clarification is needed as to the difference between site suitability criteria and site acceptability criteria.

(d) We see no reason why NRC regulations should require that MSHA regulations "where applicable" should be observed. This appears to invite extraneous ambiguity and controversy into the NRC licensing process. If the MSHA regulations are applicable, they can be enforced by MSHA.

(e) The statement that "a substantial heat output from the wastes if not properly accommodated could compromise the integrity of the repository" is indicative of the generally negative approach that appears too frequently in the draft regulations. It would appear more useful and realistic to simply state that the heat output must be accommodated in order not to compromise the performance of the overall system.

Staff Response to Comment 13:

In response to the commenter's point (a) there was no intent on the part of NRC to rank the relative importance of the five distinct problem areas. See also staff responses to Comments 7 and 51.

The commenter's point (b) appears to be based upon the assumption that the so-called dilution index which relates quantities of water needed to dilute radionuclides to the MPC values of 10 CFR Part 20 is a more or less definitive measure of the hazard posed by radioactive wastes. The use of this index is helpful in discerning properties of a geologic repository, but ignores such considerations as the concentration and chemical mobility of the wastes. Further, only after approximately 1,000 years, not 300-500 years, can the contribution to heat and radioactivity generated from the short-lived nuclides be ignored when compared to that from the longer-lived isotopes in the wastes.

Provisions for the compliance with mining regulations have been clarified in the proposed technical criteria (60.130(b)(10)).

The wording discussed by the commenter in (e) endeavored to convey NRC's cautious and conservative approach to the licensing of a geologic repository, not a negative one.

(2) PHYSICAL EXTENT

Comment 14: Cook enclosure in U.S. Department of Energy (18)

It has seemed to me always that the foremost motivation for geologic disposal is that it makes radioactive wastes much less accessible to human action and less susceptable to meteorological and geologic changes in the long-term, than can be envisaged for any form of near surface storage. If this is so, the next most important question is: Do there exist rocks at convenient depths and of sufficient extent within which it is practicable to develop a repository of a useful size? Is this question not more pertinent than the discussion on page 31295 under (2)Physical Extent? If rocks within which a useful repository could be developed exist, is the next question not: Do such rocks exist within geologic and hydrologic settings likely to provide assurance of the safety and stability of a repository, in both the short- and the long-term, and of the isolation of radioactive wastes within it? Provided that these two questions can be answered in the affirmative, and to date there does not appear to be any evidence that they cannot, the next level of detail such as waste/rock interactions and the methods by which the performance of a repository can be predicted and assured, must be examined.

Staff Response to Comment 14:

Geologic experts have identified a number of geologic formations representing an assortment of host rocks which exist at sufficient depth below the surface, and have sufficient lateral and vertical extent to initially qualify as potential repository sites. The suitability of such formations as potential repository sites will be determined by the DOE during site exploration and site characterization at the candidate areas it has chosen to study.

Although the geologic extent of the rock is an important parameter, the extent of the hydrologic system of the site and the candidate area is also fundamental to the overall performance of a potential repository site. For example, an extremely thick formation located at a sufficient depth below the surface, but

characterized by a groundwater flow system that could contact a potable aquifer may not be considered suitable for a repository site. The discussion set forth at 45 FR 31395 addresses features which could affect the integrity of a potential repository or host rock. This discussion also points out that the physical extent of the repository would encompass both surface and subsurface facilities. Finally, it should be remembered that this discussion addressed a geologic repository from the perspective of regulation - a point of view different from that needed for siting and designing a repository.

Comment 15: TASC enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

We agree that features producing effects on the repository that are "not readily understood" should be avoided, particularly for the major ones, and other features should be "made tractable" or mitigated. This concept is the key to effective siting, and its application should greatly reduce the extent of significant technical dispute and resultant institutional opposition.

Staff Response to Comment 15:

No response required.

(3) WASTE/ROCK INTERACTION

Comment 16: Bird enclosure in U.S. Department of Energy (18)

"The chemical and thermal properties of the wastes will have a significant interaction with the rock unit into which they are emplaced." Although significant heat would be generated by the waste, and would affect the surrounding rock, the statement implies that chemical reactions also would take place between the waste and the rock. One would certainly hope not! The technology exists to matrix the waste in extremely inert materials and to encapsulate the waste-matrix material in containers and overpacks that constitute a package that would prevent chemical reactions between the waste and host-rock. The matrix material and container can be constructed of analogs of minerals and rocks that are extremely inert, resistant to leaching, and of very high mechanical strength. Their behavior in repository conditions can be predicted from examples in the geologic record.

Staff Response to Comment 16:

The statement questioned by Dr. Bird did not intend to imply that waste/host rock chemical interactions are expected shortly after emplacement of HLW in a

repository. However, the waste package and backfill may lose their integrity after a period of time, albeit on the order of thousands of years after emplacement. Further, following the breakdown of the waste package and backfill, radionuclide migration (most probably due to groundwater flow) must be considered. In some instances, chemical attenuation such as sorption will result in the host rock effectively retarding radionuclide migration from the repository. Nonetheless, at some point the waste and host rock will interact. Understanding that interaction is an essential element in understanding the performance of a geologic repository.

Comment 17: TASC enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

The statement that the chemical and thermal properties of the wastes undoubtedly will have a significant interaction with the rock unit into which they are emplaced is another example of the negative approach. We believe that technology exists to enable the design of a waste package and backfill that will preclude significant interaction. The statement in the Advance Notice would be more useful and realistic if it were directed at a general requirement that such interactions will be designed against so that the overall system performance requirement will not be compromised.

Staff Response to Comment 17:

See responses to Comments 16 and 51.

(4) TREATMENT OF UNCERTAINTIES

Comment 18: A. E. Wasserbach (7)

In Section 4. Treatment of Uncertainties you state "First, geologic disposal is an entirely new enterprise - no experience exists with geologic disposal." The USSR has attempted geologic disposal. Perhaps the NRC should await the results of their initial attempts before committing the U.S. to this "disposal" method.

Staff Response to Comment 18:

See response to Comment 19.

Comment 19: Atomic Industrial Forum (14)

We disagree with the statement under Item 4 on Page 31395 that reads: "First geologic disposal is an entirely new enterprise - no experience exists with geologic disposal."

It appears that NRC is not giving appropriate consideration to the wealth of experience that has accumulated over hundreds of years of mining experience, and geologic research and evaluation. Also, geologic and archaeological studies provide data on entombment as a means of protecting man's arts and treasures over periods of thousands of years.

This large technical base of information has been recognized by many groups in both in U.S. and in other countries which have recommended the use of geologic disposal for HLW. In addition, DOE's (and AEC's) experience base with geologic disposal research and development extends back over twenty years.

Staff Response to Comment 19:

The NRC does not consider the archeological and geologic studies cited by the AIF realistic examples of previously related experience to the disposal of HLW in geologic repositories. The AIF does not recognize that soluble (or corrosion prone) substances may be subjected to leaching (or corrrosion) by groundwater or to replacement by minerals contained in the groundwater during entombment. In some instances the original substance may appear intact although mineral replacement has occurred. Preservation of fossils by recrystallization or replacement (e.g., silicification) is a common geologic example of such processes.

Secondly, archeological entombment often occurred at relatively shallow depths, usually witnin the vadose zone of the groundwater regime, in contrast to the currently proposed depths for geologic repositories which would fall below the water table in nearly every instance.

The NRC agrees that a substantial amount of relevant research has been undertaken in the past twenty years that may be useful to DOE's R&D program. However, twenty years of research cannot be presented as previous experience for developing and construct a HLW geologic repository. See also response to Comment 9.

Comment 20: U. S. Department of Energy (18)

While we agree that there are many uncertainties associated with the geologic disposal of high-level radioactive waste, this section fails to put them into perspective. Too little recognition is given to the ability to bound the issues or problems. The end result is the impression of very little confidence in the conclusion that the geologic repository concept is viable. We believe the situation in regard to treatment of uncertainties is as noted in the following quotation from the Department's Statement of Position on in the Waste Confidence Rulemaking (p. II-229):

> "The conservative approach adopted by the Department is based upon a step-wise approach to system development and implementation, a multi-barrier system for radionuclide containment and isolation, and appropriate design and operating margins to compensate for uncertainties.
>
> Proceeding in a cautious, step-wise manner in the development and implementation of waste disposal systems adds assurance that the best available information is considered in reaching decisions and irreversible impacts are minimized. The use of multiple independent natural and man-made barriers against waste release minimizes the impacts of potential disruptive forces by avoiding undue reliance on any given barrier. The use of appropriate design and operating margins provides assurance that residual uncertainties inherent in disposal systems are compensated for. Integration of scientific peer review into the program adds further assurance that the waste disposal objectives will be met. The Department's approach insures that the best available pertinent information will be considered in reaching decisions and that a high confidence in safety will be attained in spite of residual uncertainties in data, modeling, or future conditions."

Staff Response to Comment 20:

The DOE's intention to compensate for uncertainties inherent in the program of HLW disposal in geologic repositories by adopting a conservative, cautious, step-wise approach is consistent with NRC's approach to licensing HLW repositories.

Comment 21: Pinder enclosure in U.S. Department of Energy (18)

Pg. 31395, Col. 2, Line 9b-1b: Although I concur with the concept of uncertainty as a major problem with HLW repository siting, I feel the concept of uncertainty described here misses the mark. Perhaps it could be re-examined?

Staff Response to Comment 21:

The discussion in question meant to convey that one contribution to uncertainty arises from the uncertainties that exist in the understanding of the complex perturbations on the geologic and hydrologic environment caused by the presence of the waste and the repository. These uncertainties have been examined in detail by Bredehoeft and others (1978) in the U.S. Geological Survey Circular 779.

Comment 22: Pinder enclosure in U.S. Department of Energy (18)

Pg. 31395, Col 2, Line 31: Considering geologic disposal is an entirely new enterprise and that there will be no opportunity to observe behavior over the long term it seems contradictory to rely on expert opinion which, in turn, relies on past experience.

Staff Response to Comment 22:

The licensing of HLW repositories will rely on a number of factors including opinions of experts in the field. These experts can draw upon their practical experience to express the degree of confidence they have that the criteria, models, analyses, testing, etc. accurately reflect the performance of a geologic repository. The opinions of experts will, of course, be subject to scrutiny and challenge; and they will be given only such weight as is reasonable in the light of the record in the licensing proceedings.

Comment 23: Pinder enclosure in U.S. Department of Energy (18)

Pg. 31395, Col. 3, Line 13: The meaning of the statement regarding the separation of temporal and spatial elements of geological disposal eludes me. I cannot see how such a separation is possible either physically or mathematically. Moreover, were it possible, I fail to see how it would influence uncertainty.

Staff Response to Comment 23:

Temporal and spatial elements were separated for the sake of developing siting criteria. The phrase in question attempted to convey that some uncertainties are related to the long time span over which the HLW repository

must be in operation, while other uncertainties relate to the physical extent of the geologic and hydrologic system of the repository site. Uncertainties related to the passage of time include long term climatic variations, the degree of integrity of the waste packages and backfill, political changes, possible destruction of historical records on the repository site due to future activities, societal policy changes on HLW disposal, etc. Spatial aspects could include the rerouting of groundwater flow resulting from climatic changes or man-made enterprises (e.g., dams on surface), future seismic activity, faulting etc.

Comment 24: Parker enclosure in U.S. Department of Energy (18)

Page 31395, Item 4, the whole sentence states "First, geologic disposal is an entirely new enterprise/no experience with geologic disposal." It may be true that no experience exists with purposeful geologic disposal, but, in fact, one can find in salt mines relics from the Celtic age and one can find in Pompeii and other areas items that have been disposed of in a geologic setting which have remained inviolate over long periods of time. One can certainly obtain some data from these instances. The data base is not quite so bleak as is indicated in the discussion.

Staff Response to Comment 24:

See response to Comment No. 19.

Comment 25: Bird enclosure in U.S. Department of Energy (18)

P. 31395, No. 4, Treatment of Uncertainties. The statement, "First geologic disposal is an entirely new enterprise--no experience exists with geologic disposal" is misleading. The endeavor of geologic disposal of radioactive waste is not comparable in difficulty, for example, to landing on the moon. A great deal of experience and technology already exist to facilitate the task. What we want to do is, in a sense, the reverse of mining. What we want to have is great confidence in the permanence and safety of the resulting construction. Also, in the next sentence, "based upon observations of the past" does not make sense. What is intended, I believe, is -- based on observations and interpretations of the geologic record. The discussion of uncertainty is rather complex and confusing. I would argue that a large number of "geologic and hydrologic elements" in itself does not always lead to compounding uncertainty. Would one argue that a detailed map of the rivers of the U.S. is uncertain? We must specify scales when considering uncertainties in geologic feature or processes. Also, the last sentence is certainly wrong. How is it possible to argue that temporal and spatial relations are "separable aspects" of geologic disposal? This sentence supports my earlier view that the document is in places lacking in geologic understanding.

Staff Response to Comment 25:

The endeavor of geologic disposal of high-level radioactive waste may not be of comparable difficulty to various other human projects. However, the length of time necessary for the geologic repository to effectively contain or isolate HLW from the accessible environment is four to five orders of magnitude greater than that required for any human project to date.

Dr. Bird is correct in noting that the phrase "based on observations and interpretation of the geologic record" more aptly describes NRC's intended wording.

In response to Dr. Bird's example of a detailed map of the rivers of the U.S. it can be noted that the map itself would not be uncertain--however, the behavior of the rivers as a result of possible future forces (e.g., climatic changes, tectonic activity etc.) would be.

See also response to Comment 23.

Comment 26: Tauke and Adam (21)

Treatment of Uncertainties. "...no opportunity to observe behavior over the long term -- the decision to close the repository in effect will be a statement of its expected behavior based upon inference, deduction and extrapolation..." Considering the nature of the waste, and the uncertainties of its interaction with rock, it would seem short-sighted to be unable to observe it. With that many variables, it would also seem short-sighted to be unable to retrieve it even 1,000 years from now, with some wastes having a half-life of 24,000 years.

Staff Response to Comment 26:

The intent of the discussion was to relate NRC's recognition that there are uncertainties as well as means to deal with those uncertainties. The presence

of uncertainty does not imply that nothing can or should be done, but rather it demands that whatever is done be done with caution and conservatism.

Comment 27: Lowenstein, Newman, Reis, Axelrad and Toll (28)

The discussion of this important area [uncertainty] is unclear. For example, there is an implication that our understanding of natural processes in question is based upon descriptions and models. Is not the reverse the case? We agree that avoiding potentially adverse (geologic and hydrologic) features is one way of compensating for uncertainties. Placing constraints on siting and design and performance of components also may be an effective way to reduce uncertainties. However, a pre-requisite to the application of such an approach should be the determination of the relevance or importance of the uncertainty under question to the overall system performance and the sensitivity of the system performance to variations in the factor about which there is uncertainty. Otherwise there is a strong likelihood of a proliferation of constraints and criteria (manifested in this version of the draft criteria) that counter the systems approach and unnecessarily complicate repository program implementation and licensing. The statement about addressing individually the separable aspects (temporal and spatial) of geologic disposal as perhaps the surest means of dealing with uncertainties is vague and, as we interpret it, questionable. In our view, as indicated above, the surest way of dealing with uncertainties is to understand their real significance and to take such compensating action, if any, as may be needed based on such understanding.

Staff Response to Comment 27:

With respect to the comment on the technical criteria, some of the constraints placed on the design and siting criteria have been deleted from the proposed technical criteria to allow the designer more latitude in compensating for uncertainties. With respect to descriptions and models which discuss geologic processes, they are constructed from observation and intuition, and tested against other observations. Models sufficiently powerful to allow prediction are indeed the "way we understand" these processes. Separating the problem into various aspects is a useful step in understanding the significance of a given source of uncertainty. See also, responses to Comments 23 and 51.

Comment 28: Lowenstein, Newman, Reis, Axelrad and Toll (28)

The Advance Notice seems to fail to recognize that in order to deal effectively with any uncertainty, it is first important to determine its relevance or importance to overall system performance and the sensitivity of the system performance to the factor as to which there is uncertainty. In the absence of such recognition there is a strong likelihood of proliferation of constraints and criteria that counter the systems approach, as is manifested in the draft criteria.

Staff Response to Comment 28:

See response to Comment 27.

Comment 29: TASC enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

The statement that "geologic disposal is an entirely new enterprise--no experience exists..." is unduly negative in its tone. While it is true that man-made high-level radioactive wastes have not been disposed of for long periods on a production basis, there are applicable analogs and existing knowledge and data from the geologic record that provide a significant scientific and technological base with which to adequately cope with this "problem." As discussed in our major comments, it is essential to understand the significance of socalled "uncertainties" in order to deal with them appropriately. Implying that relevant knowledge and data does not exist (or ignoring its pertinence) does not help in achieving such understanding.

We do not understand how one can achieve useful or meaningful separation of temporal and spatial aspects of geologic disposal when they are so interrelated.

Staff Response to Comment 29:

See responses to Comments 9, 19 and 23.

(5) HUMAN INTRUSION

Comment 30: A. E. Wasserbach (17)

Section 5, Human Intrusions. The NRC would not have to be concerned about human intrusions in any high-level nuclear waste repository IF you were completely honest in telling the public the dangers associated with these wastes both qualitatively and quantitatively. The NRC and DOE have been very remiss in this and have simply put off the problem by promising a waste management and/or disposal program always sometime in the future.

Staff Response to Comment 30:

The most likely intrusions, in the judgment of the staff, are those which occur as a result of actions undertaken by intruders unaware of the presence or hazard of the HLW. The proposed rule contemplates long-term information techniques designed to minimize the probability of such unintended intrusions. See also response to Comment 31.

Comment 31: U.S. Geological Survey (12)

Page 31398, Col. 2, Part (7). It is noted that human intrusion cannot be prevented and that such intrusion may be either deliberate or inadvertent. Is it suggested that design of the repository consider methods that would facilitate intrusion and recovery of the wastes? Extensive knowledge of the repository and its contents would seem to be the best way of protecting future generations from the deliberate intruder. It would seem fruitless to try to specify a time when either deliberate or accidental intrusion is most likely to occur or to try to define a "reasonable" period of time.

Staff Response to Comment 31:

The Commission has adopted the position that common sense dictates that everything reasonable be done to discourage people from intruding into the repository. The proposed rule is written to direct site selection towards selection of sites of little resource value and for which there does not appear to be any attraction for future society. Further, in its application the DOE must describe in detail the measures taken or to be taken to preserve records, to regulate or prevent activities that could impair the long-term isolation of emplaced waste within the geologic repository, and to assure that relevant information will be preserved for the use of future generations. For a discussion of intrusion for the sake of retrieving the waste see comment 82.

Comment 32: Exxon Nuclear Co., Inc. (15)

There are certainly some desirable features in the philosophy regarding "Human Intrusions," i.e., site suitability criteria which would lead toward uninteresting sites having little or no resources. These criteria would appear to preclude the disposal of any significant quantity of spent fuel, since a large repository filled with spent fuel would contain an energy source equivalent to a major oil field, i.e., greater than the North Slope. As energy resources become increasingly more limited in the next several decades, and if advanced reactors operating on other than a throwaway cycle are deployed in large numbers, such a resource would be very attractive and could lead to purposeful human intrusion.

Following are several considerations which we believe need to be more fully addressed:

- No discussion is presented about the bases for a decision to permanently enclose the waste. While it may be premature to develop these bases or criteria in detail, we believe that a general outline of the decision bases should be developed.

- Criteria or considerations regarding the age of the waste prior to the burial are not presented or discussed.

- We believe that waste form is a very important parameter, as is waste type. This does not appear to be considered. For example, the release rates noted in 60.111, C.3.c., as may be required for wastes contained in spent fuel could be considerably different than that required for solidified wastes after fuel reprocessing.

- Although it is true that the geologic disposal of HLW per se is an entirely new enterprise, we believe it is misleading to omit the mention at this point of the wealth of relevant geologic, engineering and hydrologic data which are available.

Staff Response to Comment 32:

If a future societal or political decision is made to intentionally intrude a decommissioned repository appropriate legislation could then make it possible. The NRC cannot regulate the decisions or actions of a future society or government.

Both the ANPR and proposed rule set forth provisions for the disposal of HLW. The NRC's definition of this waste form is set forth in 60.2.

See also responses to Comments 9 and 19.

Comment 33: U.S. Department of Energy (18)

This discussion of human intrusion (p. 31398) identifies many problems and their lack of resolution. The rule should provide incentives for developing measures to decrease the probability or consequences of future human intrusion. It should clearly differentiate between active (institutional) controls and passive measures (e.g., markers, tell-tales, etc.). It should also recognize that avoidance of resources is a weak argument against future intrusion. Resources are largely determined by technology, i.e., our ability to use the resources. We do not know what future technology needs may be. The emphasis should be on communicating knowledge of the repository's existence to future generations such that inadvertent intrusion is avoided. Merely avoiding present resources provides little or no assurance. We intend to develop a position paper on this subject to use to initiate a dialog with the Commission staff.

Staff Response to Comment 33:

The proposed rule sets forth a number of specific records that must be preserved. The avoidance of resources was not meant as a guarantee against future intrusion but rather as a factor which would lessen the desirability of intrusion of the site in order to develop resources. The land-control criteria contemplate supplementary active controls.

Comment 34: Bird enclosure in U.S. Department of Energy (18)

"The only logical recourse, since engineering against human intrusion is impossible practically, is to avoid targets, i.e., sites which may invite such intrusion". If significant amounts of spent fuel are put into a geologic repository, an ore body has been created.

Staff Response to Comment 34:

The creation of an "ore body" by disposing of spent fuel is not a siting issue. The objective is to avoid to the extent possible inadvertent intrusion into the repository resulting from the exploration for, or development of resources associated with a site. See also response to Comment 33.

Comment 35: Tauke and Adam (21)

Human Intrusions. Those geologic, hydrologic or mineral resources that are not interesting to man now may be 1,000 years from now.

"...simplicity and stability of geologic settings." Is it feasible to try to predict geologic events with regard to the longevity of hazardous waste.

"...problems associated with HLW disposal are sufficiently understood, it is possible, even in absence of an EPA standard, to identify relevant areas of regulation..." This is debatable.

Staff Response to Comment 35:

It is not possible to predict what value present resources will have to future generations. The resource question can best be answered based on present notions of resources and in terms of relative abundances of naturally occurring materials.

The examination of the geologic record of a given area provides a means to predict future geologic processes in that area, due to the extremely long time scale over which geologic processes usually occur.

The problems associated with HLW have been investigated by the scientific and engineering communities in great detail. Many major issues have been identified and scrutinized in depth (e.g., pathways to man). There appears to be a consensus on how geologic disposal can and should be done, and an understanding of the key elements for successful geologic disposal. NRC believes that sufficient knowledge and understanding has resulted from these investigations to allow the preparation of technical criteria for regulating geologic disposal of HLW.

Although no EPA standard for disposal of HLW yet exists, the ANPR and the subsequent proposed rule have been developed to be compatible with a generally

applicable environmental standard. Specifically, the performance objectives and criteria address the functional elements of geologic disposal of HLW and the analyses required to give confidence that these functional elements will perform as intended.

Comment 36: Lowenstein, Newman, Reis, Axelrad and Toll (28)

The discussion of the human intrusion problem in the supplementary information (Nature of the Problem (5) and Considerations (7)) is internally inconsistent and, in our view, grossly misplaces emphasis on this issue. We would agree that, theoretically, over the long term human intrusion cannot be prevented. However, the implied notion that some society far into the future which possesses the geologic knowledge to determine the nature and extent of useful resources 600 meters underground and the technical capability to drill into and exploit such resources will at the same time be unaware of or unable to detect the presence of radioactive material or man-made artifacts, borders on the ludicrous. Then to suggest that the only logical recourse is to avoid sites which may invite such intrusion when spent nuclear fuel with its inherent resource value is being disposed of is anomalous, to say the least. Moreover, to state that the problem of human intrusion moots much of the previous discussions on the nature of the problem conveys the incorrect impression that, comparatively, other considerations and the criteria that might be related to them are really of no practical significance. As a result of this flawed thinking and the indication of a lack of understanding of the necessary distinction between containment and isolation*, i.e., protection of the public water supplies, for example, versus protection of individuals intruding into the waste (cf. footnote 1, p. 31395), unrealistic and unnecessarily restrictive criteria related to "potentially adverse human activities" are proposed.

Staff Response to Comment 36:

The inference made by the commenter was not meant to be drawn from the discussion in the Supplementary Information. If spent fuel is considered a resource, intrusion to recover it will hardly be inadvertent. Finally, human intrusion, whether accidental or deliberate, will in fact negate efforts to isolate wastes from the environment. See also responses to Comments 31, 32, and 35.

Comment 37: Lowenstein, Newman, Reis, Axelrad and Toll (28)

The discussion of human intrusion in the Advance Notice grossly misplaces emphasis on this issue and results in unrealistic and unnecessarily restrictive draft criteria relating to potentially adverse human activities.

Staff Response to Comment 37:

See response to Comment 36.

Comment 38: Attorney General Abrams, State of New York (11)

Similarly, the draft regulations do not face the fact that we cannot predict geologic events far into the future. Rather, they talk about compensating for the uncertainty, by selecting "geologically simple sites," avoiding potentially adverse features, and placing "constraints" on design and performance of components. P. 31395, Col. 3. But these minor steps hardly compensate for the large uncertainty, or even reduce it by any significant degree. As against the problem of uncertainty over a million years, they are a frivolous response. Indeed, talk of selecting geologically "simple" sites is pure fantasy and misses the point, because there is no way to predict that such sites will remain simple or stable even for centuries, let alone a million years.

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* See In the Matter of Proposed Rulemaking on the Storage and Disposal of Nuclear Waste, The Capability for Disposing of High-Level Wastes Safely Vol. 2 of Statement of Position in UNWMG and EEI), July 7, 1980, pp. I-4 to I-9.

Staff Response to Comment 38:

There are instances in which intense studies of the past and present geologic record can be used to offer substantiated predictions of future geologic events, as the CLIMAP study on long-term climatic changes, and preliminary earthquake predications (e.g., Blue Mountain Lake, N.Y.) have indicacted.

The term "geologically simple" was meant to convey the concept that the geology of the site would not be so complex as to preclude thorough investigation and evalutaion of the site characteristics that are important to demonstrating the siting objectives.

In terms of geologic history ($10^9$ years) a few centuries represents a rapid passing of time. Few geologic events occur instantaneously or even within the

span of a few centuries. For example, the onset of glaciation, mountain building, and plate tectonics are all processes which are active for periods of time on the order of at least $10^3$-$10^4$ years. Even earthquakes, which may seem instantaneous are the result of the release of stresses which had gradually built up within the Earth over long periods of time. Similarly, recent volcanism occurs in regions which are currently, or were at sometime in the geologic past, volcanically active. The selection of sites in areas where ongoing geologic processes have been virtually constant (though not static) since the Quaternary will give confidence that the likelihood of drastic changes in the future geologic record of the areas is minimal.

Comment 39: Pinder enclosure in U.S. Department of Energy (18)

Pg. 31396, Col. 1, Line 7b: In looking at uncertainty, I feel one must keep in mind the final goal. Is it (1) to make the uncertainty amenable to analysis, (2) to reduce its magnitude, (3) to evaluate its impact? Each objective requires a different course of action. The comment "Such measures..." seems to confound (1) and (2) above.

Staff Response to Comment 39:

A geologic repository consists of both engineered systems and a natural geologic environment. Any evaluation of repository performance will therefore consider the waste form and other engineering which is elemental to the repository as a system. By partitioning the engineered system into two major barriers--the waste package and the underground facility, and establishing performance objectives for each, the NRC has sought to exploit the ability to design the engineered features to meet specific performance objectives as a means of reducing some of the uncertainties in the calculations of overall repository performance. However, the goal is all three of commentors suggested options. Uncertainty can be made more accessible a d its impact more understandable as well as being reduced because engineering is more readily testible for expected performance than is geology.

UNDERLYING PRINCIPLES

Comment 40: Duke Power Co. (25)

We particularly agree with the statement that "the analyses and requirements must reflect a degree of examination and control which corresponds to the importance to safety of any given technical area." This concept is central to our understanding of the "systems approach" as advocated by the Interagency Review Group and the technical community at large. We would strongly suggest strict adherence to this principle will result in efficiencies in program implementation and regulation, as well as a more cost-effective waste management system.

Staff Response to Comment 40:

See response to Comment 51.

Comment 41: Parker enclosure in U. S. Department of Energy (18)

Page 31396, item 3, dealing with the conservative analysis, "conservative analysis because of the many uncertainties associated with high-level radioactive waste and geological repositories," reinforces my original comments that unless one is prepared to state what level of confidence one is willing to settle for, then one cannot handle these uncertainties. In carrying out a conservative analysis, one has to be careful that so many conservative assumptions are not made that eventually a less-conservative solution is found.

Staff Response to Comment 41:

The item referred to states that NRC will use conservative analysis in order to assure predicted compliance of a candidate repository site with the EPA HLW standard. Any such calculations which account for uncertainties will be done with a confidence level criterion in mind. The NRC has yet to decide on a particular kind of confidence level, be it qualitative (e.g. "reasonable assurance" without further specification), statistical or absolute. With a statistical confidence level, NRC would set a standard that there must be at least X% confidence that a particular site will meet the EPA standard. With an absolute confidence level, calculations would have to be done to seek the worst possible radionuclide release situation which could evolve. NRC would

then demand that a repository site undergoing the "worst case" performance would have to be predicted by the calculation to be in compliance with EPA standard.

The NRC is well aware that some conservative assumptions can work against each other to produce less conservative solutions. Identifying such situations will be part of the license review process.

Comment 42: TASC Enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

1. Particularly since it is expected that the EPA standard will be expressed in terms of a radiation dose limit to the individual, we believe that this approach (rather than release limits) should be reflected in NRC technical criteria.

2. We do not understand subsection (5), which should be clarified.

3. In subsection (7) as indicated previously the distinction between site suitability and site-facility acceptability is not clear. Further explanation is needed of the intended distinction.

Staff Response to Comment 42:

A release-rate regulation is more appropriate because it applies directly to the licensed activity. The connection between the release rate and the EPA standard is appropriately considered in the NRC rulemaking action. See also response to Comments 13, 35, and 36.

Comment 43: Cook enclosure in U. S. Department of Energy (18)

The discussion under Considerations, starting on page 31396, includes items which can be commended and others with car be criticized. As examples, a commendable statement is "The two most important attributes of the natural barrier are that the site should be geologically simple and stable so that the site can be easily understood...". On the other hand, a statement which can be criticized is "...whether the geologic setting at a particular site can fulfill the stated purpose of the geologic barrier relies fundamentally on the predictive power of the particular transport model appropriate to that site". In fact, the transport model may be quite correct but the field data used in it could easily be totally inadequate.

Finally the statement that "The lack of empirical data on the performance of engineered barriers or the inability to obtain credible data may preclude the development of use of credible quantitative models in the showing that either the uncertainties are addressed properly in the performance standards or the performance standards are met in a particular licensing action." is based on geologic analogs, the behavior of which over long periods of time is known and the properties of which have been, or can be, understood well. Such engineered barriers have all the long-term advantages of geologic media but their properties can be understood, determined and controlled for use in achieving assured performance of a repository.

The discussion and examples above indicate that the answer to Question 1 on page 31398 is "no, the list of considerations does not clearly, adequately and fully identify the relevant issues involved in disposal of HLW.".

Staff Response to Comment 43:

The second quote is taken out of context by the commenter. The portion of the statement quoted by the commenter was preceeded by a supposition that the determination of whether to license will be a calculation. If that supposition is correct, then the quote follows. Because of the limitations of models and modelling, a calculation cannot be the determination of whether to license.

The last quote cited by the commenter is also taken somewhat out of context. The ANPR only stated that some engineering may not be useful in terms of a quantitative demonstration of performance due to a paucity of data.

Comment 44: Department of Environmental Protection, State of Connecticut (27)

Although my knowledge of geologic repositories is limited, I believe that the list of considerations adequately identifies the relevant issues involved in disposal of high level waste.

Staff Response to Comment 44:

No response required.

(1) SYSTEMS APPROACH

Comment 45: Lowenstein, Newman, Reis, Axelrad and Toll (1)

We have two basic concerns with the draft regulation and the accompanying document entitled "Approach and Rationale." First, in our view, the proposal

is largely inconsistent with the widely accepted "systems approach" to nuclear waste management. We believe it is essential that the NRC regulations define standards and criteria for the acceptable performance of an overall disposal system so that sound programmatic and implementing decisions can be made that result in a conservative approach to meeting performance requirements through an appropriate combination of natural and engineered components of the system. Instead of focusing on performance of the overall system, the proposed regulation, in its present form, specifies minimum or absolute requirements for various aspects of components of the system. Whether or not any of these requirements are individually justifiable, we are concerned that when imposed as a group upon a proposed system they will result in a set of unrelated, unrealistic requirements that are not based upon potential risk to public health and safety or the environment, and that may not be attainable, in any one, specific geologic medium or site. In essence, they may amount to an unrealistic collection of redundant requirements which may conceivably be less conservative than appropriate requirements based on system performance. We urge the Commission to direct the NRC Staff to develop criteria and standards tied to a reference methodology for projecting repository performance that is delineated in a manner that bears a logical relationship to known risks (both radiological and non-radiological) from natural events and common activities.

(Note: Commenter's second concern is that the proposal contained little analysis or rationale in support of quantitative requirements.

Staff Response to Comment 45:

For a discussion of the "systems approach," see response to Comment 51. The criteria set forth in the proposed rule are closely tied to the performance objectives.

Comment 46: Atomic Industrial Forum (14)

The approach being taken by the NRC is not consistent with the objective stated on page 31396 nor with the 'systems approach" recommended by the IRG. We believe the the NRC should be establishing appropriate criteria and standards for the performance of the overall system, rather than defining specific performance values for individual components. The systems designer (DOE) should have the flexibility, for example, to permit optimum trade-offs between the waste form and the container design as long as the overall system meets those criteria that insure public health and safety.

Staff Response to Comment 46:

See response to Comment 51.

Comment 47: Exxon Nuclear Corp. (15)

The approach taken by the NRC does not appear to be consistent with the "systems approach" recommended by the IRG and as noted as an objective of the NRC: "the Commission staff believes that it is reasonable to couple a prudently and cautiously selected geologic setting (natural barriers) with a set of engineered barriers capable of performing or assisting the performance...(containment and isolation)." We believe that the NRC should establish appropriate criteria and standards for the performance of the overall system, rather than defining specific performance values for individual components. The systems designer (DOE) should have the flexibility, for example, to permit optimum trade-offs between the waste form, the container design, and the overpack as long as the overall system meets those criteria that insure public health and safety.

Staff Response to Comment 47:

See response to Comment 51.

Comment 48: Bird enclosure in U. S. Department of Energy (18)

The concept of "natural and engineered barriers" has led to considerable problems in assessing geologic disposal schemes. I consider this section to be one of the best examples in 10CFR part 60 of a lack of basic understanding about the geologic aspects of geologic disposal. If one argues that all of the components of the repository must be made of geologic materials or analogs of geologic materials, including the waste package, then "engineered barriers" are not something comprised of an artificial material for which there is no analog to be studied in this section is based on the view that the repository will contain parts made of artificial materials that will change or fail during the lifetime of the repository. It is stated that - "The state-of-the-art in the Earth sciences is such that all of the uncertainties associated with these functions can not be resolved through considerations of the geologic setting". This is not so. The Earth sciences can explain in great detail how rocks billions of years old formed and have existed to the present. Given a specific geologic site, many combinations of "engineered barriers" comprised of analogs of geologic materials can be compared and selected in designs to reduce or eliminate uncertainties about the performance of the repository. The statement -- "Engineering can be used to narrow the extent of geologic processes which need to be considered in the rule making and licensing processes; that is, engineering can be used to bound and/or diminish the importance of certain geologic processes: -- does not make much sense. Essentially, this is a philosophy that one "fights" the geologic features. I would argue that the repository must utilize the geology and be comprised of geologic materials of known properties and behavior under the conditions that would prevail in the geologic setting. Finally, the statement -- "Similarly, to the greatest extent possible, the performance of the engineered systems should be insensitive to changes in those characteristics and should provide a high degree of protection by themselves" reflects a lack of understanding about the possibility of introducing ingredients into the repository/waste package that in anticipation of changes such as inflow of water, would be sensitive to the change and react in such a way as to counter the adverse event. Many such

analogs of rock/mineral systems could be "engineered" from our understanding of geologic environments and processes. These possible ingredients for specific sites and anticipated processes need to be studied in detail. They promise to greatly increase our confidence about the behavior of a repository during its lifetime.

Staff Response to Comment 48:

The theory of uniformitarianism which underlies Dr. Bird's initial comment may explain how the present is the key to the past, but does not dictate that the present is the key to the future.

With respect to the statement "engineering can be used to narrow the extent of geologic processes which need to be considered in the rulemaking and licensing processes..."--the intention of the NRC was not to convey the idea that one "fights" the geologic features, but rather that the engineering can compensate for a potentially adverse or quantitatively intractable condition in the host rock. For example, an extremely impermeable backfill such as bentonite may be used to retard groundwater migration to the waste package and thus to compensate for a less impermeable host rock; the waste package can be designed to be quite resistant to leaching by groundwater; and materials with high sorptive properties could be incorporated into the engineered system to compensate for or to reinforce the sorptive properties of a host rock. The engineered barriers should be designed in anticipation of future changes which could occur in the host rock so that their expected performance is insensitive to those changes. The final phrase alluded to by Dr. Bird should convey a multi-barrier approach to isolation and containment of radionuclides and not a restricted engineered system. See also response to Comment 50.

Comment 49: Cook enclosure in U. S. Department of Energy (18)

In conclusion it is suggested that a systematic, hierarchical approach to the establishment of geologic waste repositories is likely to facilitate the

development of defensible regulatory criteria, including those of a specific nature, and that it is important to recognize that the establishment of a repository is likely to be a continuing process of selection based on the absence of any features which would disqualify a site or the repository within it, from providing reasonable assurance that radioactive wastes will be isolated from the biopshere adequately.

Staff Response to Comment 49:

No response required.

Comment 50: Environmental Protection Agency (23)

On page 31396 in the section on "Considerations", it is stated that engineering can be used to narrow the extent to which geological processes must be considered. This could be interpreted to mean that the NRC will allow substituting engineered barriers for poor geological characteristics. We feel that (1) a site with acceptable geologic characteristics should be selected and (2) engineering should be used to supplement the geology and enhance confidence that the waste will be retained in the repository. Thus, assurance will be given that engineering will add to the total effectiveness of a repository rather than substituting for a poor geological barrier. We believe NRC should give more emphasis to these points.

Staff Response to Comment 50:

See responses to Comments 39, 48, and 51. NRC's views are consistent with those expressed in the EPA comment. However, in terms of numerical analyses to determine whether the EPA standard is met, the engineering will carry the larger portion of the burden of containing the wastes. The reason for this is simply that the engineering is a testable system with properties which can be varied.

Comment 51: Duke Power Co. (25)

The discussion defines the term "systems approach" as "relating to the set of natural and engineered barriers which would function to contain and isolate the waste from the biosphere.." While this statement is true, we believe a "systems approach" means something more. The fundamental precept upon which this approach is founded is that the requirements for each barrier, or element of the system, should be formulated only in the context of its contribution to the performance of the overall system.

We agree with the discussion pointing out the "three primary barriers of the waste disposal system: the geologic setting; the design configuration of the repository, including the waste emplacement scheme and engineered barriers; and the waste package." We would point out however, consistent with the concept of a systems approach, additional engineered barriers between the waste package and the host geologic medium should not be a regulatory requirement unless they are shown to be necessary for overall system performance. Also, with respect to the three barriers delineated in the discussion, any analysis of health and environmental impact must also include the effects of dilution in the accessible environment and other processes comprising the pathways of radioisotopes to man. In a manner of speaking, this may also be regarded as a "barrier."

Staff Response to Comment 51:

The approach taken by the staff is not in conflict with the system approach. The staff fully recognizes that a geologic repository is a system. However the staff also recognizes that the system is comprised of two major components, the engineering and the site, which complement one another in a very natural way, both to achieve isolation of the wastes from the environment and to lend confidence in the determination that the wastes are indeed isolated. Specifically, the function and associated analysis of the two components, as set forth in the criteria, have been developed specifically to mesh in such a way that the engineering dominates under those conditions and during those times that the response of the site to the wastes is most uncertain and the site takes the major role when it is no longer realistic to rely upon the engineering. See also response to Comment 39.

Comment 52: Lowenstein, Newman, Reis, Axelrad & Toll (28)

One of the more basic concerns with this version of 10CFR60 is its identification of the "systems approach" as a fundamental requirement for implementing the deep geologic repository concept but then proceeding to place requirements on components and subsystems, presumably in the name of conservatism, that ignore the overall interactive behavior and performance of the system. The requirements for unrealistic redundancy, e.g., design a waste package and repository that assures complete safety even if the geologic barriers somehow prove to be useless and, concomitantly, find a geologic site that assures complete safety even if all the engineered barriers completely fail immediately upon repository closure. Even if such redundancy could be fully achieved, it would be obtained at a needless and inordinately expensive premium in time and cost. Inherent in requiring such extreme redundance must be assumption of probabilities and nature of failures which it is believed are incredible in a properly located, designed and constructed system.

An integral part of this same concern is the degree of detail in the requirements and specifications placed upon DOE. The presumed justification for this detail is to assure that all major safety-related features of the system are covered. Yet, anomalously on the other hand, much is made of the lack of direct experience in this area, the plethora of uncertainties and lack of knowledge or understanding of certain phenomena and their impacts. In our view, the system safety and performance objectives would be achieved in the most effective and timely manner if, given a clearly defined system performance objective, DOE was provided reasonable flexibility as to ability and audit by NRC regarding the selection, design and interactive performance of the major features of the overall system.

In our view, the proposed use of minimum performance standards for major regulatory elements and the numerical values proposed as performance specifications are basically inimical to a real systems approach, i.e., the tailoring of the components of the system to achieve the required overall system performance.

Staff Response to Comment 52:

See response to Comment 51. Setting minimum performance standards for individual barriers has been used to compensate for the major sources of uncertainty. Minimum performance standards will compensate for uncertainties by assuring a diversity of barriers and by establishing an appropriate distribution of safety margins among the barriers. The technical criteria have been revised to more clearly present the performance objectives and related requirements.

Comment 53: Lowenstein, Newman, Reis, Axelrad and Toll (28)

We believe that it is essential for the NRC regulations to define standards and criteria for the acceptable performance of an overall disposal system so that requirements can be conservatively met through an appropriate combination of natural and engineered components. Although the Advance Notice recognizes the desirability of the "systems approach," the draft criteria improperly and unrealistically place requirements on components and subsystems that wholly ignore the overall interactive behavior and performance of the system. The resulting redundant requirements are not only unnecessary and achievable only at a needless premium in time and cost, but would deprive the Department of Energy (DOE) of reasonable flexibility in achieving system safety and performance objectives in the most effective and timely manner. They are basically inimical to a real systems approach, i.e., the tailoring of the system to achieve the required overall system performance.

Staff Response to Comment 53:

See response to Comment 52.

Comment 54: Lowenstein, Newman, Reis, Axelrad and Toll (28)

Even if it were appropriate to impose requirements on individual components and subsystems, the Advance Notice fails to justify specific requirements in relation to the essential overall objective of protecting public health and safety and the environment. It also fails to compare the costs and benefits of such requirements versus alternatives or to consider the workability of such requirements in a regulatory framework. These problems are highlighted because both the Advance Notice and the previously proposed procedural portions of 10 CFR Part 60 (44 Fed. Reg. 70408) failed to provide a clear exposition of the rationale underlying the contemplated regulatory procedures and requirements. It is essential that all requirements be justified through an overall rationale which reflects an appropriate understanding of relationships between characterization procedures and activities, repository system design, data acquisition, performance evaluation vis mathematical models and testing, performance objectives in relation to protection of public health and safety and the environment, etc.

Staff Response to Comment 54:

The rationale for the performance objectives included in the proposed technical criteria is being published separately and is available free of charge upon written request.

Comment 55: TASC Enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

a. In general, but with some exceptions, this discussion seems reasonable. Unfortunately, however, as noted elsewhere in our comments, the Advance Notice then seems to ignore and even to contradict implementation of the systems approach concept and to substitute over-emphasis and over-specificity on component details.

b. The considerations should recognize that currently we are talking about a repository that will not be in operation for a number of years. In view of this, it is not realistic to expect generic specifications developed now to meet the requirements of a site-specific situation that far in the future. Instead, we believe the emphasis should be on the systems approach in which the criteria relate to overall performance, particularly at this stage of program implementation.

c. The point is made, erroneously we believe, that to the greatest extent possible, the performance of engineered systems should be insensitive to changes in geologic and hydrologic characteristics of the repository. We believe the reverse is true.

Staff Response to Comment 55:

Some of the quantitative criteria that did not directly relate to the performance objectives have been deleted from the proposed technical criteria. See also responses to Comments 48 and 51.

(2) USE OF MINIMUM PERFORMANCE STANDARDS FOR MAJOR REGULATORY ELEMENTS

Comment 56: Duke Power Co. (25)

With respect to the discussion regarding minimum performance standards, we agree that such standards are sometimes appropriate. for instance, during handling and emplacement, the waste package must retain its integrity under normal and hypothetical accident conditions, for protection of operating personnel. However, the danger in the widespread use of minimum performance standards for each element of the system is that, if too stringently set, the can defeat the systems approach concept which looks to overall system performance as the only meaningful figure of merit.

Staff Response to Comment 56:

See responses to Comments 6, 51, and 55.

Comment 57: TASC Enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

Our major comments reflect our concern as to the improper focus on standards imposed on components and subsystems rather than the performance of the repository system as a whole. As to such overall standard we suggest that a more direct articulation would be to first acknowledge the requirement to meet EPA standards, explaining that all credible events and their consequences need to be postulated and evaluated to ascertain whether the EPA standards are met. Secondly, the term "performance requirement" should be defined and its relationship to the EPA standard should be described.

Staff Response to Comment 57:

The performance objectives have been revised to clarify required conformance with generally applicable EPA standards. The term "performance requirement" has been deleted from the revised text.

Comment 58: U. S. Geological Survey (12)

Page 31397, Col. 1, Part (3). In the first paragraph the phrase "so that the site can be easily understood" could be made more precise by substituting in

future documents "so that geologic and hydrologic conditions can be easily extrapolated from one area to another."

Staff Response to Comment 58:

The phrase referred to by the USGS has been revised in more precise terms.

See also response to Comment 4.

Comment 59: Bird enclosure in U. S. Department of Energy (18)

"The two most important attributes of the natural barrier are that the site should be geologically simple and stable so that the site can be easily understood and so that there can be confidence that the ability of the site to contain and isolate the eastes will remain viable for long times." I would ask what constitutes "simple and stable." For example, basalt is not a "simple" rock in terms of its composition. What constitutes stability, e.g., tectonic stability, chemical stability, thermal stability, and to what limits? In the second paragraph, -- "their insensitivity to any changes in the site characteristics so that there can be confidence in the predictability of their performance over time"; this requirement is wrong. It can be argued that one can engineer a "barrier" that would be sensitive to a change, and would react so as to counter deleterious effects of the change. For example, an overpack containing MgO would react with entering water to produce brucite, $Mg(OH)_2$. The reaction has a significant volume increase and could tend to seal the water pathways and counter the further encroachment of water.

Staff Response to Comment 59:

See response to Comment 4. The term stability was used in the context of tectonic stability. For a discussion of engineered barriers' insensitivity to change see response to Comment 48. Dr. Bird's example of the formation of brucite is consistent with the discussion presented in response to Comment 48.

Comment 60: TASC enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

The natural barrier, i.e., the site, should first have characteristics needed for waste containment and isolation. One of these characteristics is stability. Of equal importance is little or no water flow. Simplicity is a different type of attribute; it aids selection of geohydrological models and confidence in results obtained from the use of such models.

Staff Response to Comment 60:

No response required.

(4) ADEQUACY OF FAVORABLE AND UNFAVORABLE SITE CHARACTERISTICS TO IMPOSE PROPER TECHNICAL RESTRICTIONS

Comment 61: Parker enclosure in U. S. Department of Energy (18)

Page 31397, Item 4, last sentence, "it will be necessary to determine the site-acceptability question on a case-by-case basis." Since there will be so few sites selected, picking them on a site-by-site basis is not such a bad idea, but more substance has to be given so that, in fact, the agency can have some indication whether or not it would be possible to obtain a license prior to going to the expense of developing a full-scale repository.

Further justification needs to be given for the basis upon which models are almost totally excluded except to compare sites and designs. It is not clear at all how the long-term (far future) dosages can be determined except by the use of mathematical models. While the absolute value of the numbers certainly cannot be taken to be very accurate, it is difficult to see other methods that will be superior. Expert opinion leaves the process so open ended that it is difficult to see how one can avoid using models to bound long-term futures. The major advantage of the models is that the assumptions must be documented, whereas expert opinion is based upon internalized models.

Page 31399, definition of expected processes - unfortunately agencies have frequently tried to redefine the English language. It is indicated here that human intrusion is not to be treated as an expected process and event. It should be so treated. Definition of high-level radioactive waste should indicate that spent reactor fuel will be treated as waste if so defined. Should follow the International Atomic Energy Agency's definition of high-level waste.

Staff Response to Comment 61:

DOE must submit a license application and be granted construction authorization by NRC prior to developing a repository. On the basis of that application the NRC will determine whether it believes that a licensable repository can be constructed at DOE's proposed site.

Estimates of long-term releases are part of the site and design evaluations which are performed using quantitative models. Expert opinion on what constitutes appropriate quantitative models will be reflected in the models selected.

The likelihood of human intrusion cannot be quantified or bound. It is therefore not included as an expected process or event. Analysis of the historical record indicates that there is a high degree of continuity of information transfer

over time which makes loss of societal memory of the site highly unlikely and therefore minimizes the possibility of inadvertent and deliberate human intrusion. In any case, the Commission believes that DOE should be required to do all that is reasonable to make inadvertent human intrusion as unlikely as possible. Thus the NRC will require careful marking of the site, storage of site information in a number of off-site locations, and evaluation of current or potential site-connected resource value as part of the site suitability criteria. However, evaulation of the potential consequence of human intrusion does not seem to be a way to shed much light on expected repository performance.

It is the Commission's view that, for purposes of Section 202 of the Energy Reorganization Act, spent reactor fuel is high-level waste if it is to be disposed of at a geologic repository.

Comment 62: Tauke & M. Adam (21)

Reading and re-reading consideration #4 leads one to wonder how the NRC can possibly consider licensng the DOE for HLW disposal. Specifically "...the question of general site acceptability criteria is an open one in the sense that the staff has not identified to date such criteria..."

Page 31398, Para. #2 "...Through expert opinion in public proceedings, and the exercise of judgment by the Commission, a satisfactory if imprecise margin of safety for site characteristics and engineering design can be realized..." satisfactory - maybe for DOE and NRC. What about the people who live near the site - will they be comfortable with a "satisfactory if imprecise margin of safety"??????

Staff Response to Comment 62:

The impression being discussed in calculational. The fact that it may not be clear whether the safety margin is a factor of 2 or a factor of 4 because of uncertainties in the calculation does not detract from the fact that there is indeed a margin of safety.

Comment 63: Duke Power Co. (25)

The discussion regarding the adequacy of favorable of unfavorable site characteristics to impose proper technical restrictions raises the question as to whether it may be appropriate to impose general site acceptability criteria or to determine site acceptability on a case-by-case basis. We believe a search for sites is quite properly guided by site suitability criteria; however, at the stage where a potential site must be analyzed for ultimate acceptability it is our view that such a determination should be made on a case-by-case basis. This, we feel, is consistent with the systems approach concept.

Staff Response to Comment 63:

The NRC recognizes that no "perfect" or "flawless" site exists in nature, and that both favorable and potentially adverse conditions may be present. The program of site characterization will allow the DOE to gain adequate information about the favorable and potentially adverse aspects of each site. DOE's preferred site should be selected from among the best that can reasonably be found.

NRC's intended use of favorable and unfavorable site characterisitcs has been clarified in the proposed rule.

Comment 64: TASC enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

In our view, the order and strength of describing unfavorable vs. favorable characteristics are misplaced, revealing a negative approach to licensing that does not contribute constructively to the procedure nor the outcome. Unfavorable site characteristics are dealt with absolutely, while favorable ones are considered relatively, unduly emphasizing what makes a site bad rather than makes it good. Also, the statement that site acceptability criteria have not been identified is unclear, particularly since the draft rule includes a number of criteria regarding site acceptability, suggesting that they have been and can be identified. Clearly, there will have to be included better guidance as to how favorable and potentially unfavorable site conditions can be weighed against one another or compensated for by other system features.

Staff Response to Comment 64:

The format for the presentation of conditions that may contribute to waste isolation and conditions that can adversely affect waste isolation has been

reorganized in the proposed technical criteria. Conditions that can adversely affect waste isolation include physical situations that NRC believes could jeopardize the integrity of a geologic repository. The identification of an adverse condition(s) would not automatically eliminate a site from consideration as a potential repository but would indicate the necessity of further investigation and analysis to demonstrate that the condition(s) does not compromise the performance of the geologic repository. See also, response to Comment 63.

(5) CODIFICATION OF MODELS IN LICENSING PROCESS

INTRODUCTION

A number of public comments on the ANPR addressed the discussion of the codification of models in the licensing process. Before responding to any of the comments in particular, some general remarks on how the NRC views the modeling process are in order. These remarks will cover the distinction between qualitative and quantitative models, what the staff feels are the important steps and potential sources of uncertainty in the modeling process, and the role which judgment plays throughout the modeling process. What follows sets forth the bases for the NRC staff's position that judgment is the key ingredient of each step in the modeling process. Responses to the comments will be made in light of the fact that staff feels that judgment is intrinsic to the modeling process.

In the process of modeling a set of physical phenomena, two kinds of models are considered: qualitative and quantitative. A qualitative model is a verbal description of the physical processes that are taking place. What a

modeler considers to be an adequate qualitative model is always a matter of judgment. One always has to formulate a qualitative model before emulating it with a quantitative model. The accuracy of the model is a measurer of how closely the description tracks the physical process being described. The quantitative model consists of a set of mathematical relationships which are intended to describe in a precise way the interactions among the phenomena that make up the physical processes which are described verbally but imprecisely in the qualitative model. Numerical values of physical quantities that characterize the consequences of the physical processes can be obtained from quantitative models, but not from the qualitative models. However, the quantitative model will not be any more accurate in mapping the physical process being modeled than the qualitative model from which it was derived.

Quantitative models are generally formulated under the assumption that one is given a set of well defined parameters, in the form of initial conditions, boundary conditions, and properties. The initial conditions specify the initial values of physical quantities being sought throughout the space in which the physical processes will subsequently take place. The boundary conditions specify the histories of those physical quantities on the borders of the space in which the physical processes take place throughout the time in which the processes take place. The properties will control how quickly the physical processes occur and how the desired physical quantities will be distributed at any given time. Judgment plays a key role in identifying appropriate properties.

In an ideal situation, the following conditions would hold throughout the modeling process. The qualitative model would account for all physical processes and relationships which need to be taken into consideration to

describe accurately the situation being examined. The quantitative model would accurately specify all of the precise mathematical relationships needed to emulate the qualitative model completely. The initial conditions, boundary conditions, and properties would be known exactly and one would be able to obtain exact values of the desired physical quantities, throughout the space and time of interest, from the mathematical relationships which comprise the quantitative model.

In reality, the modeling process is nearly always less than ideal. Modeling is imperfect because simplifying assumptions and approximations can be and often need to be introduced into every step of the modeling process. The choices and estimated effects of appropriate simplifying assumptions and approximations are always a matter of judgment.

The verbal description in the qualitative model may be incomplete or incorrect. It may not be possible to specify all of the mathematical relationships needed for the quantitative model. The initial and/or boundary conditions may not be well known. Very often, properties are difficult to determine. Finally, even if the qualitative model is perfect and the quantitative model is completely faithful to the qualitative model, it is very often impossible to obtain exact solutions to the mathematical relationships that constitute the quantitative model.

The mathematical relationships that make up a quantitative model are generally continuous in nature in that they describe continuous changes in time and space. Exact solutions of the mathematical relationships would describe continuous histories and spatial distributions of the physical

quantities being sought. When exact solutions cannot be obtained, there are many ways in which approximate solutions can be obtained. One particularly attractive avenue to obtaining approximate solutions is to establish discrete mathematical relationships which are approximations of quantitative models continuous relationships. This is done by selecting a finite number of points in time and space and examining how the continuous relationships may be approximated by making use of the values of the desired physical quantities at those points. Both of these steps require judgment. The solutions obtained from the approximate discrete relationships give values of the desired physical quantities only at the preselected finite number of spatial and temporal points. With a correctly established approximation procedure, better approximations to the exact solutions can be obtained by selecting a larger finite number of spatial and temporal points closer together.

The discrete approximation procedure described above is always mechanical and repetitious, and therefore amenable to digital computer programming. Computer programs, or codes, can be written to implement the discrete approximation procedure on a high speed digital computer. Alternatively, if exact solutions of the mathematical relationships of the quantitative model are available, computer codes are often written in order to extract numerical values from the expressions making up the exact solutions. The computer code is usually the most visible element of the modeling process because the code can be used to obtain numerical values of desired physical quantities in fairly short order. This has led to the unfortunate term "computer model," although computers themselves are totally incapable of performing any part of the model formulation task. The computer code is merely a set of instructions which a digital

computer follows to carry out the discrete approximation procedure or to evaluate expressions making up exact solutions. In either case, the use of computers introduces additional approximations and additional elements of judgment to the modeling process. The approximations arise from the fact that computers cannot be infinitely precise in their manipulation of numbers. A poor selection of a numerical method can have disastrous effects on the numbers obtained from discrete approximation procedures. When computers are used to evaluate expressions for exact solutions, one has to bear in mind that those expressions are often replaced by approximate representations and the numbers obtained from the computer are actually obtained from the approximate representations. Judgment is important throughout the process of writing a computer code. The ease of use of the code and the clarity of the presentation of numerical information generated by the code are strongly dependent upon the judgment exercised in writing the code.

The current state of modeling of physical processes associated with HLW geologic disposal is that the verbal description of what is expected to happen is a reliable one, but controversy remains over what mathematical relationships are useful in establishing the quantitative model. The present state of modeling for geologic repositories is closer to quanlitative than quantitative in the sense that the qualitative model is nearer to being a perfect qualitative model than the quantitative model is to being a perfect quantitative model. Furthermore, the present state of quantitative modeling is more approximate than exact in that the governing mathematical relationships contain approximations which may be in need of improvement or replacement, and the initial conditions, boundary conditions, and properties needed for those relationships are often difficult to define with a high degree of certainty.

It is unlikely that the geologic and hydrologic modeling required for analyzing a HLW geologic repository will even attain the level of "an elegant theory embodied in a mathematical description which represents a culmination of human thought." The knowledge needed for such a theory would require detailed information about the structure of the geologic and hydrologic media. Since such information cannot be obtained by any practical means, it is very likely that the geologic and hydrologic modeling required to determine the transport of radionuclides from HLW will always be based on approximate theories. It is the opinion of the NRC staff, and of experts consulted by NRC, that the present approximate theories could stand considerable improvement. Therefore to codify any particular quantitative models at this time is, in the NRC staff's opinion, inappropriate.

Comment 65: Attorney General Abrams, State of New York (11)

The draft sidesteps the problems of uncertainty also by turning to models and engineered barriers, but neither of these is an adequate response. Models are acknowledged to be very indefinite, approximate and "qualitative" rather than quantitative. P. 31395, Col. 2-3; p. 31397, Col. 2-3. The models are also highly subjective, based not on facts but on "expert opinion," yet it is recognized that different experts may have differing opinions. P. 31397, Col. 3. Additional problems with reliance on models are spelled out at pp. 50-54 of the Appendix annexed to these comments. To rely on subjective, qualitative models known to be inaccurate and uncertain, and based on insufficient data, to assure isolation for a million years appears to be reckless.*

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* The term "qualitative model" itself is confusing and requires explanation, but in any case such a model does not appear to have any real value for the process of assuring isolation for a million years.

Comment 66: Attorney General Abrams, State of New York (11)

As previously noted, p. 9, models are very inaccurate, uncertain and subjective, and therefore not reliable. For this reason it would be wrong to codify them in the regulations, as discussed beginning at p. 31397, col. 2.

Staff Response to Comments 65 and 66:

The uncertainties which have to be treated in the geologic repository of HLW arise because knowledge of the detailed geologic and hydrologic structure of

the natural media separating the HLW from the accessible environment will never be known. Therefore, the uncertainty problem can be made tractable by surrounding the HLW with engineered barriers which can be characterized with a high degree of accuracy and precision. The engineered barriers provide the first line of defense against the release of radionuclides to the accessible environment. Should the engineered barriers fail, the geologic and hydrologic media surrounding the repository will provide the second line of defense. However, because of the presence of the engineering, the required degree of accuracy and precision needed to give confidence in the site sufficient for licensing is relaxed to the point that existing quantitative models will likely be sufficient, although they are approximate, and expert opinion varies over the correctness of many of their approximations. In fact, The models seem to be reliable enough so that, when properly applied, they can be used to help identify sources of uncertainty and they can serve as a guide in finding ways to control uncertainty.

Comment 67: U. S. Geological Survey (12)

Page 31397, col. 2, part (5). It would seem almost impossible from a practical standpoint to codify in the regulations the models to be used to simulate the geologic processes affecting the performance of a repository. However, in view of the fact that predictions of alternative possibilities cannot be made without modeling, the regulations should state that judgements of the adequacy of a site will be based in part on the results of modeling. The statement in the regulations regarding modeling should be more positive than merely allowing the use of models. It should make it clear that the use of appropriate models will be expected particularly for predictive purposes. Without such models there will be no sound basis for forming expert opinions as to overall site suitability.

The appropriateness of the various models for their intended purpose and the degree to which the models approximate natural conditions must be evaluated. We question the assumption that only "old models" will be used in the foreseeable future.

It appears inconsistent to permit the use of quantitative models to compare sites and designs, which involve evaluation of the same parameters and uncertainties as a licensing decision, but to downgrade their significance in a licensing decision. Models are an essential tool for evaluation although they may be insufficient as a sole basis for judgement.

Comment 68: Bechtel National, Inc. (13)

The staff's position "not to require modeling to be the primary decision tool to determine the capability of the geologic repository to contain and isolate waste from the biosphere," as stated in the Supplementary Information, is unfounded and inappropriate. Models are generally recognized as the primary means for assessment of all complex technological systems where neither direct experience nor recourse to experimental verification exists. They are the means to systematically and logically express the sum of our knowledge (both factual and judgemental) concerning the behavior of a system under a postulated set of conditions. In addition, models can and should be used as a means to unify "expert opinion" so as to eliminate controversy and the imposition of arbitrary and capricious judgements on an ad hoc basis. Qualitative factors and judgements can be readily incorporated into models to assure that they provide conservative predictions of system behavior and adequately bound or account for the uncertainties of our knowledge. Furthermore, requirements can be established that require models to predict acceptable system behavior under a set of initial conditions that are extreme or even incredible. Consequently, the staff's arguments that models cannot accurately predict the behavior of a repository system do not detract from the fact that models can and should be used as the primary decision tool for system assessment.

Comment 69: Pinder enclosure in U. S. Department of Energy (18)

The proposed rules recognize the irreducible residual uncertainty inherent in forecasts of environmentally related processes. Radionuclide transport is, of course, such a process. However, the concomitant deductions regarding modelling which appear to have arisen out of this recognition warrant additional consideration.

Models, whether they be mathematical, physical or electrical, assist the hydrologist in predicting the behavior of hydrologic systems under new or existing stresses. They play a particularly important role when a system is so complex that hydrologic insight and experience are inadequate to provide an accurate determination of system behavior. In systems which respond very slowly one cannot rely on observed behavior to predict the future and models are essential in providing meaningful forecasts. The radionuclide transport problem certainly qualifies as a candidate for modelling when viewed from this perspective (this is consistent with the discussion of "fundamental difficulties" on page 31395).

While it is evident to most hydrologists that modeling is an important tool in forecasting the movement of contaminants in the subsurface, one may argue that our knowledge of the HLW disposal site is so inadequate that such models are fraught with fundamental irreducible uncertainty. Recall, however, that a model is simply the physical or mathematical realization of our conceptual understanding of the problem. In other words the accuracy of a model is a direct reflection of the accuracy of our conceptual model. All field investigations are designed to enhance our conceptual and, by inference, mathematical (or physical) model of the system. If the inherent uncertainty in our mathematical model is so great as to preclude its utility as a forecasting tool then, inasmuch as our conceptual model exhibits the same uncertainty, there is very little hope that "expert opinion" will provide additional insight. One must then conclude that one of two alternative remain. (1) additional field experiments or alternative investigations must be

performed to reduce the residual uncertainty or (2) the fundamental HLW problem is not amenable to analysis in a classical scientific or engineering sense.

It is stated position of the Commission staff "not to require modelling to be the primary decision tool to determine the capability of the geologic repository to contain and isolate wastes from the biosphere." I am diamatrically opposed to this point of view. I believe that a model (probably but not necessarily mathematical) is an essential element of the decision making process. It provides the following advantages:

(1) it presents, unambiguously, to the scientific community and public at large the state of knowledge regarding the behavior of the system

(2) it provides a clearly defined focus for professional discussions, contributions and criticisms which gradually illuminate our understanding of the behavior of the proposed repository site

(3) it allows us to evaluate the impact of our lack of knowledge on the acceptability of a particular site. The simplest type of analysis along these lines involves the use of ranges of parameter values in a series of simulations

(4) it is only methodology that will provide meaningful information on the time of travel of radionuclides from the disposal site to the biosphere under various breaching scenarios

(5) carefully orchestrated, the model can be used to demonstrate to public officials and the general population the probable behavior of the repository under a reasonable range of conditions.

In summary, I feel that a representative model of any potential site is a necessary but not sufficient condition for licensing. To attempt anything less would surely jeopardize the credibility of the licensing program in the eyes of the scientific community.

Comment 70: Pinder enclosure in U. S. Department of Energy (18)

Pg. 31397, Col. 2, Line 5b: The general discussion of modelling appears naive. The allusion to qualitative models is inaccurate and inappropriate. I strongly recommend reconsideration of this entire section (5). If I were to present all of my concerns about this section it would require another much longer report.

Staff Response to Comments 67- 70:

Many of these comments concern the following topics: qualitative and quantitative modeling, codification of quantitative models in licensing decisions, the role of judgment, and the applicability of modeling to particular HLW geologic repositories. The items just listed have been discussed already in the Introduction section to the public comments on the codification of modeling.

Some confusion has been caused by item (5c) under "Codification of Models in Licensing Process," which reads:

> Recognize that for the foreseeable future, the "old" models, in which there is the greatest confidence because of their "proven" use appear to be as quantitative as they are qualitative.

NRC is not assuming that only "old" quantitative models will be used in licensing decisions. It is only stating that for the foreseeable future, the greatest confidence will be accorded to "old" quantitative models because of their "proven" use.

Several comments (68, 69, 74, 76, 77) express opposition to the NRC's position "not to require modeling to be the primary decision tool to determine the capability of the geologic repository to contain and isolate waste from the biosphere." The NRC staff feels that modeling cannot be the only, nor can it always be blindly followed as an overriding decision tool in the licensing process. Confidence in the result of a calculation is not equivalent to getting the "right number."

The NRC's decision not to allow modeling to be the primary decision tool in the licensing process was not meant to imply that the NRC does not recognize the importance of models or that licenses for HLW disposal might be issued with or without the use of models in site evaluation. Several commenters have gone to great lengths to explain why modeling is essential to any licensing decision. NRC agrees that modeling is an essential element of a licensing decision, but it cannot be the only element or the overriding element.

In response to the last sentence in Comment 74, NRC recognizes that quantitative assessments have to be performed in order to show that the expected releases of radionuclides from a proposed HLW geologic respository are in compliance with EPA numerical performance requirements. Due to the uncertainties inherent in hydrologic modeling, judgment will have to be exercised in deciding what calculations should be done. It is expected that ranges of release parameters will be calculated. A calculation indicating that all of the release parameters are consistent with the EPA standard will be a prime indicator that releases from the proposed repository will meet the EPA standard, provided there can be confidence in the calculation.

The last sentence of the first paragraph of Comment 77 correctly states that there is no relationship between the discussion of models in the Supplementary Information and the draft technical criteria of 10 CFR Part 60 in the ANPR. Quantitative models have been used to develop several of the technical criteria for 10 CFR Part 60. In their final form, the 10 CFR Part 60 technical criteria will serve as a "template" for DOE in the siting and design of HLW geologic repositories. After DOE has sited and designed a repository, DOE and NRC should then be able to employ quantitative models to acquire confidence that the repository is a safe one.

Comment 71: Pinder enclosure in U. S. Department of Energy (18)

Pg. 31398, Col. 1, Line 14b: "A satisfactory if imprecise margin of safety". I have more than a little difficulty accepting an imprecise margin of safety as satisfactory -- perhaps you could substitute another word for satisfactory.

Staff Response to Comment 71:

See response to Comment 62.

Comment 72: Bird enclosure in U. S. Department of Energy (18)

The first sentence of the second paragraph is too complex. Also, as stated in the next sentence, I am not sure that it is a fact. However, the point that we should not rely solely on quantitative calculations and assessments in developing technical criteria, or licensing, is very important. It is well known that geologic features and processes have many variables. Attempts at quantification can lead to a great deal of effort to solve what might be relatively unimportant or ancillary questions.

Staff Response to Comment 72:

The staff agrees whith Dr. Bird's point.

Comment 73: Bird enclosure in U. S. Department of Energy (18)

P. 31358, 1st column, 17 lines from bottom--a satisfactory if imprecise margin of safety for site characteristics and engineering design can be realized". What is an imprecise margin of safety? I do not think it would be satisfactory.

Staff Response to Comment 73:

See response to Comment 62.

Comment 74: Environmental Protection Agency (23)

In the same section in (5) "Codification of Models in the Licensing Processes", NRC concludes that, because of the great uncertainties involved, the state of knowledge to determine the adequacy of a site is more qualitative than quantitative. Therefore, NRC proposes to rely primarily on judgements by experts in the applicable fields to arrive at a decision, rather than on numerical assessment methods (models). EPA agrees with NRC that, at the present stage of development, it is premature to codify specific models for use in the analyses. However, EPA plans to include both qualitative and quantitative requirements in its proposed standards. Therefore, EPA recommends that NRC expand the discussion to state that quantitative assessments must be performed, at least to the extent necessary to assure compliance with EPA numerical performance requirements.

Staff Response to Comment 74:

See response to Comments 67-70.

Comment 75: Duke Power Co. (25)

With respect to the discussion as to whether regulations should codify models to be used in licensing analyses or simply allow their use, it is our view that some degree of codification will be required. In the absence of such codification, the licensing proceeding will be unduly complicated and extend

not only to whether the repository meets all applicable criteria, a question quite properly addressed in such a proceeding, but also to the question as to whether the analytical models perform adequately and as they are intended.

While we claim no particular expertise in the area of nuclide transport modeling, it is our view based on our present knowledge that the statement "the 'old' models, which there is the greatest confidence because of their 'proven' use appear to be as qualitative as they are qunatitative" is in error. All models have their limitations' they represent, to varying degrees, approximations of reality. The key to the proper use of models does not necessarily lie in their development to the stage of an "elegant theory embodied in a mathematical description which represents a culmination of human thought," but rather in an understanding by the user of the limitations of the model and the sensitivity of the overall model results to approximations internal to the model and uncertainties in input data.

Staff Response to Comment 75:

See response to Comments 67-70.

Comment 76: Lowenstein, Newman, Reis, Axelrad and Toll (28)

The discussion of use of models in the licensing process requires clarification and updating, and the Advance Notice does not seem to appropriately recognize the usefulness and even necessity of models as analytical tools required in the design and prediction of performance of repository systems.

Staff Response to Comment 76:

See response to Comments 67-70.

Comment 77: Lowenstein, Newman, Reis, Axelrad and Toll (28)

In this important subject area, clarification and updating of the discussion in the supplementary information (pp. 31337-8) are needed. For example, we question the validity of the statement to the effect that "old models in which there is the greatest confidence because of their 'proven' use appear to be as qualitative as they are quantitative." The discussion appears to support the use of models to develop technical criteria but on the other hand states that the technical justification for technical criteria should not be based on the results of quantitative modeling. This appears to be inconsistent Further, it is not at all apparent how the draft criteria relate, if they do at all, to the discussion on models and their codification.

While the various limitations of models pertinent to repository system analysis and design are recognized, their use is essential, particularly with respect to the prediction of system performance in the future. First of all, there is no other methodology or approach that will be better. The major and even critical utilitarian feature of models is that assumptions involved in the model, its structure and the quantitative inputs into the model must be

rigorously and specifically identified and recorded and therefore the models and their results are amenable to rational, critical review and evaluation. Expert opinion, while certainly useful, is, in essence, based on internalized models or subjective judgments, which are less susceptible to critical analysis.

The appropriate use and utility of models does not necessarily depend on their being developed to the point of an "elegant theory embodied in a mathematical description which represents a culmination of human thought" (whatever that might mean), but more on the proper understanding of the model itself, its limitations and the determination of realistic inputs to the model taking into account their uncertainties. Because of the importance of application of models to repository system analysis, design and prediction of performance, it is clear that some degree of model codification will be required. Otherwise technical decisions are likely to be based on ad hoc and even nontechnical judgments that are further likely to result in inconsistencies, excessive conservatism and unnecessary delay in the accomplishment of objectives.

Accordingly, it is strongly suggested that proposed technical criteria recognize the usefulness and even necessity of models as analytical tools required in the design and prediction of performance of repository systems. The application of such models does not exclude the incorporation of "expert opinion" in the necessary decision making processes. Indeed, it is the combination of systematic, logical procedures for analysis (models) and quantitative descriptions of uncertainties with expert opinion that is explicit and amenable to critical analysis which represents what has come to be known as "decision analysis." The criteria at this time need not and should not specify detailed model characteristics or requirements.

Additional discussion of the use of models in the licensing process is set forth in Appendix A, which contains comments prepared by The Analytic Science Corporation.

Staff Response to Comment 77:

See response to Comments 67-70.

Comment 78: TASC enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

The subject discussion notes that

> "The question of whether regulations should codify models to be used in licensing disposal of HLW or whether the criteria shoud (sic) only allow the use of models is a controversial one."

We argue that the question is critical (in the "importance" sense) as well as controversial. As acknowledged in the sentence immediately following the above quotation, the NRC staff recognizes that models are the only means by which they can fulfill their responsibilities for conditions beyond which it can be proven that adequate public safety is assured. Properly and cautiously, the staff concludes that models are only as useful as expert judgment thinks they are. But how it is necessary to deal with "..." uncertainties" arising from differences in expert ..." (F.R. 45, 31397)?

This commentary offers suggestions concerning how the NRC can philosophically and strategically approach use of models with respect to regulating long-term safety of radioactive waste disposal in geologic formations. We concur that interplay between modeling and expert judgment is necessary. We believe, however, that careful, detailed consideration of how that interplay functions with respect to status within the licensing process is mandatory. The discussion provided under the subject Consideration (5) does a good job of exposition of relevant issues but it provides limited basis for resolution of them. We offer below some suggestions on how to proceed.

Section 2, 3, and 4 provide comments on the NRC discussion. Section 5 summarizes these comments, and Section 6 lists references.

Staff Response to Comment 78:

See response to Comments 67-70.

Comment 79: TASC enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

"...the present state of modeling is closer to qualitative than quantitative."

Not so. The models are highly quantitative and highly detailed in some cases. The results (outputs) of the models are seen to be qualitative because of lack of certainty that the models are accurate reflections of the phenomena, processes, and events they presume to represent. This is expert opinion in action. The "experts" acknowledge, better than anyone else, their lack of certainty about what will occur, how and when "it" will occur, and the consequences that will result. In perspective, this is the classic hedging against absolute certainty that is trained into members of the scientific community.

How do we improve confidence in model outputs (results)? Not by increasing model complexity. Without exception, available models are based on first principles, e.g., the Navier-Stokes equations. The issue is, how well can such models be adapted to realities such as anisotropic flow in non-homogeneous media and a mixture of nuclide holdup phenomena that are modeled empirically and simplistically? These are the sources of "uncertainty", i.e., sources of diversity of expert opinion and lack of confidence in quantitative outputs from quantitative models. This issue is addressed in more detail in Section 3 below.

We suggest that it would be useful for NRC staff to review and apply in detail some of the principles of modeling described by Aris (Ref. 1). As Aris shows, there is a rich (centuries long) basis for use of mathematical models. The challenges the NRC faces are not unique; similar modeling problems have been encountered in other situations. Review and analysis of approaches used in analogous modeling problems could give the NRC perspective and a rationale for the approach they select.

Staff Response to Comment 79:

For the reasons spelled out in the introduction to these responses, the NRC staff stands by its statement that "The present state of modeling is closer to

qualitative than quantitative." Most of the rest of this comment states advantages and characteristics of modeling that the NRC has long recognized.

The NRC agrees that available models are based on first principles. The major physical laws which have to be considered are those of radioactive decay, mass transfer, conservation of mass, conservation of energy, and conservation of momentum. The available models are most deficient in their treatment of the equations of momentum conservation, i.e., the Navier-Stokes equations. All of the conservation equations have to be averaged and solved over nonhomogeneous media in which there are anisotropic flows. The results of this averaging process are the major source of controversy and uncertainty in hydrologic modeling.

Comment 80: TASC enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

"...the validity of any licensing finding is linked to the means by which uncertainty is uncovered, explored, and treated."

The NRC discussion does not follow through on this important statement, i.e., it does not suggest means by which uncertainty issues might be addressed. In particular, it does not acknowledge factors and relationships that can provide a basis for judgments concerning uncertainty in model results.

Three basic factors affect uncertainty in model results:

- Capability of the model to represent relevant phenomena. There are two aspects to this capability: inclusiveness (has anything been left out?) and mode of representation (ranging from first-principles to purely empirical).

- Availability of data to quantify physical constants in the model. There are two data-related issues: scope, accuracy, and precision of data for the as-sited, as-designed repository system, and changes in data values that might result from future events and processes that change the state of the system from its initial condition.

- The scope and validity of assumptions (scenarious) concerning future events and processes that change the state of the repository system.

The NRC can and should develop a strategy for dealing with these sources of uncertainty on the basis of the following:

- Hundreds of models dealing with various aspects of repository system performance are available or being developed (Ref. 2). Uncertainty with respect to model capabilities can be made small by proper choice of model(s). Consensus expert judgment can confirm that the models are an insignificant source of uncertainty.

- The extent to which data are a source of uncertainties in model results will depend on data variability, the adequacy of measurement of variability, and the adequacy of representation of variability in the model(s). Since engineered features of a repository system can be characterized with a high degree of accuracy, the major possibilities for data uncertainties are associated with the site geology and hydrology.

  The role of site data in uncertainties will depend on the homogeneity of the site geology and hydrology and the degree of characterization. Characterization activities needed to establish reliable numerical values for site parameters will also depend on homogeneity. Selection of models (and their associated data requirements) will in turn depend on the degree of characterization accomplished or needed.

  The upshot of the above is that uncertainty, choice of model, site characteristics, and site characterization are all related to each other. The important thing is that the relationships can be characterized. Deliberate, informed, rationale choices of model-data acquisition-geology systems can therefore be made and selected with, for example, the objective of minimizing uncertainty resulting from numerical data inputs to the models.

The bottom line is that uncertainty issued can be reasonably and effectively addressed. Uncertainty cannot be eliminated, but it can be characterized, evaluated, and to some extent controlled.

4. Itemized specific comments

   A. "...an elegant theory embodied in a mathematical description which represents a culmination of human thought..." may be possible, but it may also not be necessary. Nor may it be an appropriate measure of the adequacy of disposal modeling. Elegant theories of fluid motions in turbulent flow have been conceived, but they are of no practical use. The complexity and diversity of disposal systems similarly precludes practical use of elegant models. The state of the modeling art should be evaluated in terms of what is necessary, not in terms of what is possible.

   B. When modeling the role of geology in repository safety performance, two distinct functions must be addressed: the role of the geology as a possible cause of deterioration of repository performance, and its role as a possible mitigator of consequences of deterioration of performance. A "good" geology does not necessarily play both roles, and the regulations should not require dual roles. Bedded salt with a long history of stability minimizes potential that the geology will be a cause of performance deterioration; it's poor nuclide holdup capability

limits its potential as a mitigator of consequences. This antithesis illustrates, incidentally, why risk calculations are necessary for evaluating repository performance.

With respect to this subject, we note that proposed rules, paragraph 60.111(4)(i), (ii), and (iii) are dangerously near demanding a dual role for the geology.

C. A key issue in use of models in licensing disposal is use of performance-deteriorating scenarios when using the models. This is an issue quite distinct from those related to the capability and viability of the models themselves: use of "perfect" models might be highly imperfect.

Questions concerning the scope and content of performance-deteriorating scenarios are now well recognized; the NRC must find a way to deal effectively with them. With respect to this function, we offer the following observations:

- The repository doesn't know if water intrusion is the result of natural processes, human action, repository-induced phenomena, or combinations of these. The scenarios and the performance assessment results may depend strongly, however, on the characteristics and relative frequency (i.e., probability) of these alternative potential causes of performance deterioration. A high-level of NRC effort on scenario definition and analysis would pay dividends with respect to "... the validity of... licensing finding(s)...".

- Aside from catastrophic external events, physical property changes that can produce safety performance deterioration are rather constrained: nature's proclivity to minimize free energy is pervasive. How much change (performance deterioration) can there really be as a result of realistic scenarios, especially with respect to the margin of safety built into the repository?

D. The above discussion leads to the observation that judgment has two distinct roles relative to use of modeling in NRC's disposal licensing responsibilities: with respect to selection and use of mathematical models, and with respect to selection and use of performance-affecting scenarios. Need for judgment vis-a-vis use of models can be minimized; the need vis-a-vis scenarios can be directed so as to maximize confidence in results.

Staff Response to Comment 80:

The NRC staff basically agrees with the thrust of this comment. It and NRC contractors have been exploring ways in which uncertainty issues should be identified and addressed. NRC has spent considerable time and money exploring all three of the basic factors affecting model uncertainty listed in this

comment. The basis for the strategy developed by NRC and its contractors for examining uncertainty is very similar to that suggested in this comment, and it is exactly these considerations which lead ultimately to the placement of performance objectives on the engineering and site in the proposed rule.

The following are the staff's responses to "Itemized specific comments":

A. The subject of this comment is discussed in the introduction to these responses.

B. The NRC staff agrees with the commentor's list of functions of the geology which must be considered. Further, the staff does not intend to require both functions, only that the potential for each be evaluated.

C. NRC and its contractors have done extensive work on the definition of performance-deteriorating scenarios.

Long lived radionuclides can be dangerous for as long as a million years. Significant geologic changes are possible over such a long period.

D. The NRC staff agrees with this statement.

(6) RETRIEVABILITY

Comment 81: G. H. Dyer (10)

The requirement that radioactive waste "... can be retrieved for a period of 50 years after termination of waste emplacement operations, if the geologic repository operations area has not been decommissioned" and that they be able to be retrieved "... in about the same period of time as that during which they were emplaced" is a good general concept but likely will lead to problems as specifically worded.

(a) It is possible that a decision might be made to retrieve only a portion of the wastes, since over the emplacement period differing materials and techniques are likely to evolve.

(b) If the repository is decommissioned immediately after the placement of the first waste package, then there is no retrieval requirement. Further, if it is intended to accomplish such early decommissioning, then the requirement to design and construct a retrievability capability could be construed to not be required. This logic could be further extended all the way out to just short of the 50-year period.

(c) This requirement makes more difficult the backfilling of emplacement tunnels immediately after emplacement -- say, with salt being excavated in other portions of the facility.

(d) I do not have facts, but I suspect removal will be considerably more complicated than placement and will require more time, especially if backfilling is conducted prior to decommissioning.

(e) To what extent must retrievability be achieved? Should there be a specification on residual radioactivity in the event of a waste package failure?

(f) What minimum conditions would lead to a requirement to conduct a retrieval operation, and who decides, etc.?

(g) In summary, while agreeing with the retrievability concept, I believe it important to recognize the dynamic nature of the emplacement operations, and to couple the retrievability requirement to them, rather than have a single simple 50-year rule.

Staff Response to Comment 81:

See response to Comment 82.

Comment 82: Bechtel National, Inc. (13)

Retrievability - The likelihood of having to retrieve nuclear waste once a license has been granted and the waste has been emplaced in the geologic medium should be extremely small. In fact, it is difficult to foresee any circumstances where this would be required. Paragraphs 60.111(a)(3), 60.132(b)(2), 60.132(c)(3), and 60.135 define design requirements for a retrievability period which extends 50 years beyond termination of waste emplacement operations, and require that the wastes be retrieved in about the same period of time as that during which they were emplaced. These requirements are much too conservative, have no apparent justification, are extremely costly with little or no benefit in terms of risk reduction to the public and, for some geologic media, are probably not obtainable. In the case of a salt repository, where creep allowance would be required, mining of a much larger cavity at greatly increased cost would be required, and maintenance of the mined opening to permit retrievability might be impossible. Furthermore, the additional excavation required would diminish the future isolation integrity of the repository. The 50-year requirement would probably rule out all soft rocks such as salt and shale which otherwise might

serve as excellent repository media. As an alternative, a 10-year retrievability period is suggested.

Staff Response to Comment B2:

The licensing procedures of 10 CFR Part 60 were written assuming that there would be a program of testing and measurement of the thermal, mechanical, and chemical properties of the major engineered barriers to confirm their expected performance. The NRC would like to have tied the requirement for retrievability of the wastes to the expected time needed to execute the performance confirmation program. However, at present it appears to the NRC that neither the specific nature nor the period needed for execution of the performance confirmation program will be certain until construction of the repository is substantially complete. Hence, it is difficult at this time to use the performance confirmation program as a basis for establishing a period of retrievability. Nonetheless, the DOE is now making critical decisions regarding the design of geologic repositories which will have a direct effect upon how long the option to retrieve wastes can be maintained, and upon the difficulty which will be encountered in exercising that option should that be necessary for protection of the public health and safety. Therefore, to provide a suitable objective in this regard, the proposed technical criteria set forth a requirement that the engineered system be designed so that the option to retrieve the waste can be preserved for up to fifty years following completion of emplacement. Thus, the waste package and the underground facility would be designed so that the period of retrievability would not be the determinant of when the Commission would decide whether to permit closure of the repository. Rather, the Commission would be assured of the option to let the conduct of the performance confirmation program indicate when it is appropriate to make such a decision.

As it is now structured, the proposed rule would require in effect that the repository design be such as to permit retrieval of waste packages for a period of up to 110 years. The components of this total period are as follows: the first waste packages to go in the repository are likely to be in place about thirty years before all wastes are in place, after which a 50-year period is required by the proposed rule. Finally, a retrieval schedule is suggested of about the same time as the original construction plus emplacement-another 30-odd years. The NRC does not want to approve construction of a design that will foreclose unnecessarily options for future decisionmakers, but it is also concerned that retrievability requirements do not unnecessarily complicate or dominate repository design.

The retrievability requirement does not specify the form in which the wastes are to be retrievable or that wastes are "readily retrievable." The requirement is simply that all the wastes be retrievable during a period equal to the period of construction and emplacement. DOE's plans for retrieval are specifically requested as part of its license application and the practicability of its proposal will be considered by the staff. Wastes may be retrieved upon NRC approval of a DOE application or upon order by NRC, or otherwise, where authorized by DOE's license.

Comment 83: Atomic Industrial Forum (14)

While we are in agreement with the concept of retrievability as a general design criteria, we believe that careful evaluation and trade-offs need to be considered before this concept is quantified or broadened extensively. We suggest that retrievability be required only during the emplacement period and until all or a part of the waste disposal facility is defined as a permanent repository.

Staff Response to Comment 83:

See response to Comment 82.

Comment 84: American Institute of Chemical Engineers (16)

Although the concept of retrievability for a period of 50 years after filling of the geologic repository seems attractive, we believe that this is illusory. Our view assumes that retrievability is to be achieved by not backfilling the repository rooms and not sealing the shafts into the repository for 50 years after waste has been emplaced. First of all, mining specialists are dubious that a deep underground structure with only partial internal support can maintain its integrity for this long a period. Secondly, failure to seal the shafts as soon as possible simply encourages influx of water to the repository, subverting the careful choice of a formation that otherwise does not allow easy influx. Furthermore, with no backfill of the rooms, the heat-flow patterns will be distorted to conduct more heat downward by means of an increased temperature gradient. These conditions are not truly representative of those that the waste will encounter during the remainder of the period during which fission product heating predominates. Finally, the retrievability period will end at about 2050, at which time our grandchildren must summon the capital to finish the job in proper fashion; it seems more prudent for our generation to complete the project.

In constrast, the unavoidable waste emplacement period of 10 to 15 years should provide satisfactory monitoring of the same aspects of repository behavior as would be revealed by the 50-year period. The early emplacements could be monitored during the decade or so of filling. Because technical flaws in systems design usually cause failure early in life, the 10 to 15 year emplacements should reveal the potential for failure nearly as well as would the 50-year period. The design criterion for the package is a 1000-year life, so that all we can detect is early failure. Emplacement could readily be stopped at any time before filling is completed, and the waste retreived.

To summarize: if "retrievability" is to be provided at the expense of early backfilling and shaft sealing, we suggest that it be deleted from these criteria.

Staff Response to Comment 84:

See responses to Comments 82 and 372.

The commenter incorrectly inferred that the requirement to design the repository to preserve the option to retrieve the wastes would pass an expense and a responsibility on to future generations that should be borne by the present generation. The NRC only requires that the design of the repository preserve the option to retrieve the wastes for future decisionmakers.

Comment 85: U. S. Department of Energy (18)

Paragraphs 60.111(a)(3) and 60.135 require that the repository be designed so that the option remains open to retrieve the waste for up to 50 years after termination of waste emplacement. The basis for this period of time is not presented. In fact, the meaning of the word "retrievability" is not clear. We certainly agree that a specific time period, during which retrievability or recoverability will have to be maintained, should be specified. "Retrievability" implies that canisters can be retrieved as easily as they were emplaced, whereas "recoverability" implies that waste canisters may be recovered intact although requiring removal of backfilled material to do so. The exact period of time during which retrievability or recoverability should be maintained should not be specified now but should be established only after more information is available on the phenomena of concern. It may very well be that the required period of retrievability will depend upon and vary according to the geologic medium and environment in which a repository will be placed.

We are not sure what the present rule intends concerning backfilling of the rooms. We accept the premise that containers should be placed so that the are recoverable intact. However, the rule should not preclude early backfilling of the repository rooms. We believe that sufficient information is not yet available to specify the exact time at which backfilling of repository passages should take place. Backfilling would provide improved conditions for maintaining operational safety. Also, the lesser amount of waste rock during operation would reduce the environmental impact of any spoils pile on the surface. Maintaining the rooms in an open, ventilated condition for long periods would amount to storage and would, in effect, pass the responsibility for disposal to future generations. Several initial options exist in approaching backfilling. For example, one option would be to backfill a representative number of rooms after loading them with easte. This would allow a productive monitoring program to begin. After the initial monitoring period, backfilling could be done for all of the rooms as they are filled with waste. Therefore we believe that specific time periods for maintaining retrievability or recoverability should not be specified at this time. Rather, the Commission should consider stating that such specific time periods will be established at the time of repository licensing depending upon the conditions at the proposed site.

The Supplementary Information states that "it might be desirable to postpone any irreversible (or not easily reversible) decisions until the maximum amount of reasonably obtainable information about how well the repository is functioning and can be expected to function and contain and isolate the waste for periods of time required is at hand". However, there is no discussion of how this leads to 50 years after termination of waste emplacement nor is there any discussion of negative aspects of postponing this decision.

Staff Response to Comment 85:

See responses to Comments 82 and 372. The NRC did not use the term "recoverability" in the ANPR and questions whether there is any real distinction between it and "retrievability."

Comment 86: Westinghouse Electric Corp. (20)

Retrievability - The time period for retrievability of 50 years after decommissioning seems excessively long. When coupled with up to a 40-year repository operational period, it could require that some mined portions of the repository remain fully operational for 90 years. To design and construct the repository openings for this period of time and to maintain them for this period of time could add very considerable expense to the repository. It would seem appropriate and reasonable to require a shorter retrievability period after start of waste emplacement (10 to 15 years) in which the major concerns about long term effects are reasonably answered and confirmed. After this point in time, going back in for retrieval for having to perform those operations is quite small. It would be better to face the small potential of these costly operations than to require the expensive, very long retrieval period be designed into every repository.

Staff Response to Comment 86:

See responses to Comment 82.

Comment 87: Tauke and Adam (21)

Retrievability. Is is possible to pinpoint a safe date for sealing the reposit ry.

Staff Response to Comment 87:

It is not possible to pinpoint a date for the sealing of a repository at this early stage. Further, the NRC believes that a decision on sealing the repository can only be made after an extensive monitoring and confirmation program has been completed.

Comment 88: Duke Power Co. (25)

In the discussion on retrievability, the implication is made that one reason for retaining retrievability might be the expectation of future, "improved technologies..., better designs..., operational procedures improved." We strongly suggest the regulations specify that retrievability need be maintained for only that period required for performance checkout. In the case of disposal of spent fuel, further retrievability for resource recovery could be maintained based on an assessment of economic viability, but should not be mandated by regulations.

We have long maintained that the waste ultimately disposed of should be high level waste from reprocessing, rather than spent fuel with its enormous energy content, and we continue to take that position. However, from the standpoint of the Commission's regulation, we hold that repository designs should be

required to incorporate retrievability only to the extent end for the period necessary to obtain meaningful data relating to long term safety of the repository.

Staff Response to Comment 88:

See responses to Comment 82.

Comment 89: Department of Environmental Protection, State of Connecticut (27)

I was pleased to see that priority consideration is being given to retrievability.

Staff Response to Comment 89:

No response required.

Comment 90: Lowenstein, Newman, Reis, Axelrad and Toll (28)

Retrievability of emplaced wastes is specified for a period of time that could be as long as 100 years from the start of repository operations. While it is recognized that a repository site would have to be abandoned whenever critically adverse circumstances might dictate, the likelihood of such circumstances evolving is vanishingly small. Accordingly, the provision for retrievability for such extensive periods is an excessive and unrealistic requirement. As is recognized in the discussion of this subject in the Advance Notice, such a requirement has a significant undesirable impact on repository design, construction and operation, particularly as it relates to potential occupational radiation exposure of workers in the repository. It also is counter to a rational systems approach and quite conceivably could complicate the use of salt, a generally acceptable repository formation, as a host rock, on a very weak and tenuous basis. In our view, the period of retrievability is more logically and realistically related to the amount of time (likely less than 10 years) during which useful in situ repository performance related information can be acquired. In any case, because of the large potential negative impacts and highly questionable benefits of such a long retrievability requirement, a more convincing rationale would have to be provided to justify any such requirement.

Staff Response to Comment 90:

See responses to Comment 82.

(7) HUMAN INTRUSION PROBLEM

Comment 91: A. E. Wasserbach (7)

Section (7) Human Intrusion Problem. "Simply stated, human intrusion cannot be prevented;" If you canNOT keep humans from intruding, HOW can you possibly

guarantee the stability of the geologic formation, or the expected behavior of a repository, or the waste/rock interaction? If humans, subject to will and reason, cannot be controlled, how do you expect a human to be able to control an inanimate rock formation?

High level wastes should be kept, as stated above, in retrievable storage facilities, until a genuine disposal method is found, not a "disposal" that is simply one of "Out of sight, and (hopefully) out of mind". A genuine "disposal" method is one that would render the nuclear wastes completely harmless to man and his environment.

Staff Response to Comment 91:

Although it is impossible to guarantee that human intrusion will not occur, history would indicate that doing all that is reasonable to inform future generations of the existence and nature of the repository located at an "uninteresting" site should minimize the chance of inadvertent human intrusion. Deliberate intrusion by future generations is impossible to prevent and criteria providing for reliable documentation of site location and explanation of the design and nature of the repository will allow future generations to make a rational decision on whether to intrude into the repository. Provision for evaluation of site resources at current value as part of the site suitability criteria will also minimize the likelihood of both inadvertent and deliberate intrusion. Further the technical criteria emphasize engineering and physical barriers, rather than human institutions, for maintaining the long term integrity of the repository.

In reference to the commenter's second point, the extensive monitoring and confirmation programs to be conducted prior to a decision to decommission a repository, hardly conforms to a policy of "out of sight, out of mind".

Comment 92: Attorney General Abrams, State of New York (11)

The question is raised whether attempts should be made "to protect future generations from the deliberate intruder." P. 31398, col. 2. The answer, of

course, is yes. Future generations should not be exposed to deadly radiation produced by our generation, even if one or more members of future generations act deliberately.

Staff Response to Comment 92:

See response to Comment 91.

Comment 93: Tauke & Adam (21)

Human Intrusion Problem. "...Simply stated, human intrusion cannot be prevented..." Simply stated, that is seemingly a significant factor in consideration of licensing a geologic site.

Staff Response to Comment 93:

Human intrusion is a factor that has been taken into consideration in siting a repository. See staff responses to Comments 31 and 91.

PART 2: QUESTIONS:

In concluding the Advance Notice of Proposed Rulemaking (ANPR), the NRC particularly solicited public comment on four questions. These four questions and their related public responses are listed separately in the following section. Since these public responses were solicited to stimulate the NRC staff's current thinking, no particularized staff responses are considered necessary. The comments received were helpful and contributed to the development of the proposed rule and accompanying documentation.

2 General Comments on the Questions were received:

Comment 94: Atomic Industrial Forum (14)

On page 31398, the question is asked, "Does the list of considerations above clearly adequately and fully identify the relevant issues involved in disposal of HLW?". Following are several considerations which we believe need to be more fully addressed:

No discussion is presented about the criteria that will be used as the bases for a decision to permanently enclose the waste. While it may be premature to develop these criteria on a detailed basis, we believe that a general outline of the decision bases should be developed.

Criteria or considerations regarding the age of the waste are not presented or discussed.

We believe that waste form is a very important parameter, as is waste type. This does not appear to be considered.

Comment 95: Exxon Nuclear Corp. (15)

Finally, we would like to briefly address the questions raised on page 31398: (1) it is difficult to comment on the list of considerations until the rationale documents have been made available. One issue that appears to have not been considered is the extent to which disposal of reprocessed high-level wastes would alter the approach to defining criteria; (2) it is inappropriate for us to comment on the scope of the rule without reviewing the rationale documents; (3) as indicated in our above comments, we feel that the NRC's EIS and technical criteria should concentrate on the systems approach and its relevance to protecting the public health and safety in a manner comparable to other nuclear activities which the NRC regulates; and (4) the environmental impacts of criteria constructed with the principles noted cannot realistically be assessed without an evaluation of the rationale upon which they are based.

Question 1:

Does the list of considerations above clearly, adequately, and fully identify the relevant issues involved in disposal on HLW?

Comment 96: U. S. Department of Energy (16)

Response: The list of considerations does identify many key issues, but does not address them with sufficient clarity. There was an apparent emphasis on exhaustively listing items believed to be important by the staff. The actual importance of meeting the criteria, relative to safety, was not explained. For example, 60.122(b) lists what the staff perceives to be "potentially adverse" conditions with no parallel attempt to explain why each item was stated.

Clarity suffers from both the organization and the writing style.

The "Nature of the Problem" is defined by listing five problem areas and six underlying principles. Seven considerations are then listed and comments requested on four questions. The draft technical criteria include eight active sections which do not appear to relate to the considerations introduced in the preamble.

The connection between the subtitles of the discussion of "Considerations" and the material discussed is difficult to understand. Subsection (1) "Systems Approach" is the basic "defense-in-depth" concept with which many are more familiar; Subsection (2) reads like design-basis events; Subsection (3) is an

enlargement of (1) and might better be a part of it. Subsections (4) and (5) are ambiguous as written. We assume that under (4) Commission staff was trying to comment on whether one could identify "fatal flaws" that would exclude sites from consideration and, conversely, whether one could identify inclusionary attributes. It seems the issue of siting criteria remains open and is not yet to be specifically addressed. In fact, however, the technical criteria do include siting criteria. In (5), Codification of Models, the staff appears to be attempting to come to grips with how much weight is to be given to the use of predictive models and whether specific models should be specified. The treatment given this subject does not clarify the issue. The codification of specific models at this stage of development for both models and criteria is premature.

The supplementary Information section is not worded clearly. The following is quoted from discussion on "Codification of Models" (p. 31397) as an example:

> "If one views the realization of our understanding in geologic disposal from successively more nearly complete and accurate qualitative descriptions of the observed phenomena in question through more precise and semiquantitative and quantitative approximations where undertainties are better understood and can be treated mathematically, to an elegant theory embodied in a mathematical description which represents a culmination of human thought, the present state of modeling for geologic repositories is closer to qualitative than quantitative."

The major problem with the Supplementary Information is the apparent inadequacy of the treatment relative to the criteria themselves. More importantly, the background section does not provide support for the criteria. For example, the numerical requirements in the Performance Objective (60.111) are totally unsupported. Prior to issuing a proposed rule, it is imperative that the bases and rationale be fully illuminated. Also, as noted above, there is little or no correlation between the organization of this section and the criteria themselves.

Comment 97: Bird enclosure in U. S. Department of Energy (18)

My view, from the preceding is no, the list of considerations does not clearly, adequately and fully identify the relevant issues involved in the disposal of high-level wastes.

Comment 98: Environmental Protection Agency (23)

The list of considerations adequately defines and identifies the relevant issues involved in disposal of HLW.

Comment 99: Duke Power Co. (25)

Response: First, we understand these considerations to relate only to the technical aspects of the problem, and not to the procedural aspects of the problem which are being addressed separately. Our comments with respect to the latter (10 CFR Part 60, Subparts A-D) were submitted by letter of March 3, 1980. As we have stated at other times and in other forums, we believe the institutional problems associated with nuclear waste management far outweigh the technical ones.

Having noted this, and in the context of our discussions above relating to the "Considerations" section, we believe the considerations identify the major technical issues. However, we are concerned that the discussion of the issues provided in the notice does not reflec' our view as to what the term "systems approach" should mean to the regulator. Simply stated, we do not believe the term "systems approach" means simply that the repository is a multicomponent series of barriers, each backstopping the next, but rather extend' ' ) the concept that each component of the system should be viewed only i. ne context of the performance of the whole to produce the desired effect.

Our other concern with respect to this section is the emphasis on the unknown. In our view, the information we lack we currently know how to get. By and large this is in-situ data which we can obtain only by moving forward in a site identification and characterization program. Naturally, there will be some uncertainty in this data, but the effects of uncertainty can be accommodated by conservative analyses. Where models need further development and validation, again it is our undertstanding that there are no insuperable difficulties; we merely need to proceed to do the necessary work.

Comment 100: Lowenstein, Newman, Reis, Axelrad and Toll (28)

While the list of considerations identifies many of the important technical issues related to HLW disposal, we believe that the several instances the discussions concerning these issues are lacking in clarity, perspective and supporting rationale. Our major comments in Part I of this enclosure have identified a number of these defects.

Question 2:

Would a rule structured along the lines of the referenced draft rule reasonably deal with issues in an appropriate manner?

Comment 101: U. S. Department of Energy (18)

The basic structure of Subparts E-I is appropriate, however, many changes to the contents are needed. More importantly the bases and rationale should be structured in a manner consistent with the structure of the rule.

Comment 102: Environmental Protection Agency (23)

The referenced draft rule will addesss the issues in an appropriate manner.

Comment 103: Duke Power Co. (25)

The overall structure of the referenced draft rule seems appropriate; however, its content indicates inadequate attention to the systems approach concept. See our specific comments on the draft rule, attached.

Comment 104: Lowenstein, Newman, Reis, Axelrad and Toll (28)

Substantial changes to the contents of the draft rule are required before one could conclude that it reasonably deals with the issues in an appropriate manner. Some of the major deficiencies relate to what we consider to be

inadequate recognition of the systems approach and the absence of supportable bases and rationales for most of the quantitative requirements proposed in the rule. Again, reference is made to our major comments in Part I of this enclosure, as well as the detailed comments in Enclosure II.

Question 3:

In light of the fact that EPA has the responsibility and authority to set the generally applicable environmental standard for radiation in the environment from the disposal of HLW, with what factors/issues should an NRC environmental impact statement on technical criteria deal?

Comment 105: Attorney General Abrams, State of New York (11)

The NRC environmental impact statement on the technical criteria should discuss, among other things: (i) worst possible accident scenarios and consequences for a repository, including multiple failure accidents; (ii) the extent to which the draft regulations assure true safety for the present and future generations; (iii) the environmental impacts of permitting regular releases of radioactivity from repositories, and of requiring less than total isolation of the wastes for the necessary one million years; and (iv) the environmental impacts of licensing repositories despite the fundamental uncertainties caused by our inability to predict geologic, meteorologic and human events far in the future.

Comment 106: U. S. Department of Energy (18)

The NRC EIS should address alternative approaches to regulating repositories (e.g., no requirements on individual elements of the system, qualitative requirements instead of quantitative requirements, etc.), environmental impacts of complying with the rule as presented compared to the alternatives, and cost benefit analyses of complying with the rule compared to the alternatives. It should also address the trade off between potential decreases in long term impacts versus the actual increases in present day impacts resulting from the extensive site characterization requirements.

Comment 107: Environmental Protection Agency (23)

The draft Environmental Impact Statement now in preparation by EPA in support of the draft environmental standards (40 CFR 191) will be less detailed than is required for an EIS supporting licensing of a HLW repository, and will be limited to a discussion of the health risks and the costs for disposal of HLW in specified model repositories. In order to avoid unnecessary duplication, we believe that the environmental impact statement to be prepared by NRC should deal with the specifics of implementation of the draft Technical Criteria. It should therefore examine implications of specific geologic and engineered alternatives which NRC believes would satisfy the Technical Criteria. The EIS should specifically address those areas where NRC judgments are operative in narrowing the choices available in the EPA standards, or where NRC interpretations are needed to define the range of available alternatives.

Comment 108: Duke Power Co. (25)

Since the EPA will presumably set generally applicable environmental standards, NRC's environmental impact statement on its technical criteria should examine only those questions related to the environmental impact of the proposed and

possible alternative criteria, including cost-benefit analyses and evaluation of resource utilization. NRC's environmental impact statement should not reexamine the programmatic choice of disposal technology, resulting from DOE's own environmental impact statement.

Comment 109: Lowenstein, Newman, Reis, Axelrad and Toll (28)

We believe that one of the principal components of the NRC EIS on technical criteria should be cost-benefit analysis of the basic regulatory approach adopted in the regulation then proposed versus alternative approaches, as well as cost-benefit analyses of specific quantitative requirements proposed in the regulation versus differing requirements or different quantifications. Thus, for example, we have suggested that proper implementation of the systems approach would involve establishment of a performance requirement applicable to the entire system. If, in lieu of or in addition to such overall performance standard, NRC proposes (as do the draft criteria) to impose requirements on individual components or subsystems, the EIS should discuss in detail the incremental benefits and the incremental costs of such requirements. An important part of such analysis would be a quantification of whether such requirements would achieve any additional level of assurance of protection of the public health and safety and the environment. It would also be important, of course, to quantify the environmental, economic and social costs that would result from such requirements. If an approach or requirement would tend to complicate or prevent the use of an otherwise acceptable formation, the adverse effects of unavailability of such formation should also be considered.

Apart from the cost-benefit analysis of the basic approach, such analyses should also be performed comparing individual requirements with alternatives thereto. In all of these cost-benefit analyses one of the factors that should explicitly be considered is the impact of the approach or the criteria on the schedule for repository development. As noted in several comments, a number of criteria appear to engender the possibility of significant delays in program implementation (e.g., requirements for extensive exploration and testing to increase assurances of repository safety). Such delays are likely to have important cost-benefit implications that should be considered to help assure that the criteria are beneficial. Such analyses and evaluations would also be important in helping to establish what level of assurance regarding data acquisition, testing, etc., is appropriate. Needless to say, such cost-benefit analyses are also essential with respect to other quantified requirements including retreivability, waste package performance, radionuclide release rates, etc.

The cost-benefit analyses should also take into account some of the indirect impacts that would result from delays in repository program implementation resulting from additional time-consuming requirements imposed in NRC regulations. Such impacts would include environmental and economic costs associated with additional interim storage, as well as the impact of delays in repository operation on public acceptance of nuclear power.

Question 4:

What are the environmental impacts of criteria constructed in accordance with the above cited principles? What alternative criteria exist and what are their impacts?

Comment 110: U. S. Department of Energy (18)

Environmental and cost impacts will be associated with the requirement to characterize multiple sites at depth (44 FR 70410), the requirement to design to preserve the option to retrieve for 50 years after emplacement, and the requirement to utilize a 1000-year waste package. Alternative criteria are proposed in the ONWI 33(1) through 33(4) series and in the Department's Statement of Position for the NRC Waste Confidence Rulemaking.

Comment 111: Environmental Protection Agency (23)

NRC will need to review applicable sections of the proposed draft Technical Criteria to reflect comments which EPA expects to receive on its forthcoming generally applicable standards (40 CFR 191), especially those comments which may lead to changes in the final standards.

Comment 112: Duke Power Co. (25)

We have indicated in the discussion contained in the body of this letter, as well as in the attached specific comments on the draft rule, that the major shortcoming of the discussed criteria lies in inadequate attention to what we believe to be the essence of the "systems approach" concept. Regulation of individual components of the system tends to separate the true purpose of regulation, the protection of public health and safety and environment, from reality, that reality being simply the overall performance of the repository system. We would suggest that it is entirely possible to develop reasonable criteria around this concept, and that the result of such an effort would be criteria which regulate exactly what we wish to regulate - population doses - rather than release rates from individual system components which are some steps removed from man.

Comment 113: Lowenstein, Newman, Reis, Axelrad and Toll (28)

In our response to Question 3 we have identified some of the impacts which must be taken into account in a cost-benefit analysis of the basic approach and quantitative requirements reflected in the draft criteria. Our previous comments have identified our basic concerns with the current basic approach and quantitative requirements and have suggested adherence to the systems approach. We believe that rigorous cost-benefit analyses will demonstrate that the draft criteria should be significantly revised.

PART 3: PUBLIC COMMENTS ON THE ACCOMPANYING DRAFT TECHNICAL CRITERIA

Comment 114: G. H. Dyer (10)

I would first like to generally concur and offer my compliments to your staff for an excellent development of the logic relative to a very difficult subject.

Next, I would like to offer the following major comments which I believe to be related to an omission rather than a comment on any one of the proposed criteria. This omission deals with the fact that it is fundamentally wrong to imply that we can predict everything that will occur, or all new factors or phenomena that we will ever discover during the radioactive decay period. However, such a problem is not new to the scientist, or engineer, except to

the degree of time involved. The normal engineering solution to such a problem falls into two broad categories. The first category is to provide in the design, and in the construction of a facility, added margins of safety, or spare back-up equipment, which can be utilized when and if necessary. This first category is generally recognized in your criteria. The second category involves incorporation in the basic design, starting at its concept selection, of adequate bases by which future changes can be made to the facility to take care of any reasonably projected possible new factors or phenomena. As examples, the designer of a facility leaves adequate room so that a piece of equipment can be replaced -- even though it may not be deemed important enough to have provided a spare, or to even have provided the needed crane. Thus, the distinction is the consideration of, and preservation of, possible future options as contrasted with those which should be fully incorporated into the facilities from the start.

This logic leads one to further consideration at the concept selection stage of such future options as the reasonableness of diverting future groundwater flows, should they be found to occur, further sealing components that may have not been effectively sealed, and even the longer term recoverability concepts under extreme conditions. (It is also recognized that a strong emphasis on this latter item would lead in the direction of selecting a concept which makes such recoverability easier -- i.e., probably the use of less depth, or even a surface final disposition concept. For this reason, I also would not favor the 300-meter minimum depth criteria.)

As a general strategy, I also believe that we ought not to be considering the subject as "disposal", which has a finality connotation that the above logic acknowledges we cannot accept, and which has a growing disfavor with the public. A more responsible scientific and engineering position to take is that we are providing for the "disposition" of wastes in a manner which will adequately store them until their inherent potentially harmful characteristics disappear. I would strongly recommend substitution of the word "disposition" for "disposal".

Staff Response to Comment 114:

Provisions for changes in a geologic repository operations area following the authorization to receive and possess source, special nuclear, or byproduct material are set forth at § 60.44 of the final 10 CFR Part 60 procedural rule, (46 FR 13971). "Disposal" is defined as the isolation of radioactive wastes from the biosphere. The staff sees no reason to substitute the term "disposition" for "disposal" in the rule.

Comment 115: G. H. Dyer (10)

The criteria acknowledges the need to avoid resources that are economically exploitable, and includes as such a resource "... a high and anomalous geothermal

gradient relative to the regional geothermal gradient". However, we also should acknowledge that the placement of heat-producing materials in a repository will build up the surrounding temperatures to a level that might be interpreted by a future explorer as just such an anomalous geothermal gradient. Thus, we must conclude that we can have administrative controls for longer than 100 years, or we must not entice the explorer by allowing temperatures to rise to the level that he might interpret as being of interest.

In this regard, it is perhaps important to categorize the wastes by a thermal characteristic, as well as the radioactive characteristics, with the distinction being the time period during which the surrounding media temperature will be increasing (due to a heat generation rate that is greater than the heat dissipation rate) and a time period after which the surrounding media will have essentially returned to normal background temperatures. (It always will be somewhat above ambient.)

Staff Response to Comment 115:

The temperature generated by the disposal of radioactive wastes in a geologic repository will be a function of a number of parameters involved in the design of the repository, waste form, and packaging. The selection of the design criteria is a programmatic responsibility of the DOE. However, the NRC believes that heat loading may be controlled in part by such factors as the loading density in the repository.

The time period during which the surrounding media temperature will be increasing will also be a function of a variety of factors, including the specific radioactive elements to be disposed of, and the concentration of each element present. Mr. Dyer's reasons for proposing categorization by thermal characteristic are not clear from his comment.

Comment 116: Bechtel National, Inc. (13)

The criteria requires the avoidance of resources that are economically exploitable, and in Paragraph 60.122(b)(2)(vii) includes as such a resource "... a high and anomalous geothermal gradient relative to the regional geothermal gradient". However, we also should acknowledge that the placement of heat-producing materials in a repository will build up the surrounding temperatures to a level that might be interpreted by a future explorer as just such a high and

anomalous geothermal gradient. Thus, we must conclude that we can have administrative controls for longer than 100 years, or we must not entice the explorer by allowing temperatures to rise to the level that he might interpret as being of interest. The term "high" needs to be defined.

In this regard, it is perhaps important to categorize the wastes by a thermal characteristic, as well as the radioactive characteristics, with the distinction being the time period during which the surrounding media temperature will be increasing (due to a heat generation rate that is greater than the heat dissipation rate) and a time period after which the surrounding media will have essentially returned to normal background temperatures. (It always will be somewhat above ambient.)

We suggest that the Criteria should provide general guidelines defining technical criteria for a safe HLW repository. To attempt to include every conceivable qualification that may or may not occur or may or may not be important for the suitability of a site will invite never ending challenges from intervenors and a correspondingly unnecessary lengthening of the repository licensing process. For example, statements like "There is a fault or fracture zone, irrespective of age of last movement, which has a horizontal length of more than a few hundreds of meters" (page 31402, line 28) is unreasonable as a technical criterion and is only a means by which an otherwise adequate site can be disqualified. It would be to the advantage of the program if those working to develop a safe repository could feel confident that the rules outlined in the 10 CFR Part 60 were directed toward licensing a repository, not away from it. Presently the NRC is working toward revising 10 CFR Part 100 to remove some of the specific details which the NRC has found are unrealistic or unnecessary. It seems that this type of problem should be avoided in 10 CFR Part 60.

There is need for improving the paragraph and respective subparts numbering system. As it now stands, referencing or finding a particular subpart is very cumbersome.

<u>Staff Response to Comment 116</u>:

See response to Comment 115. The proposed technical criteria clearly define the performance objectives for the disposal of HLW in geologic repositories. Qualifications which are not related to these objectives have been deleted.

The numbering system of the proposed technical criteria has been revised for the sake of clarity in response to public comment.

Comment 117: Bird enclosure in U.S. Department of Energy (18)

For many centuries mankind has extracted geological materials from the Earth. Today, we have a highly developed knowledge and technology of mining, and exploration for useful rocks and minerals. In fact, the basis for industrial economics is mineral and fuel extraction from the crust of the Earth. Geologic disposal of radioactive waste involves mining practice, however, with a very significant difference. What is desired, the opposite of a mine, is to put radioactive waste into the Earth so as to completely isolate it from the biosphere for times sufficient to ensure complete safety. Unfortunately, the magnitude and difficulty of this task have been underestimated until a few years ago. Now the magnitude and difficulty are being overestimated, and confused, in the context of the geologic aspects of the task. It is known that many of the various ore bodies and other rock resources mined by humans are hundreds, even thousands of millions of years old. A very sophisticated technology exists for dating these rocks, and a great deal is known about how these rocks have formed and persisted during geologic time. We know a great deal about how to extract mineral resources. What we want to know now is how to return something into the Earth so that it stays there. Therefore, it is my view that, essentially, we must utilize all those aspects of rocks, minerals, geologic processes that produce "permanent" geologic assemblages, for the design and construction of a geologic repository. Rather than "fight" the geologic environment by constructing an "unnatural" repository that would inexorably be altered by geologic processes, we must construct a repository of materials and within sites that can be demonstrated will remain in geologic "equilibrium" at depth, for a time sufficient to insure complete isolation and immobilization of the waste. Appropriate rocks, analogs of rocks and minerals, and geologic processes can be incorporated in the design and construction in ways that enhance our confidence in the safety and permanence of the repository. For example, the heat generated by the radioactive waste can be used to drive mineralogic reactions that further seal the host-rocks and retard water-migration; waste cannisters can be made of analogs of natural rocks and minerals having properties that provide great inertness and strength. My view is that the underlying philosophy for geologic disposal of radioactive waste should be to utilize all the various geologic materials and processes that lead to chemical stability and permanence as can be demonstrated in natural geologic examples. In a sense, geologic disposal of radioactive waste is the reverse of mining. Certainly there is nothing "new" about mining. However, what we are attempting is to create a long-lasting geologic feature rather than consuming one. The difficulty and magnitude of the task can, I believe, be constrained and well-defined by existing geologic knowledge. Our confidence in our ability to do so, and our confidence in resulting repository designs, will be based on our understanding of geology and geologic time rather than "expert" opinions. It is not enough to satisfy a select group of experts that the design is viable and safe. Although the repository must be evaluated and demonstrated to be safe in the most rigorous ways by our most capable minds, it must also be understandable and acceptable to all concerned. We should be able to explain and predict the behavior of the geologic repository in terms similar to those used to explain a 150 million-year-old dinosaur skeleton to a museum visitor.

It is with these views that I have studied 10CFR60, E-I; I have concentrated on those parts that are within my expertise, geology. This is in many ways a very good document. It provides a great deal of information about various

aspects of the endeavor and tasks that must be completed. However, I find that appreciation of the geologic aspects of the task is, in places confused or lacking. The document fairly states what the objectives are; however, it does not provide much evidence of a basic understanding of geologic materials and processes, and the opportunities for utilizing this knowledge to enhance the permanence and safety of a mined repository. Rather, the document reflects a lack of confidence and understanding in detail of the geologic aspects of Geologic Disposal.

Staff Response to Comment 117:

The selection of materials for repository construction and waste packaging is within the programmatic responsibilities of the DOE. The NRC has never proposed that man-made engineering (termed "unnatural" by Dr. Bird) "fight" the geologic environment.

The analogy set forth in Dr. Bird's last sentence is not exact since one case (the dinosaur) can be documented by a prolific fossil record, while the other case (the repository) is an entirely new future venture, with no previous geologic record to draw upon.

Comment 118: Atomic Industrial Forum (14)

We have also reviewed the recent DOE report regarding the Proposed Rulemaking on the Storage and Disposal of Nuclear Waste. DOE/NE-0007. We agree with the performance objectives noted in that document and presented below:

6.1 Containment should be virtually complete during the period dominated by fission product decay.

6.2 Isolation from the accessible environment should be effective for at least 10,000 years, and reasonably foreseeable events should not produce consequences greater than normal variation in background radiation.

6.3 The operational phase of a waste disposal system should be as safe as for other nuclear fuel-cycle facilities.

6.4 Environmental impacts should be mitigated to the extent reasonably achievable.

6.5 Conservative design and evaluation should be applied to waste disposal systems to compensate for any residual uncertainties.

6.6 Acceptable performance should be based on methods reasonably available and should not depend upon continued maintenance or surveillance for unreasonable times into the future.

6.7 Concepts selected for implementation should be independent of nuclear industry trends and compatible with national policies.

We suggest that regulatory criteria consistent with these objectives would provide the bases necessary for a practical and safe repository.

Staff Response to Comment 118:

The proposed technical criteria appear generally to be consistent with the above cited principles which are termed performance objectives in the DOE report.

Comment 119: American Institute of Chemical Engineers (16)

We endorse the usage in the criteria of the principle of "as well as reasonably achievable" with respect to the degree of containment required. There are many who would wish for "absolute containment" without realizing that this is an unattainable goal. In whatever changes are made to these criteria, we urge that this principle be maintained. To do otherwise would bring about lengthy delays and introduce excessive costs.

Staff Response to Comment 119:

Although the proposed rule clearly sets forth minimum performance objectives ALARA (as low as reasonably achievable) principles have not been incorporated. The reason is that the Commission does not have confidence that an ALARA finding could be made, since the more stringent the performance objectives become the more difficult it will be to prove they are met. Further, the main object is as will always be meeting the EPA standard which in fact will define what level of safety is reasonably achievable.

Comment 120: Ellison enclosure in U.S. Department of Energy (18)

The document represents a comprehensive effort with consideration of the multiple geoscience, health safety and engineering disciplines involved. It emphasizes the need of overall public safety concerns regarding radioactive waste disposal, while generally recognizing the realistic fact that absolute isolation may not be assured or necessary. The document attempts to address

fairly comprehensively major criteria for siting, design and decommissioning of repositories. A few significant reservations on the overall document are expressed below, while comments on specific sections are discussed separately.

The statement of overall performance objectives is an essential first step in the development of any design criteria. However, the draft tends to intermix the overall objectives with delineation of specific methods on how to achieve these objectives. Such specifications are not necessary at this time and will inhibit the development of alternative design approaches based upon extensive R&D activities and site specific investigations. For instance, requirement of minimum 1,000 year migration period through a geologic media [60.111(c)(4)-(iii)], probably would not affect most repository sites. However, there may be sites which have extremely low potential for any release to occur that would not completely meet the 1,000-year criterion. Each site should be judged on its total merits. Another example relates to the designation that the waste package contain radionuclides for at least the first 1,000 years. This could be stated as a general goal, but allowance should be made for consideration of a shorter period if the Department can show some repository sites to have geologic barrier conditions that can confidently be relied upon during the first 1,000 years. If the NRC feels that example specifications must be included, there should be clear designations that alternatives will be acceptable if the Department demonstrates that overall performance objectives are met.

In summary, it is recommended that all quantitative specifications related to radionuclide release be eliminated or qualified as being goals only. The final acceptance or rejection should always be based on a comparison of predicted release rates with established EPA radiation standards.

Also, comment is appropriate for absolute or extreme terms such as "all," "optimum," "minimum," "maximum," "most severe," and "too complex" that are used in many locations in the draft. It is suggested that use of these terms be reexamined to make sure that an unnecessarily rigid position is not taken that will lead to future controversies in design development and licensing. For instance, the requirement to design against "most severe" geologic event [60.132(a)(3)(ii)] is impossible to meet since literally the absolute most severe geologic event possible at any site would be eruption of a volcano or displacement due to faulting. In reality, however, the probability of occurrence of these events is so small as to make them unimportant to overall objectives.

Staff Response to Comment 120:

The technical criteria, and the performance objectives in particular, were developed to compensate for the uncertainty inherent in any demonstration of whether the EPA standard is met. The numerical values (e.g., 1000 gr containment) were chosen as a balance among desire to make the site and design as good as possible, the difficulty of achieving the objectives, and the difficulty of and confidence in the demonstration that the performance objectives have been

met. Hence, the NRC believes that these criteria will be effective in contributing to overall confidence with safety of a proposed repository.

Accordingly, the NRC declines the suggestion to eliminate all quantitative specifications related to radionuclide release. DOE always has the option to request an exception to any part of the NRC's regulation. Also see response to Comment 121.

In response to Dr. Ellison's final point, the use of some of the terms in question where inappropriate has been eliminated in the proposed rule.

Comment 121: Westinghouse Electric Corp. (20)

General - As noted in our comment letter, we believe that many of the draft technical criteria are not reasonable or realistic, and as such do not deal with the issues in an appropriate manner. We recommend the following significant changes:

a. Component performance standards should be eliminated. Instead, the criteria should focus on the performance of the overall system and on protecting current and future generations.

b. The considerations should acknowledge that these draft criteria apply to a repository which will not be operational before 1997. Engineering design requirements should be deleted from the criteria. This is needed to provide the latitude to accommodate advances in technology, and future knowledge gained on various geologic media.

c. Numerical criteria should be justified by both technical analyses and by cost/benefit analyses.

Staff Response to Comment 121:

The NRC fully recognizes that a geologic repository is a system. However, the NRC also recognizes that this system is divided into two major components - the engineering and the site - which have very definite functions, irrespective of particular repository design. The proposed rule exploits those functions in such a way that reliance on the engineering for repository performance dominates

under those conditions when the response of the site to the wastes is most uncertain, and reliance on the site dominates at the time when it is no longer realistic to rely on the engineered barriers. With respect to the commenter's second point, some of the design requirements have been deleted from the technical criteria as set forth in the proposed rule to provide for greater design latitude.

See also response to Comment 51.

Comment 122: Energy Resources Conservation & Development Commission (22)

With two exceptions, the draft technical criteria identify what appear to be the important technical issues relevant to the performance of a geologic repository for HLW. But identifying technical issues is different from resolving them. The discussion of uncertainty in the Supplementary Information accompanying these draft technical criteria indicates that the Nuclear Regulatory Commission (NRC) understands this difference. The NRC also appears to understand that efforts to resolve the outstanding technical issues through rigorous scientific investigation have begun only recently; otherwise the notion of uncertainty probably would not occupy the prominent position it does in these draft technical criteria. It is therefore difficult to determine whether the technical issues are identified "adequately and fully." (p. 31398) Some technical issues may be of wider scope than is currently believed. New issues may also arise as investigations continue.

The first exception concerns the importance of in situ testing as a necessary step in determining how the physical and chemical properties of a proposed site affect transport of radionuclides. Although § 60.122(a)(9)(iii-vi) requires in situ investigation, there is no discussion of what constitutes an in situ test. Moreover, it is unclear whether these in situ investigations are necessarily site specific or whether generic test data for a particular medium are acceptable. The CEC recommends that in situ testing be performed at repository depth and under conditions which are as close as possible to the actual repository environment. The acceptability of generic and site specific in situ testing data should also be clarified. For example, generic in situ testing data may be acceptable in conjunction with additional site characterization criteria to assure that the properties of a particular site do not vary significantly from those in which the generic data were obtained.

The second exception is more fundamental. It concerns the basic approach to scientific investigation which is embodied in the draft technical criteria.[1]

[1] The "basic approach to scientific investigation" should ot be confused with the approach to licensing in the procedural element (44FR70408).

The content of the draft technical criteria indicates that the CEC and the NRC have fundamentally different conceptions of what it means from a scientific standpoint to "reasonably deal with issues in an appropriate manner." (p. 31398)

Staff Response to Comment 122:

The NRC interpretation of the phrase "in situ testing at depth" is set forth in the Supplementary Information to the final rule 10 CFR Part 60 - licensing procedures (46FR13972) to mean the conduct of those geophysical, geochemical, hydrologic, and/or rock mechanics tests performed from a test area at the base of a shaft excavated to the proposed depth of a potential repository in order to determine the suitability of a particular site for a geologic repository.

Comment 123: Energy Resources Conservation & Development Commission (22)

The flaw in the draft technical criteria is that they do not establish a minimum of scientific knowledge which is necessary for licensing. In fact, these are not licensing criteria at all but categories of information which must be addressed to an unspecified extent in an effort to hedge against technical uncertainty. Thus, instead of assuring that a licensing decision will be based on an understanding of the repository environment, the draft technical criteria would simply use whatever body of scientific knowledge exists at the time a licensing decision is made. Although the draft technical criteria provide a framework within which the knowledge base could be advanced to the point of understanding the repository environment, the current proposal lacks sufficient clarity to be even an effective hedge against uncertainty. For example, as stated above, there is no definition of what constitutes an "in situ determination." What does it mean that the "Department (of Energy) shall validate analyses and modeling of future conditions and changes in site characteristics using field tests, in situ tests, field-verified laboratory tests, monitoring data, or natural analog studies." (p. 31401) What constitutes validation?

The CEC's position on the technical basis for a licensing decision is that a predictive capability must be demonstrated. Experiments must be performed whose anticipated results are matched by empirical data. This approach is stated more clearly in the CEC's Statement of Position in the NRC's Waste Confidence Rulemaking (44FR61372). Until a predictive capability has been achieved, no hedging strategy can presume to assure isolation of radionuclides from the biosphere.

Although the draft technical criteria represent a serious effort to come to grips with the problems of licensing a repository, the criteria are premature. The qualitative, philosophical approach embodied in these criteria is an

indication of how little unambiguous data currently exists on repository performance. This approach simply does not provide confidence in licensing decisions. Moreover, the formal criteria which do exist are not well conceived.

For example, the criteria provide no containment standard applicable to the geologic barriers. § 60.111(c)(1) directs that waste packages should provide reasonable assurance of complete containment for the first 1000 years after decommissioning. § 60.111(c)(2) requires only the same 1000-year containment, as does 60.111(c)(3) pertaining to overall performance of the engineered system. In other words, the criteria do not require the geologic media to provide any containment whatsoever. Under this approach to isolating wastes, it is not likely that investigations of the physical and chemical properties of host media will be performed adequately.

Staff Response to Comment 123:

See response to Comment 122. Predictive capability can be demonstrated either by experiment, as the commenter suggests, or by comparison of the results obtained from predictive tools to exact solutions. The predictive capability of models to be used by NRC in considering licensing proposals has been checked to some extent by both methods. A thorough empirical check of predictive capability is impossible because of the very long expected lifetimes of HLW repositories. Comparison of predicted results with exact solutions is also a limited means of demonstrating predictive capability because available and obtainable exact solutions generally pertain to very simplified situations. Long term confidence in predictive capability is based on (1) agreement between predictive models and short term (when compared to the total life of a repository) experiments, (2) agreement between predictive models and exact solutions pertaining to simplified situations, and (3) expected long term geologic stability of the repository site.

Provisions for the performance of the geologic setting during containment and isolation periods are set forth in the proposed rule at 60.111(b). Further,

required characteristics of the geologic setting and additional requirements for the geologic setting are set forth at 60.112 and 60.122 respectively.

Comment 124: Lowenstein, Newman, Reis, Axelrad and Toll (28)

We urge the Commission to determine that no proposed rule will be published until a rule is drafted which properly implements the systems approach by imposing performance standards for the whole repository system rather than individual components and until all requirements set forth therein have been appropriately reviewed and analyzed to assure that they have a suitable basis and rationale and can be effectively applied in a regulatory framework.

Since an important purpose of the NRC rule will be to implement EPA standards, which have not yet been formally proposed, we suggest that the Commission instruct its staff to respond to comments on the Advance Notice and to defer publishing a proposed rule until it can incorporate proposed EPA standards.

Staff Response to Comment 124:

See response to Comments 51 and 121 for a discussion of NRC's view of the "systems approach".

Although no EPA standard for the disposal of HLW exists, the EPA has kept the NRC staff apprised of its efforts and progress towards establishing such a standard. Therefore, the NRC believes that the technical criteria for regulating geologic disposal of HLW which have been developed will implement a generally applicable standard and assure adequate protection of the public health and safety. Whatever form the EPA standard takes it appears likely - within very broad limits - that it will be necessary to rely upon the engineered and geologic barriers to provide containment and isolation capability, respectively, at the levels specified in the proposed technical criteria.

Comment 125: B. M. McElmurry (8)

Large amounts of geologic survey work will be done to establish the stability and hydrology of a candidate repository formation. Since this will allow establishment of a high level of confidence in continued stability for a few

hundred more years, the repository should then be allowed to accept any reasonably immobilized recoverable waste form such as fused ceramic glass, or even encased metal oxides. Best presently available technology should become the guideline, not some hypothetical future perfection which further delays efforts to clean up our present mess.

Staff Response to Comment 125:

"Best presently available technology" may turn out to be a more rigorous standard than the one proposed by NRC. The NRC thinks the 1,000 year-minimum standard is an appropriate one, provided that its achievement can be predicted with confidence, even if "best", but much more expensive technology would allow longer containment times.

Comment 126: Environmental Protection Agency (23)

The proposed regulation does not adequately address the subject of groundwater resources. In several places, consideration is given only to present uses of groundwater. This view is not in concert with the recognition in § 60.121(c) that institutional controls may not persist for a long time. "Accessible environment", as defined in § 60.2(a), would only protect "presently used" aquifers as designated under 40 CFR 146. However, the legislative history of the Safe Drinking Water Act makes it clear that both currently-used and potential drinking water sources should be protected.

Staff Response to Comment 126:

The term "accessible environment" has been redefined in the proposed rule.

Comment 127: Environmental Protection Agency (23)

We anticipate that the proposed EPA standards will include a requirement that provision be made for recoverability of wastes. If this requirement is promulgated, the NRC draft Technical Criteria must provide for implementation.

Staff Response to Comment 127:

The proposed rule sets forth provisions for the retrievability of the wastes at 60.111(a)(2). The staff's bases for the requirement are explained fully in

the technical support document which accompanies the proposed rule. The provision is entirely independent of the language of the EPA standard.

Comment 128: R. E. Johnson (24)

Though it may be an EPA responsibility, I believe that the concept of relative risk must be addressed either as an equivalent ore body or otherwise. ALARA necessitates it.

Staff Response to Comment 128:

Although NRC's policy and practice with respect to executing its "health and safety" responsibility generally includes an assessment of ALARA, there is no requirement in the technical criteria to address the concept of relative risk as an equivalent ore body. NRC does not believe it would be appropriate to specify such a model since EPA has the responsibility to set generally applicable standards. EPA may choose to consider radioactivity levels in the environment resulting from the presence of ore bodies in its establishment of standards related to HLW disposal.

Comment 129: Department of Environmental Protection, State of Connecticut (27)

I do not believe that the exposure limits in Title 10 CFR-Part 20 as they apply to the general population are appropriate for this type of facility. In fact, I do not believe that they will be in agreement with the standards being developed by the U.S. Environmental Protection Agency. I believe that the facilities can be designed and constructed to operate in a manner that will produce a significantly lower exposure to the public.

Staff Response to Comment 129:

The provisions of 10 CFR Part 20 would apply to effluent releases and worker exposures during waste handling and emplacement operations. It would not apply to releases from the repository after closure.

Comment 130: Environmental Protection Agency (23)

The numbering system used does not allow for easy reading of grouped and sequential ideas. Perhaps a number of additional subheadings would provide greater clarity.

Staff Response to Comment 130:

In response to public comment the numbering system has been simplified.

Comment 131: Attorney General Abrams, State of New York (11)

The draft provides that the activities authorized by a license should "not constitute unreasonable risk to the health and safety of the public." P. 31352, col. 3. As in other NRC licensing matters, the degree of risk deemed unreasonable is not defined. It is worth noting, however, that the public's perception of risk differs from that of the technical community, which defines risk as the probability that an event (such as a major release of radioactivity from a repository) will occur multiplied by the expected consequences of the event. By this definition, if the probability is small enough the risk may be viewed as modest, despite the possibly calamitous consequences of an accident. But the public does not accept that reasoning. According to a report by Battelle Pacific Northwest Division:

> The general public often perceives the outcomes of an event to be more important than the probability.

Ref. 19, p. 14 (citation omitted). The NRC should learn to be responsive to the public's perception of risk.

Staff Response to Comment 131:

The definition of risk presented in the comment is essentially correct, that is, an expectation of an untoward outcome. The NRC attempts to describe risk in a way that accurately reflects the consequences of possible events, even if the likelihood of the event is small. The NRC believes this attempt is responsive to the public perception of risk.

Comment 132: U.S. Department of Energy (18)

NRC Proposed Wording:

"Aquifer" - means a distinct hydrogeologic unit that readily transmits water and yields significant quantities of water to wells or springs.

Recommended Revision:

"Aquifer" - means a layer of rock or soil which is relatively more permeable than the nearby layers above or below and through which water flows. In an aquifer, the yield to wells is generally considered to be more than 1/3 gallon per minute.

Rationale:

Words like "significant" can lead to endless debate in the licensing process.

Staff Response to Comment 132:

The staff believes that the definition of the term "aquifer" as appeared in the draft technical criteria conforms more closely to the definitions presented in the commonly used reference books - Dictionary of Geological Terms (1976, prepared under the direction of the American Geological Institute) and the Glossary of Geology (1980) edited by R. L. Bates and J. A. Jackson and published by the American Geological Institute than that proposed by DOE. The definition set forth in the Glossary of Geology uses the phrase "significant quantities of water to wells and springs." However, both the definition and usage of the term "aquifer" have been deleted from the proposed technical criteria. What will be important, in this context, is the accessibility of water from aquifers and the release to the environment of radioactivity levels of concentration inconsistent with the EPA standard.

Comment 133: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Aquifer

The phrase "significant quantities of water" is ambiguous and can lead to conflicting interpretations. This should be improved with a more definitive term.

Staff Response to Comment 133:

See response to Comment 132.

Comment 134: Attorney General Abrams, State of New York (11)

The definition section, Section 60.2, includes in the term "accessible environment" only those aquifers which are presently used and have been designated by the Environmental Protection Agency as underground sources of drinking water. P. 31399, col. 1. An "aquifer" is then defined in terms of yielding "significant quantities of water to wells or springs." In view of the water shortages already experienced in some parts of the country and those which could arise in the future, the regulations should attempt a more comprehensive protection of groundwater from radiation -- encompassing even small aquifers not currently used or designated by the EPA.

Moreover, the draft regulations do not require, as they should, avoiding all sites near aquifers or lakes or rivers. See Appendix, p. 58. Rather, they omit this obvious requirement from § 60.122(b)(3), p. 31402, col. 1. In addition, the regulations should require abandonment of any site where aquifers are found, but fail to do so. § 60.132(c)(9), p. 31405, col. 2.

Staff Response to Comment 134:

See response to Comment 132.

The determination as to whether a particular site is suitable to host a repository will involve manifold factors, including proximity to rivers and aquifers as part of the hydrologic system of the geologic setting. There seems to be no good reason to single out proximity to a river or lake or a siting criterion since radionuclide migration time from the emplacement to the environment is the key parameter of interest.

Comment 135: Westinghouse Electric Corp. (20)

60.2 - Under definitions, the definition of "barrier" should be expanded to include materials or structures which function to reduce corrosion and modify or exclude groundwater and thus prevent anything from getting to the radioactive waste to move it outward. As written, the barrier function only covers retardation of radionuclide movement outward.

Staff Response to Comment 135:

The definition of "barrier" has been slightly modified in the proposed technical criteria. As modified, the term barrier now means any material or structure that prevents or substantially delays the movement of water or radionuclides. Materials or structures which inhibit corrision of waste cannistern could fall within the definition of barrier.

Comment 136: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Confining Unit

This definition is also unclear. It would be improved by inserting "adjacent to an aquifer" after "hydrologic unit." After all, a confining unit should confine something, e.g., an impermeable shale bed overlying a permeable sandstone layer. In this sense a mass of granite is not a confining unit just because it is relatively impermeable, nor is it proper to consider a salt dome itself as a confining unit.

Staff Response to Comment 136:

The definition of the term "confining unit" has been deleted from the proposed rule.

Comment 137: U.S. Department of Energy (18)

NRC Proposed Wording:

"Container" - means the first major sealed enclosure that holds the waste form.

Recommended Revision:

"Canister" - means the innermost sealed enclosure that holds the waste form.

Rationale:

Canister is the more commonly used term. The term "first" is unclear depending on whether one is counting from the outside or the inside.

Staff Response to Comment 137:

The definition of the term "container" has been deleted from the proposed rule.

Comment 138: U.S. Department of Energy (18)

NRC Proposed Wording:

"Decommissioning" - means final backfilling of subsurface facilities, sealing of shafts, and decontamination and dismantlement of surface facilities.

Recommended Revision:

"Decommissioning" - means removal from active operational usage including decontamination and/or dismantlement.

Rationale:

Decommissioning should be differentiated from isolation.

Staff Response to Comment 138:

The staff believes that the present definition adequately distinguishes "decommissioning" from "isolation".

Comment 139: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.2 "Decommissioning--means final backfilling of subsurface facilities, sealing of shafts, and decontamination and dismantlement of surface facilities."

Comment:

Change of "..sealing of shafts..." to "...sealing of penetrations such as shafts..." is recommended.

Staff Response to Comment 139:

The rationale for the recommended change was not presented. The staff sees no reason to modify the definitions as suggested.

Comment 140: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Decommissioning

This is a misleading term. After backfilling and sealing is when the basic functioning of the repository begins. Suggest substitution of the word "closure."

Staff Response to Comment 140:

The term "decommissioning" has now been changed to "decommissioning" or "permanent closure" in § 60.2.

Comment 141: Arvin S. Quist (6)

"Disposal" is stated to mean "permanent emplacement within a storage space with no intent to retrieve for resource values." I would suggest that "disposal" should mean emplacement with no intent to retrieve for any reason after decommissioning of the repository. "Disposal" should emphasize that a final decision has been made with respect to these wastes except for unforeseeable circumstances that might occur within the repository prior to decommissioning.

Staff Response to Comment 141:

In response to public comment on 10 CFR Part 60, the definition of the term "disposal" has been revised.

Comment 142: U.S. Department of Energy (18)

NRC Proposed Wording:

"Disposal" - means permanent emplacement within a storage space with no intent to retrieve for resource values.

Recommended Revision:

Delete "for resource values".

Rationale:

The term "permanent emplacement" earlier in the definition implies no intent to retrieve for any reason. If there is intent to retrieve, the term "storage" rather than "disposal" would apply, and emplacement would not necessarily be "permanent". Although the capability to retrieve will be maintained through the operational phase, there is no intent to retrieve unless required for safety.

Staff Response to Comment 142:

The revised definition of the term "disposal" now reads as follows: "disposal means the isolation of radioactive wastes from the biosphere."

Comment 143: Attorney General Abrams, State of New York (11)

The definition of "expected processes and events" very specifically excludes human intrusion, § 60.2, p. 31399, col. 1 -- despite the admission that such intrusion cannot be prevented. This defined term is then used repeatedly in § 60.111(c) to free DOE from the responsibility of avoiding human intrusion in meeting performance objectives. P. 31400, col. 1-2. Thus, the theory behind the regulations is to define away the problem of intrusion and forget about it for licensing purposes -- despite the real possibility that an intrusion will permit a large release of radioactivity.

Staff Response to Comment 143:

See response to Comment 91.

Comment 144: U.S. Department of Energy (18)

NRC Proposed Wording:

"Expected processes and events" - means those natural processes or events that are likely to degrade the engineered elements of the geologic repository during a given period after decommissioning. As used in this part, expected processes and events do not include human intrusion.

Recommended Revision:

Change "degrade" to "occur and act upon".

Rationale:

The definition of "expected processes and events" is limited to these processes or events" that are likely to degrade the engineered elements..." Since this is a much narrower definition than would normally be ascribed to the term "expected processes and events", either the term should be made more specific and descriptive, or its definition should be more general for consistency with normal usage.

Staff Response to Comment 144:

"Expected processes and events" have been redefined as "anticipated processes and events" to more clearly convey what is meant and the role such events will play in the licensing process.

Comment 145: Bird enclosure in U.S. Department of Energy (18)

"'Expected processes or events' - means those natural processes or events that are likely to degrade the engineered elements of the geologic repository during a given period after decommissioning." How are these processes or

events distinguished as being deleterious? Some might improve on "engineered" barrier, as discussed earlier.

Staff Response to Comment 145:

See response to Comment 144.

Comment 146: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Expected Processes and Events

It is unreasonable to limit this definition only to those natural processes and events that are likely to degrade the engineered elements. Processes and events may also occur that would improve containment and isolation and not adversely affect engineered elements. We suggest changing "degrade" to "occur," and deleting "the engineered elements of the geologic repository.

Staff Response to Comment 146:

See response to Comment 144.

Comment 147: U.S. Department of Energy (18)

NRC Proposed Wording:

"Floodplain" - means the lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of offshore islands including, at a minimum, that area subject to a one percent or greater chance of flooding in any given year.

Recommended Revision:

Use a different word than floodplain.

Rationale:

This definition does not correspond with the standard meaning of "floodplain" as used by other government agencies (EPA). Suggest another term covering all areas susceptible to flooding, e.g., "floodprone".

Staff Response to Comment 147:

The definition of "floodplain" used in the technical criteria is derived from the definition set forth in the U.S. Water Resources Council's Floodplain Management Guidelines for Implementing E.O. 11988 published in the February 10, 1978 issue of the Federal Register (43 FR 6030). The NRC disagrees with the

DOE's opinion that this definition does not correspond to the EPA usage of the term. The NRC believes that the definition of "floodplain" set forth in the EPA's proposed Guidelines on Hazardous Waste at 43 FR 58997 (December 18, 1978) is quite similar to the definition set forth by the U.S. Water Resources Council, and hence, similar to the NRC definition.

Comment 148: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Floodplain

This definition is clarified later in the criteria as being in the context of an Executive Order precluding federal construction in a floodplain, which is that area flooded by a calculated hundred-year storm. However, as a technical definition it is ambiguous because it implies that a floodplain does or does not exist if it has a greater or lesser chance of flooding relative to some arbitrary amount. This would be patently absurd, and similar reasoning can hardly be applied to defining other geologic/geomorphic features, e.g., volcano.

Staff Response to Comment 148:

Floodplain, as defined in the technical criteria, is the lowland and relatively flat areas adjoining inland and coastal waters including floodprone areas of offshore islands. The definition also includes that area subject to a one percent or greater chance of flooding in any given year. This quantitative addition is necessary to include many areas which are not part of a floodplain in the geologic sense (lowland and relatively flat areas adjoining inland waters) but are floodprone. This addition also facilitates the inclusion of areas that are above the geologic floodplain but are now floodprone due to manmade channel obstructions or upstream development.

Comment 149: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Geologic Repository

It seems overly broad to include in this definition "all surface and subsurface areas where natural events or activities of man may change the extent to which wastes are isolated." Strict application of this definition could include parts of surface-water basins that are several tens of kilometers from the site, and other features at similar distances. While it is agreed that these

features are important to the repository and should be evaluated as part of the repository system, they are not a direct part of the repository. Use of a term such as "region of influence," which does not suggest a specific geographic location, would be preferred.

Staff Response to Comment 149:

The definition of "geologic repository" has been revised in the proposed rule to mean a system for the disposal of radioactive wastes in excavated geologic media. A geologic repository includes (1) the geologic repository operations area and (2) the geologic setting. The geologic setting is the spatially distributed geologic, hydrologic, and geomechanical systems that provide isolation of the wastes.

Comment 150: U.S. Department of Energy (18)

NRC Proposed Wording:

"Geologic repository operations area" - means a HLW facility that is part of a geologic repository, including both surface and subsurface areas, where waste handling and emplacement activities are conducted.

Recommended Revision:

Redefine to address TRU disposal also, if appropriate.

Rationale:

See major comments.

Staff Response to Comment 150:

The provisions of 10 CFR Part 60 address only those facilities that are subject to NRC licensing. If TRU is disposed of in a geologic repository operations area, the applicable provisions of Part 60 would have to be met.

Comment 151: American Institute of Chemical Engineers (16)

Definition of High-Level Waste

The definition of "high-level radioactive waste" given in the criteria document includes "irradiated reactor fuel" along with the customary HLW from reprocessing. Although either political considerations or lack of storage space for spent fuel might require disposal of unreprocessed spent fuel, we do not consider this material as a "waste" by any provident definition. As you know,

most nations using nuclear power view spent fuel as a valuable material, particularly for the breeder reactors that they have built and are continuing to build. Even the United States government must view spent fuel as having appreciable value, in a defensive sense, because of the extreme security and protection required to prevent its diversion to other uses.

Therefore, we recommend that "irradiated reactor fuel" not be included in the definition of high level radioactive waste. Instead, the usage could be something like "--emplacement of high-level waste or spent fuel in--."

Staff Response to Comment 151:

It is the Commission's position that when viewed as falling within the purview of Section 202 of the Energy Reorganization Act, irradiated reactor fuel is high-level waste.

Comment 152: Environmental Protection Agency (23)

NRC and EPA should assure that the definition of "high-level waste" be identical in § 60.2 and in the forthcoming EPA standards.

Staff Response to Comment 152:

See response to Comment 151.

Comment 153: Arvin S. Quist (6)

"Important to safety" refers to "undue risk to health and safety of the public." Subpart 60.101(b) mentions "unreasonable risk to the health and safety of the public." Is there a difference between "undue risk" and "unreasonable risk"? Why not use either term, but not both? In any event, the term(s) should be defined to provide more specific guidance in the evaluations that are to be performed in accordance with 10 CFR Part 60.

Staff Response to Comment 153:

The "unreasonable risk" standard employs statutory language. See, e.g., AEA §57d., 42 U.S.C. 2077. The "undue risk" language employs the parallel, established, phraseology from 10 CFR Part 50, Appendix A.

Comment 154: Bechtel National, Inc. (13)

The definition of items "important to safety" does not include engineered items which are important for assuring the long term isolation of the waste

from the biosphere, e.g., the waste form, container and overpack. Should such items be considered within the definition of important to safety?

The definition of "important to safety" uses the words "without undue risk to the health and safety of the public". Due to lack of specificity, this qualitative definition has caused much difficulty in the licensing of reactors. It is recommended that the definition be quantified to specifically apply to items essential to the prevention or mitigation of the consequences of operational accidents that could result in exceeding some defined radiological release or exposure limits.

Staff Response to Comment 154:

The staff believes that the present definition of "important to safety" with reference to structures, systems and components as set forth at 60.2 would include engineered items such as the examples provided by the commenter.

See also response to Comment 153.

Comment 155: U.S. Department of Energy (18)

NRC Proposed Wording:

"Important to safety" with reference to structures, systems, and components, means those structures, systems, and components that provide reasonable assurance that radioactive waste can be received, handled, and stored without undue risk to the health and safety of the public.

Recommended Revision:

"Important..." means those structures, systems, and components that prevent or mitigate events that could cause unreasonable risk to the health and safety of the public due to release of radioactive material.

Rationale:

To be consistent with 60.171(b).

Staff Response to Comment 155:

See response to Comment 153.

Comment 156: Bird enclosure in U.S. Department of Energy (18)

Overpack - "any additional receptable (sic), wrapper, box or other structure" - I would suggest adding material to the list because a component of the overpack might not be only structural.

Staff Response to Comment 156:

In response to the commenter's suggestion, the wording buffer "material" has been included in the definition of the term "overpack."

Comment 157: Bechtel National, Inc. (13)

Paragraphs 60.133(b)(4)(iii) and 60.171(b) use the term "safety related", in one case referring to safety related structures, systems or components, and in the other to functions of structures, systems or components.

Are these intended to be the same as structures, systems and components "important to safety"? In 10 CFR Part 50 the nuclear industry has lived with an ambiguity between these terms for many years. It is recommended that the same conflict not be repeated in Part 60. It would seem that the requirements should consistently refer to functions of structures, systems and components important to safety, or it should be stated that the terms "important to safety" and "safety related" as applied to equipment functions are synonymous.

Staff Response to Comment 157:

The term "safety related" has been deleted from the proposed rule. See also response to Comment 153.

Comment 158: Bechtel National, Inc. (13)

The term "single failure" is used in Paragraph 60.132(b)(8)(i) but is not defined. It is not clear whether this refers to an "active" failure or both "active" and "passive" failures. In nuclear plants, the single failure applies to a single active failure unrelated to the initiating event. Is this intended here? Single failure should be defined in Section 60.2.

Staff Response to Comment 158:

The term "single failure" has been deleted from the proposed rule.

Comment 159: U.S. Department of Energy (18)

NRC Proposed Wording:

"Stability" - means the rate of natural processes affecting the site during the recent geologic past are relatively low and will not significantly change during the next 10,000 years.

Recommended Revision:

"Stability" is a relative term indicating that the rates of natural processes such as erosion and faulting are so low that their effect will not jeopardize isolation of the waste. This is determined by measuring the present rates of those processes and, by geologic evidence, deducing the rates in effect during the recent geologic past.

Rationale:

Specifying 10,000 years is useful and reasonable, but the terms above are somewhat subjective. It is also recommended that the regulation stipulate the first 10,000 years as the period over which reasonable assurance of isolation be provided (i.e., consistent with DOE's proposed objectives as set forth in its Statement of Position in the Confidence Rulemaking).

Staff Response to Comment 159:

The definition of the term "stability" has been revised.

Comment 160: Cook enclosure in U.S. Department of Energy (18)

Turning now to Subpart E, itself, at least two of the definitions may lead to confusion. First, "'Stability' - means the rate of natural processes affecting the site during the recent geologic past are relatively low and will not significantly change during the next 10,000 years". This is neither a rigorous nor precise statement. Second, "'Underground Facility' - means the civil engineered structure, including backfill materials, but not including seals (emphasis added) in which waste is emplaced"; in some rocks backfills and seals may have to be synonymous.

Staff Response to Comment 160:

See response to Comment 159.

The definition of "underground facility" has been modified and avoids the difficulty cited by the commentor. See response to comment 165.

Comment 161: Bird enclosure in U.S. Department of Energy (18)

Stability - The definition is too imprecise, and does not make clear the distinction between rate of natural processes versus events of short duration during the specified period of the next 10,000 years.

Staff Response to Comment 161:

See response to Comment 159.

Comment 162: Bechtel National, Inc. (13)

The definition of "TRU waste" should be more specific since as currently defined spent fuel could be classified as either HLW or TRU waste. Is this overlap intended or are the definitions of TRU waste and HLW meant to be mutually exclusive as is implied by the criteria of Paragraph 60.111(c)(3)?

Staff Response to Comment 162:

See response to Comment 151. The definition of the term "transuranic wastes" has not been modified in the proposed rule.

Comment 163: U.S. Department of Energy (18)

NRC Proposed Wording:

"Transuranic wastes" or "TRU wastes" - means radioactive waste containing alpha emitting transuranic elements, with radioactive half-lives greater than one year, in excess of 10 nanocuries per gram.

Recommended Revision:

a. Insert "other than HLW" after "radioactive waste".

b. Delete numerical definition of 10 nanocuries per gram.

Rationale:

a. Clarity

b. Numerical definitions for TRU wastes are being formulated by EPA and NRC regulations would more appropriately reflect the EPA definition. While DOE regulations use 10 nanocuries per gram to define the level above which TRU-contaminated wastes will not be emplaced in shallow land burial, a more precise evaluation of this limit is underway which may lead to a redefinition.

Staff Response to Comment 163:

The NRC believes that the separate definitions of the terms "High-Level Radioactive Wastes" (HLW) and "Transuranic wastes" (TRU) clarify sufficiently their distinctiveness in 10 CFR Part 60. If the limit of 10 nanocuries per

gram should require redefinition at a future date, the appropriate provisions of the rule can then be revised by NRC.

Comment 164: U.S. Department of Energy (18)

NRC Proposed Wording:

"Underground facility" - means the civil engineered structure, including backfill materials, but not including seals, in which waste is emplaced.

Recommended Revision:

Change "civil" to "subsurface".

Rationale:

Clarity.

Staff Response to Comment 164:

The definition of the term "underground facility" has been modified in response to public comment.

Comment 165: Bird enclosure in U.S. Department of Energy (18)

Underground facility. Seals might be made of geologic materials and be part of the engineered structure.

Staff Response to Comment 165:

Seals, regardless of the type of material they are composed of, are not considered part of the underground facility by the NRC. The revised definition of the term "underground facility," may allay some of Dr. Bird's concerns.

Comment 166: Bechtel National, Inc. (13)

The term "unreasonable risk" is employed in Paragraphs 60.101(b) and 60.171(b). Is this intended to be the same as "undue risk" used in Paragraph 60.2 or to have a different meaning? Please clarify.

Staff Response to Comment 166:

See respone to Comment 153.

Comment 167: U.S. Department of Energy (18)

Definitions should be added for the following terms which were used in the regulation:

a. "Institutional Control"
b. "Long Term"
c. "Module"
d. "Saturated Media"
e. "Site Suitability", (Contrast with "Site/Facility Acceptability")
f. "Quaternary" (provide specific length of time)
g. "Vadose Zone"

Staff Response to Comment 167:

The staff believes that a number of these terms possess generally acceptable definitions to the geologic and engineering community. The terms "instituional control", "long term", "saturated media", "site suitability" and "vadose zone" are no longer used in the provisions of the proposed technical criteria.

Comment 168: Ellison in U.S. Department of Energy (18)

Definitions of the terms "saturated media", "site", "institutional control", and "module" should be added.

Staff Response to Comment 168:

See response to Comment 167. A definition of the term "site" has been added to the proposed technical criteria.

Comment 169: Everett Irish (29)

Page 31399, Definitions - Good effort, but I have some suggestions:
(a) Accessible Environment - I wonder whether or not deep oceans and ocean bed should not be excluded from the portions considered readily accessible.
(b) Disposal definition should not use term "storage space." (c) First HLW definition should have added "if declared a waste." (d) TRU wastes - isn't the 10 nanocurie per gram limit under question?

Staff Response to Comment 169:

(a) The staff believes that since rivers do ultimately flow into oceans, the oceans should be considered as part of the accessible environment.

(b) The revised definition of the term "disposal" no longer contains the term "storage space".

(c) HLW is "waste" by definition.

(d) See response to Comment 163.

Comment 170: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

60.101

Paragraph (d)

In light of what we believe are excessively detailed specifications and requirements contained in the proposed technical criteria (instead of performance criteria) it is ironic to see such a statement.

Paragraph (e)

How is "saturation" defined for salt?

Staff Response to Comment 170:

See response to Comment 171.

Comment 171: U.S. Department of Energy (18)

60.101(e)

NRC Proposed Wording:

(e) The requirements and conditions in subsequent sections assume that disposal will be in saturated media. The Commission does not intend to exclude disposal in the vadose zone or any other method by promulgating these criteria; however, different criteria may need to be developed to license other disposal methods.

Recommended Revision:

Rewrite or delete.

Rationale:

This seems unduly restrictive and raises questions as to what actually constitutes a saturated medium and as to whether these criteria apply to salt deposits.

Staff Response to Comment 171:

The requirements of Part 60 were developed assuming that disposal will occur in saturated media because it was NRC's understanding that the sites currently under consideration by DOE are at depths which would put a repository in the saturated zone. The saturated zone is a subsurface zone in which all interconnected pore spaces are filled with water. The second line of 60.101(e) recognizes that NRC is not excluding any potential sites DOE may characterize in the vadose zone. Rather, NRC intended to point out that the technical criteria were written for potential repository sites at depths which would place them in the saturated zone; therefore, some of the provisions may not be appropriate for sites situated in the vadose zone. However, in response to public comment and for clarity, references to the "saturated" and "vadose" zones have been deleted from the proposed rule.

Comment 172: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.101(e) "The requirements and conditions in subsequent sections assume that disposal will be in saturated media. The Commission does not intend to exclude disposal in the vadose zone or any other method by promulgating these criteria; however, different criteria may need to be developed to license other disposal methods."

Comment:

Without a definition of saturated media, the statement is not very precise and will have different meanings to different persons. For example, does the term "saturated media" mean that the host is within a continuous water table condition or does it simply imply "below the water table."

Staff Response to Comment 172:

See response to Comment 171.

Comment 173: Westinghouse Electric Corp. (20)

60.101(e) - We believe the first sentence of this subparagraph should state that the "subsequent sections assume that disposal will not be in saturated media".

Staff Response to Comment 173:

See response to Comment 171.

Comment 174: Duke Power Co. (25)

60.101(e) Why the presumption of saturated media?

Staff Response to Comment 174:

See response to Comment 171.

Comment 175: U.S. Geological Survey (12)

Page 31400, cols. 1 and 2, sec. 60.111. We support the performance objectives presented here. Although demanding, they seem to be attainable, though at considerable cost in funds and at a cost of several years delay in attaining operational status for a repository, when compared to the performance characteristics DOE formerly assumed.

Staff Response to Comment 175:

No response required.

Comment 176: U.S. Department of Energy (18)

The staff apparently recognizes in 60.111, Performance Objectives, that it is impossible to prove with certainty that the performance objectives will be met in the far future. Thus the phrase "reasonable assurance" is used in conjunction with several of these criteria. It would be useful to provide, possibly in the statement of considerations, a discussion of the standard of proof implied by "reasonable assurance". The Commission should also provide guidance relative to the time over which reasonable assurance of isolation must be provided. The Department has proposed an objective of 10,000 years as indicated in its Statement of Position on the Confidence Rulemaking. We propose that a 10,000 year requirement be set by the Commission in this regulation as a performance objective for the repository.

Staff Response to Comment 176:

The term "reasonable assurance" is the standard employed in the procedural rule, 10 CFR 60.31(a) and corresponds to the traditional formulation used in the review of facility license applications 10 CFR 50.40(a).

Comment 177: Bechtel National, Inc. (13)

Reasonable Assurance of Conformance to EPA Standards - The most significant of the overall repository performance objectives defined in § 60.111 of the technical criteria is for the DOE to provide reasonable assurance that, after decommissioning, the isolation of the radioactive waste will conform to the applicable environmental standards established by the EPA. A major portion of this proposed rule deals with what the NRC considers to be necessary to provide this reasonable assurance. In dealing with this question, we believe that the NRC has placed undue emphasis on the nature of the uncertainties associated with transport of the waste through the geosphere to the exclusion of other important considerations such as: the extent to which uncertainties can be negated or made inconsequential by bounding analysis and design; the very large costs in both time and effort associated with quantifying and reducing uncertainties; and the incremental magnitude of risks associated with residual uncertainties. The deficiencies in the NRC approach are evidenced not only by the tone of the proposed criteria, but also by the working draft of the bases and rational document which was placed in the NRC Public Document Room for inspection. This working draft deals almost exclusively with the uncertainties associated with geologic/hydrologic site characteristics, waste transport models, and supporting data. Little or no information or rationale is provided on the extent to which these uncertainties impact the risk to the public health and safety, or how these uncertainties when found to be safety significant can be reduced in importance by conservative design and analysis. Bechtel believes that the NRC requirements could be greatly simplified and the apparent excessive conservatisms removed if these additional factors in dealing with the question of reasonable assurance are given adequate attention.

Staff Response to Comment 177:

The NRC believes that the rule requires only those characteristics necessary to provide reasonable assurance, and that there are no "excessive conservatisms."

See also comment 176.

Comment 178: Arvin S. Quist (6)

Suggested wording in (a)(1) is: "...reasonable assurance that radiation exposures and releases of radioactive materials are as low as reasonably

gram should require redefinition at a future date, the appropriate provisions of the rule can then be revised by NRC.

Comment 164: U.S. Department of Energy (18)

NRC Proposed Wording:

"Underground facility" - means the civil engineered structure, including backfill materials, but not including seals, in which waste is emplaced.

Recommended Revision:

Change "civil" to "subsurface".

Rationale:

Clarity.

Staff Response to Comment 164:

The definition of the term "underground facility" has been modified in response to public comment.

Comment 165: Bird enclosure in U.S. Department of Energy (18)

Underground facility. Seals might be made of geologic materials and be part of the engineered structure.

Staff Response to Comment 165:

Seals, regardless of the type of material they are composed of, are not considered part of the underground facility by the NRC. The revised definition of the term "underground facility," may allay some of Dr. Bird's concerns.

Comment 166: Bechtel National, Inc. (13)

The term "unreasonable risk" is employed in Paragraphs 60.101(b) and 60.171(b). Is this intended to be the same as "undue risk" used in Paragraph 60.2 or to have a different meaning? Please clarify.

Staff Response to Comment 166:

See respone to Comment 153.

Comment 167: U.S. Department of Energy (18)

Definitions should be added for the following terms which were used in the regulation:

a. "Institutional Control"
b. "Long Term"
c. "Module"
d. "Saturated Media"
e. "Site Suitability", (Contrast with "Site/Facility Acceptability")
f. "Quaternary" (provide specific length of time)
g. "Vadose Zone"

Staff Response to Comment 167:

The staff believes that a number of these terms possess generally acceptable definitions to the geologic and engineering community. The terms "instituional control", "long term", "saturated media", "site suitability" and "vadose zone" are no longer used in the provisions of the proposed technical criteria.

Comment 168: Ellison in U.S. Department of Energy (18)

Definitions of the terms "saturated media", "site", "institutional control", and "module" should be added.

Staff Response to Comment 168:

See response to Comment 167. A definition of the term "site" has been added to the proposed technical criteria.

Comment 169: Everett Irish (29)

Page 31399, Definitions - Good effort, but I have some suggestions:
(a) Accessible Environment - I wonder whether or not deep oceans and ocean bed should not be excluded from the portions considered readily accessible.
(b) Disposal definition should not use term "storage space." (c) First HLW definition should have added "if declared a waste." (d) TRU wastes - isn't the 10 nanocurie per gram limit under question?

Staff Response to Comment 169:

(a) The staff believes that since rivers do ultimately flow into oceans, the oceans should be considered as part of the accessible environment.

(b) The revised definition of the term "disposal" no longer contains the term "storage space".

(c) HLW is "waste" by definition.

(d) See response to Comment 163.

Comment 170: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

60.101

Paragraph (d)

In light of what we believe are excessively detailed specifications and requirements contained in the proposed technical criteria (instead of performance criteria) it is ironic to see such a statement.

Paragraph (e)

How is "saturation" defined for salt?

Staff Response to Comment 170:

See response to Comment 171.

Comment 171: U.S. Department of Energy (18)

60.101(e)

NRC Proposed Wording:

(e) The requirements and conditions in subsequent sections assume that disposal will be in saturated media. The Commission does not intend to exclude disposal in the vadose zone or any other method by promulgating these criteria; however, different criteria may need to be developed to license other disposal methods.

Recommended Revision:

Rewrite or delete.

Rationale:

This seems unduly restrictive and raises questions as to what actually constitutes a saturated medium and as to whether these criteria apply to salt deposits.

Staff Response to Comment 171:

The requirements of Part 60 were developed assuming that disposal will occur in saturated media because it was NRC's understanding that the sites currently under consideration by DOE are at depths which would put a repository in the saturated zone. The saturated zone is a subsurface zone in which all interconnected pore spaces are filled with water. The second line of 60.101(e) recognizes that NRC is not excluding any potential sites DOE may characterize in the vadose zone. Rather, NRC intended to point out that the technical criteria were written for potential repository sites at depths which would place them in the saturated zone; therefore, some of the provisions may not be appropriate for sites situated in the vadose zone. However, in response to public comment and for clarity, references to the "saturated" and "vadose" zones have been deleted from the proposed rule.

Comment 172: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.101(e) "The requirements and conditions in subsequent sections assume that disposal will be in saturated media. The Commission does not intend to exclude disposal in the vadose zone or any other method by promulgating these criteria; however, different criteria may need to be developed to license other disposal methods."

Comment:

Without a definition of saturated media, the statement is not very precise and will have different meanings to different persons. For example, does the term "saturated media" mean that the host is within a continuous water table condition or does it simply imply "below the water table."

Staff Response to Comment 172:

See response to Comment 171.

Comment 173: Westinghouse Electric Corp. (20)

60.101(e) - We believe the first sentence of this subparagraph should state that the "subsequent sections assume that disposal will not be in saturated media".

Staff Response to Comment 173:

See response to Comment 171.

Comment 174: Duke Power Co. (25)

60.101(e) Why the presumption of saturated media?

Staff Response to Comment 174:

See response to Comment 171.

Comment 175: U.S. Geological Survey (12)

Page 31400, cols. 1 and 2, sec. 60.111. We support the performance objectives presented here. Although demanding, they seem to be attainable, though at considerable cost in funds and at a cost of several years delay in attaining operational status for a repository, when compared to the performance characteristics DOE formerly assumed.

Staff Response to Comment 175:

No response required.

Comment 176: U.S. Department of Energy (18)

The staff apparently recognizes in 60.111, Performance Objectives, that it is impossible to prove with certainty that the performance objectives will be met in the far future. Thus the phrase "reasonable assurance" is used in conjunction with several of these criteria. It would be useful to provide, possibly in the statement of considerations, a discussion of the standard of proof implied by "reasonable assurance". The Commission should also provide guidance relative to the time over which reasonable assurance of isolation must be provided. The Department has proposed an objective of 10,000 years as indicated in its Statement of Position on the Confidence Rulemaking. We propose that a 10,000 year requirement be set by the Commission in this regulation as a performance objective for the repository.

Staff Response to Comment 176:

The term "reasonable assurance" is the standard employed in the procedural rule, 10 CFR 60.31(a) and corresponds to the traditional formulation used in the review of facility license applications 10 CFR 50.40(a).

Comment 177: Bechtel National, Inc. (13)

Reasonable Assurance of Conformance to EPA Standards - The most significant of the overall repository performance objectives defined in § 60.111 of the technical criteria is for the DOE to provide reasonable assurance that, after decommissioning, the isolation of the radioactive waste will conform to the applicable environmental standards established by the EPA. A major portion of this proposed rule deals with what the NRC considers to be necessary to provide this reasonable assurance. In dealing with this question, we believe that the NRC has placed undue emphasis on the nature of the uncertainties associated with transport of the waste through the geosphere to the exclusion of other important considerations such as: the extent to which uncertainties can be negated or made inconsequential by bounding analysis and design; the very large costs in both time and effort associated with quantifying and reducing uncertainties; and the incremental magnitude of risks associated with residual uncertainties. The deficiencies in the NRC approach are evidenced not only by the tone of the proposed criteria, but also by the working draft of the bases and rational document which was placed in the NRC Public Document Room for inspection. This working draft deals almost exclusively with the uncertainties associated with geologic/hydrologic site characteristics, waste transport models, and supporting data. Little or no information or rationale is provided on the extent to which these uncertainties impact the risk to the public health and safety, or how these uncertainties when found to be safety significant can be reduced in importance by conservative design and analysis. Bechtel believes that the NRC requirements could be greatly simplified and the apparent excessive conservatisms removed if these additional factors in dealing with the question of reasonable assurance are given adequate attention.

Staff Response to Comment 177:

The NRC believes that the rule requires only those characteristics necessary to provide reasonable assurance, and that there are no "excessive conservatisms."

See also comment 176.

Comment 178: Arvin S. Quist (6)

Suggested wording in (a)(1) is: "...reasonable assurance that radiation exposures and releases of radioactive materials are as low as reasonably

achievable and in any event within the limits set forth in Part 20 of this Chapter." (underlined words added)

Staff Response to Comment 178:

The staff declines to make the suggested change, inasmuch as Part 20 already contains the ALARA concept.

Comment 179: Bechtel National, Inc. (13)

60.111(a)(1) - This paragraph specifies exposure or release limits during normal operation but does not specify limits for operational accidents. Should limits comparable to those of 10 CFR Part 100 apply? It should be noted that, due to the nature of potential releases from repositories under both normal and accident conditions, exposure limits need to be expressed in terms of dose commitments to critical organs for a defined time period.

Staff Response to Comment 179:

The limits of Part 100 are not applicable to accidents at a geologic repository.

Comment 180: Environmental Protection Agency (23)

§ 60.111(a)(1) "Radiation exposure or releases during operation" should add the following: "...or such other standards as may be established by EPA".

Staff Response to Comment 180:

In response to EPA's suggestion paragraph 60.111(a)(1) has been modified in the proposed rule to include a reference to "any generally applicable environmental standards established by the Environmental Protection Agency." If EPA adopts applicable standards, NRC will revise this provision as necessary or appropriate.

Comment 181: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.111(a)(2) Releases after decommissioning. "The Department of Energy shall provide reasonable assurance that after decommissioning the geologic repository will isolate radioactive wastes to such a degree that quantities and concentrations of radioactive waste in the accessible environment will conform to such generally applicable environmental standards as may have been established by the Environmental Protection Agency."

Comment:

This statement is very reasonable and discussions at meetings with many scientific contributors indicate general concurrence that releases should conform to generally applicable environmental standards.

It is noted here, that this same approach should also be taken relative to determination of the adequacy of penetration seals [§ 60.132(c)(2)(iv)(b)]. At the recent International Meeting on Penetration Sealing (May 7-9, 1980 in Columbus, Ohio) it was a consensus that required performance of seals should be measured in terms of potential nuclide release rates vs allowable standards; as opposed to relating potential seal behavior to undisturbed rock behavior.

Staff Response to Comment 181:

A number of the design requirements set forth at § 60.132 in the proposed rule tie directly into the performance objectives (60.111), which include conformance with EPA standards.

Comment 182: Westinghouse Electric Corp. (20)

60.111(a)(2) - This subparagraph refers to as yet unestablished Environmental Protection Agency performance standards which will apply to radioactive waste releases to the accessible environment after repository decommissioning. As such, it seems premature to specify an annual release rate ($10^{-5}$ of 1000 year inventory per year) without guidance from the EPA.

60.111(a)(3) - The last sentence requires that retrievability be accomplished in about the same period of time as that during which the wastes were emplaced. There is no technical justification for this requirement. The designer should estimate the time required for retrieval and design the underground structure to permit retrievability to be accomplished over the estimated time period. Since retrieval is not expected to occur, the design of the waste package should not be unnecessarily influenced by the time required for retrieval, which could be the case if a specified time requirement is imposed.

Staff Response to Comment 182:

See response to Comment 82

Comment 183: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Paragraph (a)(2)

Suggest substitute "closure" for "decommissioning."

Paragraph (c)(1)

No technical justification given for 1000 years. 300 years is suggested as technically justifiable, i.e., fission product period.

Staff Response to Comment 183:

In § 60.2, "decommissioning" is defined to mean the same as "permanent closure."

Paragraph (a)(2) has been deleted from the proposed rule. With respect to the 1000-year provision, see response to Comment 120.

Comment 184: Bechtel National, Inc. (13)

60.111(a)(3) - We recommend that the retrievability period be shortened to extend for no more than 10 years beyond the waste emplacement date. Such a requirement would appear to be as arbitrary as the proposed 50-year requirement, but would have the advantages of much reduced cost and assuring the continued viability of soft rock media, while still satisfying EPA requirements.

60.111(a)(3) - The basis upon which a decision could be made to retrieve the waste is not clear. Certainly the decision could not be expected to derive from the monitoring program of Paragraph 60.137 in a 50-year period if the system had been found to satisfy regulatory requirements for long-term barrier performance. Rather such a decision to retrieve would have to be based on some other type of data or predicted environmental occurrence. However, in the highly unlikely event that a decision were made to remove the waste, the requirement to provide for retrievability within a time period that is about the same as that in which it was emplaced seems to have little or no justification considering the low probability of having to perform this operation and the relatively large costs, difficulties, and timeframe associated with having to ship and dispose of the wastes at some other location. Therefore, it is recommended that the requirements for the retrieval timeframe be deleted from the overall retrieval requirement.

Staff Response to Comment 184:

See response to Comment 82.

Comment 185: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.111(a)(3) Retrievability. "The Department of Energy shall design the geologic repository operations area so that the radioactive waste stored there can be retrieved for a period of 50 years after termination of waste emplacement operations, if the geologic repository operations area has not been decommissioned.

If during this period a decision is made to retreive the wastes the DOE shall insure that wastes could be retrieved in compliance with Part 20 of this Chapter and in about the same period of time as that during which they were emplaced."

Comment:

As an initial comment, the above statement about retrievability can be confusing. It states fairly positively that the waste must be retrievable for 50 years after termination of operations if the area has not been decommissioned. However, the statement does not address retrievability if the area is decommissioned. Also, what are the conditions which can lead to decommissioning of an area? This confusion should be resolved in the final regulations.

Possibly of even greater importance, the period of 50 years after termination of operations appears to be very excessive. It is reasonable that the Department and the Commission have some time after waste placement to determine by monitoring that conditions are acceptable for decommissioning without providing special efforts to permit future retrieval. However, the major effort during backfilling and decommissioning should be to maximize long term adequacy of the repository. Trying to maintain a retrievable condition for the operating life plus 50 years could in-and-of-itself reduce the safety of the repository by causing undesirable rock stresses and movement. This will be important in other rocks which will crack, causing additional potential flow paths, if the voids are not backfilled in a reasonable period. The actual time required for retrieval should be set on a site by site basis depending on conditions at that site and the overall repository design. It would be reasonable to request a minimum retrievable period for the first several years of operation when monitoring is being accomplished. A reasonable time frame would be 5 to 10 years for the first portion of a repository. Then at that time, the Department and Commission should develop a final decommissioning plan for all future areas of the repository.

It is worthy to note that the regulations are requiring engineered waste packages which will last for many more than 50 years. On that basis, retrievability would always be possible for at least 50 years if some extreme condition occurred. The cost would be very high, but that very small risk is justified by having a decommissioned system that tends to maximize long term storage safety.

In closing, the Commission is urged to not close on this issue with an extreme 50 year position until all of the ramifications of such a decision are understood.

Staff Response to Comment 185:

See responses to Comment 82.

Comment 186: R. E. Johnson (24)

60.111(a)(3)(i) Quoting an annual rate quantitively appears very premature. The rates should be different for different radioisotopes.

Staff Response to Comment 186:

The release rate request has been modified.

Comment 187: Duke Power Co. (25)

60.111(a)(3) The retrievability requirement is unclear. What is the rationale behind a retrievability requirement which extends 50 years beyond emplacement of the last waste? Can the retrievability aspects of repository design, construction, and operation be relaxed if decommissioning is planned before the expiration of such a 50 year period? At any rate, such a period is far longer than that required for gathering of in-situ data confirming the acceptability of the disposal scheme.

Staff Response to Comment 187:

See response to Comment 82.

Comment 188: Pinder enclosure in U.S. Department of Energy (18)

Pg. 31400, Col. 2, Line 14b: Calculation of transport travel times requires transport models -- have you de facto required models in your rules? The same argument can be made for items (iii) top of page 31401, Col. 1 and elsewhere beyond this point.

Staff Response to Comment 188:

The Commission expects quantitative modeling to be used as part of the site and design evaluation procedure. The documentation of and results from models deemed appropriate by DOE should be a part of the license appliation. The point is that the Commission is not specifying one model as the licensing model.

Comment 189: Lowenstein, Newman, Reis, Axelrad & Toll (1)

The limitation on annual release rate of radioactive material as proposed in § 60.111(b)(3) needs to be clarified (in addition to providing the analytical basis for the quantitative value). Such a requirement must bear some logical relationship to the potential for producing hazard rather than as an arbitrary expression of total inventory (e.g., is a release from a larger capacity repository a priori more acceptable than one from a smaller capacity one?).

Staff Response to Comment 189:

The technical support document for the proposed rule sets forth the rationale for the release rates. This document is available from the NRC Public Document Room.

Comment 190: Attorney General Abrams, State of New York (11)

The draft regulations do not comport with the NRC's duty of regulating DOE's activities so as to assure public health to the maximum extent. Rather, they are written in such a way as to suggest a standard of expediency: whatever DOE can easily achieve will be deemed sufficient to satisfy the NRC, regardless of what is truly needed to protect the public today and in the future.

For example, waste packaging is required, with "reasonable assurance," to contain the radionuclides for the "first 1,000 years after decommissioning and for as long thereafter as in [sic] reasonably achievable." § 60.111(c), 31400, col. 1. In effect, whatever the state of the art may be will be accepted by the NRC, without further thought. Again, the underground facility must be designed to provide "reasonable assurance" of containment for the first 1,000 years "and as long thereafter as is reasonably achievable." Id., col. 2. Since the waste is highly toxic for a million years, there is little point in using the 1,000 year period -- it is a mere one-thousandth of the relevant time period. The standard should be true isolation for the necessary period, not for a very small portion of the necessary period.

Other provisions in the draft are vague, subjective, relative and too weak to assure safety. For example, § 60.111(c)(2)(i) requires that the environment for the waste packages "promotes the achievement of § 60.111(c)(i)" -- which is much weaker than requiring that it in fact achieves the requirements of that section. P. 31400, col. 1. Similarly, the draft does not require that the site assure isolation, but only that it "exhibits properties which promote isolation." § 60.111(c)(4)(ii), p. 31400, col. 2. Again, DOE's convenience, rather than public safety, appears to be the motivating factor behind the regulations.

The draft regulations do not adequately deal with the difficulty of predicting future geologic, meteorologic, and human events. Instead, they evade the issue, discussing some minor issues evidently thought to reduce the problem -- but these issues are so minor as to be of very little value when compared to the enormity of the problem. For example, the proposed answer to the human intrusion problem is to select deep, "uninteresting" sites of little value in terms of what are not considered valuable resources. P. 31395, col. 3. While such steps may be better than nothing, their impact on reducing the uncertainty of intrusion over a million-year period is very small.

Staff Response to Comment 190:

The regulations balance the needs for definitiveness and flexibility, but public safety is the motivating factor. See also responses to comments 91 (human intrusion) and 176 (reasonable assurance).

Comment 191: U.S. Geological Survey (12)

On the whole the document represents significant progress toward defining technical criteria for high-level waste (HLW) repositories. The overall approach to development of the criteria appears to be sound and appropriately conservative for establishment of a regulatory framework for the licensing of a new technology. Considerations given within the supplementary information are well thought out and adequate, and a rule structured upon these considerations would likely address the important issues properly.

In particular, we believe that § 60.111(c), Performance of required barriers and engineered systems, represents a sound approach to licensing. It is sometimes stated that only the performance of the total waste isolation system is relevant to licensing and performance requirements. But assessing the total system, whether by models or some other approach, is an extremely complex undertaking subject to considerable uncertainty as the supplementary information points out. By requiring each major element in the waste isolation system to independently meet certain performance objectives, the proposed rules break the problem down into more manageable parts and allow for uncertainties in the performance of some components. The requirements stipulated for the major barriers in 60.111(c) should, when met, provide reasonable assurances that the short-lived fission products (especially Sr and Cs) will be isolated from the accessible environment. The prognosis for the longer-lived radionuclides will always be more uncertain than for Sr and Cs, but the longer-lived nuclides may present a lower risk.

Staff Response to Comment 191:

No response required.

Comment 192: U.S. Department of Energy (18)

Paragraph 60.111(c) - Performance of Required Barriers and Engineered Systems requires that both the waste package and the underground facility be designed to provide reasonable assurance that radionuclides will be contained for at least 1,000 years after decommissioning. There is no basis given in the criteria or in the Supplementary Information to support the selection of 1,000 years. The discussion under "1. Lifetime of the Repository" discusses a period which "begins following closure of the repository, and will persist for the time that the relatively short-lived fission products dominate the hazard".

The Department agrees with the concept of containment during this fission product period as reflected in the "Statement of Position of the United States Department of Energy, DOE/NE-0007, April 15, 1980, in the Proposed Rulemaking on the Storage and Disposal of Nuclear Waste. In that document, the Department identifies as Performance Objectives 1 (p. II-7):

> "Waste containment within the immediate vicinity of initial placement should be virtually complete during the period when radiation and thermal output are dominated by fission product decay. Any loss of containment should be a gradual process which results in very small fractional waste inventory release rates extending over very long release times, i.e., catastrophic losses of containment should not occur".

However, if 1,000 years is intended to represent this period where the hazard is dominated by this fission products, we believe that it is excessive. Several organizations have developed curves of the relative contributions of actinides and fission products to the radioactivity, decay heat or hazard index of radioactive waste. For example, EPA 520/4-79-007A, "Technical Support of Standards for High-Level Radioactive Waste Management, Volume A, Source Term Characterization" Figures A-4 through A-23 present curves of radioactivity, decay heat generation and untreated dilution index for the cases of a PWR throwaway cycle, PWR $UO_2$ cycle and mixed oxide cycle. The following table was derived from Figures A-4, A-5, and A-6 of that report.

Fraction of Total Contributed by Fission Products in PWR Throwaway Cycle

| Decay Time in Years From Discharge | Relative Value of Radioactivity | Relative Value of Decay Heat | Untreated Dilution Index ("Hazard") |
|---|---|---|---|
| 100 | 0.5 | 0.286 | 1.0 |
| 300 | 0.18 | 0.02 | $8.3 \times 10^{-3}$ |
| 500 | $1.5 \times 10^{-3}$ | $9.0 \times 10^{-4}$ | $3.8 \times 10^{-3}$ |
| 1000 | $1.0 \times 10^{-3}$ | $3.5 \times 10^{-4}$ | $1.4 \times 10^{-3}$ |

Based on this table it can be seen that whether the concern is radioactivity, decay heat, or hazard, the fission products no longer dominate at 300 years. It is recognized that other studies have produced varying results due to the input parameters assumed (burnup, etc.). We are not aware, however, of any calculations that indicate that the hazard is dominated by fission products beyond 300-500 years, let alone 1000 years. Even using the assumption that fission products have decayed to insignificant levels (less than 0.001 of original value) after 10 half-lives, and that cesium-137 and strontium-90 (both having half lives of about 30 years) are the dominant fission products, 300 years containment would appear to be more supportable than 1000 years.

Staff Response to Comment 192:

See response to Comment 120. The bases for the 1,000 years requirement are presented in the technical support document that accompanies the proposed rule. The technical support document is available at the NRC's Public Document Room.

Comment 193: U.S. Department of Energy (18)

60.111(c) Performance of Required Barriers and Engineered Systems

NRC Proposed Wording:

(1) Waste Package

The Department shall design waste packages so that there is reasonable assurance that radionuclides will be contained for at least the first 1,000 years after decommissioning and for as long thereafter as is reasonably achievable given expected processes and events as well as various water flow conditions including full or partial saturation of the underground facility.

(2) Underground Facility

The Department shall design the underground facility to provide reasonable assurance of the following:

(i) An environment for the waste packages that promotes the achievement of Paragraph 60.111(c)(1) above under conditions resulting from expected processes and events.

(ii) Containment of all radionuclides for the first 1,000 years after decommissioning of the geologic repository operations area and as long thereafter as is reasonably achievable, assuming expected events and processes and that some of the waste dissolves soon after decommissioning.

(3) Overall Performance of the Engineered System After Containment

The Department shall design the engineered system to provide reasonable assurance that:

(i) Starting 1,000 years after decommissioning of the geologic repository operations area, the radionuclides present in HLW will be released from the underground facility at an annual rate that is as low as reasonably achievable and is in no case greater than an annual rate of one part in one hundred thousand of the total activity present in HLW within the underground facility 1,000 years after decommissioning assuming expected processes and events.

(ii) Starting at decommissioning radionuclides present in TRU waste will be released at a rate that is as low as reasonably achievable and is in no case greater than one part in one hundred thousand of the total activity present in TRU waste within the underground facility at the time of decommissioning assuming expected processes and events.

Recommended Revision:

a. Throughout, change "1,000 years after emplacement" to a value which can be more readily supported by technical analysis. (As noted in general comments, 300 years seems to represent a more appropriate period.)

b. In (2)(ii) delete all after "processes".

c. In (3)(ii) add "annual" before "rate".

d. In (3)(i) and (ii) indicate the time frame over which the release rate should be maintained.

e. In (3)(i) and (ii) the "one part in one hundred thousand" should either be substantiated with a technical basis, replaced with a value which can be substantiated, or left qualitative. Clarification should be provided as to the boundary across which the release is measured (e.g., entry into aquifer) and how compliance can be proven.

Rationale:

a. (i) The rationale for a different value is discussed under Major Comments.

(ii) As noted in 60.111(a)(3) the option exists not to close the repository for 50 years after termination of waste emplacement operations. This makes the time of decommissioning very uncertain when the first waste is emplaced.

b. The last phrase is too vague to be useful in a regulation.

c. Consistency with (3)(i). The time frame is not stated. Such rates are likely to vary with time.

d. DOE knows of no basis for either promulgating that rate in terms of safety gained or for believing that compliance with that rate could be proven in a licensing proceeding.

Staff Response to Comment 193:

(a) See response to Comment 120.

(b) Some of the wording objected to by DOE has been deleted from the provisions on the performance of the engineered system to contain HLW in the proposed technical criteria.

(c) In response to DOE's comment, the term "annual" has been inserted in the revised provision in the proposed rule.

(d) The staff declines to make the suggested change.

(e) The $1:10^5$ ratio was intended as a minimum control on release of radionuclides to the geologic setting from the underground facility. It was not intended to be the entire or limiting control on release to the environment. Its purpose was to decrease the sensitivity of the repository to the variability in performance of the site.

Comment 194: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.111(c)(1) Waste Packages. "The Department shall design waste packages so that there is reasonable assurance that radionuclides will be contained for at least the first 1,000 years after decommissioning and for as long thereafter as is reasonably achievable given expected processes and events as well as various water flow conditions including full or partial saturation of the underground facility."

Comment:

The general purpose of the 1,000 year designation appears reasonable based upon radionuclide decay rates and desired redundancy with the isolation provided by the geologic system. However, it seems premature at this time to absolutely conclude that 1,000 years is the correct number for all repository sites. For example, if a site is determined to provide extremely good natural isolation, but waste packages can be assured for only 700 years because of a chemical condition or waste package costs, the site may still present a very attractive alternative. It is strongly recommended that this section be qualified to permit shorter periods, if the Department can demonstrate that the combined geologic barriers and engineered barriers satisfy the intent of a HLW repository.

Staff Response to Comment 194:

See response to Comment 192.

Comment 195: Westinghouse Electric Corp. (20)

60.111(c)(1) - The beginning of this paragraph states that the waste packages shall be designed so that radionuclides will be "contained". Referring to the definitions of 60.2, "containment" means keeping radioactive waste within a designated boundary. In the case of the 60.111(c)(1) requirement, what is the designated boundary?. One would assume that the designated boundary is the

boundary of the waste package, but does this include the retrievable package or all components emplaced (such as a liner that might be preplaced)? This should be clarified.

This subparagraph also requires waste packages to contain all radionuclides for at least 1000 years given expected processes and events as well as various water flow conditions. These two requirements are not compatible. The assumption of full or partial saturation as part of expected processes and events is overly conservative and unreasonable. These types of conditions would most likely occur only as a result of gross failure of the geologic environment and all engineered systems, the very conditions against which the geologic environment and engineered systems were selected.

Staff Response to Comment 195: The terms "containment" and "waste package" are discussed in the new concepts section (60.102) of the proposed rule.

See responses to Comments 192 and 193.

Comment 196: Westinghouse Electric Corp. (20)

Paragraph 60.111, item (c)(1) and (2) - The footnote to these subparagraphs notes that these sections apply only to HLW. In fact, the entire regulation applies only to HLW and, as such, item (c)(3) should not distinguish between HLW and TRU waste. If a distinction is necessary, reference should be made in item (c)(3)(ii) to long-lived actinides contained within HLW such that the applicability of this regulation would not be confused.

Staff Response to Comment 196:

If TRU waste is disposed of at an HLW repository, then the requirements of Part 60 would also apply to the TRU, as appropriate. The requirements for disposing of TRU at an HLW repository have been clarified. Also see response to Comment 207.

Comment 197: Duke Power Co. (25)

60.111 (c) (1)-(2) The specific performance requirements placed on the waste package (including waste form) and underground facility violates the concept of a systems approach - overall repository performance is the appropriate figure of merit.

60.111 (c) (3)-(4) This section deals with the overall performance of the engineered system and the performance of the geologic environment. Again, the discussion ignores our view of the systems concept. In any event, however, it

would seem inappropriate to regulate a release rate per year, based in terms of a fraction of the inventory present at some given time. Such a criterion is unrelated to impact on public safety and the environment, since a greater fractional release rate from a small repository might well be less in absolute magnitude than a smaller fractional release rate from a larger repository.

In sections (4)(i) and (ii), the term "long term" needs to be defined. In section (4)(iii), we have the same problem of inconsistency with the systems approach concept, but in any event, do not understand how the specified travel time is directly related to public health effects, and cannot ascertain from what point the 1000 years is measured. From the waste package to the accessible environment? From the repository boundary (undisturbed geology) to the accessible environment?

Staff Response to Comment 197:

The proposed rule approaches the problem of HLW disposal in geologic repositories by recognizing that any repository is a system of two major components--the engineering and the site. Each major component serves a specific function over a specific period of time with respect to containing and isolating HLW. See also response to comment 120.

Comment 198: Everett R. Irish (29)

Page 31400, column 1, line 50 - What is the basis for the 1000 year waste package?

Staff Response to Comment 198:

See response to Comment 120.

Comment 199: Bechtel National, Inc. (13)

60.111(c)(2) - The first paragraph of this section states that waste package integrity must be maintained for the first 1000 years given various water flow conditions including full or partial saturation of the underground facility. Paragraph 60.111(c)(2)(i) then requires that the design environment for the waste packages promotes the 1000-year package integrity without full or partial water saturation required. Thus, if the initial requirement is intended, the requirement of Paragraph 60.111(c)(2)(i) appears superfluous.

Paragraph 60.111(c)(2)(ii) is even more confusing in that it states that the 1000-year integrity requirement must be satisfied (presumably without water saturation) but that some of the waste dissolves soon after decommissioning. The statement is self-contradicting and should be deleted.

Staff Response to Comment 199: The provisions for the containment of wastes by the engineered system have been modified. The assumption that some of the waste dissolve after decommissioning has been deleted in response to public comment.

See response to Comment 120.

Comment 200: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.111(c)(2)(ii) "Containment of all radionuclides for the first 1,000 years after decommissioning of the geologic repository operations area and as long thereafter as is reasonably achievable, assuming expected events and processes and that some of the waste dissolves soon after decommissioning."

Comment:

On the basis of § 60.111(a)(2) the geologic system should not have to contain all radionuclides under all possible conditions. Instead, the level of escape should be within an acceptable standard. Also, it does not appear appropriate to consider "expected" geologic events in this connotation.* Instead, one should consider the probability of events occurring during this relatively short geologic period and the consequences of the events. The resulting risk (determined by considering the probability of the event, the probability of waste dissolutioning, and the probability of intersection of the event and dissolved waste) should be less than the acceptable standard.

Staff Response to Comment 200:

See responses to Comments 120, 195 and 199.

Comment 201: Westinghouse Electric Corp. (20)

60.111(c)(2)(ii) - This subparagraph requires the design of the underground facility to contain all radionuclides within the first 1000 years after decommissioning. In addition to expected processes and events, it requires the assumption that "some of the waste dissolves soon after decommissioning". This assumption appears overly conservative. Major efforts and expense are going into waste package design to contain all wastes for at least 1000 years so an assumption that some dissolves immediately after decommissioning is inconsistent.

*Note: If expected means the probability of events that could occur, or only those events with a high probability of occurrence for a given period, this definition should be incorporated into the Definitions section.

Also, what is the "designated boundary" for containment? It cannot be the boundary of the underground facility since, after decommissioning, the boundary is no longer definable. What is important is that radionuclides not reach the accessible environment for 1000 years. This is accomplished by providing a waste package that will last for 1000 years and, in case of failure of the package, a geologic barrier that provides a radionuclide travel time of 1000 years as required by 60.111(c)(4)(iii).

Staff Response to Comment 201:

See response to Comment 120, and 199.

Comment 202: Tauke & Adam (21)

60.111(2)(ii) "...and that some of the waste dissolves soon after decommissioning..." What wastes, how soon???

Staff Response to Comment 202:

See responses to Comments 120 and 199.

Comment 203: Everett R. Irish (29)

Page 31400, column 2, line ii - Incorrect use of "containment."

Staff Response to Comment 203:

The revised provisions of 60.111 as set forth in the proposed rule correctly use the term "containment."

Comment 204: Bechtel National, Inc. (13)

60.111(c)(3) - After 1000 years, it should be assumed that the waste packaging (engineered system) has performed its required function and that it is then the function of the remaining barriers in conjunction with the leach rate of the waste material (waste form) to assure that the EPA criteria for radioactivity release to the biosphere are not exceeded. Thus, it is unnecessary and inappropriate to stipulate a maximum leak rate from the engineered system after 1000 years. This type of requirement adds nothing to the reduction of risk to the public since it is not likely to influence the waste package design, but it could cause considerable difficulty and delay in the licensing process assuming demonstration of the criteria is necessary. This same comment applies to the TRU waste packaging where the leak rate criterion is applied starting at decommissioning.

Staff Response to Comment 204:

See responses to Comments 120 and 207.

Comment 205: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.111(c)(3)(i) "Starting 1,000 years after decommissioning of the geologic repository operations area, the radionuclides present in HLW will be released from the underground facility at an annual rate that is as low as reasonably achievable and is in no case greater than an annual rate of one part in one hundred thousand of the total activity present in HLW within the underground facility 1,000 years after decommissioning assuming expected processes and events."

Comment:

Relating the allowable release rates to the total activity in the repository is inappropriate. Using the arbitrary 1/100,000 ratio could be either conservative or unconservative depending on the size of the site and repository conditions. Instead, the allowable release rate should be determined by the consequence or risk of the indicated release in relation to an acceptable standard. The consequence depends on the mode of potential release, concentration of contaminants, type of radioactive source, etc., in addition to the activity release rate. Risk will depend on the probability of potential events occurring. (Note: It is not appropriate to discuss "expected" geologic events in this situation.*)

Staff Response to Comment 205:

See response to Comment 193. The term "expected processes and events" has been replaced by "anticipated processes and events" which better defines which is meant and such events will be considered in the licensing process.

Comment 206: Everett R. Irish (29)

Page 31400, column 2, line 14 - Use of the word "starting" is misleading. Sounds like there is some basis for 1000-year containment and the leaching starts then.

Page 31400, column 2, lines 21-22 - 1 part in $10^5$ is technically misleading (gives impression of a constant leach rate and proportional radionuclide (content) and unrealistic. What reasonable basis is there for such a low limit? Same elsewhere.

*See footnote for Section 60.111(c)(2)(ii).

Staff Response to Comment 206:

See responses to Comments 193 and 207.

Comment 207: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.111(c)(3)(ii) "Starting at decommissioning radionuclides present in TRU waste will be released at a rate that is as low as reasonably achievable and is in no case greater than one part in one hundred thousand of the total activity present in TRU waste within the underground facility at the time of decommissioning assuming expected processes and events."

Comment:

[See the comments to § 60.111(c)(3)(i).] The Commission should always limit releases so that consequences or risks are within acceptable standards. Arbitrary quantitative designations cannot be appropriate for all repositories and all conditions. Also, geologic events are not "expected."* Instead, there is a probability of their occurrence during any designated time per od.

Staff Response to Comment 207: This provision has been modified in the proposed rule and the words "starting at decommissioning have been replaced with "at any time following permanent closure.

Since TRU wastes do not generate significant quantities of heat, there is no advantage to containment for any specified period. Therefore, the requirement for TRU is simply a controlled release equivalent to that for HLW, provided they are physically separated from HLW so that they will not experience a significant increase in temperature. See also response to comment 205.

Comment 208: Attorney General Abrams, State of New York (11)

Various terms used in the draft regulations need to be defined. For example, DOE is required to establish that certain properties of the geologic environment "will not significantly decrease over the long term." Section 60.111 (c)(4) (i) and (ii), p. 31400, col. 2. The standard is very vague, and "long term" is not defined. Also undefined are "near field," in § 60.122(b)(2)(iv),

*See footnote for Section 60.111(c)(2)(ii).

p. 31401, col. 3, and "low population density," in § 60.122(c)(2)(v), p. 31402, col. 3.

Staff Response to Comment 208: The provisions which set forth performance objectives for the geologic setting have been modified, and the phrase "will not significantly decrease over the long term" has been deleted. The staff has tried to minimize any vagueness in this provision by replacing references to the "long term" with more specific references to the containment and isolation periods. The term "near field" has been deleted from the proposed rule, and has been replaced with the term "disturbed zone". A definition of "disturbed zone" is set forth at 60.2 in the proposed rule. Ther term "low population density "has been deleted from the proposed rule.

Comment 209: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.111(c)(4)(iii) "The Department shall provide reasonable assurance that the hydrologic and geochemical properties of the host rock and surrounding confining units will provide radionuclide travel times to the accessible environment of at least 1,000 years assuming expected processes and events."

Comment:

This objective is technically impractical. The travel time alone is only one consideration in determining the influence of nuclear waste release on public health. Other considerations include type, rate, concentration, total quantity of release, entry point to biosphere, mans use of biosphere, etc. As noted in comments on § 60.111(c)(3)(i) and (ii), the Commission should be consistent in limiting the consequence on risk of any release to accepted standards. Arbitrary quantitative designations without consideration of site specific conditions just do not make sense and can not be rationally defended. An appropriately designed repository will have varying requirements on engineered and geologic barriers, such that the net release to accessible environment is acceptable. Imposing an arbitrary travel time requirement could lead to discarding of some otherwise very attractive sites.

Staff Response to Comment 209:

Subpart 60.111(c)(4) has to be considered in conjunction with 60.111(c)(3), which pertains to engineered barriers surrounding nuclear waste packages. The

NRC requires the engineered barriers to last at least 1000 years because it is desirable to isolate the short-lived fission products from the accessible environment. The rate of heat generated by the waste package also decreases significantly (to roughly $10^{-3}$ of its original intensity) over this time. Reduction of the heat generation rate is desirable because the heat from nuclear waste is a major impetus to the flow of radionuclides to the accessible environment. Should the engineered barriers fail, the next line of defense is the geologic environment, which is the subject of 60.111(c)(4). The 1000 year travel time specified in 60.111(c)(4)(iii) was also chosen to provide assurance that the fission products would have decayed and the heat source generation rate would have decreased significantly.

In terms of during transport calculations, the 1000 year radiation time eliminates the need to examine the transport of most fission products to the accessible environment, and also reduces the calculational uncertainties associated with the perturbation of the hydrologic and geologic neighborhood of the emplaced waste by high heat generation rates.

Comment 210: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Paragraph (c)(2)(ii)

Again, there is no basis for 1000 years (see comment re paragraph (c)(i) above). Also, the required assumption that some of the waste dissolves soon after decommissioning (closure) is internally contradictory with other requirements. How much is some?

Paragraph (c)(3)(i)

This wording makes the unreasonable assumption that radionuclides will be released after 1000 years, and is misleading in that it implies the facility will be designed to start releasing radionuclides at that time. While this may be helpful in reducing the concentration, this has not been the intent of the NRC heretofore. We suggest rewording the sentence to eliminate this interpretation.

Paragraphs (c)(3)(i) and (ii)

Presumably the heading of paragraph 3 should read after "closure." No rationale is given for this release rate requirement, it bears no quantitative relationship to potential radiation exposure of people and is impossible of direct proof. Parenthetically, where is such a criterion to be applied and evaluated, i.e., what is the boundary of the underground facility? These paragraphs need serious re-analysis.

Paragraph (c)(4)(iii)

It is not clear whether this paragraph is intended to refer to travel times for specific radionuclides (if so, which) or to travel time for water. Once again there is no technical rationale for the 1000-year period.

Staff Response to Comment 210:

The basis for the 1,000 years groundwater travel time requirement is discussed in the technical support document prepared in conjunction with the rule. See also responses to Comments 206, 207 and 209.

Comment 211: U.S. Department of Energy (18)

Paragraph 60.111(c)(3)(i) specifies the annual release rate from the repository but does not provide any basis or justification for the value given. Since this release rate will be a direct contributor to the release to the biosphere, it should be related to the EPA criteria and to the state-of-the-art rather than stated as an a priori number. Also, it is not clear how long that release rate must be maintained (100,000 years?) or where the boundary of the "underground facility", at which the release is to be evaluated, is located. It must be noted that compliance with this criterion, as well as the other performance objectives, must be demonstrated by predictive calculations and cannot be "proven".

Staff Response to Comment 211:

See response to Comment 210.

Comment 212: U.S. Geological Survey (12)

Page 31400, col. 2, par. (3)(ii). We suggest the following insertion: "at a rate that is as low as reasonably achievable and in no case greater than an annual rate of one part in one hundred thousand" (addition underlined).

Staff Response to Comment 212:

Similar wording to that suggested by the USGS has been added to the proposed rule.

Comment 213: Westinghouse Electric Corp. (20)

60.111(c)(3) - The title of this section should be "Overall Performance of the Engineered System After the Containment Period."

Staff Response to Comment 213:

Section titles in the proposed rule have been revised to reflect changes made in the text.

Comment 214: Ross enclosure in U.S. Department of Energy (18)

§60.111 Performance Objectives

(3) Retrievability - The requirement of 50 year retrievability should not exclude backfilling of the mined areas; to do so may place unnecessary thermal and mechanical stress on the repository site. - Is the waste package requirement of radionuclide containment for 1,000 years feasible with current state-of-the-art? If there is some uncertainty in this, the specific (1,000 years) time requirement should be modified.

(4) Performance of the geologic stability - Reasonable assurance of geologic stability for 10,000 years seems reasonable and achievable.

Staff Response to Comment 214:

See responses to Comments 82, and 372.

The definition of stability has been modified to more accurately reflect the characteristic which the staff believes important to confidence in the performance of a repository.

Comment 215: U.S. Department of Energy (18)

60.111(c)(4) Performance of the Geologic Environment

NRC Proposed Wording:

i The Department shall provide reasonable assurance that the degree of stability exhibited by the geologic environment at present will not significantly decrease over the long term.

ii The Department shall provide reasonable assurance that the site exhibits properties which promote isolation and that their capability to inhibit the mitigation of radionuclides will not significantly decrease over the long term.

iii The Department shall provide reasonable assurance that the hydrologic and geochemical properties of the host rock and surrounding confining units will provide radionuclide travel times to the accessible environment of at least 1,000 years assuming expected processes and events.

Recommended Revision:

a. In (c)(4)(i) change "decrease" to "degrade". Replace "over the long term" with "for the first 10,000 years".

b. Delete (c)(4)(iii).

Rationale:

a. Clarity. Additionally, references in this proposed 10CFR60 to changes in ambient conditions as "unfavorable" need to be considered in terms of some favorable, static ambient reference condition. That is, degradation per se is not relevant, performance degradation beyond some critical value is relevant. Clarity would be enhanced by using 10,000 years (consistent with § 60.2 definition of "stability") in place of the more subjective "long term".

b. This item notes that the host rock will provide radionuclide travel time to the accessible environment of at least 1,000 years assuming expected events. Why a time restriction of 1,000 years? The principal point of waste isolation is missed here. The effectiveness of isolating must be related to risk criteria and dose to man predictions.

Staff Response to Comment 215:

Provisions of the rule dealing with the performance of the geologic setting have been revised and clarified. The wording of the revised provisions should alleviate some of DOE's concerns.

Comment 216: Lowenstein, Newman, Reis, Axelrad & Toll (1)

The unduly lengthy retrievability requirement in proposed § 60.111(d) will inevitably result in some compromise of containment/isolation integrity. Not only does it violate a systems approach to attainment of effective radiological protection, it also re-raises the issue of putting off disposal decisions to future generations. The retrievability requirement needs much more careful and rigorous analysis before specifying any arbitrary requirement. One basis that should be included in such an analysis is the time frame in which useful performance or test data and information may be acquired following waste emplacement.

Staff Response to Comment 216:

See response to Comment 82.

Comment 217: Everett R. Irish (29)

Page 31400, column 3, line 33 - Isn't English a language? Should be [60.121(c)] "including English."

Staff Response to Comment 217:

Mr. Irish's point is well-taken. Provisions of 60.121 have been revised and the phrase in question deleted.

Comment 218: U.S. Department of Energy (18)

60.121 SITE AND ENVIRONS OWNERSHIP AND CONTROL

General:

This section appears to recognize that permanent markers and records will last longer than the 100 year institutional control period. There needs to be a clear definition of what credit can be taken for markers and records, but we agree that it is not appropriate to do it at this time.

Staff Response to Comment 218:

No response required.

Comment 219: Bureau of Land Management (26)

Section 60.121 -- This section limits geologic repositories for high-level radioactive wastes to lands that are either acquired lands under the jurisdiction and control of DOE or to lands permanently withdrawn and reserved for its use [section 60.121(a)]. This rulemaking does not specifically mention Federal lands administered by BLM or any other agency. However, provisions of section 106(a)(4) and (b) of DOE #14, Draft Bill -- Residual Radioactive Material Control Act, provides that the Secretary of the Interior may be requested to transfer Federal land to DOE for use as disposal sites. If BLM-administered lands other than those under the present control of DOE or NRC will be required for the repository sites, I recommend that, "the Secretary of the Interior, with the advice of BLM, shall select and designate the land to be used for such sites to ensure that: (a) the area is remote from human habitation and use; (b) the area does not have potential value for resource uses other than waste disposal; and (c) the area is transferred to DOE with full responsibility for any hazards that might arise from the presence of radioactive waste."

The term "control zone" is also identified in this section [§60.121(b)] as that area surrounding the geologic repository operations area. This explanation is inadequate in that several variables including size, purpose, ownership and land use are not clear. This term should be defined with respect to size and shape and relationship to the excavation.

Staff Response to Comment 219:

The DOE alone has the programmatic responsibility to select potential sites for a future repository. Therefore it would not be appropriate for the NRC to designate any part of DOE's authority to the Secretary of the Interior as suggested by the BLM. It would be inappropriate for NRC to undertake to direct the Secretary in the exercise of his discretion to select lands. For that reason, the proposed rule speaks to the status of the land, not to the process by which such status has been obtained.

With respect to the surrounding areas, application of the variables mentioned by the BLM will be highly site-specific. The term "control zone" has been deleted from the proposed rule. Instead, DOE is required to establish appropria controls outside of the geologic repository operations area. The controls must be sufficient to permit reasonable judgment to be made regarding protection of public health and safety.

Comment 220: Tauke & Adam (21)

60.121(a) Ownership and control of the geologic repository operations area. "...lands that are either acquired lands under the jurisdiction and control of the Department or lands permanently withdrawn and reserved for its use..." How does the DOE propose to "acquire" 2000-6000 acres of land. In all probability, it will not be without considerable ill will by former land owners; certainly with the discomfort of neighboring landowners. What about control - completely by DOE? Is it feasible or advisable for local input?

(c) Long-term control. It is good to see that the NRC recognizes that this procedure is of global concern. "...For the purpose...institutional controls will not persist for more than one hundred years." Does that mean that after 100 years someone else (i.e., a private company) takes over management of facility?

Staff Response to Comment 220:

The NRC cannot address the questions of how the DOE will acquire the necessary land for a geologic repository operations area, or to what extent DOE will solicit local input. These questions are best answered by DOE. It is not intended that any particular scheme of management be employed after presumed institutional controls lapse. See response to Comment 222.

Comment 221: Lowenstein, Newman, Reis, Axelrad & Toll (1)

60.121(b): The purpose of the Control Zone (CZ) as stated in this section differs from its application in 60.122. The requirements for controlling human activities differ from the need to avoid natural processes, and the same dimension may not be appropriate for both. Indeed, the dimensions for avoiding some hazards will be different than for others. The vertical distance specified for the CZ would appear to allow directional drilling or mining below the actual repository. If this is intended, it should be clear that such activities must be shown not to compromise containment.

Staff Response to Comment 221:

See response to Comment 219.

Comment 222: Bechtel National, Inc. (13)

60.121(c) - Limiting institutional controls to only 100 years is overly conservative. Although the controlling organizations of today may not be the same ones 500 years from now, it is not unreasonable to assume that there will be some controlling authority. Past history has shown that civilized and conscienc authority has been present at least since the end of feudalism (1000 to 1200 A.D.). Hence, planned and planning organizations have been present for the past 700 to 900 years.

Staff Response to Comment 222:

The requirement that DOE assume that other institutional controls will not persist for more than one hundred years has been deleted from the proposed technical criteria.

Comment 223: Westinghouse Electric Corp. (20)

60.121(c) - The last sentence indicates that institutional controls should not be assumed to persist for more than 100 years. Based on past history, this assumption is unnecessarily conservative. Also, the time assumed for institutional controls to exist should be specified to start after decommissioning.

Staff Response to Comment 223:

See response to Comment 222.

Comment 224: Duke Power Co. (25)

60.121(c) We believe it realistic to assume that institutional controls will last beyond 100 years.

Staff Response to Comment 224:

See response to Comment 222.

Comment 225: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

§ 60.121 Site and Environs Ownership and Control

Paragraph (c)

The required assumption that institutional controls (presumably beginning after closure) will only last 100 years is unrealistically restrictive in the light of extensive historical evidence.

Staff Response to Comment 225:

See response to Comment 222.

Comment 226: Bureau of Land Management (26)

Section 60.122 - Geologic repository is identified in this section as an excavation of unspecified dimensions of which "the volume will extend a horizo distance of 2 kilometers from the limits of the repository excavation and a vertical distance from the surface to a depth of 1 kilometer below the limits of the repository excavation." I recommend the addition of an estimate of the diameter and the total area of the excavation as a guide to the quantity of land that might be involved in such disposal sites if Federal lands transfers are required.

In addition, the quantity of high-level waste is not clearly identified in thi section. As stated, the top of the emplaced waste must be a minimum depth of 300 meters from the ground surface of the excavation and extend downward to an

undesignated depth. An estimate of the total amount of high-level waste to be deposited at any given site and the total depth required for its emplacement, starting at 300 meters below the surface, should be provided.

Staff Response to Comment 226:

It is not possible for the NRC to quantify the total area, amount of emplaced waste at any given site and the total depth of emplacement since these parameters are determined by the specific site and repository and waste package design. DOE has the programmatic responsibility for selection of a repository site and the design and construction of the underground facility.

Comment 227: Lowenstein, Newman, Reis, Axelrad & Toll (28)

The draft criteria pertaining to repository siting improperly stress the effect of potentially adverse conditions, fail to recognize the distinction between important siting requirements and conditions that are desirable, but not necessary, and do not provide a baseline for guidance in the balancing of favorable and potentially unfavorable conditions.

Staff Response to Comment 227:

The staff believes that the provisions of 60.122 as set forth in the proposed rule address a number of the concerns of the commenter.

Comment 228: Lazlo Toth (17)

60.122 Siting

Since radioactive waste gives off heat and we have an energy problem your repositories should be under our cities. That way we could save on heating in the winter. Also you wouldn't need salt on icy streets or snow removal equipment.

I read in the newspaper that someone is thinking of putting that waste on Pacific Islands. That wouldn't be a good idea. We ought to keep it in the good old USA (the Best!). We don't want to let those Commies get it. I am sure you have heard about Continental Drift. Well those Russians invented it. They are just waiting for us to put the waste on an island and it will drift over to them and get it for themselves. I bet those Japs would be happy also to see us put the waste on a Pacific Island. They'd sure like to get their hands on it. We all know that it will leak into the sea water. The tuna will eat it and the Japs will catch all the tuna and then keep the waste for themselves.

Staff Response to Comment 228:

The proposed regulations apply only to HLW facilities subject to NRC jurisdictic

Comment 229: U.S. Geological Survey (12)

Page 31400, col. 3, sec. 60.122. The tenor of (a) is that only the simplest of geologic sites need be considered. This is too restrictive; rather the point should be that the knowledge acquired be complete and thorough, regardless of how difficult this was to do or how complicated the details may appear as they become understood. In reality, most "simple" sites have been and are subjected to very complicated geologic processes of recrystallization (WIPP), creep and/or folding (WIPP), emplacement as domes with differential flow between portions of the body, complex regional stresses and resulting fracture patterns, and so forth.

Page 31401, col. 1, pars. (ii) and (iii). How is it possible to present bounding values, etc., that affect "demonstration" of repository stability or nuclide isolation?

Staff Response to Comment 229:

See responses to Comment 38.

Comment 230: Bird enclosure in U.S. Department of Energy (18)

It is not clear what -- "not so complex" means. For example, the tectonics of salt domes can be very complex and the petrology of the rock salt relatively simple. The tectonics of plateau basalts is relatively simple whereas the petrology of the basalt is quite complex. This is an important requirement and its intentions must be made quite clear. Under (2) - "The natural conditions include geologic, tectonic, hydrologic and climatic process." "Tectonic" and "hydrologic" are part of the geology of a site and should not be distinguished as separate "natural conditions". In (i) following, on what basis was 100 kms selected. The list of objectives of understanding the geology and climate of a site preclude specifying such a distance before-hand. This distance would have to be evaluated on a site-by-site basis.

Staff Response to Comment 230:

See response to Comment 38. The terms "not so complex" and "100 km" have been deleted from the proposed rule.

Comment 231: B. R. McElmurry (8)

We already have a fission product and transuranic waste repository, namely the Nevada bomb test site. That repository does not seem to be regarded as a

particularly serious hazard, and it has not been engineered for multiple barrier containment, or to prevent future human intervention. Therefore, while it is necessary to have some plan for this, it does not appear justified to study this aspect of the problem exhaustively as suggested in 60.122(1-3), nor to spend any major effort to validate the modeling of future conditions as called for in 60.122(a-6).

Staff Response to Comment 231:

The quantities of radioactive materials involved make the comparison between a test site and a geologic repository invalid.

Comment 232: Bechtel National, Inc. (13)

60.122(a)(2) - "Geologic" includes "tectonic". If tectonic is segregated out, then other geologic aspects should be segregated also.

Staff Response to Comment 232:

In response to the commenter's suggestion, the major aspects of geology (tectonic structural, hydrogeologic, geochemical, geomorphic and mineralogic) have been separately identified in 60.122.

Comment 233: Bechtel National, Inc. (13)

60.122(a)(2) - The rule requires investigation and evaluation of "natural conditions" and "human activities" that can affect various repository activities. However, subsequent paragraphs (i), (ii), (iii) seem to be directed toward "natural conditions" only. It is recommended that combining the terms "natural conditions" and "human activities" should be avoided. They are very separate.

60.122(a)(2)(i) - The paragraph requires the conduct of investigations over a radius of 100 km, however, the amount of detail required is not indicated. The investigations should be performed in much less detail beyond the first 2 km.

Staff Response to Comment 233:

The staff has attempted to separate "natural conditions," from "human activities" in the proposed rule. It should be noted however that some human activities could have direct effects on existing natural conditions.

The requirement for the conduct of investigations over a radius of 100 km has been deleted from the technical criteria as overly specific.

Comment 234: Lowenstein, Newman, Reis, Axelrad & Toll (28)

Paragraph (a)(2)(i)

There is no technical basis for the 100-km radius for investigations. The requirement should be directed at features or factors potentially affecting the repository site. Depending on the specific features and the specific site it could be more or less than 100 km.

Staff Response to Comment 234:

See response to Comment 233.

Comment 235: J. G. McCray (9)

Ref Section 60.122(a)(2)(i) and 60.122(a)(8)

100 kilometers is very arbitrary. The geologic setting could be such that the horizontal extent of investigations would be adequate within 25 kilometers of the operations area. The requirement should indicate detailed investigations to the horizontal extent necessary to define actual and potential, natural and human, impacts.

Staff Response to Comment 235:

See response to Comment 233.

Comment 236: B. R. McElmurry (8)

No environment can be controlled or assured for very long periods of time. Therefore the fuel reprocessing step should be calibrated so that the activity resulting from the actinide content of the finished waste form does not greatly exceed that in naturally occuring uranium or thorium ores. If this is done, the repositories would need no special considerations for the very long term, including the 10000 years mentioned in 60.122(a-2-iii). 500 years would be more reasonable, as a suggestion.

Staff Response to Comment 236:

The particular nature of the waste form is entirely within the discussion of the DOE.

Comment 237: U.S. Department of Energy (18)

60.122(a)(2)

NRC Proposed Wording

The Department shall investigate and evaluate the natural conditions and human activities that can reasonably be expected to affect the design, construction, operation, and decommissioning of the geologic repository operations area. The natural conditions include geologic, tectonic, hydrologic, and climatic process. The Department shall evaluate the stability of the geologic repository and the isolation of radionuclides after decommissioning.

(i) The Department shall conduct investigations on the order of 100 kilome horizontal radius from the geologic repository operations area.

(ii) The Department shall emphasize those natural conditions active anytime since the start of the Quaternary Period in their investigatic

(iii) The Department shall emphasize the first 10,000 years following decommissioning in their prediction of changes in natural conditions and the performance of the geologic repository.

Recommended Revision:

a. Change (i) to: "The Department shall conduct investigations throughout the area and volume of the geologic and hydrologic environment which may affect or be affected by the geologic repository to assure that the local site conditions are compatible with the regional setting. The level of detail investigated at each distance from the geologic operations area shall be commensurate with the importance of data at that location."

b. Change (ii) to: "The Department shall document those natural processes active during the Quarternary Period in their investigations.

c. In (iii) insert "and extrapolation" after "prediction". Subsection (iii) is a very significant principle and should be elevated to a major performan objective.

Rationale:

a. The area to be investigated is site dependent. Clearly there is no need to do investigations beyond a defined connection to the accessible environment. Also the level of detail at the outer limits of the investigation does not necessarily have to be as intense as at the site itself.

b. Clarity. Conditions are not active.

c. Completeness. Also, the principle of 10,000 years being the most significant time of interest is very important and should be emphasized.

Staff Response to Comment 237:

See response to Comment 233. The provisions of 60.122 have been revised to provide greater clarity. With respect to DOE's third point, the subparagraph in question has been deleted.

Comment 238: Ross enclosure in U.S. Department of Energy (18)

§60.122 Siting Requirements

(a)(2)(i) Geologic investigations completed for a radius of 100 km from the repository area is a reasonable requirement, but the level of detail of these investigations is not specified. It is probably best this way, with the level of detail being a judgment rather than specified regulatory consideration.

(a)(2)(iii) A 10,000 year period for prediction of changes in natural conditions and the performance of the geologic repository is reasonable and appropriate.

(a)(5) A reasonable trade-off must be made between drill hole testing to reduce geologic uncertainty and the intent to minimize drilling to preserve the integrity of the reservoir.

(a)(9)+ Knowledge of the geologic and physical properties of the repository host for a distance of 2 km from the limits of excavation is reasonable and prudent. A similar knowledge for depths of 1 km below the repository excavation must either

a) admit and accept considerable uncertainty and rely largely upon geologic judgement and geophysical measurement, or
b) provide for several drill holes within and surrounding the repository, to depths 1 km below excavation levels.

A reasonable trade-off between the two possibilities must be accepted and acknowledged as a clarification of statements within this section.

Staff Response to Comment 238:

See response to Comments 233, 236 and 237. For the purpose of investigating the properties of the potential host rocks such investigations can range to a depth of 500 m below the limits of repository excavations.

Comment 239: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.122(a)(2)(i) "The Department shall conduct investigations on the order of 100 kilometers horizontal radius from the geologic repository operations area."

Comment:

For some sites 100 km may be too small, while for others, such as salt domes, 100 km may be too large. It is recommended that this section eliminate the str use of a "quantitative designation" and replace it with "the investigation of each geologic tectonic, hydrologic and climatic factor important to repository functioning should be conducted over that area required to fully describe and analyze that feature." At some sites and for some factors, the distances from the repository site shall be determined to suit the type and importance of data at that location.

Staff Response to Comment 239:

See response to Comment 233.

Comment 240: Westinghouse Electric Corp. (20)

60.122(a)(2)(i) - The 100 kilometer radius specified for investigations has no technical basis. The area surrounding the repository site should be investigated to the extent required to characterize the principal features of the geologic regions in which the repository will reside. The extent of this area is site specific.

Staff Response to Comment 240:

See response to Comment 233.

Comment 241: Arvin S. Quist (6)

It is suggested that the words "Demonstration of" be omitted from (3)(ii) and (3)(iii).

Staff Response to Comment 241:

In response to public comment the words "demonstration of" have been deleted in the revised provisions as set forth in the proposed rule.

Comment 242: Bechtel National, Inc. (13)

60.122(a)(3) - The paragraph asks for "representative and bounding values" for "human activities and natural events" for three items. Two of the items, (ii) and (iii), ask for "demonstration" of natural events only, which is not compatib with "representative and bounding". It is recommended that sections (ii) and (iii) be combined and made a separate number, e.g. (4).

Staff Response to Comment 242:

See response to Comment 241. The phrase "representative and bounding "has been deleted from the proposed rule.

Comment 243: U.S. Department of Energy (18)

60.122(a)(3)(ii) and (iii)

NRC Proposed Wording:

(ii) Demonstration of the stability of the geologic repository after decommissioning.

(iii) Demonstration of the isolation of radionuclides from the accessible environment after decommissioning.

Recommended Revision:

Replace the word "Demonstration" in each sentence with "Prediction," and add the phrase "based upon the state-of-the-art," to the end of each sentence.

Rationale:

One cannot demonstrate the future, but one can predict future processes to varying degrees based upon state-of-the-art techniques.

Staff Response to Comment 243:

See response to Comment 241. Section 60.122 - "Favorable conditions" as set forth in the proposed rule uses the term "when projected "instead of either "demonstration" or "prediction".

Comment 244: Everett R. Irish (29)

Page 31401, column 1, line 25 - "Demonstration" of the isolation of radionuclides is not feasible, if my understanding of demonstration is correct.

Staff Response to Comment 244:

See response to Comment 241.

Comment 245: U.S. Department of Energy (18)

60.122(a)(4)

NRC Proposed Wording:

The Department shall evaluate reasonably likely future variations in the site characteristics which may result from natural processes, human activities, construction of the repository, or waste/rock/water interactions.

Recommended Revision:

Insert "thermomechanical and physiochemical" before "waste/rock/water".

Rationale:

Clarity.

Staff Response to Comment 245:

The provision in question has been deleted from the technical criteria.

Comment 246: Attorney General Abrams, State of New York (11)

DOE is required by the draft to conduct site investigations so as to obtain the necessary information "with minimal adverse effects on the long-term performance of the geologic repository." § 60.122(a)(5), p. 31401, col. 1. The regulations should require that the investigation work have no adverse effects on the long-term performance, and certainly that it not breach the integrity of the repository.

Staff Response to Comment 246:

The staff believes that realistically one must expect some minimal adverse effects on the geologic repository (e.g., minor fractures generated during drilling operations, reduction in strength of rock with temperature increases, etc.). The proposed rule sets forth conditions which the staff feels may adversely affect the performance of the geologic repository. Such conditions when compounded by the effects of repository construction and the heat generated by the waste could result in an unacceptable level of uncertainty about repository performance.

The paragraph referred to by Attorney General Abrams has been deleted from the proposed rule. A proposed amendment to 60.10 (procedural rule) now contains the provision that investigations to obtained the required information shall be conducted to limit adverse effects on the long-term performance of the geologic repository to the extent practical.

Comment 247: Bechtel National, Inc. (13)

60.122(a)(5) - The paragraph requests site investigations be done in such a manner to produce minimal adverse effects on long term performance. Early shafts, particularly on multiple sites as requested by the Commission, could produce significant adverse effects.

Staff Response to Comment 247:

The NRC believes that adequate precautionary measures associated with the sinkin of a test shaft (and an auxiliary ventilation shaft if necessary) can be adopted to ensure minimal adverse effects on the integrity of a potential repository site. However, the NRC has recognized that if such site characterization work is not carefully done, it may render the site unusable for a repository (44 FR 70409). Proposed amendments to 60.10 (procedural rule) further add esses this issue. The NRC does not understand why the commenter is linking early shafts at a number of various sites throughout the United States to the production of significant adverse effects at DOE's preferred repository site.

Comment 248: U.S. Department of Energy (18)

60.122(a)(6)

NRC Proposed Wording:

The Department shall validate analyses and modeling of future conditions and changes in site characteristics using field tests, in situ tests, field-verified laboratory tests, monitoring data, or natural analog studies.

Recommended Revision:

a. Insert "to the extent practicable" after "characteristics".

b. Delete "field-verified".

Rationale:

a. The Supplementary Information section recognized the difficulties encounte in validation.

b. Meaningful field verifications of laboratory tests are not always possible within a "real-time" period.

Staff Response to Comment 248:

The requirement was intended to apply to confirmation of model used to assess expected performance of the repository, and has been so clarified.

Comment 249: Ellison enclosure ir U.S. Department of Energy (18)

Subject of Comment:

60.122(a)(6) "The Department shall validate analyses and modeling of future conditions and changes in site characteristics using field tests, in situ tests, field-verified laboratory tests, monitoring data, or natural analog studies."

Comment:

It is always difficult to envision every scientific procedure that may be used to verify and/or validate a finding, particularly in an area with major R&D efforts. It is recommended that the following statement be added to the end of this section: "...or other method demonstrated to be appropriate by the Department."

Staff Response to Comment 249:

See response to Comment 248.

Comment 250: Bechtel National, Inc. (13)

60.122(a)(7) - The DOE is requirec to "continuously" assess and verify changes. An assessment and verification time period should be stipulated.

Staff Response to Comment 250:

This provision has been deleted from the technical criteria.

Comment 251: U.S. Department of Energy (18)

60.122(a)(7)

NRC Proposed Wording:

The Department shall continuously verify and assess any changes in site conditi which pertain to whether the performance objectives will be met.

Recommended Revision:

Change "continuously" to "continue to".

Rationale:

Continuously means without interruption.

Staff Response to Comment 251:

See response to Comment 250.

Comment 252: Tauke and Adam (21)

The Department shall continuously verify and assess any changes..." What if 51 years later adverse conditions appear and the repository is sealed? How often is "continuously"?

Staff Response to Comment 252:

See response to Comment 250.

Comment 253: Westinghouse Electric Corp. (20)

60.122(a)(7) - This paragraph requires continuous verification and assessment of changes in site conditions. This is impractical if the word "continuous" is interpreted literally. Furthermore, there is no indication of how long this should be carried out.

Comment 254: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Paragraph (a)(7)

It is not clear what the intent or scope of "continuous" verification and assessment of changes in site conditions are.

Staff Response to Comment 254:

See response to Comment 250.

Comment 255: Attorney General Abrams, State of New York (11)

The draft would require DOE to perform a resource assessment for the region of the proposed repository site "using available information". § 60.122(a)(8), p. 31401, col. 1. Yet DOE acknowledges that present levels of information on possible regions are inadequate. See pp. 65-67 of the attached Appendix. Because of the importance of a complete resource assessment for the human intrusion and other issues, DOE should be required to do further studies and testing, rather than limit itself to available information.

Staff Response to Comment 255:

See response to Comment 256.

Comment 256: Bechtel National, Inc. (13)

60.122(a)(8) - The request is made to assess the site within 100 km radius using available literature. However, it is also requested to use geologic and geophysical information to evaluate mineral deposits. Is it the intention of the Commission to require geologic or geophysical surveys if none are available? Furthermore, the resource assessment should be in far less detail beyond say the first 10 km from the center of the site

Staff Response to Comment 256:

Provisions requiring a resource assessment have been deleted from the proposed rule and are set forth as proposed amendments to the Safety Analysis Report (60.21). The required 100 km has been replaced by the disturbed zone.

Comment 257: U.S. Department of Energy (18)

60.122(a)(8)

NRC Proposed Wording

The Department shall perform a resource assessment for the region within 100 km of the site using available information. The Department shall include estimates of both known and undiscovered deposits of all resources that (1) h been or are being exploited or (2) have not been exploited but are exploitabl under present technology and market conditions. The Department shall estimat undiscovered deposits by reasonable inference based on geologic and geophysic information. The Department shall estimate both gross and net value of resou deposits. The estimate of net value shall take into account development, extraction and marketing costs.

Recommended Revision:

a. Change "undiscovered deposits" to "potential reserves".

b. Delete "both gross and".

c. Change "net" to "fair market".

Rationale:

a. It is impossible to assess undiscovered deposits, but is common to estim potential reserves.

b. Gross value is irrelevant if extraction or marketing costs make it impra tical to develop.

c. Fair market is a more useful term than net value in this case.

Staff Response to Comment 257:

The NRC believes that the terms "known" and "undiscovered" will encompass the total mineral endowment. The term "reserves," as defined in the U.S. Geologi Survey Circ. 831 entitled "Principles of a Resources/Reserve Classification for Minerals (1980) is "that portion of the identified resource that can be economically mined at the time of determination." Reserve is derived by appl a recovery factor to that component of the identified resources designated as the reserve base. Therefore, the NRC believes that the term "potential reser suggested by DOE is somewhat contradictory since by definition, reserves are known. The NRC feels that the both terms suggested in (b) and (c) by DOE and those currently set forth in the technical criteria are generally accepted in economic gelogy. This being the case, the NRC sees no reason to substitute

DOE's terminology for that currently in the technical criteria. See also respc to Comment 256.

Comment 258: Westinghouse Electric Corp. (20)

60.122(a)(8) - This paragraph requires estimates of all resources. This can be an endless job depending on the interpretation of "all" and the definition of a "resource."

Staff Response to Comment 258:

In response to the commenter's suggestion, the word "all" has been deleted fror the provisions on resource evaluations (and assessments) as set forth in the proposed amendment to 60.21.

Comment 259: Duke Power Co. (25)

60.122(a)(8) The question of avoidance of natural resources has, in our view, been somewhat overemphasized. We find it difficult to envision a future civilization with the capability to bore 2000 ft. deep holes, which at the same time is unable to detect radioactivity. Even this unlikely set of circumstances is of concern only if all records of repository location and content are lost.

Staff Response to Comment 259:

The NRC agrees with the commenter that it is inconsistent to assume the scienti and technical capability to identify and explore an anomalous heat source sever hundred meters below the surface and not assume that those exploring would have some idea of either what might be the cause of the anomaly or what steps to take to mitigate any consequences of that exploration. The question is not whether a future generation can detect radioactivity, but rather whether anothe natural resource that could also be present in the area of the repository coulc be in such a major demand in future years that a future society would risk rupt or intrusion of a HLW repository to obtain the alternate resource.

Comment 260: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Paragraph (a)(8)

There should be some clarification of the purpose for this resource assessment requirement. Since presumably this requirement is related to the possibility of human intrusion the significance of exploitation under present technology and market conditions is irrelevant. How would such an assessment relate to or be compared with the value of the site as a waste repository?

Staff Response to Comment 260:

See response to Comment 259. The staff has no means of accurately estimating the future market conditions of resources. Dr. Bird's example in the following comment illustrates the relative economic importance of resources.

Comment 261: Bird enclosure in U.S. Department of Energy (18)

P. 31401, 1st column, (8). Under (ii) -- have not been exploited but are exploitable under present technology and market conditions". This is an important task. However, it is not clear why, in terms of the desire to understand the possibilities of human intrusion, why the resources would be estimated using present market conditions. For example, one hundred years ago, a large copper ore body became uneconomic if the grade of the ore went below approximately 14%. Today, such an ore body would be valuable.

Staff Response to Comment 261:

See response to Comment 259.

Comment 262: Environmental Protection Agency (23)

§ 60.122(a)(8) and 60.122(b)(1)(iii) indicate the need to avoid sites with significant resource potential. However, these provisions specify resources which "are economically exploitable using existing technology under present market conditions" (emphasis added). Interpreted strictly, this could mean that a resource like oil shale need not be considered if a repository were to be licensed today. We believe that this provision should be broadened to include "reasonably foreseeable" technology and market conditions; this would be consistent with the approach used for other site characteristics.

Staff Response to Comment 262:

In response to this comment, a proposed amendment to the final procedural rule (46 FR 13971) requires for a description by physical factors (such as tonnage, grade, and quality) of natural resources without current markets but which would

be marketable given credible projected changes in economic or technological factors.

Comment 263: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.122(a)(9) "The Department shall determine by appropriate analyses the extent of the volume of rock within which the geologic framework, ground-water flow, ground-water chemistry, or geomechanical properties are anticipated to be significantly affected by construction of the geologic repository or by the presence of the emplaced wastes, with emphasis on the thermal loading of the latter. In order to do the analyses required in this paragraph, the Department shall at a minimum conduct investigations and tests to provide the following input data...

"As a minimum, the Department shall assume that the volume will extend a horizontal distance of 2 kilometers from the limits of the repository excavation and a vertical distance from the surface to a depth of 1 kilometer below the limits of the repository excavation."

Comment:

In some cases, such as a salt dome, a distance of 2 km from the repository may be excessive. This can be handled without excessive effort, if all parties recognize the level of detail actually needed as distance may vary from site-to-site. Possibly of greater importance, the 1 km depth below the repository as an unqualified requirement may not always be desirable. For example, if there are several aquifers within 1 km distance, it will be desirable that borings below the repository be limited to only the absolute minimum required--and their locations should be very carefully selected. It is recommended that thi section be changed to say that the volume extends to 1 km, but that the extent of data required between 300 m and 1 km below the repository will be determined on a site-by-site basis.

Staff Response to Comment 263:

The proposed rule assumes a disturbed zone to extend the greater of either its calculated extent or a horizontal distance of 2 km from the limits of the underground facility and from the surface to a depth of 500 m below the limits of the repository excavation.

Comment 264: Bechtel National, Inc. (13)

60.122(a)(9)(i) - The paragraph calls for characterization of fractures, etc., of the "host rock and confining units"; however, in some cases (e.g., granite)

there may be no confining unit, and if there is it may not be within the "volume of rock" defined at the beginning of Paragraph (9).

60.122(a)(9)(iii) thru (vi) - Is it intended that the term "in situ" imply a shaft to repository level to acquire data? If so, this intent should be clearly stated. However, we believe that in situ tests in shafts and drifts are necessary only for site validation purposes after site selection. It should be noted that in situ determinations in a host rock will not guarantee that the measured condition exists throughout the repository.

60.122(a)(9) - The last paragraph of this section states that "the Department shall assume that the volume will extend a horizontal distance of 2 km...", whereas the first paragraph of this section indicates the applicant shall determine what volume of rock will be significantly affected by construction of the geologic repository. We believe that determining in situ properties for a volume at least 2 km from the limits of the repository and 1 km deep is excessive for this purpose.

Staff Response to Comment 264:

With respect to the commenter's first point, the NRC acknowledges that in the case of a granitic pluton there may indeed be no confining unit. The term has been dropped. For NRC's interpretation of the phrase "in situ testing at depth" see response to Comment 122. The NRC believes that in situ testing at depth is an essential technique for DOE to obtain sufficient data to determine whether and to what extent the surrounding geologic medium is suitable for hosting a repository, and has required in situ testing at depth as part of site characterization (See 51.40 and proposed amendments to 60.10). Therefore, the NRC does not agree with the commenter that in-situ testing is only necessary for site validation after site selection. See also response to Comment 263.

Comment 265: U.S. Department of Energy (18)

60.122(a)(9)

NRC Proposed Wording:

The Department shall determine by appropriate analyses the extent of the volume of rock within which the geologic framework, ground water flow, ground water chemistry, or geomechanical properties are anticipated to be significantly affected by construction of the geologic repository or by the presence of the emplaced wastes, with emphasis on the thermal loading of the latter. In order to do the analyses required in this paragraph, the Department shall

at a minimum conduct investigations and tests to provide the following input data:

(i) The pattern, distribution, and origin of fractures, discontinuities, and heterogeneities in the host rock and surrounding confining units;

(ii) The presence of potential pathways such as fractures, discontinuities, solution features, unsealed faults, breccia pipes, and other permeable anomalies in the host rock and surrounding confining units;

(iii) The in situ determination of the bulk geomechanical properties, pore pressures and ambient stress conditions of the host rock and surrounding confining units;

(iv) The in situ determination of the bulk hydrogeologic properties of the host rock and surrounding confining units;

(v) The in situ determination of the bulk geochemical conditions, particularly the redox potential, of the host rock and surrounding confining units;

(vi) The in situ determination of the bulk response of the host rock and surrounding confining units to the anticipated thermal loading given the pattern of fractures and other discontinuities and the heat transfer properties of the rock mass.

As a minimum, the Department shall assume that the volume will extend a horizontal distance of 2 kilometers from the limits of the repository excavation and a vertical distance from the surface to a depth of 1 kilometer below the limits of the repository excavation.

Recommended Revision:

a. Delete the last paragraph.

b. In (i) add "statistical" in front of "distribution".

c. In (i), (ii), and (vi) change the discussion of fractures to permeability.

d. In (ii) delete "such as...anomalies".

e. In (iii), (iv), (v), and (vi) delete "in situ" and add at the end "by in situ, laboratory, and field tests and/or calculation as practicable".

f. In (v) change "redox potential" to "equilibrium solubility sorption data for the waste package and radionuclides".

Rationale:

a. If the volume of rock defined at the end of this section is the volume referred to in the first paragraph, it is impossible to assess all of these features throughout the volume (e.g., how can fracture patterns

one km below the repository horizon be evaluated). Also, stating a minimum volume, without considering a site, is unrealistic. A detailed in situ determination of the properties discussed in (i) through (vi) of this subsection, to a depth of one km below the repository horizon could possibly compromise the integrity of the system by introducing potential pathways for fluid migration where none existed previously. What is pertinent to determine, by whatever means are available, is whether extensive confined aquifers occur below the repository level at depths which could be significantly affected by the waste repository. The depth of investigation should be determined by the regional geology.

b. Mapping the entire volume is impossible.

c. The term "fracture" tells nothing about the ability of the rock medium to affect waste transport, while permeability does.

d. Some of the features mentioned such as breccia pipes and solution feature may be less permeable than the surrounding rock.

e. These items all specify in situ determination of properties. This is appropriate for many properties but some geomechanical (iii) and most geochemical (v) properties cannot practically be subject to "in situ determination". However, the "in situ properties" may be determined in the laboratory. The language needs to be clarified to allow this.

In addition, the type of testing and depth of data should be a function of parameter sensitivity (how much is warranted), uncertainty (is more data required), and ramifications (is data collection compatible with maintaining a sound structure).

By requiring in situ determinations in both host rock and surrounding confining units, NRC is requiring at least two, and perhaps many, test facilities to be constructed at each site. One facility will not be able to propagate thermal effects to surrounding rock units in a reasonable time frame. This appears to be an unreasonable requirement.

There should be some clarification here about ambient stress conditions. In situ determination is hard to do for the host rock, but impossible for the surrounding confining units. This should refer to calculational determination of ambient stress conditions.

Response of surrounding confining units to anticipated thermal loading cannot be measured, it can only be calculated. The time required for heat to reach surrounding confining units is very long and therefore it cannot be measured.

f. Redox potential is not a unique property of the rock but is dependent on the geochemistry, the volume of fluid and the behavior of the waste package.

Staff Response to Comment 265:

(a) In response to public comment, the NRC has revised the paragraph in questic (b) The paragraph 60.122(a)(9)(i) has been deleted from the technical criteria. Revised wording has been proposed as an amendment to 60.21. However, the staff does not believe it is appropriate to add the term "statistical" to the provision. (c) The reference to fractures has been changed to permeability in (ii) only in the proposed amendment to 60.21. The NRC believes that the term "fractures" is more correct in the other two provisions questioned by DOE. (d) Some of the examples listed in (ii) have been deleted from the proposed amendment to 60.21, in response to DOE's suggestion. (e) In response to DOE's comment, the phrase "in situ" has been deleted from the provisions as provided in the proposed amendments to 60.21, but the staff declines to make the second suggested change. (f) Provision (v) has been simplified in the proposed rule and the phrase in question has been deleted.

Comment 266: Bird enclosure in U.S. Department of Energy (18)

(i)-(vi). At what level would all of these questions and tasks be resolved? I very much doubt that all of the fractures, for example, at a given site could be recorded; how would the "bulk geomechanical properties" be recorded, and at what level of detail, etc? These topics constitute a list of things that, from a geologic point of view, could never be "satisfied" beyond some level of accuracy and description. To present such a list in the way it is here again reflects a lack of judgement and understanding of geologic features, processes, and the ways they are studied.

Staff Response to Comment 266:

The level of detail should be sufficient to permit a determination that requirements for the design and construction of the geologic repository operations area have been met and that the performance objectives of the waste packages will be achieved. See comment 265.

Comment 267: Westinghouse Electric Corp. (20)

60.122(a)(9) - Many of the properties and characteristics required to be determined by the subparagraphs of this section are impossible or impractical to obtain in the implied detail without adversely affecting the future integrity of the repository. Also, use of field tests in lieu of on site in-situ tests and off site in-situ tests where appropriate, should be allowed.

Staff Response to Comment 267:

See response to Comment 266.

Comment 268: TASC enclosure in Lowenstein, Newman, Reis, Axelrad and Toll (28)

Paragraph (a)(9)

The emphasis on thermal loading is inappropriate since this factor is so readily amenable to direct control. The requirements for input data identified in paragraphs (i) through (vi) are inordinate. If interpreted literally within the volume noted it is quite likely to destroy the utility of the proposed site for repository purposes. The implied level of data indicated seems quite impractical to achieve and presents an undesirable opportunity for endless discussion as to when this requirement is satisfied.

Staff Response to Comment 268:

The NRC does not agree with the commenter that the emphasis on thermal loading is inappropriate. Many of the perturbations that are expected in the performance of the repository system will occur as the result of the increased temperature in the host rock due to radioactive decay heat. See also responses to Comments 265 and 266.

Comment 269: U.S. Geological Survey (12)

Page 31401, col. 2, par. (v). This paragraph should be augmented by specific reference to sorption properties ("$K_D$") determined in situ at the candidate site.

Staff Response to Comment 269: See comment 265.

The proposed amendments to 60.21 contain a simplified reference to "the bulk geochemical properties" without specific references to any particular geochemical parameter.

However, 60.122, as set forth in the proposed rule specifically addresses sorp as a favorable condition of the geologic setting (60.122(g)).

Comment 270: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.122(a)(9)(v) "The in situ determination of the bulk geochemical conditions particularly the redox potential, of the host rock and surrounding confining units."

Comment:

This statement implies that the most important geochemical characterization is likely to be redox potential (or eH). First, it may not be; pH or trace element/mineral geochemistry may be far more important. Second, this is a very difficult measurement to make accurately under good in situ conditions. Finally, unless the location of in situ measurements is exceptionally clean of foreign matters (drilling mud, oxygen, etc.), the measurement may be meaningle More important and practical than in situ measurement may be good laboratory work using simulated host rock and fluids.

Staff Response to Comment 270:

See response to comment 269.

Comment 271: U.S. Geological Survey (12)

Page 31401, col. 2, par. (vi). Detailed characterization of this large volume of rock using available or foreseeable geophysical methods does not appear possible.

Staff Response to Comment 271:

See response to Comment 265.

Comment 272: Pinder enclosure in U.S. Department of Energy (18)

Pg. 31401, Col. 2, Line 14-Line 18b: I believe this list of (vi) requirements is not now, nor likely to be in the foreseeable future, within the capability of earth scientists or engineers. This strikes me as an unreasonable wish-lis devoid of consideration for and of available technology.

Staff Response to Comment 272:

The requirements of 60.122(a) have been reviewed and revised.

Comment 273: Attorney General Abrams, State of New York (11)

The draft establishes a presumption against repository sites with potentially adverse conditions, but allows for a rebuttal of the presumption, § 60.122(b). p. 31402, col. 1. In view of the commitment to conservative planning expressed by DOE and NRC, any presumption based on the existence of adverse conditions should be irrebuttable.

Staff Response to Comment 273:

The presence of a potentially adverse condition would not necessarily make a site unsuitable for a repository site. It is generally accepted that a complete unflawed geologic environment is not attainable in nature. Whether or not a potentially adverse condition would affect the integrity of a potential repository would depend upon a number of factors such as the physical extent of the condition and the ability of the engineered barriers to compensate for the condition.

Comment 274: Bechtel National, Inc. (13)

60.122(b) - The statement "the presence of any of the potential adverse human activities or natural conditions will give rise to a presumption that the geologic repository will not meet the performance objectives" is extreme and could rule out many excellent sites. There is no basis for this presumption from the presence of such activities or conditions.

Staff Response to Comment 274:

See response to Comment 273. In addition, both the draft technical criteria (45 FR 31402) and the proposed rule set forth provisions by which DOE can show that a potentially adverse condition or combination of conditions does not im

significantly the ability of the geologic repository to isolate the radioactiv waste.

Comment 275: U.S. Department of Energy (18)

60.122(b) POTENTIALLY ADVERSE CONDITIONS

NRC Proposed Wording:

The following paragraphs describe human activities or natural conditions which can adversely affect the stability of the repository site, increase the migrat of radionuclides from the repository, or provide pathways to the accessible environment. The Department shall demonstrate whether any of the potentially adverse human activities or natural conditions are present. The Department shall document all investigations.

The presence of any of the potentially adverse human activities or natural conditions will give rise to a presumption that the geologic repository will not meet the performance objectives. The conditions and activities in this section apply, unless otherwise stated, to the volume of rock determined by the Department in Paragraph 60.122(a)(8) above.

Recommended Revision:

Replace "can adversely" with "may have the potential to". Delete second paragraph.

Rationale:

Whether or not the stated conditions are actually of importance is a matter of speculation. The statement as written is without basis.

These conditions should not give rise to the stated presumption. The last paragraph of the section identifies ways to show how they may be acceptable. Also, 60.122(a)(8) is an incorrect reference as it refers to the entire area with a 100 km radius. Presumably (a)(9) is meant.

Staff Response to Comment 275:

The provisions of the technical criteria relating to potentially adverse condi tions have been substantially rewritten as set forth in the proposed rule. In response to DOE's comment, the latter part of the second paragraph has been deleted.

Comment 276: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.122 (b) Potentially Adverse Conditions. "The following paragraphs describe human activities or natural conditions which can adversely affect the stability of the repository site, increase the migration of radionuclides from the repository, or provide pathways to the accessible environment. The Department shall demonstrate whether any of the potentially adverse human activities or natural conditions are present. The Department shall document all investigations. The presence of any of the potentially adverse human activities or natural conditions will give rise to a presumption that the geologic repository will not meet the performance objectives. The conditions and activities in this section apply, unless otherwise stated, to the volume of rock determined by the Department in § 60.112(a)(8) above."

Comment:

The impact of potentially adverse conditions is very much overstated by the statement that "the presence of any of the potentially adverse ....conditions will give rise to a presumption that the geologic repository will not meet the performance objectives." That statement is qualified at the end of § 60.122(b) by allowing a rebuttal if it can be shown that the potentially adverse conditions does not adversely affect performance of the geologic repository. It is strongly recommended that this latter position be taken at the beginning of this section to avoid the process of first "disqualifying" and the "requalifying" sites. This could be accomplished by changing the above wording to state "The presence of any of the potentially adverse human activities or natural conditions will require demonstration by the Department that the conditions do not adversely affect repository performance within acceptable standards if the site is to be considered as a viable option." Example methods of demonstrations are included at the end of this section. (Another way to accomplish this would be to leave the adverse list out of the regulations entirely and state that it is the Department's obligation to show that the repository will perform adequately for all site conditions. This process will give better potential for selection of the best candidate sites in the United States.

Finally, the volume considered for evaluation cannot possibly be the 100 km distance stated in § 60.122(a)(8). It is assumed that this was a typographic error in the draft regulations. The correct reference for volume would appear to be § 60.122(a)(9).

Staff Response to Comment 276:

The revised wording on potentially adverse conditions as set forth in the proposed fule, now states that "the presence of any such conditons may compromise site suitability and will require careful analysis and such measures as are necessary to compensate for them adequately. See also response to comment 274. Provisions for a resource evaluation have been deleted in the proposed rule

and are set forth as proposed amendments to 60.21. The proposed amendment requires a resource evaluation for the disturbed zone and for areas of similar size that are representative of and are within the geologic setting. A definition of the term "disturbed zone" is set forth in 60.2, as amended.

Comment 277: Lowenstein, Newman, Reis, Axelrad & Toll (28)

A major conceptual problem in the draft technical criteria appears in the presentation of potentially adverse conditions and favorable conditions, in § 60.122(b) and (c). The approach to siting expressed in these sections seems to be impractical and appears to conflict with the viewpoints expressed in the supplementary information and the DTSD. The potentially adverse conditions in § 60.122(b) are presented in an absolute manner, such that a site would be presumed to be unsuitable if they were present, even though many of the described conditions would probably not prevent achieving adequate performance. On the other hand, the favorable conditions are presented more as options than as essentials, indicating that a site should possess as many as practicable. As noted in the DTSD, some of the favorable conditions are virtually essential for adequate repository performance, and should not be optional. The draft criteria further states that the presumption that a site will not meet the performance objectives can be rebutted by demonstrating that the potentially adverse conditions are compensated by favorable conditions. However, the criteria do not provide a baseline from which the degree of compensation can be determined. In particular, the criteria do not indicate what favorable conditions, as a minimum, the repository should possess. The impression given by this emphasis on adverse conditions is that the NRC favors avoiding the "bad" instead of demonstrating the "good."

The draft criteria would be improved by recognizing the distinction between important siting requirements and conditions that are desirable, but not necessary, and by emphasizing a more positive approach to siting. The essential conditions for a repository (e.g., geologic stability, long flow paths, relatively impermeable host rock, etc.) should be highlighted and identified as requirements early in the discussion of siting. Potentially adverse conditions that cannot be compensated by engineered barriers (e.g., potential igneous intrusion, active structural deformation, etc.) should be required to be avoided. In practice, siting studies would, and should, begin by considering fundamental needs and unacceptable flaws. Conditions that can be compensated by engineered barriers, and favorable and potentially unfavorable conditions that actually can be weighed against one another (e.g., weighing degree of fracturing against degree of geochemical retardation) should then be required in a more flexible manner. This suggested approach would be more workable for the licensing process and would be consistent with the systems approach for meeting performance objectives. It would allow DOE to optimize selected aspects of the repository system to compensate for deficiencies or uncertainties elsewhere.

Staff Response to Comment 277:

Section 60.122 has been revised in response to public comment to present the favorable and potentially adverse conditions in an equilvalent manner. Provisions for the "presumption" that a site will not meet its performance objectives if potentially adverse conditions are present, as well as the conditions for a rebuttal of this presumption have been modified in the proposed rule. See also response to comment 274. The NRC does not feel that it would be appropriate to specify what favorable conditions a repository should possess since many of the conditions, both favorable and potentially adverse are site-specific. The staff believes that the revised version of § 60.122 as well as the proposed amendments to 60.21 should be responsive to a number of points made by the commenter in the second paragraph. For a discussion of the repository system see response to comment 51.

Comment 278: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Paragraph (b)

The reference at the end of the introductory portion of this paragraph should obviously be to § 60.122(a)(9). This whole paragraph, including the subparagraphs discussed below, represent a "negative" approach to repository siting (see major comments), and seems inconsistent with the systems approach. The indication that "rebuttal" of adverse presumptions may be possible comes much too late in the paragraph. Moreover, it is questionable whether some of the potentially adverse conditions or human activities identified justify a presumption that the geologic repository will not meet the performance objectives, (e.g., shallow drill holes, shallow mining and resources, etc.) Some of the requirements can be construed (totally incorrectly, in our view) as eliminating the use of salt formations.

Paragraphs (b)(1)(iii) and (b)(1)(iv)

These paragraphs presumably would eliminate from further consideration sites where there are economically exploitable resources or there are resources that are of above-average value for other areas in the region containing the geologic repository. The value of such resources will clearly be a matter of degree and, in any case, should be compared with the value of the repository itself. There should be no reason for eliminating a site area because it contains resources of relatively low value, particularly if the resources are located at insignificant depths. An apparent justification for excluding areas with

substantial resource values, as presented in the DTSD, is to assure that the site has no greater potential for being explored than any other site. However, even if such resource values are present it does not seem reasonable to categorically exclude otherwise suitable sites solely on that basis. At most, the presence of these resources should lead to consideration of the types of specific impacts that exploration might have upon repository integrity and the potential effect, if any, of such impacts upon the repository's satisfaction of performance standards. Such consideration is not likely to lead to the exclusion of a site with suitable natural characteristics as the location of a well-designed repository.

Staff Response to Comment 278:

See responses to Comments 2, 275 and 277. On the issue of resources see response to Comments 257 and 260. The value of the natural resources is only one of the factors used in determining the suitability of a site as a repository.

Comment 279: U.S. Geological Survey (12)

Pages 31401-31402, sec. 60.122(b). This part specifies those potentially adverse conditions which may result in the major components of the system not meeting the performance objectives of section 60.111(c). At this point, the language seems to depart from the sense intended in section 60.111 in that repeated references are made to the geologic repository (total system), not individual barriers. For example (p. 31401, col. 3, par. (1)(ii)), prior drilling to depths below the lower limit of the accessible environment will not affect the waste package and, depending on depth, may not affect the underground facility. It most likely would affect the geologic environment. It would sharpen up the regulations and make the potentially adverse conditions less sweeping if the following changes in language were made:

1) On page 31401, col. 2, last sentence: "The presence of any of the potentially adverse human activities or natural conditions will give rise to a presumption that those barriers affected by the adverse human activity or natural condition will not meet the performance objectives of 60.111(c)" (change underlined).

2) On page 31402, col. 1, par. 4, sentence 2: "A presumption that any of the major barriers will not meet the performance objectives stated in 60.111 can be rebutted upon showing that the presence of the potentially adverse condition does not adversely affect the performance of any of the barriers within the system" (change underlined). As it stands, the applicant might argue that the waste package alone ensures that the system will perform as required and that therefore any adverse condition may be tolerated.

Staff Response to Comment 279:

See response to comment 276.

Comment 280: J. G. McCray (9)

Ref § 60.122(b)(1) What about large populations?

Staff Response to Comment 280:

Reference to population density has been deleted from the proposed rule.

Comment 281: Duke Power Co. (25)

60.122(b)(1): Again we have the problem of an overemphasis on recoverable resources. While we see the need to limit the possibility of future adverse human activities at the repository site, the draft criteria are much too stringent and could well eliminate otherwise superior sites, especially in salt. In particular, the criterion that "drilling for whatever purpose to depths below the lower limit of the accessible environment" shall "give rise to a presumption that the geologic repository will not meet the performance objectives" is particularly inappropriate.

Staff Response to Comment 281:

See response to Comment 282.

Comment 282: U.S. Department of Energy (18)

60.122(b)(1)

NRC Proposed Wording:

Potentially Adverse Human Activities

(i) There is or has been conventional or in situ subsurface mining for resources.

(ii) Except holes drilled for investigations of the geologic repository, there is or has been drilling for whatever purpose to depths below the lower limit of the accessible environment.

(iii) There are resources which are economically exploitable using existing technology under present market conditions.

(iv) Based on a resource assessment, there are resources that have either higher gross or net value than the average for other areas of similar size in the region in which the geologic repository is located.

(v) There is reasonable potential that failure of human-made impoudments could cause flooding of the geologic repository operations area prior to decommissioning.

(vi) There is reasonable potential based on existing geologic and hydrologic conditions and methods of construction for construction of large-scale impoundments which may affect the regional ground water flow system.

(vii) There is indication that present or reasonably anticipatable human activities can significantly affect the hydrogeologic framework. Human activities include ground water withdrawals, extensive irrigation, subsurface injection of fluids, underground pumped storage facilities or underground military activities.

Recommended Revisions:

a. In (ii) delete everything after "purpose" and add "at depths which would adversely affect the subsurface repository volume".

b. Delete (iv).

c. In (vii) change to read "...activities that would alter the hydrogeologic framework in an unacceptable manner".

Rationale:

a. Mines and boreholes which would not adversely affect the repository volume should not preclude the use of a site. Past drilling to above the repository horizon or outside the horizontal extent of the subsurface workings does not impact the ability of the repository to isolate wastes. Known holes can be sealed and unknown holes are not known and therefore would not be considered.

b. This philosophy places too much importance on resources which, as indicated in the general comments, results in a weak argument for proving safety. The nature of future resource needs is not readily predictable and constantly changes.

c. Referring to 60.122(b)(1)(vii), it is conceivable that some future human activities can have little effect or actually improve the repository hydrologic framework. Ground water withdrawals from closed basins could eliminate a potential water transport capability. Of importance is the significance of the change to safety.

Staff Response to Comment 282:

Sections of the proposed rule (60.123) dealing with potentially adverse conditions has been significantly revised with respect to the provisions set forth in the ANPR. In the proposed rule the potentially adverse conditions are segregated into those which affect the geologic setting (60.123(a)) and those occuring in the disturbed zone. Although the provisions addressed by DOE are still found

in the proposed rule NRC feels that some of the language modifications and segregation of the conditions may be responsive to DOE's concerns.

Comment 283: Ellison enclosure in U.S. Department of Energy (18)(c) Subparagraph 60 122(b)(1)(vii) has also been revised and is set forth as 60.122(b)(1)(iii) in the proposed rule.

Subject of Comment:

60.122(b)(1)(ii) "Except holes drilled for investigations of the geologic repository, there is or has been drilling for whatever purpose to depths below the lower limit of the accessible environment."

Comment:

The requirement to consider all drilled holes as an "adverse" condition as defined in the draft regulations is unnecessarily restrictive. Certainly, borings several km from the site do not necessarily pose extreme problems in all cases. A primary example would be a salt dome where the boring is completely away from the dome.

Further, borings nearer to the site may be separated from the repository by an adequate barrier or they may be sealed--and all open borings can be reentered for cleaning and sealing. This statement should be eliminated entirely or restated to include only borings at locations which could adversely affect containment and if the boring is not accessible for sealing.

Staff Response to Comment 283:

See response to Comment 282.

Comment 284: Lowenstein, Newman, Reis, Axelrad and Toll (1)

Some of the requirements can be construed as unjustifiably precluding salt and basalt formations as potentially suitable for a deep geologic repository. (See proposed sections 60.122(b)(1)(ii), 60.122(b)(3)(iii), 60.122(b)(4)(ii), 60.122(b)(5).) Clarification and/or revision is needed to relate these requirements to acceptable system performance.

Staff Response to Comment 284:

See response to Comment 279. The technical criteria were not intended to preclude any geologic medium from consideration as a potential repository site, but rather to provide the characteristics of any site in any geologic medium

which the NRC feels would either support or not support a finding that a site was suitable to host a repository.

Comment 285: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.122(b)(1)(iii) "There are resources which are economically exploitable using existing technology under present market conditions."

Comment:

This item should refer to resource demands and alternate supplies and not just to its exploitability. For example, salt is a resource which could be exploited economically from many salt domes and bedded salt areas. However, that resource will not be exploited because of the abundance of salt. Therefore, use of a particular dome for waste disposal is a preferable use of that resource.

Staff Response to Comment 285:

The provision of the proposed rule which addresses the presence of resources has been modified to limit consideration to those resources occurring in the disturbed zone that have either greater gross value, net value, or commercial potential than the average for other representative areas of similar size that are representative of, and located in the geologic setting (60.123(b)(3)).

Comment 286: Westinghouse Electric Corp. (20)

60.122(b) - The applicability of this section should refer to Paragraph 60.122(a)(9), (2 kilometers from the limits of the repository) rather than item (a)(8), (within 100 kilometers of the site).

60.122(b)(1) - In the draft technical criteria, paragraph 60.122(b)(1) "Potentially adverse human activities" the repeated use of the word "reasonable" when assessments are made may well lead to significant controversy. Better definitions would be appropriate and quantification best, if such were possible.

60.122(b)(1)(iii) - This subparagraph indicates that the presence of economically exploitable resources would disqualify a site. This is overly restrictive since it will be difficult to find a site where no resources exist (again, what is the definition of resource). This restriction makes some sense in the case of a rare commodity, but not in the case of a commodity that is widely available

since the probability of that commodity being sought for at the precise location of the repository is low.

60.122(b)(1)(iv) - Resource assessments should be limited to the net comparative value of the resource since this value and not the gross value will determine the probability of recovery.

60.122(b)(4)(1) - This paragraph is confusing and appears to be unnecessary.

Staff Response to Comment 286:

The proposed technical criteria have been revised to separate conditions in the geologic setting that can adversely affect waste isolation from those conditions in the disturbed zone that can also affect waste isolation. In response to the commenter's second suggestion, the use of the term "reasonable" has been minimized. With respect to the commenter's third point, a potentially adverse condition, in this case, the presence of economically exploitable resources can be addressed in accordance with provisions set forth in the proposed technical criteria at 60.124. For a discussion of 60.122(b)(1)(iv) see Comment 285. Provisions relating to the assessment of potentially adverse conditions have been modified in the proposed rule. The NRC declines to change the paragraph addressed in the final comment of Westinghouse Electric.

Comment 287: Bird enclosure in U.S. Department of Energy (18)

(1)-(iii). Present market conditions should not be used, as discussed previously.

Staff Response to Comment 287:

The staff declines to make the suggested change.

Comment 288: Everett R. Irish (29)

Page 31401, column item 1 iii - Automatically eliminates salt as a repository medium.

Staff Response to Comment 288:

See response to Comment 284.

Comment 289: U.S. Geological Survey (12)

Page 21401, col. 3, par. (1)(vi). The statement about the effect on the regional ground-water flow system of large-scale impoundments is vague. The statement should specify which elements of the flow system might be affected and the extent of change that would be considered significant.

Staff Response to Comment 289:

Provisions are set forth in the proposed technical criteria at 60.124 which can be used in the assessment of potentially adverse conditions.

Comment 290: Ross enclosure in U.S. Department of Energy (18)

(b)(1) Potenially adverse human activities.
Items (i) through (vii) provide an adequate and reasonable listing of potentially adverse human activities.

(b)(2) Potentially adverse natural conditions - geologic and tectonic.
Items (i), (iii), (iv), (v), (vi), (vii) are reasonable and prudent.

(b)(2)(ii) Evidence of dissolutioning, collapse, or similar features which resulted from Pre-Quaternary geologic processes that have since been inactive, should not in itself disqualify a site. Reasonable proof of stability during the Quaternary should be required and adequate.

(b)(3) Potentially adverse natural conditions - hydrologic.
(iv) Presence of a fault or fracture zone with a horizontal length of more than a few hundreds of meters should not by itself disqualify a site. Countless examples may be sited of fractures tightly sealed with quartz, calcite or clays which show no evidence of movement or fluid flow for 10's of millions of years. The requirement as stated may be unnecessarily restrictive.

Staff Response to Comment 290:

No response is necessary to Mr. Ellison's first two points. With respect to the final two items, see response to Comment 289.

Comment 291: Environmental Protection Agency (23)

Section 60.122(b)(2), Potentially adverse natural conditions - geologic and tectonic, should include an additional item which reads as follows: "(viii) there is a uniqueness about the site that may substantially increase future exploration for purposes other than resources".

Staff Response to Comment 291:

Since it is not clear what purposes other than exploration for resources EPA envisions, the staff sees no reason to include the suggested wording in the rule.

Comment 292: U.S. Department of Energy (18)

60.122(b)(2)

NRC Proposed Wording:

(i) There is evidence of extreme bedrock incision since the start of the Quaternary Period.

(ii) There is evidence of dissolutioning, such as karst features, breccia pipes, or insoluble residues.

(iii) There is evidence of processes in the candidate area which could result in structural deformation in the volume of rock such as uplift, diapirism, subsidence, folding, faulting, or fracture zones.

(iv) The geologic repository operations area lies within the near field of a fault that has been active since the start of the Quaternary Period.

(v) There is an area characterized by higher seismicity than that of the surrounding region or there is an area in which there are indications, based on correlations of earthquakes with tectonic processes and features, that seismicity may increase in the future.

(vi) There is evidence of intrusive igneous activity since the start of the Quaternary Period.

(vii) There is a high and anomalous geothermal gradient relative to the regional geothermal gradient.

Recommended Revision:

a. General; these features mentioned are merely an inventory of natural processes going on almost everywhere. Whether or not they matter is part of the site selection procedure and the presumption that they do is a judgement made with bias. They should be deleted or a technical basis provided to support each.

b. Clarify the meaning of "extreme" in (i).

c. In (ii) replace "dissolutioning" with "dissolution". Insert "Quaternary" before "dissolution".

d. In (iii) insert "Quaternary tectonic" before processes.

e. In (iv) define "near field".

f. Delete (v) or put an absolute level on seismicity.

g. In (vi) delete "intrusive".

Rationale:

b. The meaning of "extreme" is subject to wide-ranging interpretations. Moreover, this requirement rules out investigation into the source of the entrenchment and its present and anticipated state of activity. The requirement ought to allow the Department to demonstrate by analysis whether ground-surface lowering could adversely affect the repository during the required containment period.

c. The presence of dissolution features does not necessarily discredit a candidate site. In the case of salt domes the cap rock is a by-product of dissolution that may have occurred much earlier in geologic history and may presently be acting as an effective impermeable seal.

Evidence of dissolution, collapse, or similar features which resulted from Pre-Quaternary geologic processes that have since been inactive, should not by itself disqualify a site. Reasonable proof of stability during the Quaternary should be required and adequate.

d. A time frame for these processes must be listed - otherwise all areas of the earth are "adverse".

e. "Near field", in contemporary usage, applies to earthquakes. It is not meaningful to refer to the "near field of a fault". This criterion is important, and it should be addressed more clearly and directly.

f. Increased seismicity is identified as a potentially adverse natural condition. Seismic activity can range from minor crustal adjustments to major disruptive events. Therefore, by simply noting that an increase in seismicity (with no qualification as to magnitudes) is potentially a disruptive event involves faulty logic. In any case, seismicity effects on a repository must be considered in two time frames - during operation and after decommissioning. Effects on a repository vary greatly depending on the time frame. After decommissioning, seismicity may or may not be significant.

g. Any igneous activity since the start of the Quaternary Period is more disqualifying than many factors listed in this section.

Staff Response to Comment 292:

(a) The technical basis for the siting requirements set forth in the proposed rule will be presented in an accompanying technical support document available in the NRC's Public Document Room.

(b) The provision relating to extreme bedrock incision has been changed.

(c) The staff has retained the term "dissolutioning".

(d) In response to DOE's comment, these processes are limited to activity during the Quaternary Period.

(e) The term "near-field" has been deleted from the proposed rule. The term "near-field" has been replaced by the term "disturbed zone" which has been defined in the proposed rule.

(f) The provision involving seismicity has been revised and divided into two separate provisions in the proposed rule. The NRC does not believe it is appropriate to place an absolute level on seismicity in the technical criteria.

(g) In response to DOE's suggestion, the term "intrusive" has been deleted.

Comment 293: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Paragraph (b)(2)

In general, this part of the draft rule does not encourage a workable approach to siting. The adverse conditions in this section are presented in an absolute manner, stating that their presence will give rise to the presumption that performance objectives will not be met, unless proven otherwise by DOE. However, several of the described conditions would be unlikely to prevent adequate performance. In contrast, the favorable conditions in § 60.122(c) are presented almost as options, with the statement that sites having as many favorable characteristics as practicable are preferred. Many of these favorable characteristics, however, are important for adequate repository performance. The tone of these two sections, in combination with the adverse conditions being presented first in the rule, suggests a "negative" approach to siting. That is, it suggests emphasis on avoiding specified adverse

conditions in the initial phases of siting, thus delaying attention to favorable conditions until the later phases of site-specific investigation. The rule should be structured to encourage a more workable approach. In discussing application of the adverse conditions requirements to siting, the DTSD (Section 5.1) states: "It should be emphasized here that it is the intent of these requirements not to require absolute proof (underlining in original) that a specified condition either exists or does not, but to require a reasonably vigorous and state-of-the-art investigation and evaluation." This intent is not expressed by the draft rule. Instead, potentially adverse conditions are presented in a generally absolute manner.

Paragraph (b)(2)(i)

The term "extreme bedrock incision" is vague. The highest rates of erosion that have been estimated over periods of tens to hundreds of thousands of years would be very unlikely to compromise the integrity of a typical repository in the 10,000-year period that this rule addresses. If retained, this term would be better replaced with wording along the line of "erosion rates that could compromise repository performance."

Paragraph (b)(2)(ii)

The problem with this requirement is that any deposit of evaporite minerals is likely to contain some evidence of minor dissolutioning, much or all of which may no longer take place because of changed hydrologic conditions. Examples include the caprock of salt domes and the argillaceous interbeds in bedded salt formations. Presumably the paragraph's intent is to exclude large dissolution features and active dissolution features of any size. If it could be improved by specifying "evidence of substantial dissolutic .that has occurred under hydrologic conditions that may be anticipated du..ng the repository lifetime." This would be consistent with the discussion in the DTSD (§ 5.2.2.2.).

Staff Response to Comment 293:

In response to the commenter's first item, a serious attempt has been made to present favorable and potentially adverse conditions in a similar light in the proposed technical criteria. As previously noted, the NRC believes its approach to siting is cautious and conservative, not negative as stated by the commenter. An attempt has been made to revise the technical support document so that it presents more clearly the supporting rationale for the requirements set forth in the proposed rule.

Regarding the comment on "extreme bedrock incision," the staff was not so much focusing on the downcutting of a river or stream compromising the integrity of

a repository, but rather, the staff believed that extreme bedrock incision would provide evidence of active tectonic processes such as uplift and subsequent fluviatile downcutting. This provision has been revised to now read "evidence of extreme erosion during the Quaternary."

Finally, dissolution is not solely a feature of evaporite minerals. Dissolutioning also occurs along fractures in a variety of rock types. See also response to Comment 274.

Comment 294: U.S. Geological Survey (12)

Page 31401, col. 3, par. (2)(i). The term "extreme" is vague in this context. The concern here, presumably that erosion might exhume the repository, should be stated explicitly.

Staff Response to Comment 294:

See response to Comment 293.

Comment 295: Bird enclosure in U.S. Department of Energy (18)

(2)-(ii). "There is evidence of dissolutioning, such as karst features, breccia pipes, or insoluble residues". Many breccia pipes are not the result of "dissolutioning", such as diatremes. Many sedimentary rocks contain evidence of dissolutioning, such as styolites in limestone, and clay mineral segregations in rock salt. These features would not necessarily be potentially adverse natural conditions in a site. Also, under (iv) what amount of activity of the fault would be serious? It can be argued that all faults are active, even very ancient and "inactive" ones, because of tidal forces and plate movement. It is very important that (i) through (vii) be re-written and very carefully considered. These statements are based on the premise that any geologic "activity" would be detrimental to the site. One can argue that the converse might be true in the context of using geologic processes to enhance the repository design!

Staff Response to Comment 295:

In response to public comment on the draft technical criteria, the provisions addressed by Dr. Bird have been substantially revised and clarified. With respect to Dr. Bird's comment on "breccia pipes," it should be noted that

Staff Response to Comment 298:

The NRC has deleted this provision. The proposed rule contains as a potentially adverse condition in the geologic setting, earthquakes which occurred historically, which if repeated could effect the geologic repository significantly.

Comment 299: J. G. McCray (9)

Ref § 60.122(b)(2)(vii) Substitute "heat flux" for "gradient" in that gradients vary due to changes in thermal conductivity and boundary conditions.

Staff Response to Comment 299:

Paragraph 60.122(b)(2)(vii) has been deleted from the proposed technical criteria.

Comment 300: U.S. Geological Survey (12)

Page 31402, col. 1, par. (vii). This criterion is questionable. We believe a more relevant criterion would be "There are geophysical indications of the presence of a magma body at depth." A cooling regime is as likely to have a high gradient as a warming regime, but would not be equally adverse.

Staff Response to Comment 300:

See response to Comment 299.

Comment 301: Bechtel National, Inc. (13)

60.122(b)(2)(i) - The word "extreme" should be defined.

60.122(b)(2)(ii) - "Karst features", "breccia pipes" and especially "insoluble residues" are not necessarily "extreme" bedrock incisions.

60.122(b)(2)(iii) - Such evidences are often not extreme bedrock incisions.

60.122(b)(2)(iv) - The term "near field" should be defined.

60.122(b)(2)(v) - Having a "higher seismicity" is certainly not an extreme bedrock incision, and may not even be a potential hazard.

60.122(b)(2)(vii) - A higher than regional geothermal gradient may not be extreme.

breccia pipes were simply cited as one type of dissolution feature that could be present. The NRC did not intend to imply that all breccia pipes are dissolution features.

Comment 296: U.S. Geological Survey (12)

Page 31401, col. 3, par. (2)(iii). With the exception of fracturing ("fracture zones" is not a process), the processes listed could result in structural deformation of the volume of rock in a repository. However, it should be stated that structural deformation is significant to the extent that it results in an increase in the hydraulic conductivity of the rocks (through fracturing), and the consequent increase in the rate of leaching and transport of waste radionuclides. Uplift or subsidence may not be harmful by themselves if they are not differential within the candidate area.

Staff Response to Comment 296:

The NRC agrees with the position taken by the USGS. Provisions dealing with rebuttal of the presumed adverse conditions are set forth in the proposed rule.

Comment 297: U.S. Geological Survey (12)

Page 31401, col. 3, par. (2)(iv). The phrase "near field of a fault" requires definition. In fact, the whole question of how to assess tectonic conditions and future tectonics could well be the subject of a Regulatory Guide.

Staff Response to Comment 297:

See response to Comment 292.

Comment 298: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.122(b)(2)(v) "There is an area characterized by higher seismicity than that of the surrounding region or there is an area in which there are indications based on correlations of earthquakes with tectonic processes and features that seismicity may increase in the future."

Comment:

This factor is not needed as special adverse condition. The seismicity of an area will always be one of the important site selection and design factors. The importance of seismicity will be decided on a site-by-site basis.

Staff Response to Comment 301:

For a discussion of Bechtel National's first and fourth points, see response to Comment 292. It appears that Bechtel National has misread the beginning of paragraph 60.122(b)(2), since the reference to "extreme bedrock incision" was limited to subparagraph (i) and Bechtel National seems to have the impression that the remaining subparagraphs were given as examples of "extreme bedrock incision."

See also response to Comments 298 and 299.

Comment 302: J. G. McCray (9)

Ref § 60.122(b)(3) What about endangered ecosystems or biota? What about archaeological or historical sites?

Staff Response to Comment 302:

The technical criteria of Part 60 are concerned with health and safety issues under the Atomic Energy Act. Environmental (NEPA) considerations must be taken into account as provided under other regulations (especially 10 CFR Part 51).

Comment 303: U.S. Department of Energy (18)

60.122(b)(3)

NRC Proposed Wording:

(i) There is potential for significant changes in hydrologic conditions including hydraulic gradient, average pore velocity, storativity, permeability, natural recharge, piezometric level, and discharge points. Evaluation techniques include paleohydrologic analysis.

(ii) The geologic repository operations area is located where there would be long term and short term adverse impacts associated with the occupancy and modification of flood-plains. (Executive Order 11988).

(iii) There is reasonable potential for natural phenomena such as landslides, subsidence, or volcanic activity to create largescale impoundments that may affect the regional ground water flow system.

(iv) There is a fault or fracture zone, irrespective of age of last movement, which has a horizontal length of more than a few hundreds of meters.

Recommended Revision:

a. General:

The criteria listed are stated to be "technical" against which a license application can be reviewed. However, few criteria (and here hydrologic criteria are principally addressed) can possibly be called technical. The regulations heavily rely on qualified terms such as low hydraulic gradient, little hydraulic communication, long ground water residence time, long flow paths, or such phrases as "may effect the regional ground water flow system". Instead of (or perhaps in addition to) emphasizing these terms, the regulations should stress end products of waste isolation rather than a descriptive hydrogeologic narrative. For example, important products should be (a) estimates of acceptable risk afforded by specific radionuclide retention in a given geologic medium or comparisons between media, and (b) dose calculations under natural flow conditions and reasonable scenario variations. To understand these items, it is necessary to evaluate ground water flow paths and travel times plus radionuclide concentrations and distributions to the biosphere. The difference being the former is the end product while the latter are intermediate steps. Waste isolation is not assured by high or low gradients or long or short flow paths but rather by the response of the entire hydrogeologic and hydrochemical system of the host medium.

b. In part (i) delete "average pore velocity" or change it to "seepage velocity". Also insert "adverse" before "changes".

c. Delete part (iv) as written and replace with a criterion that addresses ground water conductivity.

Rationale:

a. Pore velocity is not a uniquely defined term. Potential for change to improve the isolation capability is not adverse.

b. No site is likely to be free of this sort of feature. If such "old" features exist, they should require detailed investigation to determine whether it functions as a ground water barrier or conductor, where in the ground water system it occurs, and how it may perturb the system.

c. It is the existing hydrologic environment that will be the prime factor in assessing transport. The scenarios for change should not be considered more important than the existing conditions.

Staff Response to Comment 303:

(a) In response to public comment, a number of qualified terms, including those cited by DOE have been deleted from the technical criteria.

(b) "Average pore velocity" has been changed to "average interstitial velocity."

(c) In response to DOE's suggestion, subparagraph (iv) has been deleted.

Comment 304: Pinder enclosure in U.S. Department of Energy (18)

Pg. 31402, Col. 1, Line 12: "Storativity" is irrelevant to problems within this time frame.

Staff Response to Comment 304:

See response to Comment 305.

Comment 305: U.S. Geological Survey (12)

Page 31402, col. 1, par. (3)(i). "Storativity" is somewhat an archaic word; "storage coefficient" clearly indicates the attribute intended.

Staff Response to Comment 305:

In response to the USGS comment, the term "storage coefficient" has replaced the term "storativity "in the proposed rule.

Comment 306: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.122(b)(3)(i) "There is potential for significant changes in hydrologic conditions including hydraulic gradient, average pore velocity, storativity, permeability, natural recharge, piezometric level, and discharge joints. Evaluation techniques include paleohydrologic analysis."

Comment:

What is "average pore velocity?" Also, if required at all, this section should apply only if the change would reduce the isolating capability of the repository.

Staff Response to Comment 306:

See response to Comment 303.

Comment 307: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.122(b)(3)(ii) "The geologic repository operations area is located where there would be long term and short term adverse impacts associated with the occupancy and modification of floodplains. (Executive Order 11988)."

Comment:

The intent of this condition is not clear. Apparently, it deals only with surface facilities. It is premature at this time to rule out underground spaces on the basis of surface hydrologic and hydraulic conditions. Future studies may show that surface facility designs can be changed at less cost than required to improve less suitable underground conditions.

Staff Response to Comment 307:

This provision has been deleted from the technical criteria.

Comment 308: U.S. Geological Survey (12)

Page 31402, col. 1, par. (3)(iii). Refer to our comment (above) regarding page 31401, col. 3, par. (1)(vi).

Staff Response to Comment 308:

See response to Comment 289.

Comment 309: U.S. Geological Survey (12)

Page 31402, col. 1, par. (3)(iv). What is the basis for stipulating a horizontal fault length of "more than a few hundred meters?" There is no obvious relation between fault length and hydraulic properties.

Staff Response to Comment 309:

In response to public comment, the specified fault length has been deleted

from the proposed rule.

Comment 310: Bechtel National, Inc. (13)

60.122(b)(3)(iv) - A length of "a few hundred meters" is too vague and should be defined.

60.122(b) - The section at the end of 60.122(b) that rebuts requirements stated earlier is confusing and should be incorporated in the individual sections.

Staff Response to Comment 310:

See response to Comment 309. For the sake of clarity, the section referred to by the commenter has been deleted and a new section 60.124 "Assessment of potentially adverse conditions" has been included in the proposed rule.

Comment 311: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Paragraph (b)(3)(iv)

The concern here has nothing to do with rock movement along or across the fault or fracture zone, and age of last movement is irrelevant. Coming as it does under the section on hydrologic conditions, this paragraph is apparently concerned with the ability of the fault or fracture zone to significantly transmit ground water. In that case, it is not just the existence of the fault or fracture zone that matters, but whether it is of a nature that water can move along it, which may indeed not be possible for many such features. Application of this paragraph as written would unnecessarily eliminate many otherwise suitable sites, particularly those in basalt and granite. It should be revised to reflect the level of hydrologic conductivity along faults or fractures zones that will be considered significantly adverse.

Staff Response to Comment 311:

The language of this provision has been modified as set forth at 60.123(b)(7) in the proposed rule. See also response to Comment 309.

Comment 312: U.S. Geological Survey (12)

Page 31402, col. 1, par. (4). Clarify as follows: "...Geochemical. The sum of the rock units ... exhibits ....".

Staff Response to Comment 312:

This paragraph has been deleted, and the potentially adverse geochemical conditions are now set forth more clearly in the provisions of 60.122, in the proposed rule.

Comment 313: U.S. Department of Energy (18)

60.122(b)(4)

NRC Proposed Wording:

The rock units between the repository and the accessible environment exhibit low retardation for most of the radionuclides contained in the radioactive waste.

Recommended Revision:

Delete this paragraph.

Rationale:

Unspecific terms such as "low retardation" and "most" make this useless as an adverse characteristic.

Staff Response to Comment 313:

See response to Comment 312.

Comment 314: Bird enclosure in U.S. Department of Energy (18)

This section is confusing and imprecise. It reflects a lack of understanding of potential benefits of ground water on sealing certain kinds of rock. Although it is true that waste-generated heat would tend to increase water flow, it is also possible that such an effect might be utilized to drive mineralogic reactions that would seal fractures and effectively prevent the water from reaching the waste package. This section reflects the general assumption that water in the repository site is always an adverse condition. We are not yet sure that this is so.

Staff Response to Comment 314:

The NRC staff is well aware of the geochemical reactions which could have the effect of filling fractures. However, since the migration of groundwater is considered by many scientists to be the most likely means by which the radionuclides may be removed from the repository and could migrate towards the accessible environment, the staff prefers to consider the presence of groundwater as a potentially adverse condition.

See also response to Comment 289.

Comment 315: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

There are other geochemical conditions that may cause adverse reactions between the waste or engineered systems and the host rock or fluids that may be unacceptable in the repository. Moreover, low retardation by itself should not be an exclusion factor because some media, e.g., salt, can provide adequate repository performance without retardation, and because retardation can be provided by engineering design of selected backfill materials (e.g., bentonite).

The role of sorption in the repository system, as discussed in the DTSD, is somewhat of a paradox. Geochemical properties of a site, particularly sorption, are cited as the most significant barrier to radionuclide movement, although it is also noted that some nuclides are little affected by sorption. The potential for major variations in retardation within a rock unit, as discussed in DTSD § 3.3.3.3., appears to be a major factor in the perceived need for extensive in situ testing to assure suitability of a repository. However, the DTSD also emphasizes a number of uncertainties associated with sorption and concludes in § 5.2.4 that sorption should be considered "...a dubious but necessary safety margin."

The need for retardation in the natural repository system is based on analyses such as those by de Marsily and coworkers (1977, Science, v. 197, pp. 519-527). The analyses by de Marsily indicate that radionuclides can be transported from a repository to the environment, even in a host rock of low permeability, in an unacceptably short period of time without sorption, and that travel times can be orders of magnitude longer if sorption is considered. However, there are three important factors that should also be considered in determining the appropriate emphasis on natural sorption properties for siting:

(a) The analyses by de Marsily assume groundwater flow vertically upward from a repository at 500 meters depth. This type of groundwater flow occurs in nature only under limited hydrologic conditions that readily can be avoided in siting. Vertical flow from convection caused by the heat in the repository also can be avoided by appropriate repository design. Accordingly, the flow paths from a repository can be orders of magnitude longer than assumed by de Marsily.

(b) The natural sorption properties of a site can be supplemented by using bentonite or other high-sorption materials in the repository backfill. In this manner, sorption can also be used as an engineered barrier.

(c) Sorption may not assure that a repository meets the system performance objectives or the EPA requirements. Because some nuclides are retarded little if at all by sorption, long groundwater travel times may be needed in addition to whatever sorption properties are present.

In view of these factors, it seems more desirable to emphasize groundwater travel time in siting, as this is very much a site-related property, and to allow the DOE the option of providing sorption as an engineered barrier. This approach can facilitate siting and the meeting of the performance objectives while providing the desired safety margins.

Staff Response to Comment 315:

See response to Comment 303. In the proposed technical criteria, both groundwater flow characteristics (including travel times) and geochemical conditions (including the promotion of sorption) are listed among the conditions of the geologic setting that may contribute to waste isolation. DOE, with the responsibility for the design and construction of the geologic repository, always has the option of providing sorption in the engineered barrier.

Comment 316: U.S. Geological Survey (12)

Page 31402, col. 2, par. (4)(c), line 11. Clarification is requested as to what constitutes full documentation. Does this imply QA standards or some lesser set of records?

Staff Response to Comment 316:

The paragraph in question has been deleted from the proposed technical criteria. A new Subpart G - "Quality assurance" is set forth in the proposed rule.

Comment 317: U.S. Department of Energy (18)

Textual Material Following 60.122(b)(4)

NRC Proposed Wording:

A presumption that the geologic repository will not meet the performance objectives can be rebutted upon showing that the presence of the potentially adverse condition does not adversely affect the performance of the geologic repository. In order to make this showing, the Department shall first demonstrate that--

(1) The potentially adverse human activity or natural condition has been adequately characterized, including the extent to which the particular feature may be present and still be undetected taking into account the degree of resolution achieved by the investigations;

(2) The effect of the potentially adverse human activity or natural condition on the geologic framework, ground water flow, ground water chemistry and geomechanical integrity has been adequately evaluated using conservative analyses and assumptions, and the evaluation used is sensitive to the adverse human activity or natural condition;

(3) The effect of the potentially adverse human activity or natural condition is compensated by the presence of favorable characteristics in Paragraph 60.122(c) of this Section; and

(4) The potentially adverse human activity or natural condition can be remedied during construction, operation, or decommissioning of the repository.

Recommended Revision:

Change the first paragraph to:

In order to make a showing that any potentially adverse condition does not adversely affect the performance of the geologic repository, the Department shall first demonstrate that--; and put all of this material before 60.122(b)(1).

Rationale:

See Major Comments.

Staff Response to Comment 317:

The wording of the first paragraph has been revised. Provisions for assessing potentially adverse conditions are set forth in a new section 60.124 which follows the list of potentially adverse conditions (60.123) since the staff feels that this is the most logical means of presentation.

Comment 318: TASC enclosure in Lowenstein, Newman, Reis, Axelrad & Toll (28)

Untitled Paragraph at the End of Section 60.122(b) (p. 31402)

The stated requirements for rebutting the presumption that a repository will not meet performance objectives are unclear as presented. It appears that DOE is required to (1) characterize the adverse feature, if detected, or its potential presence, if undetected; (2) evaluate its effect; (3) demonstrate that it is compensated by favorable conditions; and (4) demonstrate that it can be remedied. It is unlikely that all of these requirements would be needed for many of the unfavorable but possibly insignificant conditions described in the proposed rule. For example, boreholes, erosional features, evidence of dissolutioning, or ancient fracture zones may be characterized, evaluated, and shown to have no adverse effect on performance without additional compensation or remedy.

The requirement that potentially adverse conditions be characterized to include the extent to which the feature may be present and undetected by the site investigation could cause extreme delay in licensing because of the difficulties inherent in proving a negative. Potentially adverse conditions listed in the proposed rule include features (such as the examples cited above) that may be very difficult to resolve fully even though they are unlikely to render a site unsuitable. The criteria should clearly indicate that the requirement for

characterizing undetected features applies to those features of sufficient extent to impair performance.

The requirement to demonstrate that the unfavorable condition is compensated by favorable conditions is particularly unclear. The manner in which the favorable and unfavorable conditions are presented in the proposed rule does not provide a baseline from which the degree of compensation can be determined.

Staff Response to Comment 318:

The sections of the proposed rule which set forth favorable potentially adverse conditions (60.123) and the characteristics, assessment of potentially adverse conditions (60.124) have been modified. The staff believes that some of the commenter's concerns will be resolved by these modific actions.

Comment 319: U.S. Geological Survey (12)

Page 31402, col. 2, par. (c). Favorable characteristics. The first paragraph contains the notion of isolating the waste from the accessible environment by restricting the access of ground water to the waste. A repository depth of 300 meters would place the waste below the regional water table in most of the United States. It must be assumed, therefore, that after some time the closed repository would be saturated. Of most significance is the travel time of ground water and its contained radionuclides from the repository to a discharge area or some other accessible part of the environment. The notion of restricting the access of ground water to the waste is meaningful only over the short term with respect to an engineered barrier such as the waste container. The movement of the water and nuclides through the geologic medium is related to its natural characteristics and the effect, on the hydraulic conductivity of the medium, of stresses produced by the presence of the repository.

Staff Response to Comment 319:

See response to Comment 315.

Comment 320: Bechtel National, Inc. (13)

60.122(c) - Several references are made to a host rock possessing "to the extent practicable" certain characteristics (page 31402, middle column). While one can probably understand what the Commission is suggesting, the meaning is diffused with the use of "practicable". Rocks cannot possess favorable characteristics as practicable.

60.122(c)(1)(i) - Requirement may be too stringent and not attainable.

60.122(c)(1)(ii)(a) - "Long flow paths" should be defined. Does this imply distance or time? Time would be preferable.

60.122(c)(1)(ii)(b) - "Surrounding confining units" need not possess inactive ground water circulation if there is little or no communication to the host rock.

60.122(c)(2)(v) thru (vii) - These sections do not fit in 60.122(c)(2).

Staff Response to Comment 320:

In response to Bechtel National's comment, the phrase "to the extent practicable" has been deleted from the proposed rule. The staff believes that the rule as revised is responsive to the commenter's specific concerns with 60.122(c)(1) and (2).

Comment 321: U.S. Department of Energy (18)

60.122(c)

1. General comment: This section should precede Potentially Adverse Characteristics and a basis for each characteristic should be provided.

2. NRC Proposed Wording:

   Each of the following characteristics represents conditions which enhance the ability of the geologic repository to meet the performance objectives. Candidate areas and sites which exhibit as many favorable characteristics as practicable are preferred.

   Recommended Revision:

   Delete "Candidate areas and". Add "may" before "enhance".

   Rationale:

   The definition of candidate area (44FR60415) does not indicate the size of an area. DOE uses the term to describe an area on the order of 1000 square miles. It is not known whether or not the characteristics mentioned would enhance isolation in actual cases.

Staff Response to Comment 321:

In response to public comment, the NRC has restructured the proposed technical criteria so that the conditions that may contribute to waste isolation precede the conditions that can adversely affect waste isolation. The NRC believes that the revised version of the paragraph referred to in the DOE's second point addresses DOE's concerns.

Comment 322: Ross enclosure in U.S. Department of Energy (18)

Favorable characteristics.

The intent of this section is clear and reasonable. However the degree to which many characteristics can be measured or demonstrated is questionable. The entire section should be qualified by "consistent with the state-of-the-art" and "in-so-far as possible with acceptable drilling limitations".

Staff Response to Comment 322:

The NRC has removed the requirements for the "demonstration" of the favorable characteristics from the rule. The staff believes that the rule, as now written, does not need the qualifying statements proposed by Mr. Ross.

Comment 323: U.S. Department of Energy (18)

60.122(c)(1)(i)

NRC Proposed Wording:

(i) Exhibits demonstrable surface and subsurface geologic, geochemical, tectonic, and hydrologic stability since the beginning of the Quaternary Period; and

Recommended Revision:

Provide more guidance on what is meant by this criterion.

Rationale:

These are extremely vague terms. As stated, all areas affected by Pleistocene glaciation (including the periglacial zone) would be unsuitable for siting. That is not reasonable, and its probably is not the intent. Also, tectonically stable, meaning zero, does not exist.

Surface "stability" and near-surface hydrologic "stability" according to the definition in 60.2 are certainly not demonstrable since the beginning of the Quaternary Period. What is a more reasonable approach to surface geology and near-surface hydrology is the concept of acceptable ranges and rates of change. The surface and near-surface is the zone where rapid changes in earth processes take place. The changes which have occurred during the Quaternary Period can be evaluated and future changes predicted within limiting values. If it can be shown that changes which occur within these limiting values have no effect on repository safety, then "stability" of the processes need not be demonstrated.

We believe a revision of this item (i) should separate surface geology and near-surface hydrology from subsurface characteristics. Stability of subsurface geologic characteristics should be demonstrated. Surface characteristics and processes need to have limits or limiting ranges defined and evaluated.

Hydrologic attributes may need to be evaluated separately for the near-surface and for the deeper subsurfaces.

Staff Response to Comment 323:

The NRC believes that the technical criteria, as revised, provide more clearly the type of information which DOE must accumulate. The term "demonstrable" has been removed from the provision in question. The NRC also recognizes that nature is not in a static state and hence does not interpret "tectonic stability" to mean "zero" change.

Comment 324: U.S. Department of Energy (18)

60.122(c)(1)(ii)

NRC Proposed Wording:

(ii) contains a host rock and surrounding confining units that provide:

(a) long ground water residence times and long flow paths between the repository and the accessible environment;

(b) inactive ground water circulation within the host rock and surrounding confining units, and little hydraulic communication with adjacent hydrogeologic units due to ground water characteristics such as low intrinsic permeability and low fracture permeability of the rock mass; and

(c) geochemical properties, such as reducing conditions which result in low solubility of radionuclides, and near-normal pH, or a lack of complexing agents.

Recommended Revision:

a. In (b) change "inactive" to "negligible deep".

b. Change (c) to "favorable geochemical properties".

Rationale:

a. The term "inactive" requires an absolute lack of movement, and it implies that there must once have been movement. We are hopeful that candidate areas and sites will show evidence of there never having been significant ground water circulation in the vicinity of the host rock.

b. It would be preferable to state the characteristics in terms of net geochemical performance, rather than specifying which part of the redox,

pH, and complexing spectra is desirable. This could also include such items as low leachability and mobility of radionuclides.

It is not clear what is meant by "near-normal pH". Whatever conditions exist at the site prior to disturbance are, by definition, normal. If the authors mean "neutral pH", that is neither possible nor beneficial in rocks whose usual environment is acidic or basic. Furthermore, "neutral" pH contradicts "reducing conditions".

Staff Response to Comment 324:

As previously noted, the provisions of the technical criteria which set forth the conditions that may contribute to waste isolation (the so-called "favorable characteristics") have been revised to clarify and simplify the requirements. Terms such as "inactive groundwater circulation" and "near-normal pH" have been deleted from the revised provisions. In regards to DOE's second point, NRC feels that the provision relating to geochemical conditions, as revised, should alleviate some of DOE's concerns.

Comment 325: Pinder enclosure in U.S. Department of Energy (18)

Pg. 31402, Col. 3, Items a)-f). Many of these items are irrelevant misleading, or misinterpretations of the literature. I think this section requires careful scrutiny by a qualified hydrologist.

Staff Response to Comment 325:

The NRC has revised the section noted by Dr. Pinder's comment. However, since Dr. Pinder did not elaborate on which particular items he felt were "irrelevant, misleading or misinterpretations of the literature," the staff cannot judge whether or not the revisions are responsive to Dr. Pinder's concerns.

Comment 326: U.S. Geological Survey (12)

Page 31402, col. 2, par. (1)(ii)(b). What is meant by "inactive ground-water circulation?" Virtually all ground water is moving but rates of movement can range over 20 or more orders of magnitude.

Page 31402, col. 2, par. (1)(ii)(C). What is meant by near-normal pH?

Staff Response to Comment 326:

See response to Comment 324.

Comment 327: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.122(c)(1)(ii)(c) "Geochemical properties, such as reducing conditions which result in low solubility or radionuclides, and near-normal pH, or a lack of complexing agents."

Comment:

It would be preferable to state the characteristics in terms of net geochemical performance, rather than specifying which part of the redox,,pH, and complexing spectra is desirable. This could also include such items as low leachability and mobility of radionuclides.

Staff Response to Comment 327:

The relevant provisions of the technical criteria have been rewritten in terms of geochemical conditions instead of geochemical properties. In response to the commenter's suggestion, the terms of "redox" and "pH" have been deleted, and the term "mobility of radionuclides" has been added in the proposed technical criteria.

Comment 328: U.S. Geological Survey (12)

Page 31402, col. 3, par. (iii)(a). This paragraph should read "very low ground-water content."

Page 31402, col. 3, par. (iii)(b). Stipulation of "prevent ground-water intrusion" is in clear contradiction of section 60.101(3) which assumes disposal in a saturated medium--by definition a zone where ground-water intrusion must occur. In reality, what is to be regulated is not the presence of water, but its movement. We suggest rewording: "(b) Retard circulation of ground water in the host rock."

A generalization about Section 60.122 is that in many ways these attributes resemble the general site acceptability citeria described on page 31397, item 4, last paragraph.

Staff Response to Comment 328:

In response to the first comment by the USGS, the wording has been changed from "very low water content" to "very low groundwater content." The NRC has modified (b) along the lines of the wording suggested by the USGS.

Comment 329: U.S. Geological Survey (12)

Page 31402, col. 3, par. (iii)(d). Low hydraulic gradients are commonly indicative of high permeability and rapid water movement. A low hydraulic gradient does not indicate a low rate of water movement. Conversely, a high hydraulic gradient does not imply rapid water movement. What is the intent here?

Staff Response to Comment 329:

The intent of this provision was to identify hydrogeologic units with low hydraulic potential. A low hydraulic gradient, especially for confined aquifers, combined with other "favorable conditions" would lengthen the residence time and reduce the likelihood of premature groundwater intrusion through the borehole seals and into the underground facilities. To avoid further misinterpretations, this provision has been deleted.

Comment 330: U.S. Department of Energy (18)

60.122(c)(2)(iii)

NRC Proposed Wording:

(iii) possesses ground water flow characteristics that--

(a) result in a host rock with very low water content;

(b) prevent ground water intrusion or circulation of ground water in the host rock;

(c) prevent significant upward ground water flow between hydrogeologic units or along shafts, drifts, and boreholes;

(d) result in low hydraulic gradients in the host rock and surrounding confining units;

(e) result in horizontal or downward hydraulic gradients in the host rock and surrounding confining units; and

(f) result in ground water residence times under ambient conditions, between the repository and the accessible environment, that exceed 1000 years.

Recommended Revision:

a. Delete (a).

b. In (b) delete "ground water intrusion or". Add "rapid" before "circulation".

Rationale:

a. Water content is not relevant, permeability and water movement are.

b. By definition ground water will be intruded into the rock. Also, some ground water movement, albeit slow, would be expected. Ground water movement at a rate which would result in insufficient isolation times are to be avoided.

Staff Response to Comment 330:

See response to Comment 328. In response to DOE's second point, the phrase "ground water intrusion has been deleted from the rule, but the staff has not adopted DOE's suggestion to insert the work "rapid" before "circulation".

Comment 331: Parker enclosure in U.S. Department of Energy (18)

Page 31402, (C)(2)(iii)(a), normally "result in a host rock with very low water content." This would, in effect, eliminate clay, which I do not think is the intent.

Staff Response to Comment 331:

See response to Comment 320. Mr. Parker is correct in his inference that the requirement was not meant to eliminate clay.

Comment 332: U.S. Department of Energy (18)

60.122(c)(2)(v)

NRC Proposed Wording:

"possess a low population density";

Recommended Revision:

Specify and explain why a low population density is necessary.

Rationale:

Low population density means different things to different people. As written this could lead to endless debate in a hearing. Note that population density and meteorological characteristics (vi) are not properties of the volume of rock as stated.

Staff Response to Comment 332:

Reference to "a low population density" has been deleted from the technical criteria.

Comment 333: U.S. Geological Survey (12)

Page 31402, col. 3, par. (vii). Assuming that a reasonable range of climatic extremes can be postulated, it is difficult to conceive of a relationship between climatic change and tectonic characteristics.

Staff Response to Comment 333:

The staff believes that the relationship between glaciation and isostatic rebound would be one such example. However, in the proposed rule tectonic activity is no longer linked to climatic changes.

Comment 334: Lowenstein, Newman, Reis, Axelrad & Toll (1)

60.122(c)(3)(i): Permeability of $1 \times 10^{-12}$ is below the resolution of most measuring equipment and likely would be difficult to demonstrate with confidence. Instead, there should be included a more reasonable limit that could be measured within the state-of-the-art. Furthermore, existing and anticipated hydraulic gradients are equally important to fluid movement and should also be addressed.

Staff Response to Comment 334:

There is no § 60.122(c)(3) provision in the draft technical criteria as published in the May 13, 1980 issue of the Federal Register. In any event, there is no provision for a permeability value of $1 \times 10^{-12}$ in the proposed technical criteria.

Comment 335: Lowenstein, Newman, Reis, Axelrad & Toll (1)

60.122(d)(1): Investigations in the area extending 100 km or more from the site may be appropriate. However, it should be clear that the actual distance investigated would be determined by the location of conditions affecting the site. It may be necessary to investigate certain aspects of some sites at distances of more than 100 km while investigations of other factors or at other sites may be adequate at distances much less than 100 km.

Staff Response to Comment 335:

There was no 60.122(d) in the draft technical criteria as published in the May 13, 1980 issue of the Federal Register. In any event, the requirement for DOE to conduct investigations on the order of 100 km horizontal radius from the geologic repository operations area (60.122(a)(2)(ii)) has been deleted from the proposed technical criteria. The staff assumes that this is the provision the commenter was concerned with. The proposed rule contains provisions requiring DOE to conduct investigations of the disturbed zone, which is defined in the rule.

Comment 336: Lowenstin, Newman, Reis, Axelrad & Toll (1)

The proposed regulations appropriately do not require the design to accommodate the effects of meteorite or aircraft impacts. They should similarly exclude from consideration geologic events (e.g., vulcanism, active faulting) that obviously will be extremely improbable at a suitable repository location.

Staff Response to Comment 336:

Consideration is given to vulcanism and active faulting as unfavorable characteristics in the proposed rule.

Comment 337: Arvin S. Quist (6)

The word "practicable" is used in (a)(5)(ii). It should be defined, e.g., to include economic as well as technical and health and safety considerations. The word "feasible" could perhaps be used instead of "practicable." "Feasible" has been judicially defined with respect to OSHA standards for noise [Turner Co. v. Secretary of Labor and OSHRC, 7th Cir., 1977, 561 F.2d 82,85 (5 OSHC 1790)].

The phrase "essential to safety" is used in (a)(8)(iii). This should be defined or the previously defined phrase "important to safety" should be used instead.

Suggested wording in (a)(9)(ii)(a) is: "...to insure that exposures are as low as reasonably achievable and in any event within the limits of Part 20 of this Chapter." Also, it would be useful to define what is meant by "significantly above background levels." Is this 25 percent greater, 50 percent greater, or what? "Small as compared with the natural background" has been suggested to be interpreted as the standard deviation of the natural background or about 20 millirems/year [H. I. Adler and A. M. Weinberg, Health Physics, 34, 719-720 (1978)]. (in suggested wording, underlined words added)

Staff Response to Comment 337:

Subparagraph 60.132(a)(5)(ii), as revised in the proposed technical criteria

no longer contains the phrase "The [sic] the extent practicable."

Comment 338: Lazlo Toth (17)

60.132 Repository Design

I guess you know Mr. Secretary, that radioactive waste gives off heat. So why not put some of it in the middle of very elastic balloons. They ought to be very large. The waste will heat the air making the balloons rise. Our repositories can then float high above the earth on the fringes of space. As they rise the air in them will become less dense. If we plan it right the density will be so low that they'll be just like giant neon tubes. We can then use them to send messages or to advertise. That would make the best use of the capitalist system. We could make money on this!

Staff Response to Comment 338:

Alternative disposal technologies would be treated in other regulations.

10 CFR Part 60 deals with disposal in geologic repositories only.

Comment 339: Bird enclosure in U.S. Department of Energy (18)

I do not have significant comments or this section. I found it to be clear and well thought-out, and the best part of the 10CFR60 document.

Staff Response to Comment 339:

No response required.

Comment 340: Cook enclosure in U.S. Department of Energy (18)

With a few reservations noted below, the discussion under the heading Design requirements is probably the best section of Subpart E. Possibly, the reason for this is that it is closest in character to questions for which precedents exist in licensing of reactors. The first reservation concerns Compliance with mining regulations; a repository is not a mine. To "design and construct" a repository "to comply" with "all applicable Federal and State mining regulations" may not result in the best repository. Certainly, they should be applied where beneficial and this is likely to be the case in the underground operations but not applied indiscriminately elsewhere. Items 7 and 8 under this heading are very important; sufficiently so to warrant a separate discussion.

Items [2] Construction and mapping records and [3] Retention of cores and logs on page 31406 and other vitally important data are identified but no mention is made of how this information should be adduced to confirm or reject the suitability of a site. Such information must be collected, analyzed and adduced on a continuing basis throughout the development of any repository.

Under General design requirements for subsurface operation a highly significant statement concerning the design of a repository in modules is made. This concept should not be limited to repositories where concurrent excavation and emplacement of wastes are planned; it is not unlikely that even a suitable repository site will not be uniformly satisfactory in its properties. Modular design enhances greatly the opportunity for using those parts of a site which are suitable, without jeopardizing them by including parts found to be less than completely suitable.

Staff Response to Comment 340:

The NRC realizes that a repository is not a mine. However, during the excavation and construction of the repository a number of mining activities will be employed. The language has been revised so as to avoid the undesirable consequences identified in Mr. Cook's first point. See also response to Comment 342.

Provisions for construction and mapping records and the retention of cores and logs were included in the draft technical criteria primarily for the purpose of maintaining a historical record of the repository which would be available to future generations if needed.

Comment 341: Attorney General Abrams, State of New York (11)

The design requirements, § 60.132(a), pp. 31402-3, appear to contain special requirements for structures, systems and components "important to safety."

While special treatment of items so classified is not new, it was criticized by the Kemeny Commission because the failure of items not so labeled can similarly have serious safety implications. Therefore, all items should be put to the more stringent requirements. The Kemeny Commission also criticized the NRC requirement to analyze only "single-failure" accidents, noting that Three Mile Island was a multiple failure accident. The draft regulations, therefore, should not limit themselves to single-failure analysis. § 60.132(a)(8), p. 31403, col. 2. Indeed, during the course of a million years many multiple-failure accidents must be considered likely. This consideration also demonstrates the inadequacy of the criticality provision, § 60.132(a)(10), id., col. 3. During the course of a million years, "two unlikely, independent and concurrent or sequential changes" are not so unlikely.

Staff Response to Comment 341:

§60.132(a)(8) addressed utility services and was applicable only during operations. There is no stipulation in §60.132 that only single failure events are to be considered in the safety review. The design section has been revised in the proposed rule and the intent and period of applicability of the design requirements hopefully are now clear.

Comment 342: U.S. Department of Energy (18)

1. 60.132(a)(1) Compliance with Mining Regulations

NRC Proposed Wording:

The Department shall design, construct and operate the surface and subsurface facilities to comply with all applicable Federal and state mining regulations including Subchapters D, E, and N of 30 CFR Part 57 as applicable.

Revision:

Delete.

Rationale:

This paragraph is not appropriate in an NRC regulation. There is some question whether an underground civil structure is a mine. This regulation refers to it as a "civil engineered structure". This question will be resolved by DOE and MSHA. If it is determined that MSHA rules are applicable, they will be enforced by MSHA and the NRC paragraph adds nothing. If MSHA determines that their rules are not applicable, the NRC would be in the position of enforcing another agency's rules which that agency says are not applicable.

It should also be noted that mine safety regulations may, in some cases, be incompatible with safe repository operations. For example, reversing air flow direction in the case of a fire would bypass the ventilation exhaust filters.

These cases need to be worked out among the applicable regulatory agencies to avoid conflicting objectives.

Staff Response to Comment 342:

See response to Comment 340.

Comment 343: U.S. Department of Energy (18)

60.132(a)(1)(i)(a)

NRC Proposed Wording:

Prevent the accumulation of radioactive material in those systems to which access by personnel is required.

Recommended Revision:

Change "Prevent" to "minimize".

Rationale:

In general it is impossible to prevent slight accumulation of radioactive material, but proper design can minimize it.

Staff Response to Comment 343:

There is no subparagraph 60.132(a)(1)(i)(a) in the draft technical criteria as published in the May 13, 1980 issue of the Federal Register. The staff believes that DOE's comment referred to paragraph 60.132(a)(9)(a) of the ANPR. This paragraph has been deleted from the proposed rule.

Comment 344: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(a)(3)(ii) "The Department shall design and locate structures, systems and components important to safety to withstand the most severe of natural phenomena that are likely to occur at the site including seismic, meteorologic and hydrologic events without loss of capability to perform their safety function."

Comment:

It is assumed that this section deals with support facilities during the operations and not related to the repository after decommissioning. In that event, it is noted that the issue of designing nuclear facilities for natural events such as earthquakes has been debated for two decades. The proposed wording is sufficiently subjective to initiate a new series of debates to define "most severe," "likely to occur," and "safety function." It appears more logical for the Commission to adopt the "operating basis" and "safe shut down basis" events presently used for nuclear power plants as given in 10 CFR 100 Appendix A. The analyses procedures are understood and accepted. Also, they should not be highly controversial for repositories because they usually will not be sited in high risk areas and/or the number of safety-related facilities are relatively limited.

Staff Response to Comment 344:

Subparagraph 60.132(a)(3) has been revised, and specific mention of "seismic, meteorologic and hydrologic events" has been deleted.

Comment 345: Parker enclosure in U.S. Department of Energy (18)

Page 31403 (4), should be some indication of the use of modular design which does show up later. (5) should also include non-propagation.

Staff Response to Comment 345:

The staff does not see any need for a modular design requirement here, although that is one method for meeting the subject requirement. Similarly, the staff believes the section dealing with fires and explosions in the proposed rule is adequate to the purpose.

Comment 346: Attorney General Abrams, State of New York (11)

In discussing emergency capability, § 60.132(a)(7), p. 31403, col. 1-2, the draft regulations do not require emergency plans for evacuating the surrounding population even for the 10-mile area now being required for nuclear plants. Because of the serious consequences a repository accident could have, evacuation and other emergency planning no less than that required for power plants should be required for repositories.

Staff Response to Comment 346:

Unlike a power plant, a geologic repository has neither direct access to the biosphere nor a mechanism to spread contamination offsite in the event of an

accident. DOE will need to consider accidents during the operation period nonetheless, and plan for emergencies accordingly.

Comment 347: Attorney General Abrams, State of New York (11)

The regulations require DOE to design and construct surface facilities for retrieval of waste, but do not require storage capacity for all of the emplaced waste because "shipment offsite" is contemplated. § 60.132(b)(2), p. 31403, col. 3 - p. 31404, col. 1. It is not clear, however, where the waste could be shipped offsite, or if any suitable site would exist. Even if one does exist, shipment of nuclear waste would be required, and that is very hazardous. Therefore, DOE should be required to have sufficient storage capacity in a safe, licensed storage facility at the repository site to permit prompt retrieval of all the waste in case DOE sees a need for retrieval, or the NRC orders it.

Also with respect to retrievability, the regulations require DOE to design the repository to permit retrieval for 50 years "if the geologic repository operations area has not been decommissioned." § 60.111(a)(b), p. 31400, col. 1. See also § 60.135, p. 31407, col. 2. While retrievability for at least 50 years may be desirable, it is not clear what period would be required in case the area has been decommissioned, or why a different period should be designated.

Staff Response to Comment 347 :

The relevant requirement is that DOE have a means of accommodating retrieved wastes safely whether shipped off site or not. Decommissioning would mark the permanent closure of the repository and would end the retrievability option. For a discussion of retrievability, see responses to Comments 82 and 372.

Comment 348: U.S. Geological Survey (12)

Page 31403, col. 3, par. (b)(2). There is vagueness here as to whether the retrieved wastes were recovered because they failed themselves, or were recovered because of a failure of some other portion of the repository, or for an institutional reason. We believe there normally would be time to rig the special facilities required for failed canisters before retrieving them, but the present statement does not distinguish among the kinds of facilities needed as related to reason for retrieval.

Staff Response to Comment 348:

Since the reason for retrieval would be case specific the staff cannot say why retrieval might be ordered other than, in the judgment of the NRC, to not do so would pose an unreasonable risk to the public health and safety.

Comment 349: U.S. Department of Energy (18)

60.132(b)(2)

NRC Proposed Wording:

The Department shall design and construct surface facilities to facilitate safe and prompt retrieval of wastes including facilities to inspect, repair, decontaminate, and store retrieved wastes prior to their shipment offsite. Surface storage capacity of all emplaced waste is not required, but must be sufficient to handle waste backlogs prior to shipment offsite.

Recommended Revision:

Delete "and construct".

Rationale:

We agree that designs should exist for facilities required to retrieve waste to assure that they are properly integrated into the overall design. However, the actual construction of facilities that will not be used for several years and in all probability may never be used.

Staff Response to Comment 349:

In response to public comment, the phase "and construct" has been deleted.

Comment 350: Westinghouse Electric Corp. (20)

60.132(b)(2) - The option to overpack rather than decontaminate retrieved waste should be maintained.

Staff Response to Comment 350:

See response to Comment 348.

Comment 351: Duke Power Co. (25)

60.132(b)(2) We do not see the logic in requiring that full scale retrieval facilities be built on the surface. To the extent the retrieval option is considered necessary for repository performance checkout, the surface facility should be designed and constructed to allow full scale retrieval facilities to be added if deemed necessary in the future. We simply cannot conceive of a situation where we find outselves so much in error as to the actual performance of the repository system that we find it necessary to immediately remove waste; rather, we would have time to act to put in place any surface facilities required.

Certainly the capability of retrieving small numbers of canisters should be incorporated into the surface facilities, and the design of such facilities should include the capability for expansion, but any further requirement for such full-scale facilities to be actually constructed at the outset would result in an unjustifiable expenditure of funds.

Staff Response to Comment 351:

See response to Comments 348 and 349. The proposed rule requires facilities to handle wastes safely, whether received for emplacement or retrieval.

Comment 352: Bechtel National, Inc. (13)

60.132(b)(4)(i) - The requirement to "minimize" the release of radioactive materials in effluents during normal operations should be deleted. The requirement to meet the requirements of 10 CFR Part 20 which requires ALARA has already been specified.

Staff Response to Comment 352:

In response to the commenter's suggestion, the word "minimize" has been replaced with "control."

Comment 353: B. R. McElmurry (8)

Since this is a waste repository, only packaging, not processing, of onsite waste should be required (60.132-b-5).

Staff Response to Comment 353:

The NRC believes that it may be necessary to process any site generated wastes into a form suitable to permit safe disposal at the repository site or to permit safe transportation and conversion to a form suitable for disposal at an alternative site. Therefore, the use of "processing" is correct and no change is necessary.

Comment 354: U.S. Department of Energy (18)

In some sections of the document, specific design solutions to problems rather than technical criteria or performance objectives are stated. Specific examples of this are 60.132(c)(9)(v) which states "if aquifers or water-bearing structures are encountered during construction then the Department must use

pregrouting in advance of excavation", and 60.132(c)(6)(ii) which states "The Department shall design hoists with mechanically geared lowering devices that preclude cage free fall". While these may be appropriate designs in some cases, they are not the only solutions to the anticipated problem and may not be the best solutions. The regulation should state criteria not designs. The Department will design to meet the criteria and the NRC staff will have the opportunity to review the design and discuss, with the Department, alternative designs and their relative merits.

Staff Response to Comment 354:

A number of the so-called "specific design solutions" set forth in 60.132 are not included in the proposed rule. The revised 60.132 should be responsive to the concerns raised by DOE.

Comment 355: U.S. Department of Energy (18)

60.132(c)(1)

NRC Proposed Wording:

The Department shall design the underground facility as an underground civil engineered structure that satisfies requirements for structural performance, control of ground-water movement and control of radionuclide transport. The Department shall design the facility to provide for safe operation during construction, emplacement, and retrieval of waste and to assure compliance with §60.111 (Performance Objectives).

Recommended Revision:

This paragraph should be revised to indicate what is meant by an underground civil engineered structure and reference the requirements for structural performance that are mentioned.

Rationale:

Clarity.

Staff Response to Comment 355:

The concept of the "underground civil engineered structure" has been deleted from the proposed technical criteria.

Comment 356: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(2)(i) "The Department shall demonstrate that the underground facility includes those engineered features that are needed to limit radioactive releases after decommissioning to levels that are as low as reasonably achievable. The Department shall include an identification and a comparative evaluation of alternatives to the major design features that are provided to enhance radionuclide retardation and containment."

Comment:

As low as reasonably achievable could be stated as a goal. However, the requirement should be related to the acceptable standard.

Staff Response to Comment 356:

See response to Comment 357.

Comment 357: Tauke & Adam (21)

Waste isolation engineering (1) "The Department shall demonstrate that the underground facility includes those engineering features that are needed to limit radioactive releases after decommissioning to levels that are as low as reasonably achievable."

"Reasonably achievable" may vary from agency to agency, expert to expert.

Staff Response to Comment 357:

The term "as low as reasonably achievable" has been deleted from this provision in the proposed technical criteria.

Comment 358: B. R. McElmurry (8)

Per comment 3, major efforts to study alternative engineered barriers referred to in 60.132-C-2 do not appear reasonable or justified.

Staff Response to Comment 358:

See response to Comment 359.

Comment 359: Bechtel National, Inc. (13)

60.132(c)(2)(ii) - A regulatory requirement for design optimization is inappropriate. It should only be necessary to demonstrate with reasonable assurance that safety and environmental requirements have been met.

Staff Response to Comment 359:

In response to public comment the requirement for optimization has been deleted from paragraph 60.132(c)(2).

Comment 360: Parker enclosure in U.S. Department of Energy (18)

Page 31404 (2)(ii), would seem to indicate that if one wants the optimum solution one should extract maximum amount. In fact would like to err on the side of safety so that one would leave a larger amount of media to be sure of providing a margin of safety. The same point is made (iv)(2), optimizing opening design, etc.

Staff Response to Comment 360:

See response to Comment 359.

Comment 361: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(2)(ii) "The Department shall design the underground facility such that the orientation, geometry, layout, and depth of the underground excavation in addition to any engineered barriers provided as part of the underground facility are optimized for that site. The Department shall use as optimization criteria the performance objectives in Section 60.111(c)(2), (c)(3)."

Comment:

This paragraph requires that the underground facility be optimized (presumably with respect to performance objectives, although this is not clear) for a given site. First, optimization is a normal design function and does not need to be stated in a regulation. More importantly, the section specifies the optimization criteria. It is impossible for anyone to state today all of the factors that should be considered in the design process. These factors and their relative importance for different site conditions will be finalized during the next few years as site investigations, designs and R&D programs are completed. The last sentence of this section should be eliminated as a minimum.

Staff Response to Comment 361:

See response to Comment 359.

Comment 362: Westinghouse Electric Corp. (20)

60.132(c)(2)(i) - The second sentence of this paragraph states, "The Department shall include an identification and a comparative evaluation of alternatives to the major design features that are provided to enhance radionuclide retardation and containment." It is reasonable to describe alternatives that have been considered, but as stated, this requirement implies a never ending search for perfection when the objective should be to exceed the performance requirements. Looking at all possible alternatives will not help in performing this function.

60.132(c)(2)(iv)(2) - It is unclear what the phrase "sealed along their entire length" requires. It may not be desirable to provide a continuous seal from the repository level to the surface in lieu of a series of seals separated by backfill of the host rock. The criteria borehole plugging methods and their anticipated performance prematurely.

60.132(c)(2)(iv)(a) - This subparagraph should be deleted. It is up to the designer, not the regulator, to determine how the shafts and boreholes should be sealed as long as the seals meet the performance criterion which is stated in the following subparagraph. Furthermore, the time of sealing will be dictated by operational considerations and should not be specified by the regulator. Subparagraphs (c) and (d) are redundant to the basic criterion of subparagraph (b).

60.132(c)(2)(vi) - This subparagraph is incorrectly designated as (iv).

Staff Response to Comment 362:

In response to public comment paragraph 60.132(c)(2) has been revised and simplified. The provisions addressed by the commenter have all been deleted. Therefore, the NRC believes that the proposed technical criteria are responsive to the concerns expressed by Westinghouse Electric, and the other commenters.

Comment 363: U.S. Department of Energy (18)

60.132(c)(2)(iv)(a)

NRC Proposed Wording:

The shafts and boreholes are sealed along their entire length as soon after they have served their operational purpose as is practicable.

Recommended Revision:

Delete.

Rationale:

This paragraph would seem to contradict 60.111(a)(3) which indicates that the option must exist to leave the shafts open for 50 years after they have served their operational purpose. The time at which boreholes and shafts are to be sealed should be determined as part of the licensing process between issuance of the License and Decommissioning.

Staff Response to Comment 363:

See response to Comment 362.

Comment 364: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(2)(iv)(a) "The shafts and boreholes are sealed along their entire length as soon after they have served their operational purpose as is practicable;"

Comment:

Justification for not initially sealing the entire length could include:

- Only certain locations along penetrations are critical to seal performance. Sealing of one or several critical locations could be satisfactory for interim sealing if reentry at a later time to complete the seal is assured.

- Partial seals in boreholes for a temporary period would allow for some monitoring or testing of the seal before the entire penetration is filled.

- Possibly of greatest importance, by only partially sealing a penetration initially it will be possible to complete the seal at a later time (possibly at the time of decommissioning) using the best techniques available at that time. Improved techniques will be developed by ongoing R and D programs and/or by sealing activities of other repositories.

- In the case of shafts and tunnels, it may be desirable to temporarily leave a condition which permits reentry if desirable for future overall operational changes.

ONWI and the BWIP programs are both sponsoring major multiyear contracts to develop acceptable criteria for the materials, installation, and performance of penetration seals. Preliminary results (ONWI-55 and ONWI-90), show the potential benefits stated above for only partial sealing initially. The desirability and technical requirements for temporary partial sealing will be extended to firm, fully justified recommendations during the next several years of these ongoing investigations. To account for the Commission's objective to assure that penetrations are sealed and yet leave room for improved

procedures resulting from extensive generic and site-specific design efforts, the following wording is recommended for this section.

"Penetrations such as boreholes, shafts, and access tunnels shall be sealed along their entire length as soon as practicable after they have served their operational purpose, unless the Department provides procedures for only partially sealing any penetration initially, and has acceptable procedures for completing the seal prior to decommissioning. Justification for partial sealing will only be if there is a real potential for reentry into the penetration or if a substantial benefit from future advanced sealing technology is anticipated. In all cases where partial sealing is planned, the Department must demonstrate that the unsealed portion of the penetration will be preserved in an accessible condition and that all sealing will be completed at the time of decommissioning."

It is recommended that the extent and timing and extent of sealing be incorporated in repository and seal designs and that the NRC criteria reflect this recommendation.

Staff Response to Comment 364:

See response to Comment 362.

Comment 365: Duke Power Co. (25)

60.132(c)(2)(iv) In paragraph (a), the requirement for shaft and borehole sealing "as soon after they have served their operational purpose as is practicable" seems to be inconsistent with the retrievability requirement. With respect to paragraph (b), we would suggest that the requirement that sealed shafts and boreholes provide at least as good a barrier to radionuclide migration as does the undisturbed rock ignores the concept of a systems approach.

Staff Response to Comment 365:

See response to Comment 362.

Comment 366: U.S. Department of Energy (18)

60.132(c)(2)(iv)(b)

NRC Proposed Wording:

The sealed shafts and boreholes provide a barrier to radionuclide migration which is at least equivalent to the barrier provided by the undisturbed rock.

Recommended Revision:

The sealed penetrations such as boreholes and shafts provide a barrier such that radionuclide migration from all penetrations is sufficiently low so that

acceptable consequences are not exceeded when penetration migration potentials are added to all other repository release potentials. The margin of safety applied to determine acceptable seal performance shall be determined on a site-by-site basis.

Rationale:

The criteria should relate to repository performance, not the undisturbed rock properties. This criterion could, in the extreme, lead to rejection of rock with very low permeability because seals could not be developed to match the rock.

Staff Response to Comment 366:

See response to Comment 362.

Comment 367: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(2)(iv)(b) "The sealed shafts and boreholes provide a barrier to radionuclide migration which is at least equivalent to the barrier provided by the undisturbed rock."

Comment:

The report ONWI-55 (Office of Nuclear Waste Isolation, "Repository Sealing Design Approach - 1979") discussed the following alternative design goals for penetration seals.

1. Flow of permeant through the seal zone should be no greater than the flow through a similar area of undisturbed host material.

2. Flow of permeant through the seal zone is small compared with the total flow over the entire repository area.

3. The concentration of any radionuclide escape is within an acceptable limit.

4. The radionuclide migration rate through the seal zone is always less by a specified factor of safety than an acceptable level determined by a consequence analysis.

The proposed draft regulation is similar to the first of these alternatives except that the seal function is related to blockage of radionuclide migration as opposed to permeant flow. ONWI-55 also concludes that radionuclide flow is the appropriate measure for evaluation of seal adequacy.

Arguments against either the proposed draft criterion as well as the first two ONWI-55 design goal alternatives are:

- They are not quantitatively related to the most fundamental objective of the repository, i.e., to mitigate the consequences of the stored waste to the biosphere.

- With them it will not be possible to conclusively prove that the objective of the goal is ever met, except perhaps after long-term monitoring of the performance of the seals.

- The goal does not recognize time variations of the repository conditions and of the seal materials.

To these, one could add that the goal could result in the best host rock not being acceptable because it's very low permeability condition makes it much more difficult to satisfy sealing requirements according to the draft. In the limit, a very good repository could be disqualified even if extremely tight seals could be placed--if one could not demonstrate that the seal was exactly equivalent to the host rock in terms of radionuclide blockage.

ONWI-55 recommends that the fourth design goal (see above) be accepted as a criterion for sealing. This goal is the most flexible and workable considering:

- The goal relates to acceptable release rates, thus requiring consideration of all site-specific conditions and institutional standards.

- It is expected that sealing investigations will show that sealing can be accomplished so that potential escape rates are very low. However, it may not be possible to positively conclude that escape rates at and near to a seal positively will be equal to or less than through a very good host material. Thus, the recommended goal does not unduly penalize (and possibly eliminate) the best host rock environments by requiring extreme sealing requirements, while much reduced sealing is required for less ideal host conditions.

- The use of a factor of safety (or some other similar reducing factor) permits the acceptable release level to be reduced as appropriate to account for the total number of penetrations, other potential release paths, any uncertainties in seal behavior or future events, and potential future reductions in institutional standards.

- The use of the factor of safety concept can permit consideration of time changes in repository and seal conditions, by assigning different factors for different time considerations.

Recognizing that the concepts of penetration sealing requirements will be greatly enhanced during the next several years, it is recommended that the draft regulations at this time be revised to permit the Commission and Department to agree upon the best solution when actual seal designs are being developed. The following wording is suggested.

"The sealed penetrations such as boreholes and shafts provide a barrier such that radionuclide migration from all penetrations is sufficiently low so that acceptable consequences are not exceeded when penetration migration potentials are added to all other repository release potentials. The margin of safety

applied to determine acceptable seal performance shall be determined on a site-by-site basis."

Staff Response to C  't 367:

See response to Comment 362.

Comment 368: U.S. Geological Survey (12)

Page 31404, col. 3, par. (5). Substitute the word "build" or "construct" for "design."

Staff Response to Comment 368:

The NRC does not understand the USGS's reason for the suggested change.

Comment 369: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(2)(v) "The Department shall place emphasis on multicomponent borehole and shaft and seals and use materials that are compatible with the rock properties and other in situ conditions."

Comment:

Consideration should be given toward better qualification of the term "compatible." Compatibility incorporates a spectrum of material properties, including geochemical, thermal response, mechanical response, and must consider host conditions, under a range of physiochemical conditions. It is not necessary for the seal properties to be the same as the rock for compatibility requirements to be completely satisfied. For example, it often will be desirable for the seal material to be more ductile/flexible than the host rock so that the seal will not crack under thermally or mechanically induced movements.

Staff Response to Comment 369:

This provision has been deleted from 60.132(c)(2) in the proposed rule.

Comment 370: U.S. Department of Energy (18)

60.132(c)(2)(vi)(c)

NRC Proposed Wording:

The Department shall design the underground facility to include engineered barriers which protect the waste package from (1) natural events and

processes, (2) in situ stresses, (3) chemical attack, and (4) groundwater contact. The Department shall determine the location of the barriers by proper engineering analysis and in situ testing. The Department shall include in the design--

Recommended Revision:

Delete

Rationale:

This section calls for reduced creep deformation in the host rock and consequent reduced deformation in the waste package. This implies that reduced deformation would enhance long-term isolation which probably is not true. Highly plastic materials, such as salt, possess excellent long-term isolation capabilities precisely because they do creep at a high rate, thus closing the voids in the repository that would otherwise act as preferential pathways for the radionuclides to reach the accessible environment. Creep must be accommodated for in the design, not simply "reduced" as this section stipulates.

Staff Response to Comment 370:

In response to DOE's comment, this provision has been deleted from the proposed rule.

Comment 371: U.S. Department of Energy (18)

60.132(c)(3)

NRC Proposed Wording:

The Department shall design the underground facility to facilitate retrieval of waste in accordance with §§60.111(a)(3). To accomplish this the Department shall design the underground facility to assure structural stability of openings and minimize ground water contact with the waste packages and design an emplacement environment that otherwise promotes waste recovery without compromising the ability of the geologic repository to meet the performance objectives.

Recommended Revision:

This requirement to assure structural stability of openings appears to assume no backfill during the retrieval period. See major comment on retrievability. The regulation should state the requirement (first sentence). The Department will design to meet it and NRC should review the design for adequacy.

Staff Response to Comment 371:

The wording has been modified in the proposed rule.

Comment 372: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(3) "Design to facilitate retrieval of waste. The Department shall design the underground facility to facilitate retrieval of waste in accordance with Section 60.111(a)(3). To accomplish this, the Department shall design the underground facility to assure structural stability of openings and minimize groundwater contact with the waste packages and design an emplacement environment that otherwise promotes waste recovery without compromising the ability of the geologic repository to meet the performance objectives."

Comment:

[See comments to Section 60.111(a)(3).] It is apparent that much additional discussion and evaluation is required before the Commission can give an absolute quantitative requirement for retrievability. It may be that there are several types of retrievability; i.e., "with direct access" before backfilling which would apply for a short period; and "technically feasible but with remining" for some longer period after backfilling. However, the backfilling would be accomplished using procedures aimed primarily at the long term isolation goal. It does not make sense to jeopardize long term isolation of an entire repository simply to achieve an excessive period for "direct access" retrievability.

Staff Response to Comment 372:

See response to Comment 82. Maintaining the option to retrieve the wastes does not necessarily entail keeping the mined areas open. For example, DOE may prefer a design in which emplacement areas are backfilled and sealed but corridors and shafts are open and surface facilities are maintained.

Comment 373: U.S. Department of Energy (16)

60.132(c)(4)(i)

NRC Proposed Wording:

The Department shall design subsurface openings to assure stability throughout the construction, operation, and retrieval periods. If support systems and structures are required for stability, the Department shall design them to be compatible with long-term deformation characteristics of the rock and to allow for subsequent placement of backfill.

Recommended Revision:

Delete retrieval periods.

Rationale:

See previous comment.

Staff Response to Comment 373:

In response to the DOE's comment, "retrieval periods" has been deleted from the provisions for the "Design of Surface Openings" in 60.132(c).

Comment 374: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(4)(ii) "The Department shall design openings to minimize the potential for deleterious rock movement or fracturing of overlying or surrounding rock. The Department shall optimize opening design, including shape, size orientation, spacing and support materials with respect to natural stress conditions, deformation characteristics of the host rock under thermal loading, and the nature of weaknesses or structural discontinuities present at the location of the opening."

Comment:

See comment to Section 60.132(c)(2)(ii).

Staff Response to Comment 374:

The concept of "optimization' has been deleted from this provision in the proposed rule.

Comment 375: Westinghouse Electric Corp. (20)

60.132(c)(4)(ii) - This subparagraph indicates that the design of openings shall be "optimized". What is the meaning of "optimized"?

60.132(c)(6)(ii), (iii), and (iv) - Criteria of this type should generically address the issue. It is up to the designer to develop a satisfactory means of meeting the criteria.

Staff Response to Comment 375:

See response to Comment 374. In reference to the commenter's second point, these provisions have been deleted from the proposed rule.

Comment 376: U.S. Geological Survey (12)

Page 31405, col. 1, par. (5)(i) and col. 2, par. (5)(v). Both paragraphs deal with water-bearing rocks encountered in subsurface facilities. As written these are vague. It would be more appropriate to set limits to permissible potential inflows from aquifers. In the event of failure of the positive control device (linings, grouting, etc.), the repository might be flooded if the capacity of the water control system is exceeded. Furthermore, the potential inflow specifies the capacity of the devices that must be supplied to restrict the release of radionuclides through mine waters that must be routinely pumped or would need to be discharged to contain or recover from flooding.

Staff Response to Comment 376:

To avoid any misunderstanding, these words on control and monitoring of ground water movement from the underground facility, including shafts and boreholes, have been rewritten. It would be inappropriate to set limits for permissible potential in flows from aquifers due to the uniqueness of each hydrologic setting for any chosen site. Therefore, the technical criteria require that the design features include monitoring systems, with alarms, controlling ground-water movement, and restricting or preventing the release of radionuclide in the event of any inadvertent ground-water intrusion.

During the review process, the adequacy of the design features to control ground-water movement and release of radionuclide will be assessed along with the site characteristics which will be governing and not predetermine permissible in-flow limits.

Comment 377: U.S. Department of Energy (18)

60.132(c)(6) [sic]

NRC Proposed Wording:

Lining of Subsurface Excavations

The Department shall line subsurface excavations in areas that require:

(i) A positive control of water or gas inflow from aquifers or other porous zones;

(ii) Support for zones of weak or fractured rock;

(iii) Anchorage for equipment or hardware.

Recommended Revision:

Delete.

Rationale:

This paragraph would, presumably, eliminate alternate technologies to lining, even when alternatives may prove suitable and cost effective. In some cases, lining may be particularly undesirable. For example, adequate anchorage is possible in competent rock without lining. Further, this criterion should consider any consequences of lining or requirements for sealing. If the statement is required at all, it should simply state that: "Engineered control procedures should be used in any areas that require:..."

Staff Response to Comment 377:

In response to the DOE's comment, these provisions have been deleted.

Comment 378: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(5) Lining of subsurface excavations. "The Department shall line subsurface excavations in areas that require:

(i) A positive control of water or gas inflow from aquifers or other porous zones;

(ii) Support for zones of weak or fractured rock;

(iii) Anchorage for equipment or hardware."

Comment:

This paragraph would, presumably, eliminate alternate technologies to lining, even when alternatives may prove suitable and cost effective. In some cases, lining may be particularly undesirable. For example, adequate anchorage is possible in competent rock without lining. Further, this criteria should consider any consequences of lining on sealing requirements. If the statement is required at all, it should simply state that: "Engineered control procedures should be in any areas that require:..."

Staff Response to Comment 378:

See response to Comment 377.

Comment 379: Bechtel National, Inc. (13)

60.132(c)(6)(i) - This requirement should be deleted. The requirement implies that the definition of "important to safety" is not adequate for all components. If this is the case, the definition should be changed. Determining that certain components are important to safety by regulation in advance of design is not defensible.

60.132(c)(6)(ii) - This requirement prejudges the design and prevents the DOE from using more desirable equipment or mitigating devices should they be available. At most, the requirement should specify a no-free-fall characteristic.

60.132(c)(9)(ii) - "Geologic repository operations area" should replace the word "repository". This requirement also implies that water will be allowed to flow into or from the repository operations area. Please clarify.

Staff Response to Comment 379:

See response to Comment 377. In the proposed rule, the term "underground facility" is used instead of "repository" in this paragraph.

Comment 380: U.S. Department of Energy (18)

60.132(c)(6)

NRC Proposed Wording:

Shaft conveyances used in waste handling

(i) The Department shall consider shaft conveyances as a system important to safety.

(ii) The Department shall design hoists with mechanical geared lowering devices that preclude cage free fall.

(iii) The Department shall design hoists with a reliable cage location system that provides direct signals from all levels in the shaft. The Department shall design and construct final unload points which are controlled and verified by local position detectors.

(iv) The Department shall design shaft loading and unloading systems with a reliable system of interlocks that will fail safely upon malfunction. The Department shall include in the design two independent indicators to indicate whether waste packages are in place, grappled, and ready for transfer.

Recommended Revision:

a. Insert "Radioactive" before "waste" in the title.

b. Insert "used to transport radioactive wastes" before "as" in (i).

c. Delete "with mechanically geared lowering devices" in (ii).

Rationale:

a&b It should be clear that these requirements do not apply to the waste rock hoists.

c. Although the prevention of free fall is an important design goal, there is no reason at this time to restrict the technology method for achieving it.

Staff Response to Comment 380:

In response to DOE's suggestions, all three recommended revisions have been adopted in the proposed rule.

Comment 381: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(6)(ii) "The Department shall design hoists with mechanical geared lowering devices that preclude cage free fall."

Comment:

Although the prevention of free fall is an important design goal, there is no reason at this time to restrict the technology method for achieving it.

Staff Response to Comment 381:

See response to Comment 380.

Comment 382: U.S. Department of Energy (18)

60.132(c)(7)(ii)

NRC Proposed Wording:

The Department shall insure that the contact between lining and the rock surrounding subsurface excavations does not jeopardize repository containment by providing a preferential pathway for ground water or radionuclide migration.

Recommended Revision:

Delete all after "containment".

Rationale:

A preferential pathway may or may not jeopardize repository containment.

Staff Response to Comment 382:

The NRC staff believes that groundwater and radionuclide migration are important factors that must be considered in the disposal of HLW in geologic repositories. Therefore, the staff has not adopted DOE's recommended revision.

Comment 383: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(7)(iii) "During repository construction and operation the Department shall conduct a continued program of surveillance, testing, measurement, and geologic mapping to ensure that design parameters are verified and to provide additional data to confirm the isolation and containment characteristics of the seals and the underground facility. The Department shall measure and monitor changes in subsurface conditions on a regular basis."

Comment:

As with all underground construction activities, it must be anticipated that changed conditions will be encountered from time to time that may require that revisions be made to design parameters and construction techniques. It will be of major benefit to repository schedules and costs if the regulations include a mechanism for making the changes that will not change the overall intent of the repository without disrupting operations. Section 60.132(c)(7)(iii) appears to be an appropriate location to introduce this concept. A suggestion is to modify the wording as follows: "...that design parameters are verified or appropriate changes made to suit actual field conditions, and to provide data..."

Staff Response to Comment 383:

This requirement was recognized as being procedural in nature and covered by procedural requirements. However as a clarification sections have been proposed for a performance confirmation program (cf § 60.137 and Subpart F).

Comment 384: Tauke & Adam (21)

(7) In situ testing and verification (iii)...The Department shall measure and monitor changes in subsurface conditions on a regular basis..." How regular - daily, every 10 years???

(9) Water control during operations "...The Department shall provide water control systems...to minimize the potentially adverse effect..." minimize - once again, an imprecise measure. The tendency to use such terminology is also extensive on page 41306 under (3) Waste handling an emplacement (1) and (ii).

Staff Response to Comment 384:

This requrement was dropped. However new sections on performance confirmation

(cf § 60.137 and Subpart F) have been added.

Comment 385: Parker enclosure in U.S. Department of Energy (18)

Page 31405(8), presupposes that compaction is the best method. One might want to use material that would expand upon being wetted.

(9)(v) The requirement of using pregrouting is not compatible with mandating performance rather than technique.

Staff Response to Comment 385:

See response to Comments 386 and 387.

Comment 386: U.S. Department of Energy (18)

60.132(c)(9)

NRC Proposed Wording:

Compacted Backfill Test Section

To verify performance requirements intended in the design the Department shall establish, before any backfill placement is initiated, a program for placement, sampling, and testing of the backfill section. If the result of testing and observations made at the test section are different from the original design intent then the Department must analyze the need for changes and report the recommended changes to the Commission.

Recommended Revision:

Delete "Compacted" from the title.

Rationale:

It presupposes that compaction is the best method. One might want to use material that would expand upon being wetted. Most backfill may not be compacted.

Staff Response to Comment 386:

This requirement was deleted and the requirements on backfill have been revised (cf § 6.132(i)) to place technical criteria on the backfill and its performance would be confirmed by the requirements set forth in § 60.141(a).

Comment 387: Westinghouse Electric Corp. (20)

60.132(c)(9)(iv) - This subparagraph talks about control of water from waste emplacement areas. Is the concern that the water might be contaminated? If so, it should be stated.

60.132(c)(9)(v) - This is too specific. The concern should be specified along with a requirement that a means be provided to ameliorate the concern. It is up to the constructor to determine if pregrouting is appropriate.

Staff Response to Comment 387:

The requirements have been revised to clarify the requirements on water control.

The pregrouting requirement has been deleted from the proposed rule.

Comment 388: U.S. Department of Energy (18)

60.132(c)(9)(v)

NRC Proposed Wording:

If aquifers or water-bearing structures are encountered during construction then the Department must use pregrouting in advance of excavation.

Recommended Revision:

Delete.

Rationale:

Pregrouting in advance of excavation is only one of several engineering solutions to water inflow problems. Others include freezing and lining and temporary dewatering with short boreholes from within the excavation. In the case of repositories, pregrouting may be particularly unattractive because the grout may eventually reduce the effectiveness of backfilling and repository

sealing. This paragraph should be removed from the regulations entirely. The method for handling water is a normal design consideration.

Staff Response to Comment 388:

In response to DOE's suggestion, this provision has been deleted.

Comment 389: Pinder enclosure in U.S. Department of Energy (18)

Pg. 31405, Col. 2, Line 9b-5b: Why?

Staff Response to Comment 389:

See response to Comment 388.

Comment 390: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(c)(9)(v) "If aquifers or water bearing structures are encountered during construction then the Department must use pregrouting in advance of excavation."

Comment:

Pregrouting in advance of excavation is only one of several engineering solutions to water inflow problems. Others include freezing and lining and temporary dewatering with short boreholes from within the excavation. In the case of repositories, pregrouting may be particularly unattractive because the grout may eventually reduce the effectiveness of backfilling and repository sealing. This paragraph should be removed from the regulations entirely. The method for handling water is a normal design consideration.

Staff Response to Comment 390:

See response to Comment 388.

Comment 391: U.S. Department of Energy (18)

60.132(d)(1)(ii)

NRC Proposed Wording:

The Department shall coordinate the design of the geologic repository with site characterization activities to assure that boreholes necessary for site characterization are located as future positions of shafts or large unexcavated pillars.

Recommended Revision:

Delete.

Rationale:

Requiring boreholes for site characterization to be located at positions of future shafts or pillars is desirable but too restrictive for all cases. This restriction may cause important geologic information to be missed during investigation. For example, (1) it may be desirable to drill a boring away from the shaft area to further examine anomalous conditions in a geophysical survey or (2) inclined boreholes may provide significant geologic information but tunnels or shafts may not be constructed around these boreholes. Also a deep borehole cannot be controlled well enough to provide this assurance.

In any event, it should be made clear that this section deals only with deep boreholes that penetrate the host rock or other rocks important to isolation. It does not necessarily apply to shallow hydrologic boreholes.

Staff Response to Comment 391:

An amendment has been proposed to § 60.10 that would require site characterization to be conducted so as to limit the total number of subsurface penetrations above and around the underground facility (46 FR 35286). In addition, the amendment would require the exploratory boreholes and shafts to be located where shafts and large unexcavated pillars (boreholes) are planned.

Comment 392: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.132(d)(1)(ii) "The Department shall coordinate the design of the geologic repository with site characterization activities to assure that boreholes necessary for site characterization are located at future positions of shafts or large unexcavated pillars."

Comment:

Requiring boreholes for site characterization to be located at positions of future shafts or pillars is desirable but too restrictive for all cases. This restriction may cause important geologic information to be missed during investigation. For example, (1) it may be desirable to drill a boring away from the shaft area to further examine anomalous conditions in a geophysical survey or (2) inclined boreholes may provide significant geologic information but tunnels or shafts may not be constructed around these boreholes. This section could state the boreholes for site investigation that will be at a shaft and will require sealing should be minimized, and that they will be permitted only if the Department demonstrates their need and how the seal will be successfully placed.

In any event, it should be made clear that this section deals only with deep boreholes that penetrate the host rock or other rocks important to isolation. It does not necessarily apply to shallow hydrologic boreholes.

Staff Response to Comment 392:

See response to Comment 391.

Comment 393: B. R. McElmurry (8)

Section 60.132-D-1-iii does not seem creditable. If the mass of investigation done prior to the start of construction is not sufficient to generate the required confidence the site should be abandoned. No "pilot program" can prove what the site investigations didn't, unless it lasts hundreds of years.

Staff Response to Comment 393:

The specific requirement has been deleted. However, a new Subpart (F-Performance Confirmation) has been proposed which should clarify this point.

Comment 394: U.S. Department of Energy (18)

60.132(d)(1)(iii)

NRC Proposed Wording:

If critical host rock and other site specific design assumptions cannot be verified from boreholes, geophysical measurements, and/or an exploratory shaft and initial excavation, then the Department must establish a pilot program to further characterize the entire volume to be occupied by the underground facility and to verify critical host rock and site specific design assumptions prior to design finalization and waste emplacement.

Recommended Revision:

Clarify the timing of this pilot program.

Rationale:

We assume that this additional characterization is to be performed following the CA, concurrent with repository development.

Staff Response to Comment 394:

See response to Comment 393.

Comment 395: U.S. Department of Energy (18)

60.132(d)(3)

NRC Proposed Wording:

Excavation Techniques

The Department shall assure that methods used for excavation will neither create a preferential pathway for ground water or radioactive waste migration, nor increase the potential for migration through existing pathway. The Department shall use to the extent practicable mechanical excavators, boring machines and other nonblasting methods. If blasting is required for excavation, the Department must use methods specifically designed for each phase of the work that minimize fracturing of the surrounding rock. In this program the Department may include the use of pilot bores and tunnels and delay systems designed to minimize the amount of explosives detonated simultaneously. If blasting is utilized the Department must utilize controlled perimeter blasting such as the smooth blasting or preshearing techniques and cushion.

Recommended Revision:

Delete all after the first sentence.

Rationale:

The regulation should only state the criterion not the techniques used to meet it.

Staff Response to Comment 395:

See response to Comment 396.

Comment 396: Bechtel National, Inc. (13)

60.132(d)(3) thru (5) - The portions of these paragraphs that dictate techniques instead of specifying objectives and standards should be deleted. During the licensing review, the NRC can review the techniques or methods developed to meet the standards imposed.

Staff Response to Comment 396:

These provisions have been deleted in the proposed rule.

Comment 397: U.S. Geological Survey (12)

Page 31406, col. 1, part (e). The quality assurance records demanded by section 60.171 are not integrated with this section. Must all the records demanded by section 60.132(e) meet QA standards?

Staff Response to Comment 397:

A new Subpart G - Quality Assurance, requires a quality assurance program based upon criteria set forth in Appendix B to 10 CFR Part 50. All activities important to safety must meet Q.A. standards.

Comment 398: U.S. Department of Energy (18)

10 CFR 60.132(e)(3) Retention of Cores and Logs

NRC Proposed Wording:

The Department shall retain on site, until decommissioning, all cores from all exploratory borings drilled during site selection, site characterization, construction, and operation. The Department shall store the cores in durable boxes housed in weather-proof building. The Department shall arrange the cores to be readily available for inspection. The Department shall store in the same area logs of the borings, including geophysical logs.

Recommended Revision:

Change first sentence to: The Department shall retain until decommissioning, the representative cores from exploratory borings drilled at the site during site characterization, construction, and operation.

Rationale:

The requirement, as written, is unrealistic. During the course of the national site characterization and selection program, tens of miles of cores will be generated from all over the United States. There is no obvious utility in storing a core from a salt dome in Mississippi at a basalt repository in Washington, or vice versa. If a regional repository program were to be initiated, it would be impossible to store all cores at all repositories. In addition, it is common, and necessary, to send portions of cores to laboratories for testing. Such testing may be destructive and therefore that portion of the core cannot be stored in accordance with the requirement. The staff should review this paragraph to determine what is really required.

Staff Response to Comment 398:

This requirement has been revised to reflect comments. See § 60.134(d) of proposed rule.

Comment 399: Bechtel National, Inc. (13)

60.132(f)(3)(i) and (ii) - Change the concept of this requirement to one of reducing hazards and potential for errors to acceptable levels. The Department cannot demonstrate that requirements for optimization, minimization etc., have been achieved for these items.

Staff Response to Comment 399:

The proposed rule reflects this and similar comments.

Comment 400: B. R. McElmurry (8)

Comparative evaluations of alternative waste forms for every repository, as called for in 60.133-a-1, are not justified. DOE should either specify allowable waste forms, or set specifications. In fact this appears to have done in (b), so (a) is entirely without merit.

Staff Response to Comment 400:

This requirement has been deleted from the proposed rule. However, an amendment has been proposed to § 60.21(c)(3) to require a compative evaluation of the alternatives to the major design features. This would encompass the design of the waste package.

Comment 401: U.S. Department of Energy (18)

60.133(a)

NRC Proposed Wording:

General Requirements. The Department shall insure...

Recommended Revision:

General Requirements. The requirements of this section are applicable only to HEW. The Department shall insure...

60.133(a)(2)

NRC Proposed Wording:

Provide reasonable assurance that the in situ chemical, physical, and/or nuclear properties of the waste package and/or its interactions with the emplacement environment will not compromise the function of the waste packages. Supporting analyses shall include, but not be limited to, evaluation of the following factors solubility, chemical reactions, corrosion, gas

generation, thermal effects, mechanical strength, mechanical stresses, radiolysis, radiation damage, nuclide retardation, leaching, fire and explosion hazards, thermal loads, and synergistic interactions.

Recommended Revision:

Change "synergistic" to "adverse".

Rationale:

Synergistic interactions may not always be unfavorable.

Staff Response to Comment 401:

The requirements of 10 CFR Part 60 are applicable to TRU or any other wastes at an HLW geologic repository to the extent that their presence could compromise the integrity of the repository, or they are subject to the EPA HLW standard, or both. As for the second comment, the staff believes that it is important to examine possible combined effects, advese or favorable, in developing the design of a waste package.

Comment 402: Bechtel National, Inc. (13)

60.133(a)(1) - Revise this requirement merely to give acceptable standards. Optima cannot be demonstrated.

60.133(a)(5) - Revise this requirement. Delete the specification for waste package tests to verify performance objectives. This is not possible. Waste package life can be verified only by an analysis based on test data that indicate performance requirements are likely to be met. Delete the reference to 60.133(a)(2). It is not necessary to test waste packages to insure that site functions are not compromised.

Staff Response to Comment 402:

In response to public comment, the requirement to "optimize" the waste package performance has been deleted.

Comment 403: Westinghouse Electric Corp. (20)

60.133(a)(1) - The comments on 60.132(c)(2)(i) and 60.132(c)(4)(ii) also apply here with regard to "comparative evaluation" and "optimization".

During the design process, it can be expected that a number of designs will be developed and evaluated. However, this is an evolutionary process aimed at achieving a balanced design to accommodate all the applicable functional requirements and performance objectives, some of which might be conflicting (for example, the desire to design a package to contain radionuclides for as long as possible is contradictory with the requirement for retrieval; that is, the package cannot be designed with such high integrity that it cannot be taken apart again). Making design comparisons solely for the purpose of comparison is not productive.

Staff Response to Comment 403:

See response to Comments 399, 400 and 402.

Comment 404: Westinghouse Electric Corp. (20)

60.133(a)(5) - Testing to show compliance with 60.133(a)(1) has no meaning. Testing should be directed toward supporting the basis for concluding that the performance objectives of 60.111 will be met.

Staff Response to Comment 404:

See response to Comment 402.

Comment 405: Lazlo Toth (17)

60.133 Waste Form

The best solution to the waste form problem is to use the good old American system of GELT (Good Engineering Long Term). GELT can make us a lot of money. We ought to package the waste in clear lucite blocks and gift box them. We can sell it in all our Department stores. If you get on the ball Mr. Secretary you can get it into the stores by Christmas.

Staff Response to Comment 405:

See response to Comment 338.

Comment 406: U.S. Department of Energy (18)

60.133(b)(3) Free Liquids

NRC Proposed Wording:

The waste package must contain no free liquids.

Recommended Revision:

Change "must not contain free liquids in amounts that could 1) impair the structural integrity of waste package components due to chemical interactions or formation of pressurized vapor, or 2) result in spillage and the spread of contamination in the event of package perforation.

Rationale:

In the case of spent fuel, it is not apparent how the presence of free liquids could be detected, how they could be removed, or what harm they could cause. In any case, an indication of what must be protected against should be provided.

Staff Response to Comment 406:

In response to DOE's comment, NRC has adopted the recommended revision.

Comment 407: U.S. Geological Survey (12)

Page 31407, col. 2, par. (5). This paragraph prohibits the presence of chemically toxic wastes, which is what many radioactive wastes are. The wording about the chemical toxicity of these wastes should be deleted or modified.

Staff Response to Comment 407:

This provision has been deleted in response to the USGS's comment.

Comment 408: U.S. Department of Energy (18)

60.133(c)(1)

NRC Proposed Wording:

Physical Dimensions and Weight. Each container has been designed and fabricated to permit safe handling at the repository during operations and if necessary, during retrieval prior to repository decommissioning.

Recommended Revision:

Change "has been" to "shall be".

Rationale:

Editorial.

Staff Response to Comment 408:

In response to DOE's comment the wording has been revised.

Comment 409: Arvin S. Quist (6)

Subpart 60.133 Waste package and emplacement environment

Suggested wording in (c)(3) is: "...exposure to operational personnel will be as low as reasonably achievable and in any event not exceed the values in Part 20 of this Chapter;..." (underlined words added)

Staff Response to Comment 409:

Part 20 requires exposures to be ALARA. Accordingly, no change is required.

Comment 410: Westinghouse Electric Corp. (20)

Paragraph 60.133(c)(3) - Surface contamination limits should not be referenced to an exposure criteria but rather should relate to the waste package content such as the DOT regulations do.

Staff Response to Comment 410:

The staff agrees with the commentor. Accordingly, the request has been deleted. The requirement in the proposed rule which addresses occupational exposure is adequate to deal with surface contamination of packages onsite, while other regulations deal with exposures from packages in transit to the repository.

Comment 411: Bechtel National, Inc. (13)

60.135 - Revise this requirement to say that the EPA standards covering release shall be met. Whether packages are intact and whether all material is recovered is immaterial. And it is impossible to predict and guarantee compliance. For example, there may be a very small fraction of waste packages that are not intact even at the time they are emplaced.

Staff Response to Comment 411:

The requirement has been modified to state that the waste package must assure containment of the wastes during retrieval. The staff acknowledges that "intact" did not convey exactly what was being sought.

Comment 412: Ellison enclosure in U.S. Department of Energy (18)

Subject of Comment:

60.135 "The Department shall design and construct the geologic repository operations area to permit retrieval of all waste packages, mechanically intact, if retrieval operations begin within 50 years after all of the waste has been emplaced and if the geologic repository has not been decommissioned. The design of the geologic repository operations area shall provide for retrievability of the waste within a period of time that is about the same as that in which it was emplaced."

Comment:

It is again noted that the retrieval/decommissioning situation in the draft regulations is confusing and probably not appropriate. [See comments to Sections 60.111(a)(3) and 60.132(c)(3).]

Staff Response to Comment 412:

See responses to Comments 82, 347 and 372.

Comment 413: Westinghouse Electric Corp. (20)

60.135 - The comment to 60.111(a)(3) also applies here with regard to the time period in which the waste must be retrieved.

Staff Response to Comment 413:

See responses to Comments 82 and 372.

Comment 414: Tauke & Adam (21)

60.135 Retrieval of waste "...The design of the geologic repository operations area shall provide for retrievability of the waste within a period of time that is about the same as that in which it was emplaced." ---Vague and non-specific.

Staff Response to Comment 414:

See response to Comment 82.

Comment 415: Lowenstein, Newman, Reis, Axelrad & Toll (28)

The draft criteria impose unduly lengthy retrievability requirements which would have significant undesirable impacts on repository design, construction and operation and could have adverse impacts on site selection, notwithstanding that such requirements would provide highly questionable benefits.

Staff Response to Comment 415:

See response to Comment 82.

Comment 416: Bechtel National, Inc. (13)

60.137(a) and (c) - Define the terms, "site" and "engineered elements of the geologic repository".

60.137 - Delete the requirement to monitor through the period of institutional controls. This monitoring cannot verify in the short term that EPA standards will be met through millions of years. And in the short term of say, 1000 years, there is no undetected way enough nuclear material can be transported and released to exceed EPA standards. Monitoring prior to decommissioning should be sufficient.

Staff Response to Comment 416:

Definitions of the terms "site" and "engineered system" have been included in the proposed rule. The proposed rule has been revised to require that the waste package monitoring program continue as long as practical up to the time of permanent closure (60.143d).

Comment 417: U.S. Department of Energy (18)

60.137 MONITORING PROGRAMS

NRC Proposed Wording:

The Department shall initiate a system of monitors during site characterization. The Department shall maintain and supplement these monitors, as appropriate, throughout the period of institutional control. The Department shall design the monitoring systems to verify that the performance objectives of Section 60.111 are being achieved.

Recommended Revision:

Change "throughout the period of institutional control" to "until repository closure".

Rationale:

Most of the monitoring performed during repository operation is not appropriate after closure (e.g., 60.132(c)(2)(vii)(b)). Post closure monitoring is a different subject altogether and should be treated separately from preclosure monitoring. Perhaps it is too early to develop a regulatory requirement for post closure monitoring.

Staff Response to Comment 417:

See response to Comment 416.

Comment 418: U.S. Department of Energy (18)

60.137(b)

NRC Proposed Wording:

They provide baseline information on those parameters and natural processes pertaining to the safety of a candidate site that may be caused by site characterization activities.

Recommended Revision:

Clarify

Rationale:

The meaning of this item is not clear. Is it the intent to measure base line information on parameters and processes which may be disturbed by characterization activities?

Since NRC is requiring multiple sites be characterized, these monitoring requirements are excessive. At best, monitoring of key parameters should continue on a selected for the repository and not on all "banked" sites.

Staff Response to Comment 418:

In response to DOE's suggestion, the provision in question hs been modified

for the sake of clarity.

Comment 419: Ross enclosure in U.S. Department of Energy (18)

60.171 Quality Assurance Program

The need for a quality assurance program to maintain quality control for studies and data gathering associated with siting a geologic repository is recognized. Nevertheless many geological, geophysical, geochemical and hydrologic studies are not readily amenable to tightly specified field procedures, measurement procedures, etc. The nature of geoscience exploration activities is that step 3 depends upon the results of steps 1 and 2, upon terrain and earth conditions, etc. The implementation of a quality control program for these activities implies substantial increases in cost, perhaps less data for the same budgeted expenditures, and increased delays in receiving data and survey results. Thus I urge recognition of the unique aspects of geoscience exploration in the detailed statement of the quality assurance program, and I

encourage the use of reasoned judgement and flexibility instead of rigid specifications normally associated with quality assurance programs.

Staff Response to Comment 419:

Subpart G - "Quality Assurance" has been revised in the proposed rule.

# APPENDIX A

Advance Notice of Proposed Rulemaking - 10 CFR Part 60 and Draft Technical Criteria -- "Technical Criteria for Regulating Geological Disposal High-Level Radioactive Waste," (45 FR 31393)

authority may be used under circumstances such as the following:

(1) An employee or an agency presents material facts not previously considered by the regional office involved.

(2) There is room for reasonable doubt as to the appropriateness of a regional office decision, or

(3) The potential impact of a regional office decision on similar jobs under other regional offices is sufficiently significant to make central office review of the decision desirable.

(h) The Director of the Office of Personnel Management, may, in his discretion, reopen and reconsider any previous decision when the party requesting reopening submits written argument or evidence which tends to establish that:

(1) New and material evidence is available that was not readily available when the previous decision was issued;

(2) The previous decision involves an erroneous interpretation of law or regulation or a misapplication of established policy; or

(3) The previous decision is of a precedential nature involving a new or unreviewed policy consideration that may have effects beyond the actual case at hand, or is otherwise of such an exceptional nature as to merit the personal attention of the Director of the Office of Personnel Management.

(i) A final decision by the Office of Personnel Management constitutes a certificate which is mandatory and binding on all administrative, certifying, payroll, disbursing and accounting officials of the Government.

[FR Doc. 80-14047 Filed 5-12-80; 8:45 am]

BILLING CODE 6325-01-M

## DEPARTMENT OF AGRICULTURE

### Agricultural Stabilization and Conservation Service

### 7 CFR Part 780

### Beekeeper Indemnity Payment Program (1978-81)

**AGENCY:** Agricultural Stabilization and Conservation Service, USDA.

**ACTION:** Lengthen comment period on proposed rule

**SUMMARY:** On April 11, 1980, a notice was published in the Federal Register (45 FR 24899) that the Agricultural Stabilization and Conservation Service proposed to amend its regulations relating to the Beekeeper Indemnity Payment Program by terminating the program on May 15, 1980. This action was taken because of a lack of funds for a program which has been determined to be of low priority. The new proposed date for termination of the program is July 1, 1980. The comment period is being lengthened to allow interested parties time to familiarize themselves with the information, determine the impact and prepare their responses. This notice invites further comments on the proposed termination.

**DATE:** Comments must be received on or before June 12, 1980.

**ADDRESS:** Send comments to Director, Emergency and Indemnity Programs Division, ASCS, USDA, P.O. Box 2415, Room 4095 South Building, Washington, D.C. 20013.

**FOR FURTHER INFORMATION CONTACT:** Robert Cook, Emergency and Indemnity Programs Division, ASCS, USDA, P.O. Box 2415, Room 4095 South Building, Washington, D.C. 20013, (202) 447-7997.

**SUPPLEMENTARY INFORMATION:** The Food and Agriculture Act of 1977, 91 Stat. 921, 7 U.S.C. 284, extended the authority of the Secretary to conduct the Beekeeper Indemnity Payment Program through September 30, 1981. On July 14, 1978, the Department published Final regulations (43 FR 30226) to govern the conduct of the program through September 30, 1981. It is not mandatory that the program be conducted.

The proposed 1980 budget for the Department of Agriculture contained no funding for the Beekeeper Indemnity Payment Program. On June 15, 1979, the Beekeeper Indemnity Payment Program Regulations were amended to provide that payment of claims filed after that date would be conditioned upon the availability of funds. Claims for 1978 losses, approved for approximately $2.10 million, were unpaid because of the lack of funds. The Agriculture Appropriations Act for Fiscal Year 1980 authorized $2.80 million for the beekeeper indemnity program.

The public is invited to submit written comments regarding the proposed termination, to the Director, Emergency and Indemnity Programs Division, ASCS, USDA, P.O. Box 2415, Room 4095 South Building, Washington, D.C. 20013. Persons submitting comments should include their names and address and give reasons for the comments. Copies of all written comments received will be available for review by interested persons in Room 4095 South Building, USDA, during regular business hours.

Accordingly, the comment period is lengthened and public comments must be received by June 12, 1980, in order to be assured of consideration.

### Proposed Rule

The Department proposes to amend 7 CFR Part 780, by revising the title of the Subpart—Beekeeper Indemnity Payment Program (1978-1981)—and § 780.101(b) to read as follows:

**Subpart—Beekeeper Indemnity Payment Program (1978-80)**

* * * * *

**§ 780.101 Definitions.**

* * * * *

(b) "Application period" means any period with respect to which application for payment is made beginning not earlier than January 1, 1978, and ending not later than July 1, 1980.

This regulation has been determined significant under the USDA criteria implementing Executive Order 12044 "Improving Government Regulations." An approved impact analysis on the proposal to terminate the program is available from the Emergency and Indemnity Programs Division.

Signed at Washington, D.C., on May 7, 1980.

Ray Fitzgerald,

*Administrator, Agricultural Stabilization and Conservation Service.*

[FR Doc. 80-14048 Filed 5-12-80; 8:45 am]

BILLING CODE 3410-05-M

## NUCLEAR REGULATORY COMMISSION

### 10 CFR Part 60

### Technical Criteria for Regulating Geologic Disposal High-Level Radioactive Waste

**AGENCY:** Nuclear Regulatory Commission.

**ACTION:** Advance Notice of Proposed Rulemaking.

**SUMMARY:** In the December 6, 1979 edition of the Federal Register (44 FR 70408), the Commission published its proposed licensing procedures for the disposal of high-level radioactive wastes (HLW) in geologic repositories. This advance notice is the next stage in the HLW rulemaking process. This notice informs the public and interested parties concerning the status of efforts related to the development of technical criteria to become part of 10 CFR Part 60. It invites public comment on issues related to such development; on the approach being considered, including partitioning of the problem into workable elements and statements of underlying principles and technical considerations. Attached to this notice are draft technical criteria. These criteria are a result of the efforts

of the staff to accommodate and include the best thinking which has been made available to the staff from technical experts in the form of technical points, suggestions and criticisms on previous drafts of technical criteria. However, these criteria do not necessarily represent staff positions with respect to rulemaking on this subject.

**DATE:** Comments must be received by July 14, 1980.

**ADDRESS:** Written comments or suggestions on the advance notice should be sent to the Secretary of the Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch. Copies of comments may be examined in the U.S. Nuclear Regulatory Commission Public Document Room, 1717 H Street, NW., Washington, D.C. 20555.

**FOR FURTHER INFORMATION CONTACT:** I. Craig Roberts, Assistant Director for Siting Standards, Office of Standards Development, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Telephone 301-443-5965.

**SUPPLEMENTARY INFORMATION:**

## Background

On December 6, 1979, the Nuclear Regulatory Commission published for comment in the Federal Register, proposed regulations for licensing geologic repositories for disposal of HLW (44 FR 70408). The proposed regulations contained only the procedural requirements for licensing: Subparts A, B, C, D, concerning general provisions, licenses, participation by State governments, and records, reports, tests and inspections, respectively. The technical criteria against which a license application will be reviewed were and are still under development. However, the technical and scientific understanding concerning the scope of the technical criteria were regarded as sufficiently developed to enable an appropriate licensing procedure to be established for their implementation. Thus, the Commission was able to propose a procedural rule to establish the necessary regulatory framework for licensing.

Since then the staff of the Commission has made further progress in focusing more sharply on the technical and scientific issues and problems related to licensing geologic disposal of HLW, in partitioning the problem so as to facilitate the development of practicable technical criteria, in articulating principles which might reasonably underlie the technical criteria; and in considering these principles in the identification of approaches to specifying the technical criteria. The Commission seeks comment from all interested parties in order to provide the Commission and its staff the opportunity to obtain public assessment of the general direction being taken in the development of the technical criteria.

The formative work on the technical criteria has been conducted in as public a manner as possible. Numerous drafts of the technical criteria have been developed, and widely circulated to interested agencies, groups, and individuals to obtain input. These drafts, prepared by the licensing staff, have formed the basis for this interaction with outside groups. They started with a fairly diffuse set of principles and ideas and have evolved with an increasing concreteness through 14 staff drafts. Technical reviews of early drafts of the criteria have been conducted by the Keystone Radioactive Waste Review Group and at a workshop held at the University of Arizona. The results of these reviews have been placed in the NRC public document room. Other Federal agencies and groups which have been involved in the review of one or more of the drafts include DOE, EPA, USGS, NRDC, Atomic Industrial Forum, Bureau of Mines, and a host of individual Scientists, engineers, and public interest groups.

The technical criteria include specific numerical criteria in certain areas in order to further stimulate the thoughts and commentary of the public. The staff is preparing a document explaining the basis and rationale for these technical criteria. It is anticipated that this document will be available as a NUREG report at the time that the technical criteria are published in the form of a proposed rule. A working draft of the bases and rationale document has been placed in the NRC Public Document Room for inspection.

## Nature of the Problem

To best comprehend regulation of geologic disposal of HLW it is useful to note that such disposal of HLW is separable into five distinct problem areas: lifetime of the repository, physical extent, waste/rock interaction, treatment of uncertainties, and the problem of human intrusion. In turn, each of these areas can be further separated into fairly distinct regimes over which certain aspects or characteristics of the problem area dominate. Each of these regimes then can be treated more-or-less individually, not as specific criteria, but as functional elements addressed by the criteria. What is described below is essentially a matrix for the technical criteria cutting across the five areas above.

### *1. Lifetime of the Repository*

The operational life of a geologic repository for the disposal of HLW quite naturally divides into three periods—the period of construction and emplacement of the wastes; the period during which the shortlived fission products dominate the hazard posed by the wastes, and the long term during which the hazard is dominated by the very long-lived isotopes including the actinides. The technical criteria must reflect the different physical conditions of the repository during these periods and be responsive to the specific nature of the hazard posed by the wastes.

During site selection, the ongoing program is one of probing and testing to find an appropriate site for a repository and develop a compatible design. Construction has not yet begun, and no radiologic hazard is posed. Nonetheless, technical criteria are needed (1) to indicate site features which clearly render a site suitable or unsuitable (site suitability criteria), and (2) to allow a judgment as to whether a proposed site can accommodate an effective repository design and together provide the protection sought (site acceptability criteria). The nature of the criteria is changed to fit the particular needs of the periods as explained below.

Construction and emplacement of wastes is the next period which the criteria must address. During this period the immediate radiologic hazard is to those who are working at the repository and to a much lesser extent those who reside nearby. (There are also the hazards of construction to workers. Criteria which address these hazards would be expected to follow the regulations of the Mine Safety and Health Administration.) In addition, there is the actual design and construction of the repository to be considered for the long term. But the more proximate problem during this phase is that the construction and emplacement methods used will not compromise the ability of the repository to protect future populations. Thus, the technical criteria directed at this period deal with construction techniques, emplacement techniques, operations procedures, and designs for radiological protection of workers and persons living nearby (accidents).

The third period begins following closure of the repository, and will persist for the time that the relatively short-lived fission products dominate the hazard. During this time there will be a substantial heat output from the wastes which if not properly accommodated by site selection and engineering could compromise the

integrity of the repository. In addition, the chemical species and makeup of the emplaced wastes are rapidly changing due to radioactive decay. Criteria applicable to this period will focus on selecting sites and generating designs to accommodate these two major features.

By the time the short-lived fission products no longer dominate the hazard, the wastes are no longer generating significant amounts of heat. Moreover, the short-lived elements have for the most part decayed away and the chemical properties of the waste have greatly stabilized—generally dominated by the actinides. However, for this final period it would be imprudent to rely on engineering to contain the emplaced wastes, and final protection is achieved by the ability of the geologic setting to inhibit migration of the wastes leached from the waste form in a controlled manner. Properties which affect leaching of the waste and which affect transport of the wastes such as fractures, porosity, sorption, hydraulic gradient, and thermal gradient, and determination of the long-term stability of the geologic setting will dominate the criteria addressed to this period.

*2. Physical Extent*

A repository also can be divided physically into two broad categories—surface and subsurface. The subsurface can be further divided into the area affected by excavation and emplacement of waste and the broad geologic environment into which the repository is set.

The surface portion is comprised of the surface facilities and operations areas needed to support construction and emplacement of wastes. Generally, the criteria which apply here are those which address the construction and emplacement period.

The criteria which pertain to the broad geologic environment address those geologic and hydrologic features which if too close to the excavated area can produce effects on the integrity of the repository that are not readily understood, and, therefore, lead to doubt that the waste can be safely disposed at the repository. The thrust of these criteria would be to assure that such features are far enough away so that they either present no problem, or the prolem they do present can be made tractable.

The last division in the subsurface is the area affected by excavation and emplacement of wastes. It is here that the wastes are emplaced and that the engineering is expected to be used during the first period following closure. It is also here that the construction and emplacement activities must be carried out in a manner which assures that the integrity of the repository is maintained. Hence criteria applicable to the excavated area address siting, design, operations and the first two periods of concern.

*3. Waste/Rock Interaction*

The chemical and thermal properties of the wastes undoubtedly will have a significant interaction with the rock unit into which they are emplaced. To assure that the repository will function as planned, siting, designing, emplacement methods, engineering and waste form criteria will be needed to understand, control, and assess the effect of the waste upon its surroundings. These criteria are the complement to the excavated area criteria above. Those criteria are to protect the emplaced wastes from their surroundings; whereas these protect the repository from the effects of waste themselves.

*4. Treatment of Uncertainties*

If there is to be confidence that wastes disposed in a geologic repository will not pose a significant hazard to the health and safety of future populations, then two factors which pose fundamental difficulties must be addressed satisfactorily. First, geologic disposal is an entirely new enterprise—no experience exists with geologic disposal. Second, there will be no opportunity to observe behavior over the long term—the decisions to close the repository in effect will be a statement of its expected behavior based upon inference, deduction, and extrapolation from results of tests and experiments carried out for a comparatively short period and upon predictions of future geologic, hydrologic, and climatologic conditions based upon observations of the past. These facts impose very definite constraints as to how confidence is achieved that the expectation of behavior will match actual behavior over the long term. These constraints fairly clearly define the items of uncertainty which arise because qualitative descriptions and models necessarily approximate nature rather than exactly describe or predict nature; uncertainties which arise because the data used as input to those descriptions and models upon which our understanding of the natural processes in question are based, are the result of tests and measurements which themselves have degrees of uncertainty. Finally, there are uncertainties which arise simply because of the large number of geologic and hydrologic elements which must be identified, measured, and combined to determine the expected behavior of a repository—in fact, the very process of combining those elements compounds the uncertainties associated with them. Thus, criteria are needed to assure that those uncertainties are identified, understood, and compensated. Avoiding potentially adverse features is one way of compensating for uncertainties. Placing constraints on design and performance of components is another. Siting criteria which tend to lead toward relatively geologically simple sites are a third. Finally, developing criteria which address individually the separable aspects (temporal and spatial) of geologic disposal is perhaps the surest means of dealing with uncertainties.

*5. Human Intrusions*

To this point the discussion has focused upon the processes of nature—how the repository can be expected to behave over the long term. However, the problem of human intrusions, intentional or inadvertent moots much of the previous discussions since there is no way to reasonably limit the variety of conceivable human activities which might compromise a forgotten repository. The only logical recourse, since engineering against human intrusion is impossible practically,[1] is to avoid targets, i.e., sites which may invite such intrusion. Mineral resources, water resources, interesting geologic or hydrologic features are sure to attract the developer or the explorer. Shallow repositories would more easily be intruded upon than deep ones. Therefore, what is needed are site suitability criteria which would lead toward uninteresting sites of little resource value, and design criteria which would yield designs that present minimal "targets."

**Underlying Principles**

The efforts of the Commission staff to develop the technical criteria have been guided by the following principles:

(1) Under Reorganization Plan Number 3 of 1970, the Environmental Protection Agency (EPA) was given the authority under the Atomic Energy Act of 1954 as amended to set the generally applicable standards for radiation in the environment. Such standards represent a broad social consensus concerning the amount of radioactive materials and levels of radioactivity in the general environment that are compatible with

[1] Actually containing the wastes within a canister for the period that the relatively short-lived fission products dominate the hazard does tend to lessen the impact of drilling into the repository by localizing the waste (i.e., keeping the "target" small) and leaving a smaller quantity available for dispersion during that period should drilling penetrate a waste container.

protection of the health and safety of the public. This EPA authority extends to the setting of the standard and not to the implementation of such standards or to the establishing of requirements concerning how they are to be met. The Commission is bound to implement these standards in its regulations, thus assuring that they will be met by activities authorized by the Commission's licensing decisions. The Commission may not substitute its judgment for that of the EPA, but the Commission may, and must, determine whether particular proposed disposal activities will conform to the EPA standard.

The EPA has published its generally applicable environmental standard for all of the fuel cycle except waste storage and disposal, 40 CFR 190, which expresses the limit in the form of a quantitative dose limit to the individual. The EPA is in the process of developing its HLW standard. The Commission expects this standard (40 CFR 191), to be similar in approach to that followed in 40 CFR 190.

(2) As noted above, although the Commission is bound to implement the EPA HLW standard, it has the authority and discretion to determine how that standard will be achieved. In particular, the Commission must decide how it will develop its regulatory requirements, viz., the technical criteria of 10 CFR Part 60, and carry out its decision process to show that in each particular licensing case, the EPA standard will be met.

(3) In order to establish the technical criteria for meeting the EPA standard and to make individual licensing decisions as to whether such criteria are met, the Commission needs to carry out conservative analyses because of the many uncertainties associated with HLW waste disposal in geologic repositories. These uncertainties arise from the inability, given the present and expected state of science and technology, to determine precisely the degree to which wastes, under credible conditions for the time periods involved, will be contained and isolated. Further, in order to carry out such analyses the Commission may require measures which may not directly enter into the analyses, but will add to confidence in those analyses, thus adding to the Commission's confidence in the degree to which the EPA standard can be or has been met. Such measures are likely to be aimed at simplifying the problem: such as requiring that precepts of simplicity and stability of the geologic settings govern the site selection process in order to reduce the overall uncertainty and thus render more tractable the problem of demonstrating that the criteria and the EPA standard are met.

(4) Because the scientific and technical problems associated with HLW waste disposal are sufficiently understood, it is possible, even in the absence of an EPA standard, to identify relevant areas of regulation. These are the areas which contribute to: protection of the public health and safety or the environment; the reduction of uncertainty; or the confidence in any decision as to whether the EPA standard and NRC regulations are met.

(5) The natural divisions of the problem in time and space and the separation of the problem of human intrusion from natural events aid in understanding which areas should be regulated, facilitate the analyses which will serve as the decision-bases, and so will increase confidence in regulating and licensing decisions.

(6) The analyses and requirements must reflect a degree of examination and control which corresponds to the importance to safety of any given technical area. Thus, the technical criteria must address not only questions of site suitability, but—to the extent possible—address questions of site/facility acceptability.

## Considerations

In the course of developing technical criteria a number of considerations have arisen. The Commission believes that the program to develop the technical criteria for HLW disposal in geologic repositories would benefit from comment on them:

(1) *Systems approach.* The term "systems approach" relates to the set of natural and engineered barriers which would function to contain and isolate the waste from the biosphere for the periods of time required, to increase the degree of the Commission's confidence that indeed such containment and isolation would be achieved, or to permit appropriate and conservative analyses to be performed which would form the decision bases.

It is evident that for a geologic repository, the geologic setting must be one barrier. In considering whether there should be other barriers, a key question which needs to be answered is whether it is prudent, in view of the nature of the problems and the uncertainties involved, to rely on the geologic setting alone to accomplish the functions stated above. The state-of-the-art in the earth sciences is such that all of the uncertainties associated with these functions cannot be resolved through consideration of the geologic setting.

It is appropriate, therefore, to consider how engineering—in the broadest sense of anything used to effect a purpose—might be used to compensate for, reduce, or eliminate at least some of the uncertainties inherent in reliance on the geologic setting alone. Engineering can be used to narrow the extent of geologic processes which need to be considered in the rulemaking and licensing processes; that is, engineering can be used to bound and/or diminish the importance of certain geologic processes. Engineering also can be used to make the containment of emplaced waste as insensitive as possible to potential changes in the geologic environment. For example, the use of buffering materials to retain radionuclides is one possible way to compensate for uncertainties in the sorption capabilities of a particular medium and site.

In light of these considerations, therefore, the Commission staff believes that it is reasonable to couple a prudently and cautiously selected geologic setting (natural barrier) with a set of engineered barriers capable of performing or assisting the performance of the functions stated above. Further, the Commission staff believes that sites which are relatively easily understood and can be expected to be stable for long times, are the most desirable; and that engineered systems which are compatible with and make the least adverse impacts upon the geologic and hydrologic characteristics of the site will contribute most to the performance of the overall disposal system. Similarly, to the greatest extent possible, the performance of engineered systems should be insensitive to changes in those characteristics and should provide a high degree of protection by themselves.

Given the nature of the problems, as discussed earlier, the Commission staff has identified the following as composing the set of three primary barriers of the waste disposal system: the geologic setting; the design and configuration of the repository, including the waste emplacement scheme and engineered barriers; and the waste package.

(2) *Use of Minimum Performance Standards for Major Regulatory Elements.* Determining the expected evolution of a geologic repository in time is the key to understanding the consequences of emplacing wastes in a repository. Such expectation of the effects of perturbations and changes, both natural and man-caused to the the hydrologic environment, serves to identify the kinds of events, including

institutional failures, which might cause a radioactive release to the biosphere. Assessment of such events that reasonably can be assumed to occur and their likely consequences permits the identification of the "credible" events which should be considered in the design of the repository and evaluated in rulemaking and licensing decisions. Identification of these "credible" events permits development of performance requirements for both the natural and engineered barriers to assure that such events are avoided where possible for their consequences mitigated when these performance requirements are met. Such describes the deterministic approach the Commission staff has been taking in development of the performance requirements for HLW disposal in geologic repositories, and defense-in-depth approach to provide assurance and confidence that the EPA standard can be met.

(3) *The Nature of the Major Regulatory Elements.* The regulatory elements selected should be either important to safety, that is, contain and isolate the waste from the biosphere for the periods of time required, or contribute to confidence in the functioning of the repository system or individual components. As discussed above, the repository is conceived as a system of multiple barriers, both natural and engineered. The two most important attributes of the natural barrier are that the site should be geologically simple and stable so that the site can be easily understood and so that there can be confidence that the ability of the site to contain and isolate the wastes will remain viable for long times.

The three most important attributes of the engineered barriers must be their compatibility with the geologic and hydrologic characteristics of the site so that the engineered barriers will have the least adverse impact on the site's ability to retain the emplaced wastes; their insensitivity to any changes in the site characteristics so that there can be confidence in the predictability of their performance over time; and their ability to complement the performance of the site so as to increase confidence in overall repository performance to supplement the performance of the site—where possible—to increase the overall margin of safety.

(4) *Adequacy of Favorable and Unfavorable Site Characteristics to Choose Proper Technical Restrictions.* Consideration of site characteristics is important to the development of technical requirements for HLW disposal from several aspects. The first relates to question of site suitability, that is, to the potential of a site to serve as the location for a repository. Unfavorable site characteristics are identified to eliminate from consideration sites which would not be acceptable under any circumstances for a HLW geologic repository or which would present insuperable difficulties in terms of understanding the geology and hydrology of the site or would introduce or compound uncertainties which would affect negatively confidence in any licensing decisions. Favorable site characteristics are identified where the likelihood of a site/facility combination (repository) being acceptable is greater or which would contribute to increased understanding of the geology and hydrology, permit uncertainties to be better handled, and increase confidence in any licensing decisions. However, neither kind of site suitability characteristics say anything about the ultimate acceptability of the repository system as a means to safely contain and isolate the wastes for the time required with the degree of confidence necessary to a licensing decision. Criteria by which the acceptability of the site/facility combination can be assessed are needed for this determination.

Specifically, this second aspect relates to questions of whether or not, given the present state-of-the-art in the earth sciences, it is possible to identify on a generic basis site characteristics the presence of which at an otherwise suitable site would render the site/facility combination unacceptable for HLW disposal. The question of general site acceptability criteria is an open one in the sense that the staff has not identified to date such criteria. Should general site acceptability criteria not be developed, it will be necessary to determine the site acceptability question on a case-by-case basis.

(5) *Codification of Models in Licensing Process.* The question of whether regulations should codify models to be used in licensing disposal of HLW or whether the criteria shoud only allow the use of models is a controversial one. In considering these questions the staff recognizes that it is necessary to: (a) Use descriptions (models) of the behavior of geologic processes and of the repository and of the consequences associated with that behavior; (b) Acknowledge that these descriptions are approximations to nature and as such introduce uncertainties into the process; (c) Recognize that for the foreseeable future, the "old" models, in which there is the greatest confidence because of their "proven" use appear to be as qualitative as they are quantitative; (d) Consider that the judgement of the appropriateness of these models for their intended purpose will be supported largely through expert opinion; (e) Confront and explore fully these uncertainties and their ramifications including "uncertainties" arising from differences in expert opinion; (f) Judge the acceptability of the consequences of events in the light of these uncertainties; and (g) assure that the judgment itself will be detailed in the public record.

If one views the realization of our understanding in geologic disposal from successively more nearly complete and accurate qualitative descriptions of the observed phenomenon in question through more precise and semi-quantitative and quantitative approximations where uncertainties are better understood and can be treated mathematically, to an elegant theory embodied in a mathematical description which represents a culmination of human thought, the present state of modeling for geologic repositories is closer to qualitative than quantitative. This fact does not make whatever understanding we have less valid—we know what we know. Rather this means that neither the process by which the technical criteria should be developed nor the process by which a licensing decision should be made should rely solely on quantitative calculations and assessments. It means that when analytical techniques are used, care must be taken not to apply those techniques outside their established region of validity. Finally, it means that confidence in a licensing finding is inextricably linked to uncertainty; and the validity of any licensing finding is linked to the means by which uncertainty is uncovered, explored, and treated.

There are a number of considerations that need to be taken into account before establishing whether qualitative/quantitative models will be codified in the regulations or their use merely permitted: (1) If modeling is used as the primary decision tool then demonstration of whether the geologic setting at a particular site can fulfill the stated purpose of the geologic barrier relies fundamentally on the predictive power of the particular transport model appropriate to that site; (2) The less stable the site geologically and hydrologically, the less reliable the transport model as a description of the steady-state; (3) The more complex with respect to geologic and climatology processes, the poorer the model is as an approximation to nature and the greater the uncertainty of any prediction; (4) The more complex the site or less stable

the site, the greater the difficulty in modeling long-term behavior at the interface between the geologic barrier and the set of engineered barriers. (5) The lack of empirical data on the performance of engineered barriers or the inability to obtain credible data may preclude the development or use of credible quantitative models in the showing that either the uncertainties are addressed properly in the performance standards or the performance standards are met in a particular licensing action. In light of these considerations, the staff's thought has been not to require modeling to be the primary decision tool to determine the capability of the geologic repository to contain and isolate waste from the biosphere. The staff believes, however, that quantitative models can be used to compare sites and designs.

In sum, the staff considers the following to be a reasonable position with respect to the use of models:

Technical criteria must be developed through a rulemaking process in which the logic and factual basis is clearly articulated and can withstand challenge. Hence, where appropriate, quantitative models should be used to develop technical criteria. However, because of the limitations discussed above, it is desirable to specify technical criteria associated with the regulatable elements in such a manner as not to predicate their technical justification on the results of quantitative modeling, except in those instances where quantitative modeling can contribute to their technical justification. Where quantification is not possible, without meaning, incomplete or ambiguous, the process must rely on expert opinion to provide insight and alternatives. This process is particularly appropriate to the development of criteria for which neither direct experience nor recourse to experimental verification exists to provide the basis for the criteria. Through expert opinion in public proceedings, and the exercise of judgment by the Commission, a satisfactory if imprecise margin of safety for site characteristics and engineering design can be realized. This is particularly important where quantitative modeling and experimental verification alone cannot be used to establish a sound record. When these qualitative and semiquantitative considerations are combined with quantitative models to develop a scheme for comparison, the staff believes the result will lead to a sound regulation and to sound licensing decisions.

(6) *Retrievability.* Selection of a suitable site for a geologic repository for HLW disposal and the design, construction and operation of a repository is a new human enterprise. In undertaking such a venture for the first time, it is reasonable to expect that, whatever the care exercised and however advanced the techniques, mistakes will occur, improved technologies developed, better designs created, and operational procedures improved. It is reasonable, therefore, to assume that it might be desirable to postpone any irreversible (or not easily reversible) decisions until the maximum amount of reasonably obtainable information about how well the repository is functioning and can be expected to function to contain and isolate the waste for the periods of time required is at hand. The staff believes that it may be desirable to maintain the option to retrieve the wastes for a period of time after the last waste is emplaced and is developing criteria to require it. The draft technical criteria contain a requirement that the repository be assigned to preserve the option to retrieve the wastes for a period of years following emplacement. This option, however, is not without impact, particularly in the areas of repository design and waste emplacement. However, it would allow monitoring and taking corrective actions if required, including removal of the wastes, before the repository is sealed.

(7) *Human Intrusion Problem.* For geologic repositories, the human intrusion problem is not a simple or straightforward extension of natural events and may require different standards as well as a different approach. Simply stated, human intrusion cannot be prevented: In spite of all efforts to avoid sites which may prove attractive to humans, there may be deliberate or inadvertent intrusion. In the former instance, it is reasonable to assume that the intruder has access to information which makes it attractive to intrude. For example, the intruder may know of the location and contents of the repository itself and may regard the HLW as a resource of some value. How should such an intrusion be regarded as an event to be considered in the design of the repository? That is, should attempts to be made to protect future generations from the deliberate intruder? What are the consequences of intrusion to the intruder? To the general population? In the latter instance, where the event is one of inadvertent (accidental) intrusion other questions occur. Did the intrusion occur beyond the time that it is reasonable to expect that knowledge of the existence of the repository is known? What is a reasonable period of time? What steps in repository design and enforcement can be taken to mitigate the consequences of an accidental intrusion? Is one kind of intrusion more likely than the other? Are the consequences of inadvertent intrusions different from those for deliberate intrusions? The human intrusion issue is a difficult one that is far from having been resolved.

*Questions:* In particular, we are seeking comment on the following questions.

(1) Does the list of considerations above clearly, adequately and fully identify the relevant issues involved in disposal of HLW?

(2) Would a rule structured along the lines of the referenced draft rule reasonably deal with issues in an appropriate manner?

(3) In light of the fact that EPA has the responsibility and authority to set the generally applicable environmental standard for radiation in the environment from the disposal of HLW, with what factors/issues should an NRC environmental impact statement on technical criteria deal?

(4) What are the environmental impacts of criteria constructed in accordance with the above cited principles? What alternative criteria exist and what are their impacts?

## Draft Technical Criteria for 10 CFR Part 60

Subparts E–I are proposed to be added to Part 60 as set forth below:

## PART 60—DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN GEOLOGIC REPOSITORIES

### Subpart E—Technical Criteria

Sec.

60.2 *Definitions* (to be inserted as appropriate into subpart A).
60.101 Purpose.
60.111 Performance objectives.
60.121 Site and environs ownership and control.
60.122 Siting requirements.
60.132 Design requirements.
60.133 Waste package and emplacement environment.
60.135 Retrieval of waste.
60.137 Monitoring programs.

### Subpart F—Physical Protection [Reserved]

### Subpart G—Quality Assurance

§ 60.171 Quality Assurance Program.

Subpart H—Criteria for Personnel Training [Reserved]

Subpart I—Emergencies and Emergency Programs [Reserved]

Subpart E—Technical Criteria

§ 60.2 Definitions.

For the purpose of this part—

"Accessible Environment"—means those portions of the environment directly in contact with or readily available for use by human beings. It includes the earth's atmosphere, the land surface, surface waters, and the oceans. It also includes presently used aquifers which have been designated as underground sources of drinking water under the Environmental Protection Agency's proposed rule 40 CFR Part 146.

"Aquifer"—means a distinct hydrogeologic unit that readily transmits water and yields significant quantities of water to wells or springs.

"Barrier"—means any material or structure which prevents or substantially delays movement of radionuclides from the radioactive wastes towards the accessible environment.

"Candidate area"—means a geologic and hydrologic system within which a geologic repository may be located.

"Container"—means the first major sealed enclosure that holds the waste form.

"Containment"—means keeping radioactive waste within a designated boundary.

"Confining unit"—means a distinct hydrogeologic unit which neither transmits ground water readily nor yields significant quantities of water to wells or springs.

"Decommissioning"—means final backfilling of subsurface facilities, sealing of shafts, and decontamination and dismantlement of surface facilities.

"Department"—means the U.S. Department of Energy (DOE) or its duly authorized representatives.

"Disposal"—means permanent emplacement within a storage space with no intent to retrieve for resource values.

"Expected processes and events"—means those natural processes or events that are likely to degrade the engineered elements of the geologic repository during a given period after decommissioning. As used in this part, expected processes and events do not include human intrusion.

"Floodplain"—means the lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of offshore islands including at a minimum that area subject to a one percent or greater chance of flooding in any given year.

"Geologic repository"—means a system for the disposal of radioactive wastes in excavated geologic media. A geologic repository includes (1) the geologic repository operations area, and (2) all surface and subsurface areas where natural events or activities of man may change the extent to which wastes are effectively isolated from the accessible environment.

"Geologic repository operations area"—means an HLW facility that is part of a geologic repository, including both surface and subsurface areas, where waste handling and emplacement activities are conducted.

"High-level radioactive waste" or "HLW"—means (1) irradiated reactor fuel, (2) liquid wastes resulting from the operation of the first-cycle solvent extraction system, or equivalent and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel, and (3) solids into which such liquid wastes have been converted.

"HLW facility"—means a facility subject to the licensing and related regulatory authority of the Commission pursuant to Sections 202(3) and 202(4) of the Energy Reorganization Act of 1974 (88 Stat. 1244).

"Host rock"—means the geologic medium in which the waste is emplaced.

"Hydrogeologic unit"—means any soil or rock unit or subsurface zone that has a distinct influence on the storage or movement of ground water by virtue of its porosity or permeability.

"Important to safety" with reference to structures, systems, and components, means those structures, systems, and components that provide reasonable assurance that radioactive waste can be received, handled, and stored without undue risk to the health and safety of the public.

"Intrinsic permeability"—means a measure of the relative ease with which a porous medium transmits a liquid under a potential gradient. It is a property of the medium alone and is independent of the nature of the fluid.

"Isolation"—means segregation of waste from the accessible environment within acceptable limits.

"Overpack"—means any additional receptacle, wrapper, box or other structure which becomes an integrated part of a waste package and is used to enclose a waste container for purposes of providing additional protection or meeting the requirements of an acceptance criteria.

"Packaging"—means the container, and any overpacks, and their contents excluding radioactive materials and their encapsulating matrix, but including absorbent material, spacing structures, thermal insulation, radiation shielding devices for absorbing mechanical shock, external fittings or handling devices, neutron absorbers or moderators and other supplementary equipment.

"Stability"—means the rate of natural processes affecting the site during the recent geologic past are relatively low and will not significantly change during the next 10,000 years.

"Radioactive waste"—means HLW and other radioactive materials that are received for emplacement in a geologic repository.

"Transuranic wastes" or "TRU wastes"—means radioactive waste containing alpha emitting transuranic elements, with radioactive half-lives greater than one year, in excess of 10 nanocuries per gram.

"Underground facility"—means the civil engineered structure, including backfill materials, but not including seals, in which waste is emplaced.

"Waste form"—means the radioactive waste materials and any associated encapsulating or stablizing materials.

"Waste package"—means the physical waste form, its container and any ancillary enclosures, including its shielding, packing, and overpack.

§ 60.101 Purpose.

(a) This subpart states the performance objectives to be achieved and the technical criteria to be met by the Department of Energy in order for the Commission to make the findings called for in Subpart B.

(b) The Commission will apply the technical criteria in this subpart in making findings that the activities authorized by a license, or any amendment thereof, will not constitute unreasonable risk to the health and safety of the public.

(c) The Commission will also apply the technical criteria in this subpart, insofar as they may be pertinent, in making determinations with respect to the issuance of a construction authorization.

(d) Omissions in the General Design Criteria do not relieve an applicant from the requirement of providing the necessary safety features in the design of a specific facility.

(e) The requirements and conditions in subsequent sections assume that disposal will be in saturated media. The Commission does not intend to exclude disposal in the vadose zone or any other method by promulgating these criteria; however, different criteria may need to be developed to license other disposal methods.

**§ 60.111 Performance objectives.**

(a) *Overall repository performance.* (1) *Radiation exposure or releases during operation.* The Department of Energy shall design and operate the geologic repository operations area to provide reasonable assurance that radiation exposures and releases of radioactive materials are within the limits set forth in Part 20 of this Chapter.

(2) *Releases after decommissioning.* The Department of Energy shall provide reasonable assurance that after decommissioning the geologic repository will isolate radioactive wastes to such a degree that quantities and concentrations of radioactive waste in the accessible environment will conform to such generally applicable environmental standards as may have been established by the Environmental Protection Agency.

(3) *Retrievability.* The Department of Energy shall design the geologic repository operations area so that the radioactive waste stored there can be retrieved for a period of 50 years after termination of waste emplacement operations, if the geologic repository operations area has not been decommissioned. If during this period a decision is made to retrieve the wastes the Department shall insure that wastes could be retrieved in compliance with Part 20 of this Chapter and in about the same period of time as that during which they were emplaced.

(b) *Required barriers.* In the design and construction of a geologic repository, the Department shall utilize (1) an engineered system including waste package and an underground facility, and (2) the geologic environment.

(c) *Performance of required barriers and engineered systems.* (1) *Waste Packages.* [*] The Department shall design waste packages so that there is reasonable assurance that radionuclides will be contained for at least the first 1,000 years after decommissioning and for as long thereafter as is reasonably achievable given expected processes and events as well as various water flow conditions including full or partial saturation of the underground facility.

(2) *Underground facility.* The Department shall design the underground facility to provide reasonable assurance of the following:

(i) An environment for the waste packages that promotes the achievement of § 60.111(c)(1) above under conditions resulting from expected processes and events.

(ii) Containment of all radionuclides for the first 1,000 years after decommissioning of the geologic repository operations area and as long thereafter as is reasonably achievable, assuming expected events and processes and that some of the waste dissolves soon after decommissioning.

(3) *Overall performance of the engineered system after containment.* The Department shall design the engineered system to provide reasonable assurance that:

(i) Starting 1,000 years after decommissioning of the geologic repository operations area, the radionuclides present in HLW will be released from the underground facility at an annual rate that is as low as reasonably achievable and is in no case greater than an annual rate of one part in one hundred thousand of the total activity present in HLW within the underground facility 1,000 years after decommissioning assuming expected processes and events.

(ii) Starting at decommissioning radionuclides present in TRU waste will be released at a rate that is as low as reasonably achievable and is in no case greater than one part in one hundred thousand of the total activity present in TRU waste within the underground facility at the time of decommissioning assuming expected processes and events.

(4) *Performance of the geologic environment.* (i) The Department shall provide reasonable assurance that the degree of stability exhibited by the geologic environment at present will not significantly decrease over the long term.

(ii) The Department shall provide reasonable assurance that the site exhibits properties which promote isolation and that their capability to inhibit the migration of radionuclides will not significantly decrease over the long term.

(iii) The Department shall provide reasonable assurance that the hydrologic and geochemical properties of the host rock and surrounding confining units will provide radionuclide travel times to the accessible environment of at least 1,000 years assuming expected processes and events.

**§ 60.121 Site and environs ownership and control.**

(a) *Ownership and control of the geologic repository operations area.* The Department shall locate the geologic repository operations area in and on lands that are either acquired lands under the jurisdiction and control of the Department or lands permanently withdrawn and reserved for its use. The Department shall hold such lands free and clear of all significant encumbrances (including rights arising under the general mining laws, easements for right-of-way, and all other rights arising under lease, rights of entry, deed, patent, mortgage, appropriations, prescription, or otherwise).

(b) *Establishment of a control zone.* The Department shall establish a "Control Zone" surrounding the geologic repository operations area. The Department shall exercise such jurisdiction and control with respect to surface and subsurface estates in the control zone as may be necessary to prevent adverse human actions that could significantly reduce the ability of the natural or engineered barriers to isolate radioactive materials from the accessible environment. The Department's rights may take the form of appropriate possessory interests, servitudes, or withdrawals from location or patent under the general mining laws.

(c) *Long-term control.* The Department shall identify the geologic repository operations area by the most permanent markers and records practicable. The markers shall be inscribed in several languages as well as English. In addition, the Department shall deposit records of the location of the geologic repository operations area and the nature and hazard of the waste in the major archives of the world. For the purpose of demonstrating compliance with § 60.111 (Performance Objectives), the Department shall assume that other institutional controls will not persist for more than one hundred years.

**§ 60.122 Siting requirements.**

(a) *General requirements.* (1) The Department shall select the site and environs so that they are not so complex as to preclude thorough investigation and evaluation of the site characteristics that are important to demonstrating that the performance objectives of § 60.111 will be met.

(2) The Department shall investigate and evaluate the natural conditions and human activities that can reasonably be expected to affect the design, construction, operation, and decommissioning of the geologic repository operations areas. The natural conditions include geologic, tectonic, hydrologic, and climatic process. The Department shall evaluate the stability of the geologic repository and the isolation of radionuclides after decommissioning.

(i) The Department shall conduct investigations on the order of 100

[*] Sections 60.111(c)(1) and 60.111(c)(2) apply only to HLW.

kilometers horizontal radius from the geologic repository operations area.

(ii) The Department shall emphasize those natural conditions active anytime since the start of the Quaternary Period in their investigations.

(iii) The Department shall emphasize the first 10,000 years following decommissioning in their prediction of changes in natural conditions and the performance of the geologic repository.

(3) The Department shall conduct investigations that adequately characterize and provide representative and bounding values for those human activities and natural events and conditions that may affect any of the following:

(i) The design, construction, operation, and decommissioning of the geologic repository operations area.

(ii) Demonstration of the stability of the geologic repository after decommissioning.

(iii) Demonstration of the isolation of radionuclides from the accessible environment after decommissioning.

(4) The Department shall evaluate reasonably likely future variations in the site characteristics which may result from natural processes, human activities, construction of the repository, or waste/rock/water interactions.

(5) The Department shall conduct the site investigations in such a manner as to obtain the required information with minimal adverse effects on the long-term performance of the geologic repository.

(6) The Department shall validate analyses and modeling of future conditions and changes in site characteristics using field tests, in situ tests, field-verified laboratory tests, monitoring data, or natural analog studies.

(7) The Department shall continuously verify and assess any changes in site conditions which pertain to whether the performance objectives will be met.

(8) The Department shall perform a resource assessment for the region within 100 km of the site using available information. The Department shall include estimates of both known and undiscovered deposits of all resources that (i) have been or are being exploited or (ii) have not been exploited but are exploitable under present technology and market conditions. The Department shall estimate undiscovered deposits by reasonable inference based on geologic and geophysical information. The Department shall estimate both gross and net value of resource deposits. The estimate of net value shall take into account development, extraction and marketing costs.

(9) The Department shall determine by appropriate analyses the extent of the volume of rock within which the geologic framework, ground-water flow, ground-water chemistry, or geomechanical properties are anticipated to be significantly affected by construction of the geologic repository or by the presence of the emplaced wastes, with emphasis on the thermal loading of the latter. In order to do the analyses required in this paragraph, the Department shall at a minimum conduct investigations and tests to provide the following input data:

(i) The pattern, distribution and origin of fractures, discontinuities, and heterogeneities in the host rock and surrounding confining units;

(ii) The presence of potential pathways such as fractures, discontinuities, solution features, unsealed faults, breccia pipes, and other permeable anomalies in the host rock and surrounding confining units.

(iii) The *in situ* determination of the bulk geomechanical properties, pore pressures and ambient stress conditions of the host rock and surrounding confining units;

(iv) The *in situ* determination of the bulk hydrogeologic properties of the host rock and surrounding confining units;

(v) The *in situ* determination of the bulk geochemical conditions, particularly the redox potential, of the host rock and surrounding confining units;

(vi) The *in situ* determination of the bulk response of the host rock and surrounding confining units to the anticipated thermal loading given the pattern of fractures and other discontinuities and the heat transfer properties of the rock mass.

As a minimum, the Department shall assume that the volume will extend a horizontal distance of 2 kilometers from the limits of the repository excavation and a vertical distance from the surface to a depth of 1 kilometer below the limits of the repository excavation.

(b) *Potentially adverse conditions.* The following paragraphs describe human activities or natural conditions which can adversely affect the stability of the repository site, increase the migration of radionuclides from the repository, or provide pathways to the accessible environment. The Department shall demonstrate whether any of the potentially adverse human activities or natural conditions are present. The Department shall document all investigations. The presence of any of the potentially adverse human activities or natural conditions will give rise to a presumption that the geologic repository will not meet the performance objectives. The conditions and activities in this section apply, unless otherwise stated, to the volume of rock determined by the Department in § 60.122(a)(8) above.

(1) *Potentially adverse human activities.* (i) There is or has been conventional or in situ subsurface mining for resources.

(ii) Except holes drilled for investigations of the geologic repository, there is or has been drilling for whatever purpose to depths below the lower limit of the accessible environment.

(iii) There are resources which are economically exploitable using existing technology under present market conditions.

(iv) Based on a resource assessment, there are resources that have either higher gross or net value than the average for other areas of similar size in the region in which the geologic repository is located.

(v) There is reasonable potential that failure of human-made impoundments could cause flooding of the geologic repository operations area prior to decommissioning.

(vi) There is reasonable potential based on existing geologic and hydrologic conditions and methods of construction for construction of large-scale impoundments which may affect the regional ground-water flow system.

(vii) There is indication that present or reasonably anticipatable human activities can significantly affect the hydrogeologic framework. Human activities include ground-water withdrawals, extensive irrigation, subsurface injection of fluids, underground pumped storage facilities or underground military activities.

(2) *Potentially adverse natural conditions—geologic and tectonic.* (i) There is evidence of extreme bedrock incision since the start of the Quaternary Period.

(ii) There is evidence of dissolutioning, such as karst features, breccia pipes, or insoluble residues.

(iii) There is evidence of processes in the candidate area which could result in structural deformation in the volume of rock such as uplift, diapirism, subsidence, folding, faulting, or fracture zones.

(iv) The geologic repository operations area lies within the near field of a fault that has been active since the start of the Quaternary Period.

(v) There is an area characterized by higher seismicity than that of the surrounding region or there is an area in which there are indications, based on correlations of earthquakes with tectonic processes and features, that seismicity may increase in the future.

(vi) There is evidence of intrusive igneous activity since the start of the Quaternary Period.

(vii) There is a high and anomalous geothermal gradient relative to the regional geothermal gradient.

(3) *Potentially adverse natural conditions—hydrologic.* (i) There is potential for significant changes in hydrologic conditions including hydraulic gradient, average pore velocity, storativity, permeability, natural recharge, piezometric level, and discharge points. Evaluation techniques include paleohydrologic analyses.

(ii) The geologic repository operations area is located where there would be long term and short term adverse impacts associated with the occupancy and modification of floodplains. (Executive Order 11988).

(iii) There is reasonable potential for natural phenomena such as landslides, subsidence, or volcanic activity to create large-scale impoundments that may affect the regional ground-water flow system.

(iv) There is a fault or fracture zone, irrespective of age of last movement, which has a horizontal length of more than a few hundreds of meters.

(4) *Potentially Adverse Natural Conditions—Geochemical.* The rock units between the repository and the accessible environment exhibit low retardation for most of the radionuclides contained in the radioactive waste.

A presumption that the geologic repository will not meet the performance objectives can be rebutted upon showing that the presence of the potentially adverse condition does not adversely affect the performance of the geologic repository. In order to make this showing, the Department shall first demonstrate that:

(1) The potentially adverse human activity or natural condition has been adequately characterized, including the extent to which the particular feature may be present and still be undetected taking into account the degree of resolution achieved by the investigations;

(2) The effect of the potentially adverse human activity or natural condition on the geologic framework, ground-water flow, ground-water chemistry and geomechanical integrity has been adequately evaluated using conservative analyses and assumptions, and the evaluation used is sensitive to the adverse human activity or natural condition.

(3) The effect of the potentially adverse human activity or natural condition is compensated by the presence of favorable characteristics in Paragraph 60.122(c) of this Section; and

(4) The potentially adverse human activity or natural condition can be remedied during construction, operation, or decommissioning of the repository.

(c) *Favorable characteristics.* Each of the following characteristics represent conditions which enhance the ability of the geologic repository to meet the performance objectives. Candidate areas and sites which exhibit as many favorable characteristics as practicable are preferred. The Department shall demonstrate the degree to which each favorable characteristic is present. The Department shall fully document all investigations. The Department shall perform evaluations to demonstrate to what extent the favorable characteristic contributes to assuring the stability of the site and/or the isolation of the waste by restricting the access of groundwater to the waste, the rate of dissolution of the waste, or the migration of radionuclides from the geologic repository. The Department shall use conservative analyses to demonstrate the significance of the favorable characteristics. The Department shall include evaluation of the degree to which the favorable characteristic has been adequately characterized, given the degree of resolution achieved by the investigations. The specific favorable characteristics are the following:

(1) The Department shall select the site so that to the extent practicable the candidate area—

(i) Exhibits demonstrable surface and subsurface geologic, geochemical, tectonic, and hydrologic stability since the beginning of the Quaternary Period, and

(ii) Contains a host rock and surrounding confining units that provide:

(a) Long ground-water residence times and long flow paths between the repository and the accessible environment;

(b) Inactive ground-water circulation within the host rock and surrounding confining units, and little hydraulic communication with adjacent hydrogeologic units due to ground-water characteristics such as low intrinsic permeability and low fracture permeability of the rock mass; and

(c) Geochemical properties, such as reducing conditions which result in low solubility of radionuclides, and near-normal pH, or a lack of complexing agents.

(2) The Department shall select the site so that to the extent practicable the volume of rock—

(i) Possesses the favorable characteristics described above;

(ii) Possesses a geologic framework that permits effective sealing of shafts, drifts, and boreholes, and that permits excavation of a stable subsurface opening, and the emplacement of waste at a minimum depth of 300 meters from the ground surface;

(iii) Possesses ground-water flow characteristics that—

(a) Result in a host rock with very low water content;

(b) Prevent ground-water intrusion or circulation of ground water in the host rock;

(c) Prevent significant upward ground-water flow between hydrogeologic units or along shafts, drifts, and boreholes;

(d) Result in low hydraulic gradients in the host rock and surrounding confining units;

(e) Result in horizontal or downward hydraulic gradients in the host rock and surrounding confining units; and

(f) Result in ground-water residence times under ambient conditions, between the repository and the accessible environment, that exceed 1000 years.

(iv) Possesses geomechanical properties that provide stability during construction, operation, and under the influences of thermal load or other waste/rock/water interactions;

(v) Possesses a low population density;

(vi) Possesses a combination of meteorological characteristics (especially prevailing wind flow direction) and population distribution such as to assure that a radiological exposure of the population, which is within the limits of Part 20 of this chapter; and

(vii) Is in an area where climatic change is not expected to have an adverse impact on the geologic, tectonic, or hydrologic characteristics.

**§ 60.132 Design requirements.**

(a) *General design requirements.* The requirements in this section apply to surface and subsurface facilities.

(1) *Compliance with mining regulations.* The Department shall design, construct and operate the surface and subsurface facilities to comply with all applicable Federal and state mining regulations including Subchapters D, E, and N of 30 CFR Part 57 as applicable.

(2) *Identification of structures, systems, and components important to safety.* The Department shall identify by appropriate analyses those systems, structures and components that are important to safety.

(3) *Protection against natural phenomena and environmental conditions.* (i) The Department shall

design and locate structures, systems and components important to safety to accommodate the effects of and to be compatible with site characteristics and environmental conditions associated with normal operation, maintenance and testing at any time prior to decommissioning.

(ii) The Department shall design and locate structures, systems and components important to safety to withstand the most severe of natural phenomena that are likely to occur at the site including seismic, meteorologic and hydrologic events without loss of capability to perform their safety function.

(4) *Protection against dynamic effects of equipment failure and similar events.* The Department shall design and locate structures, systems and components important to safety to resist dynamic effects that could result from equipment failure, missile impacts, the dropping of crane loads in transit, and similar events and conditions.

(5) *Protection against fires and explosions.* (i) The Department shall design and locate structures, systems, and components important to safety to minimize the potential for impairment of their ability to perform their safety functions during fires or explosions.

(ii) The the extent practicable, the Department shall design the geologic repository to incorporate noncombustible and heat resistant materials.

(iii) The Department shall design the geologic repository to include explosion and fire detection alarm systems and appropriate suppression systems with sufficient capacity and capability to minimize the adverse effects of fires and explosions on structures, systems, and components important to safety.

(iv) The Department shall design the geologic repository to include provisions to protect personnel from either the operation of, or the failure of the fire suppression systems.

(6) *Inspection, testing, and maintenance.* The Department shall design and locate structures, systems and components important to safety to permit periodic inspection, testing, and maintenance, as appropirate, to ensure their continued functioning and readiness.

(7) *Emergency capability.* (i) The Department shall design and locate structures, systems, and components important to safety to assure safe storage of radioactive waste, prompt termination of operations and evacuation of personnel during an emergency.

(ii) The Department shall design the geologic repository to include onsite facilities and services that assure a safe and timely response to emergency conditions and facilitate the use of available offsite services such as fire, police, medical and ambulance service that may aid in recovery from emergencies.

(8) *Utility services.* (i) The Department shall design each utility service system to provide for the meeting of safety demands under normal and abnormal conditions. The Department shall design utility services and distribution systems important to safety to include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform safety functions assuming a single failure.

(ii) The Department shall design emergency utility services to permit testing of the functional operability and capacity, including the full operational sequence, of each system for transfer between normal and emergency supply sources, and the operation of associated safety systems.

(iii) The Department shall make provisions so that in the event of a loss of the primary electric power source or circuit, reliable and timely emergency power is provided to instruments, utility service systems, and operating systems including the security central alarm station, in amounts sufficient to allow safe conditions to be maintained with all safety devices essential to safety functioning.

(9) *Radiological protection.* (i) The Department shall design structures, systems, and components for which operation, maintenance, and required inspections could involve radiological exposure to personnel to include means to control external and internal radiation exposures within the limits specified in Part 20 of this Chapter. This includes the means to:

(*a*) Prevent the accumulation of radioactive material in those systems to which access by personnel is required.

(*b*) Minimize the time required to perform work in the vicinity of radioactive components, such as by providing sufficient space for ease of operation and designing equipment for ease of repair and replacement; and

(*c*) Provide shielding to assure that exposures to personnel in accessible areas are within the limits of Part 20.

(ii) The Department shall design the geologic repository to include means to—

(*a*) Provide appropriate radiation protection systems and programs for all areas and operations where personnel may be exposed to levels of radiation or airborne radioactive materials significantly above background levels to insure that exposures are within the limits of Part 20;

(*b*) Control and monitor the spread of contamination;

(*c*) Control access to areas of high radiation or potential contamination; and

(*d*) Warn workers by a radiation alarm system of significant increases in radiation levels in normally accessible areas and of excessive radioactivity released in effluents. The Department shall design such systems with redundancy and *in situ* testing capability.

(10) *Criticality control.* The Department shall design all systems for processing, transporting, handling, storage, retrieval, emplacement, and isolation of radioactive waste to insure that a nuclear criticality accident is possible only if at least two unlikely, independent and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. Demonstration of criticality safety under normal and accident conditions shall be by calculation of the effective multiplication factor ($k_{eff}$). This value must be sufficiently below unity to show at least a 5% margin after allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation.

(11) *Instrumentation and control systems.* The Department shall provide instrumentation and control systems to monitor and control the behavior of engineered systems that are important to safety over anticipated ranges for normal operation, for abnormal operation and for accident conditions. The Department shall design the systems with sufficient redundancy to assure that adequate margins of safety are maintained.

(b) *Additional design requirements for surface facilities.* The requirements in this section apply only to the design of surface facilities.

(1) *Compliance with Part 72.* If the geologic repository includes surface facilities that would be required to comply with 10 CFR Part 72, were they to be geographically removed from the site, the Department shall design, construct and operate those surface facilities to conform with 10 CFR Part 72.

(2) *Facilities for retrieval of waste.* The Department shall design and construct surface facilities to facilitate safe and prompt retrieval of wastes including facilities to inspect, repair, decontaminate, and store retrieved wastes prior to their shipment off site. Surface storage capacity of all emplaced waste is not required, but must be

sufficient to handle waste backlogs prior to shipment offsite.

(3) *Ventilation.* The Department shall design surface facility ventilation system(s) supporting waste transfer, inspection, decontamination, processing and/or packaging to assure that occupational exposures and releases of gases and airborne radioactive particulate materials during normal operations do not exceed the limits identified in Part 20 of this chapter.

(4) *Radiation control and monitoring.* (i) *Effluent control.* The Department shall design the surface facilities to minimize the release of radioactive materials in effluents of any form, during normal operations. The Department shall monitor the systems provided to guard against the release of radioactive materials. The Department shall insure that the monitoring systems are provided with alarms which are periodically tested. The Department shall design and construct facilities to assure treatment of contaminated effluents as necessary to ensure that the concentrations and total quantities of radioactive materials in effluents are maintained within the limits of Part 20 of this chapter.

(ii) *Effluent monitoring.* The Department shall design effluent monitoring systems to adequately measure the amount and concentration of radionuclides in any effluent to assure that radioactive materials are maintained within the limits of Part 20 of this Chapter.

(5) *Waste treatment.* The Department shall design radioactive waste treatment facilities to process all site generated wastes.

(6) *Consideration of decommissioning.* The Department shall design and construct surface facility structures to facilitate decommissioning.

(c) *Additional design requirements for subsurface facilities.* The requirements in this section apply only to subsurface facilities.

(1) *Underground facility.* The Department shall design the underground facility as an underground civil engineered structure that satisfies requirements for structural performance, control of groundwater movement and control of radionuclide transport. The Department shall design the facility to provide for safe operation during construction, emplacement, and retrieval of waste and to assure compliance with § 60.111 (Performance Objectives).

(2) *Waste isolation engineering.* (i) The Department shall demonstrate that the underground facility includes those engineered features that are needed to limit radioactive releases after decommissioning to levels that are as low as reasonably achievable. The Department shall include an identification and a comparative evaluation of alternatives to the major design features that are provided to enhance radionuclide retardation and containment.

(ii) The Department shall design the underground facility such that the orientation, geometry, layout, and depth of the underground excavation in addition to any engineered barriers provided as part of the underground facility are optimized for that site. The Department shall use as optimization criteria the performance objectives in § 60.111, (c)(2), (c)(3).

(iii) The Department shall design the underground facility so that the effects of disruptive events will not propagate through the facility.

(iv) To assure that shafts and boreholes do not act as preferential pathways for ground-water or radionuclide migration, the Department shall design shaft and borehole seals such that—

(a) The shafts and boreholes are sealed along their entire length as soon after they have served their operational purpose as is practicable;

(b) The sealed shafts and boreholes provide a barrier to radionuclide migration which is at least equivalent to the barrier provided by the undisturbed rock;

(c) There is effective sealing to the rock contact and the adjacent zone of disturbed rock surrounding boreholes and shafts; and

(d) The shaft and borehole seals can accommodate potential variations of stress, temperature, and moisture, and to provide for radionuclide retardation.

(v) The Department shall place emphasis on multicomponent borehole and shaft and seals and use materials that are compatible with the rock properties and other *in situ* conditions.

(iv) The Department shall design the underground facility to include engineered barriers which protect the waste package from (1) natural events and processes, (2) *in situ* stresses, (3) chemical attack, and (4) groundwater contact. The Department shall determine the location of the barriers by proper engineering analysis and *in situ* testing. The Department shall include in the design—

(a) Engineered barriers where shafts could provide access for ground water to enter or leave the underground facility;

(b) Creation of a near-field waste package environment which favorably controls chemical reations affecting the performance of the waste package or other engineered barriers;

(c) Creation of an emplacement environment which reduces the potential for creep deformation in the rock and deformation of waste packages; and

(d) Backfill materials as a barrier to ground-water movement into the repository. The Department shall select backfill materials to provide for (1) adequate placement and compaction in underground openings, (2) seals to reduce and control ground-water movement, (3) absorption of radionuclides, and (4) preservation of favorable properties in the presence of anticipated rise of rock temperatures.

(vii) Thermal and thermomechanical response of the rock—

(a) The Department shall design the underground facility to assure that the predicted thermal and thermomechanical response of the rock could not adversely affect the performance of the natural or engineered barriers to radionuclide migration.

(b) The Department shall conduct *in situ* monitoring of the thermomechanical response of the geologic repository until decommissioning to assure that the thermomechanical response of the natural and engineered features are within design limits. Should these limits be exceeded, the NRC shall be notified and informed of any needed changes or actions.

(3) *Design to facilities retrieval of waste.* The Department shall design the underground facility to facilitate retrieval of waste in accordance with § 60.111(a)(3). To accomplish this the Department shall design the underground facility to assure structural stability of openings and minimize ground-water contact with the waste packages and design an emplacement environment that otherwise promotes waste recovery without compromising the ability of the geologic repository to meet the performance objectives.

(4) *Design of openings.* (i) The Department shall design subsurface openings to assure stability throughout the construction, operation, and retrieval periods. If support systems and structures are required for stability, the Department shall design them to be compatible with long-term deformation characteristics of the rock and to allow for subsequent placement of backfill.

(ii) The Department shall design openings to minimize the potential for deleterious rock movement or fracturing of overlying or surrounding rock. The Department shall optimize opening design, including shape, size, orientation, spacing and support

materials with respect to natural stress conditions, deformation characteristics of the host rock under thermal loading, and the nature of weaknesses or structural discontinuities present at the location of the opening.

(5) *Lining of subsurface excavations.* The Department shall line subsurface excavations in areas that require:

(i) A positive control of water or gas inflow from aquifers or other porous zones;

(ii) Support for zones of weak or fractured rock;

(iii) Anchorage for equipment or hardware.

(6) *Shaft conveyances used in waste handling.* (i) The Department shall consider shaft conveyances as a system important to safety.

(ii) The Department shall design hoists with mechanical geared lowering devices that preclude cage free fall.

(iii) The Department shall design hoists with a reliable cage location system that provides direct signals from all levels in the shaft. The Department shall design and construct final unload points which are controlled and verified by local position detectors.

(iv) The Department shall design shaft loading and unloading systems with a reliable system of interlocks that will fail safely upon malfunction. The Department shall include in the design two independent indicators to indicate whether waste packages are in place, grappled, and ready for transfer.

(7) *In situ testing and design verification.* (i) During the early or developmental stages of construction an area the Department shall excavate and reserve an area for *in situ* testing of borehole and shaft seals, backfill, and thermal effects and waste-rock interaction. The Department shall initiate the testing as early as is practicable and continue as long as necessary to demonstrate that performance is within design limits.

(ii) The Department shall insure that the contact between lining and the rock surrounding subsurface excavations does not jeopardize repository containment by providing a preferential pathway for ground-water or radionuclide migration.

(iii) During repository construction and operation the Department shall conduct a continued program of surveillance, testing, measurement, and geologic mapping to ensure that design parameters are verified and to provide additional data to confirm the isolation and containment characteristics of the seals and the underground facility. The Department shall measure and monitor changes in subsurface conditions on a regular basis.

(iv) The Department shall, as a minimum, make measurements of rock deformations and displacement, changes in rock stress and strain, water inflow into subsurface areas, changes in ground-water locations and conditions, host rock pore water pressures, and host rock thermal and thermomechanical response as a result of development and operations of the geologic repository. The Department shall compare such measurements and observations with original design bases and assumptions and if significant differences exist the Department must determine modifications to design or construction methods and report to the Commission the recommended changes.

(8) *Compacted Backfill Test Section.* To verify performance requirements intended in the design the Department shall establish, before any backfill placement is initiated, a program for placement, sampling, and testing of the backfill section. If the result of testing and observations made at the test section are different from the original design intent then the Department must analyze the need for changes and report the recommended changes to the Commission.

(9) *Water control during operations.* (i) The Department shall provide water control systems which are of sufficient capability and capacity to minimize the potentially adverse effects of ground water or service water (including that supporting excavation) intrusion on structures systems and components important to safety, waste emplacement operations, the performance of waste packages as engineered barrier to radionuclide migration, or effect retrieval capability.

(ii) The Department shall design the water control systems to monitor and control the quality and quantity of water flowing into or from the repository.

(iii) The Department shall provide water control storage capability, modular designs, or other provisions to assure unexpected inrush or flood can be controlled are contained.

(iv) The Department shall construct water control systems to control water from waste emplacement areas and shall keep those systems separate from the systems controlling water in the excavation areas.

(v) If aquifers or water bearing structures are encountered during construction then the Department must use pregrouting in advance of excavation.

(d) *General design requirements for construction.* The requirements in this section include general design criteria which are important for construction.

(1) Site development and excavation sequence. (i) The Department shall plan the exploratory program so that construction takes advantage of exploratory boreholes, shafts, and excavations in order to minimize the total number of penetrations within the geologic repository operations area.

(ii) The Department shall coordinate the design of the geologic repository with site characterization activities to assure that boreholes necessary for site characterization are located at future positions of shafts or large unexcavated pillars.

(iii) If critical host rock and other site specific design assumptions cannot be verified from boreholes, geophysical measurements, and/or an exploratory shaft and initial excavation, then the Department must establish a pilot program to further characterize the entire volume to be occupied by the underground facility and to verify critical host rock and site specific design assumptions prior to design finalization and waste emplacement.

(iv) The Department shall design the subsurface facilities with sufficient flexibility to ensure that designs are compatible with specific site features encountered during pilot development and excavation, and to facilitate the use of tests and monitoring system outputs.

(2) *Construction management program.* The Department shall establish a construction management program which is sufficient to assure that construction activities do not adversely affect the suitability of the site or jeopardize the containment capabilities of the underground facility. The Department shall include in the program means to assure that the underground facility is excavated and constructed as designed.

(3) *Excavation techniques.* The Department shall assure that methods used for excavation will neither create a preferential pathway for ground water or radioactive waste migration, nor increase the potential for migration through existing pathways. The Department shall use to the extent practicable mechanical excavators, boring machines and other nonblasting methods. If blasting is required for excavation, the Department must use methods specifically designed for each phase of the work that minimize fracturing of the surrounding rock. In this program the Department may include the use of pilot bores and tunnels and delay systems designed to minimize the amount of explosives detonated simultaneously. If blasting is utilized the Department must utilize controlled perimeter blasting such as the

smooth blasting or presheering techniques and cushion.

(f) *Control of explosives.* If explosives are used, the Department must meet the provisions of 30 CFR Part 57.6 as minimum safety requirements for storage, use and transportation. The Department shall use electrical detonation. If the rock contains open joints or fractures the Department must use cartridge or packaged explosives only.

(5) *Support structures.* If temporary support structures are used the Department must assure that they do not impair the placement of permanent structures or the ability of the repository to contain wastes by adversely affecting the ability to seal excavated areas.

(e) *Records and reporting requirements.* (1) *Identification and reporting of adverse features or conditions.* (a) If any feature listed under § 60.122(b)(1) (Adverse Conditions) is encountered during excavations then the Department must report it to the Commission within 5 days. The Department must analyze the effect of such features or conditions report as required in § 60.122(b).

(2) *Construction and mapping records.* The Department shall maintain and preserve records which provide a complete, documented history of the repository construction.

The Department shall include in the records the following—

(i) Surveys of underground excavations and shafts located with respect to readily identifiable surface features or monuments;

(ii) Materials encountered;

(iii) Geologic maps and profiles;

(iv) Locations and amount of seepage;

(v) Details of equipment, methods, progress and sequence of work;

(vi) Construction problems;

(vii) Anomalous conditions encountered;

(viii) Instrument locations, reading, and analysis;

(ix) Location and description of support systems;

(x) Location and description of dewatering systems; and

(xi) Details of seals used, methods of emplacement, and location.

The Department shall perform and plot surveys and geologic mapping as the work progresses.

(3) *Retention of cores and logs.* The Department shall retain on site, until decommissioning, all cores from all exploratory borings drilled during site selection, site characterization, construction, and operation. The Department shall store the cores in durable boxes housed in a weatherproof building. The Department shall arrange the cores to be readily available for inspection. The Department shall store in the same area logs of the borings, including geophysical logs.

(f) *General design requirements for subsurface operation.* The requirements of this section apply during repository operations.

(1) If concurrent excavation and emplacement of wastes are planned, then the Department must design the repository in modules which are sufficiently separated to assure that excavation activities could not impair emplacement operations or adversely affect retrieval.

(i) If interconnections are provided, the Department shall design each module to be sealed and isolated from all other modules in the event of an accident and so that waste can be safely retrieved if necessary.

(ii) The Department shall separate ventilation systems supporting excavation and waste emplacement.

(iii) The Department shall coordinate excavation rates and emplacement rates and schedules to assure physical separation of activities and further assure that handling and emplacement operations are not adversely affected by the excavation activities.

(2) *Ventilation.* (i) The Department shall design ventilation system(s) which are capable of controlling the transport of radioactive particulates and gases within and from the subsurface facility. The Department shall design and test the ventilation system to assure that radiological exposures during operations will not exceed the limits of 10 CFR Part 20.

(ii) The Department shall design ventilation systems to permit occupancy of all areas as required either for normal operations, cessation of operations, or for maintaining the facility in a safe condition.

(iii) The Department shall design the ventilation system(s) to be capable of accommodating changes in operating conditions such as variations in temperature and humidity.

(iv) The Department shall design the ventilation system(s) to protect against the intake and accumulation of radioactive materials and hazardous substances.

(v) The Department shall design ventilation system(s) for under normal and accident conditions.

(vi) The Department shall design the ventilation system to assure by means of redundant equipment, fail safe control systems or other provisions, the continuity of ventilation.

(3) *Waste handling and emplacement.* (i) The Department shall design the systems used to handle, transport, and emplace radioactive wastes to have positive, fail safe designs to preclude impairment of the performance of the waste packages as a barrier to radionuclide migration and to minimize radiological hazards.

(ii) The Department shall design the handling systems for emplacement and retrieval operations to minimize the potential for operator error.

(iii) The Department shall demonstrate that the handling equipment and systems for emplacement and retrieval operations are effective under *in situ* conditions prior to the start of waste emplacement operations.

(iv) The Department shall inspect any holes that are bored to receive waste prior to waste emplacement, to assure the absence of adverse conditions that could jeopardize the integrity of the waste package.

(4) The Department shall determine by analysis the specifications of waste loading and waste spacings. The Department shall make the analysis prior to receipt of waste. The Department shall include in the analysis—

(i) Effects of the design of the geologic repository on the thermal and thermomechanical response of the host rock;

(ii) The characteristics of the site and the host rock that affect the thermal response of the host rock;

(iii) Site and host rock features that affect the thermomechanical response of the seals and underground facility, including but not limited to: behavior and deformational characteristics of the host rock, the presence of insulating layers, aquifers, faults, orientation of bedding planes and the presence of discontinuities in the host rock.

(iv) The effect of temperatures and stresses on the performance of the waste packages and other engineered barriers; and

(v) The extent to which fracturing of the host rock occurs during temperature increase and decrease cycles.

**§ 60.133 Waste package and emplacement environment.**

(a) *General Requirements.* The Department shall insure that waste packages are designed and fabricated to so that the performance objectives of § 60.111 will be met. To demonstrate that the waste package meets these objectives, the Department at a minimum, shall do the following—

(1) Perform comparative evaluation of several candidate waste form and packaging combinations considering the proposed emplacement environment to

# APPENDIX B

Proposed Rule 10 CFR Part 60 "Disposal of High-Level Radioactive Wastes in Geologic Repositories," (46 FR 35280)

were reviewed and published, in summary form, on March 31, 1980 (45 FR 21186). In general, the comments were supportive of the agency's efforts.

It was also at this time, March 1980, that Packers and Stockyards printed its timetable for review anticipating the publication of a specific set of regulations for review every 6 months until all regulations were considered or a total time period of approximately 5 years. Fourteen specific regulations, six policy statements and various report forms were selected for review, and comments were again solicited.

In response to the March request, 21 additional comments were received concerning the specific areas targeted for review, i.e.: (1) Current levels of required bonding; (2) proper maintenance of custodial accounts; (3) packer sales promotion policies; and (4) required annual reporting for market agencies and dealers. The agency's third Federal Register publication, dated December 31, 1980 (45 FR 87002), discussed these comments and detailed specific changes in these target areas designed to be responsive to suggestions by the industry, to lessen regulatory burdens on the industry, and to encourage competitive markets within the industry.

**Present Activities**

The agency has decided to accelerate the regulatory review and reform process which it has already begun. To assist the agency in achieving this end, the Deputy Administrator, Packers and Stockyards, AMS, established an internal task force in January 1981 to review each rule and regulation and to suggest changes thereto which would lessen or eliminate any regulatory burden imposed without restricting the agency's ability to enforce the Packers and Stockyards Act. An interim report of the task force has been prepared and a final report is expected by the Administrator of Packers and Stockyards Administration on August 1, 1981.

**Revised Plan**

Packers and Stockyards Administration will not follow its previously published plan for regulatory review. Rather, the agency will review all currently effective regulations, policy statements and reporting requirements by the close of fiscal year 1983 (September 30, 1983). As a part of this review, effort will be made to obtain input from the affected industries, State Departments of Agriculture, and other interested persons prior to formal publication of proposals. Proposed changes and deletions will then be published in the Federal Register for comments prior to final adoption. Additionally, by September 30, 1981, the agency will publish, pursuant to the requirements of the Regulatory Flexibility Act, a listing of all rules having a significant economic impact on a substantial number of small business entities which will be reviewed during the succeeding 12 months. the proposed regulations published December 31, 1980, in the Federal Register will be reconsidered by the agency to incorporate, where appropriate, the recommendations of the task force and comments filed by the industry, and where necessary, such regulations will be republished for comment.

Done at Washington, D.C., this 1st day of July 1981.

James L. Smith,

*Acting Administrator, Packers and Stockyards Administration.*

[FR Doc. 81-[illegible] Filed [illegible]; 8:45 am]

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## NUCLEAR REGULATORY COMMISSION

**10 CFR Part 60**

**Disposal of High-Level Radioactive Wastes in Geologic Repositories**

**AGENCY:** Nuclear Regulatory Commission.

**ACTION:** Proposed rule.

**SUMMARY:** The NRC is publishing proposed amendments which specify technical criteria for disposal of high-level radioactive wastes (HLW) in geologic repositories. The proposed criteria address siting, design, and performance of a geologic repository, and the design and performance of the package which contains the waste within the geologic repository. Also included are criteria for monitoring and testing programs, performance confirmation, quality assurance, and personnel training and certification. The proposed criteria are necessary for the NRC to fulfill its statutory obligations concerning the licensing and regulating of facilities used for the receipt and storage of high-level radioactive waste.

**DATE:** Comments received after November 5, 1981 will be considered if it is practical to do so, but assurance of consideration cannot be given except for comments received on or before this date.

**ADDRESS:** Written comments or suggestions on the proposed amendments should be sent to the Secretary of the Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch. Copies of comments may be examined in the U.S. Nuclear Regulatory Commission Public Document Room, 1717 H Street NW, Washington, D.C. Comments may also be delivered to Room 1121, 1717 H Street NW, Washington, D.C., between 8:15 a.m. and 5:00 p.m.

**FOR FURTHER INFORMATION CONTACT:** Frank J. Arsenault, Director of the Division of Health, Siting and Waste Management, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Telephone (301) 427-4350.

**SUPPLEMENTARY INFORMATION:**

**Background**

On December 8, 1978 the Nuclear Regulatory Commission (Commission or NRC) published for comment proposed procedures for licensing geologic disposal of high-level radioactive wastes. The licensing procedures were published in final form on February 25, 1981 (46 FR 13971). On May 13, 1980 (45 FR 31393) the Commission published for comment an Advance Notice of Proposed Rulemaking (ANPR) concerning technical criteria for regulating disposal of high-level radioactive wastes (HLW) in geologic respositories. Included with the advance notice was a draft of the technical criteria under development by the staff. The public was asked to provide comment on several issues discussed in the advance notice and to reflect on the draft technical criteria in light of that discussion. The comments received were numerous and covered the full range of issues related to the technical criteria. The technical criteria being proposed here are the culmination of a number of drafts, and were developed in light of the comments received on the ANPR. It is the Commissions's belief that the regulation proposed here is one which is both practical for licensing and this notice provides a flexible vehicle for accommodating comments in that it points out alternatives and calls for comment in a number of critical plans. The Commission has prepared an analysis of the comments which explains the changes made from the ANPR, and intends to publish soon the comments and the analysis as a NUREG document. A draft of this NUREG has been placed in the Commission's Public Document Room for review. In addition, the staff has begun a program to develop guidance as to the methods that it regards as satisfactory for demonstrating compliance with the requirements of the proposed rule.

The technical criteria being set forth here as proposed rulemaking are a result of the Commission's further effort in regulating geologic disposal of HLW by the Department of Energy (DOE). The rationale for the performance objectives and the Environmental Impact Assessment supporting this rulemaking are also being published separately and are available free of charge upon written request to Frank Arsenault at the above address. In developing these criteria we have not reexamined DOE's programmatic choice of disposal technology resulting from its Generic Environmental Impact Statement, inasmuch as the Commission has expressly reserved until a later time possible consideration of matters within the scope of that generic statement (44 FR 70408). Accordingly, the technical criteria apply only to disposal in geologic repositories and do not address other possible or potential disposal methods. Similarly, in that DOE's current plans call for disposal at sufficient depth to be in the area termed the saturated zone, these criteria were developed for disposal in saturated media. Additional or alternative criteria may need to be developed for regulating disposal in the unsaturated or vadose zone.

### Authority

Sections 202 (3) and (4) of the Energy Reorganization Act of 1974, as amended, provide the Commission with licensing and regulatory authority regarding DOE facilities used primarily for the receipt and storage of high-level radioactive wastes resulting from activities licensed under the Atomic Energy Act and certain other long-term HLW storage facilities of DOE. Pursuant to that authority, the Commission is developing criteria appropriate to regulating geologic disposal of HLW by DOE. The requirements and criteria contained in this proposed rule are a result of that effort.

### Relation to Generally Applicable Standards for Radiation in the Environment Established by the Environmental Protection Agency

The Environmental Protection Agency (EPA) has the authority and responsibility for setting generally applicable standards for radiation in the environment. It is the responsibility of the NRC to implement those standards in its licensing actions and assure that public health and safety are protected. Although no EPA standard for disposal of HLW yet exists, these proposed technical criteria for regulating geologic disposal of HLW have been developed to be compatible with a generally applicable environmental standard. Specifically, the performance objectives and criteria speak to the functional elements of geologic disposal of HLW and the analyses required to give confidence that these functional elements will perform as intended.

### Disruptive Processes and Events

The NRC's implementing regulations assume that licensing decisions will be based, in part, on the results of analysis of the consequences of processes and events which potentially could disrupt a repository. Thus, throughout the criteria are requirements that the design basis take into account processes and events with the potential to disrupt a geologic repository. If the process or event is anticipated, i.e., likely, then the design basis requires barriers which would not fail in a way that would result in the repository not meeting the performance objectives. Anticipated processes and events would include such items as waste/rock interactions that result from emplacement of the wastes or the gradual deterioration of borehole seals. If the process or event is unlikely, then the overall system must still limit the release of radionuclides consistent with the EPA standard as applied to such events. An example of an unlikely event would be reactivation of a fault within the geologic setting which had not exhibited movement since the start of the Quaternary Period. In general, both likely and unlikely processes and events are expected to be site and design specific and would be identified by DOE in its license application.

### Multiple Barriers

The proposed technical criteria were developed not only with the understanding that EPA's generally applicable environmental standard would need to be implemented, at least in part, by performing calculations to predict performance, but also with the knowledge that some of those calculations would be complex and uncertain. Natural systems are difficult to characterize and any understanding of the site will have significant limitations and uncertainties. Those properties which pertain to isolation of HLW are difficult to measure and the measurements which are made will be subject to several sources of error and uncertainty. The physical and chemical processes which isolate the wastes are themselves varied and complex. Further, those processes are especially difficult to understand in the area close to the emplaced wastes because that area is physically and chemically disturbed by the heat generated by those wastes.

However, a geologic repository consists of engineered features as well as the natural geologic environment. Any evaluation of repository performance, therefore, will consider the waste form and other engineering factors which are elemental to the performance of the repository as a system. By partitioning the engineered system into two major barriers, the waste package and the underground facility, and establishing performance objectives for each, the Commission has sought to exploit the ability to design the engineered features to meet specific performance objectives as a means of reducing some of the uncertainties in the calculations of overall repository performance.

In addition, the requirements for containment, controlled release rate, and 1,000-year groundwater transit time are three criteria which act independently of the overall repository performance to provide confidence that the wastes will be isolated at least for as long as they are most hazardous.

### Containment and Isolation

During the first several hundred years following emplacement of the wastes, both the radiation from and the heat generated by the wastes are attributable mainly to the decay of the shorter-lived nuclides, primarily fission products. At about 1,000 years after emplacement both the radiation from and heat generated by decay of the wastes have diminished by about 3 orders of magnitude. As the decay of the longer-lived nuclides, primarily actinides, begins to dominate, both the radiation from and thermal output of the wastes continue to fall until almost 100,000 to 1,000,000 years after emplacement. By that time both have diminished by about 5 orders of magnitude and both heat and radiation become roughly constant due to the ingrowth of daughter nuclides, primarily Ra-225, Ra-228 and their decay products.

The technical criteria would require the engineered system to be designed so that the wastes are contained within the waste package for the first thousand years following emplacement. Following this period, containment is no longer assumed and the function of the waste package and underground facility is to control the release of radionuclides from the underground facility. By requiring containment during the period when the thermal conditions around the waste packages are most severe, evaluation of repository performance is greatly simplified to considerations of the degree of conservatism in the containment design relative to events

and processes that might affect the performance during the containment period.

Although both the radiation from and heat generated by the decay of the wastes have diminished about 3 orders of magnitude during the containment period, the area surrounding the emplaced wastes will not return to temperatures near those before the wastes were emplaced until after about 10,000 years. As mentioned earlier, the thermal disturbance of the area near the emplaced wastes adds significantly to the uncertainties in the calculation of the transport of the radionuclides through the geologic environment. The technical criteria are intended to compensate for uncertainties by imposing further design requirements on the waste package and underground facility, thereby limiting the source term by controlling the release rate.

Role of the Site

The Commission neither intends nor expects either containment to be lost completely at 1,000 years following emplacement or the engineered system's contribution to the control of the release of wastes to cease abruptly at some later time. However, the Commission recognizes that at some point the design capabilities of the engineered system will be lost and that the geologic setting—the site—must provide the isolation of the wastes from the environment, and has translated this requirement into a performance objective for the geologic setting. The Commission also recognizes that isolation is, in fact, a controlled release to the environment which could span many thousands of years, and that the release of radionuclides and the potential exposures to individuals which could result, should be addressed in the evaluation of a repository. A complement to the evaluation of the effects of design basis processes and events which might disrupt the repository is a projection of how the repository, unperturbed by discrete external events, will evolve through the centuries as a result of the geologic processes operating at the site. Hence, an amendment is being proposed to that portion of Subpart B of 10 CFR Part 60 which describes the contents of the Safety Analysis Report of DOE's application for geologic disposal of HLW which would require DOE to project the expected performance of the proposed geologic repository noting the rates and quantities of expected releases of radionuclides to the accessible environment as a function of time.

Retrievability

The licensing procedures of 10 CFR Part 60 were written assuming that there would be a program of testing and measurement of the thermal, mechanical, and chemical properties of the major engineered barriers to confirm their expected performance. The Commission would like to tie the requirement for retrievability of the wastes to the expected time needed to execute the performance confirmation program. However, at present it appears to the Commission that neither the specific nature nor the period needed for execution of the performance confirmation program will be certain until construction of the repository is substantially complete; that is, until the actual licensing to receive wastes at a geologic repository. Hence it is difficult at this time to use the performance confirmation program as a basis for establishing a period of retrievability. Nonetheless, DOE is now making critical decisions regarding the design of geologic repositories which will have a direct effect upon how long the option to retrieve wastes can be maintained, and upon the difficulty which will be encounted in exercising that option, should that be necessary for protection of public health and safety. Therefore, to provide a suitable objective in this regard, the proposed rule sets forth a requirement that the engineered system be designed so that the option to retrieve the waste can be preserved for up to fifty years following completion of emplacement. Thus, the waste package and the underground facility would be designed so that the period of retrievability would not be the determinant of when the Commission would decide to permit closure of the repository. Rather, the Commission would be assured of the option to let the conduct of the performance confirmation program indicate when it is appropriate to make such a decision. In particular, the Commission is concerned that the thermo-mechanical design of the underground facility be such that access can be maintained until the Commission either decides to permit permanent closure of the repository or to take corrective action, which may include retrieval.

As it is now structured, the rule would require in effect that the repository design be such as to permit retrieval of waste packages for a period of up to 110 years. The components of this total period are as follows: the first waste packages to go in the repository are likely to be in place about thirty years before all wastes are in place; thereafter, a 50-year period is required by the rule; finally, a retrieval schedule is suggested of about the same time as the original construction plus emplacement operations—another 30-odd years. Since it is probably not practical to adjust the retrievability design aspects of the repository according to the order of emplacement of the waste packages, the 110-year requirement will apply to all of the waste. The Commission is particularly interested in comments on the degree to which this requirement will govern the thermal and mechanical design of the repository and on whether some shorter period would be adequate or whether there are other ways than an overall retrievability requirement to preserve options before permanent closure. The Commission does not want to approve construction of a design that will foreclose unnecessarily options for future decisionmakers, but it is also concerend that retrievability requirements not unnecessarily complicate or dominate repository design.

The retrievability requirement does not specify the form in which the wastes are to be retrievable or that wastes are "readily retrievable." The requirement is simply that all the wastes be retrievable during a period equal to the period of construction and emplacement. DOE's plans for retrieval are specifically requested as part of its license application and the practicability of its proposal will be considered by the Commission. Waste may be retrieved upon NRC approval of a DOE application or upon order by NRC, or otherwise, where authorized by DOE's license.

Human Intrusion

Some concern has been raised on the issue of human intrusion into a geologic repository. Human intrusion could conceivably occur either inadvertently or deliberately. Inadvertent intrusion is the accidental breaching of the repository in the course of some activity unrelated to the existence of the repository, e.g., exploration for or development of resources. For inadvertent intrusion to occur, the institutional controls, site markers, public records, and societal memory of the repository's existence must have been ineffective or have ceased to exist. Deliberate or intentional intrusion, on the other hand, assumes a conscious decision to breach the repository; for example, in order to recover the high-level waste itself, or exploit a mineral associated with the site.

Historical evidence indicates that there is substantial continuity of

information transfer over time. There are numerous examples of knowledge, including complex information, being preserved for thousands of years. This has occurred even in the absence of printing and modern information transfer and storage systems. Furthermore, this information transfer has survived disruptive events, such as wars, natural disasters, and dramatic changes in the social and political fabric of societies. The combination of the historical record of information transfer, provisions for a well-marked and extensively documented site location, and the scale and technology of the operation needed to drill deeply enough to penetrate a geologic repository argue strongly that inadvertent intrusion as described above is highly improbable, at least for the first several hundred years during which time the wastes are most hazardous. Selecting a site for a repository which is unattractive with respect to [illegible] resource value and scientific [illegible] further adds to the improbability of inadvertent human intrusion. It is also logical to assume that any future generation possessing the technical capability to locate and explore for resources at the depth of a repository would also possess the capability to assess the nature of the material discovered, to mitigate consequences of the breach and to reestablish administrative control over the area if needed. Finally, it is inconsistent to assume the scientific and technical capability to identify and explore an anomalous heat source several hundred meters beneath the Earth's surface and not assume that those exploring would have some idea of either what might be the cause of the anomaly or what steps to take to mitigate any untoward consequence of that exploration.

The above arguments do not apply to the case of deliberate intrusion. The repository itself could be attractive and invite intrusion simply because of the resource potential of the wastes themselves. Intrusion to recover the wastes demands (1) knowledge of the existence and nature of the repository, and (2) effort of the same magnitude as that undertaken to emplace the wastes. Hence intrusion of this sort can only be the result of a conscious, collective societal decision to recover the wastes.

Intrusion for the purpose of sabotage or terrorism has also been mentioned as a possibility. However, due to the nature of geologic disposal, there seems to be very little possibility that terrorists or saboteurs could breach a repository. Breach of the repository would require extensive use of machinery for drilling and excavating over a considerable period of time. It is highly improbable that a terrorist group could accomplish this severity.

In light of the above, the Commission adopted the position that commonsense dictates that everything that is reasonable be done to discourage people from intruding into the repository. Thus, the proposed technical criteria are written to direct site selection towards selection of sites of little resource value and for which there does not appear to be any attraction for future societies. Further, the proposed criteria would require reliable documentation of the existence and location of the repository and the nature of the wastes emplaced therein, including marking the site with the most permanent markers practical. However, once the site is selected, marked, and documented, it does no use to argue over whether these measures will be adequate in the future, or to speculate on the virtual infinity of human intrusion scenarios and whether they will or will not result in violation of the EPA standard. Of course, the Commission recognizes that there are alternative approaches to the Human Intrusion question. Accordingly, comment on this and alternative approaches is welcome.

## Relation to Other Parts of NRC Regulations

The proposed rule contemplates that DOE activities at a geologic repository operations area may in appropriate cases be licensed under other parts of NRC regulations and would then not be governed by these technical criteria. We note, in this connection, that the scope section of the procedural rule specifically provides that Part 60 shall not apply to any activity licensed under another part. This allows an independent spent fuel storage installation to be licensed under Part 72, even though located at a geologic repository operations area (provided, of course, it is sufficiently separate to be classified as "independent"). Other DOE activities of the geologic repository operations area could be licensed under Parts 30 or 70 if an exemption from Part 60 is determined to be appropriate.

## Alternative Approach

In the course of the Commission's deliberation, it becomes evident that in order to have confidence in the ability of a geological repository to contain and isolate the wastes for an extended period of time, the repository must consist of multiple barriers. In view of the uncertainties that attach to reliance on the geologic setting alone, the Commission believes that a repository should consist of two major engineered barriers (waste packages and underground facility) in addition to the natural barrier provided by the geological setting. The Commission is emphasizing these elements to take advantage of the opportunity to attain greater confidence in the isolation of the waste. Having reached these conclusions, the Commission considers next whether or not and to what level of detail the performance criteria for a geological repository should be prescribed. In this regard, the Commission considers the following 3 alternatives:[1]

1. Prescribe a single overall performance standard that must be met. The standard in this case would be the EPA standard;

2. Prescribe minimum performance standards for each of the major elements, in addition to requiring the overall system to meet the EPA standards; and

3. Prescribe detailed numerical criteria on critical engineering attributes of the repository system.

Alternative 3 is considered overly restrictive on the design flexibility and judged to be inappropriate at this stage of technological development. Therefore, this alternative is quickly eliminated as a viable regulatory approach.

Alternative 1 has as its principal advantage the fact that it provides maximum flexibility in apportioning credit for containment and isolation to the several elements of the repository. It also allows the designer to incorporate and apply new technological developments and knowledge from the site characterization phase to the repository design. Notwithstanding some concern over its practicality in the regulatory framework, the Commission cannot at this time eliminate it from further consideration. The Commission is, therefore, specifically requesting the general public, particularly those from the technical communities, to comment on this point. In addition, the Commission requests commentors espousing this alternative to address specifically ways in which the Commission might find reasonable assurance that the ultimate standards

[1] Detailed discussions on the advantages and disadvantages of each of these alternatives are given in Appendix J to Commission Paper SECY-81-287, April 27, 1981, "Rationale for Performance Objectives and Required Characteristics of the Geologic Setting." This appendix is being published separately and is available without charge on request to the Commission's Public Document Room, 1717 H St. NW, Washington, D.C. 20555.

are met without prescribing standards for the major elements of a repository.

In relation to the first and the third alternatives that are briefly discussed above, Alternative 2 appears to offer a reasonable and practical compromise. In addition to retaining the single overall performance standard in Alternative 1 as the final performance objective, this approach establishes the minimum performance objectives for each of the 3 major barriers of the repository. While this approach limits the repository designer's flexibility, it is clear that meeting these minimum design goals would substantially enhance the Commission's confidence that the final EPA standard will be met. Therefore, the Commission prefers a technical rule established upon this approach.

It should be noted that, in the event that the Commission decides to adopt the Alternate 1 approach in the final rulemaking, portions of the proposed rule (e.g., the section on requirements for the geological setting) would have to be further studied and possibly revised. In addition, it is possible that further public comments would have to be sought.

Major Features of the Proposed Rule

1. *Overall Description.* The proposed technical criteria have been written to address the following performance objectives and requirements for siting, design and construction of the repository, the waste package, confirmation of repository performance, quality assurance, and the training and certification of personnel. As appropriate, these topics are divided in turn to address separately requirements which apply during construction, waste emplacement, and after permanent closure (decommissioning) of the repository. Although the licensing procedures indicate that there would be separate subparts for siting and design requirements, viz. Subparts E and F, respectively (cf. § 60.31(a)(2)), the NRC now believes that the site and design are so interdependent that such a distinction is artificial and misleading. For example, although the requirement to place the underground facility at a minimum depth of 300 meters is clearly a design requirement, it is manifested as a siting requirement since unless the site has a host rock of sufficient thickness at sufficient depth, the above design requirement cannot be met. Hence the proposed Subpart E to 10 CFR Part 60 contains both site and design requirements.

To enable the Commission to reach a finding as to whether the generally applicable environmental standard for disposal of HLW is met and that public health and safety will be protected, a careful and exhaustive analysis of all the features of the repository will be needed. That analysis necessarily must be both qualitative and quantitative although the analysis can and will be largely quantitative during the period that greatest reliance can be placed upon the engineered system. Thereafter, although the issues of concern, and certainly the physics of a repository itself, do not change, the numerical uncertainties begin to become so large that calulations become a weak indicator of expected repository performance.

In sum, the technical criteria perform two tasks. First they serve to guide DOE in siting, designing, constructing, and operating a repository in such a manner that there can be reasonable confidence that public health and safety will be protected. Second, they serve to guide DOE in those same areas in such a manner that there can be reasonable confidence that the analyses, needed to determine whether public health and safety is protected, can be performed.

2. *Performance Objectives.* The design and operation of the repository are prescribed to be such that during the period that wastes are being emplaced and performance assessed, exposure to workers and releases of radioactivity to the environment must be within limits set by the Commission and the EPA. Further, the repository is to be designed so that the option can be preserved to retrieve the emplaced wastes beginning at anytime up to 50 years following completion of emplacement. Following permanent closure, the repository must perform so that releases are within the limits prescribed by the generally applicable environmental standard which will be set by the EPA. Further, the design of the repository must include a waste package and an underground facility, as well as the site, as barriers to radionuclide migration.

The performance of the engineered system (waste package and underground facility) following permanent closure is specified to require containment of the wastes within the waste package for at least 1000 years following closure, when temperatures in the repository are substantially elevated, and control of the release of nuclides to the geologic environment thereafter.

Transuranic waste (TRU) may be disposed of in a geologic repository. Since transuranic waste does not generate significant amounts of heat, there is no advantage to containment for any specified period. Hence, the requirement for TRU waste is simply a controlled release equivalent to that for HLW, provided they are physically separated from the HLW so that they will not experience a significant increase in temperature.

Although a minimum 1,000-year containment and a maximum one part in 100,000 release rate will satisfy these criteria, the Commission considers it highly desirable that wastes be contained as long thereafter as is reasonably achievable, and that release rates be as far below one part in 100,000 as is reasonably achievable.

3. *Siting Requirements.* Although no specific site suitability or exclusion requirements are given in the criteria, stability and minimum groundwater travel times are specified as required site characteristics. ALARA (as low as reasonably achievable) principles have not been applied to the natural features of a site because they are not amenable to modification once a site is chosen. However, the technical criteria do identify site characteristics considered favorable for a repository as well as characteristics which, if present at the site, may compromise site suitability and which will require careful analysis and such measures as may be necessary to compensate for them adequately. The impact of these characteristics on overall performance would be site specific. Thus, the Commission has judged that these should not be made absolute requirements. Presence of all the favorable characteristics does not lead to the conclusion that the site is suitable to host a repository. Neither is the presumption of unsuitability because of the presence of an unfavorable characteristic incontrovertible. Rather, the Commission's approach requires a sufficient combination of conditions at the selected site to provide reasonable assurance that the performance objectives will be achieved. If adverse conditions are identified as being present, they must be thoroughly charaterized and analyzed and it must be demonstrated that the conditions are compensated for by repository design or by favorable conditions in the geologic setting.

The Commission has not included any siting requirements which directly deal with population density or proximity to population centers. Rather, the issue has been addressed indirectly through consideration of resources in the geologic setting. The Commission believes this to be a more realistic approach given the long period of time involved with geologic disposal. Nonetheless, the Commission invites comment on whether population related siting requirements should be included in the final rule and how they might be implemented.

4. *Design and Construction.* In addition to the requirements on designing for natural phenomena, criticality control, radiation protection, and effluent control, the proposed technical criteria require the design of the repository to accommodate potential interaction of the waste, the underground facility, and the site. Requirements are also placed upon the design of the equipment to be used for handling the wastes, the performance and purpose of the backfill material, and design and performance of borehole and shaft seals. Further, there are requirements related to the methods of construction. The Commission believes such requirements are necessary to assure that the ability of the repository to contain and isolate the wastes will not be compromised by the construction of the repository.

The proposed technical criteria would require that the subsurface facility be designed so that it could be constructed and operated in accordance with relevant Federal mining regulations, which specify design requirements for certain items of electrical and mechanical equipment and govern the use of explosives.

These criteria are a blend of general and detailed prescriptive requirements. They have been developed from Commission experience and practice in the licensing of other nuclear facilities such as power plants and fuel cycle facilities. While there are differences in the systems and components addressed by these criteria from those of power plants or fuel cycle facilities, and the criteria have been written to be appropriate for a geologic repository, the proposed criteria represent a common practice based on experience which has shown that the above items need to be regulated. The level of detail of these criteria reflects the Commission's current thinking on how to regulate effectively geologic disposal of HLW. However, the Commission continues to examine other possibilities for promulgating the more detailed of these requirements. Comments are invited on formulations for the design and construction criteria in the rule, perhaps in a more concise form; these may be supplemented, of course, with more details in staff guidance documents such as Regulatory Guides.

5. *Waste Package.* The proposed requirements for the design of the waste package emphasize its role as a key component of the overall engineered system. Besides being required to contribute to the engineered system's meeting containment and controlled release performance objectives, both compatibility with the underground facility and the site and a method of unique identification are required of the waste package. Included in the section of the proposed technical criteria which deals with the waste package are requirements that the waste form itself contained within the package be consolidated and non-pyrophoric.

6. *Performance Confirmation.* The proposed technical criteria include requirements for a program of testing and measurement (Subpart F). The main purpose of this program is to confirm the assumptions, data, and analyses which led to the findings that permitted construction of the repository and subsequent emplacement of the wastes. Further, the performance confirmation program includes requirements for monitoring of key geologic and hydrologic parameters throughout site characterization, construction, and emplacement to detect any significant changes in the conditions which supported the above findings during, or due to operations at the site. Also included in the program would be tests of the effectiveness of borehole and shaft seals and of backfill placement procedures.

**Regulatory Flexibility Certification**

In accordance with the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission hereby certifies that this rule will not, if promulgated, have a significant economic impact on a substantial number of small entities. This proposed rule affects only the Department of Energy, and does not fall within the purview of the Act.

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, the National Environmental Policy Act of 1969, as amended, and sections 552 and 553 of title 5 of the United States Code, notice is hereby given that adoption of the following amendments to Title 10, Chapter I, Code of Federal Regulations is contemplated.

## PART 60—DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN GEOLOGIC REPOSITORIES

1. The authority citation for Part 60 reads as follows:

Authority: Secs. 51, 81, 82, 83, 84, 91, 161b, i, l, o, p, 181, 182, Pub. L. 83-703, as amended, 68 Stat. 929, 930, 932, 933, 935, 948, 953, 954, as amended (42 U.S.C. 2071, 2073, 2082, 2083, 2097, 2111, 2201, 2232, 2237); Secs. 202, 206, Pub. L. 93-438, 88 Stat. 1244, 1246 (42 U.S.C. 5842, 5846); Sec. 14, Pub. L. 95-601 (42 U.S.C. 2021a); Sec. 10(a)(2), Pub. L. 95-128, 95 Stat. 853 (42 U.S.C. 6134).

2. Section 60.2 is revised to read as follows:

**§ 60.2 Definitions.**

For the purposes of this Part—

"Accessible Environment" means those portions of the environment directly in contact with or readily available for use by human beings.

"Anticipated Processes and Events" means those natural processes and events that are reasonably likely to occur during the period the intended performance objective must be achieved and from which the design bases for the engineered system are derived.

"Barrier" means any material or structure that prevents or substantially delays movement of water or radionuclides.

"Candidate area" means a geologic and hydrologic system within which a geologic repository may be located.

"Commencement of construction" means clearing of land, surface or subsurface excavation, or other substantial action that would adversely affect the environment of a site, but does not include changes desirable for the temporary use of the land for public recreational uses, site characterization activities, other preconstruction monitoring and investigation necessary to establish background information related to the suitability of a site or to the protection of environmental values, or procurement or manufacture of components of the geologic repository operations area.

"Commission" means the Nuclear Regulatory Commission or its duly authorized representatives.

"Containment" means the confinement of radioactive waste within a designated boundary.

"Decommissioning" or "permanent closure," means final backfilling of subsurface facilities, sealing of shafts, and decontamination and dismantlement of surface facilities.

"Director" means the Director of the Nuclear Regulatory Commission's Office of Nuclear Material Safety and Safeguards.

"Disposal" means the isolation of radioactive wastes from the biosphere.

"Disturbed zone" means that portion of the geologic setting that is significantly affected by construction of the subsurface facility or by the heat generated by the emplacement of radioactive waste.

"DOE" means the U.S. Department of Energy or its duly authorized representatives.

"Engineered system" means the waste packages and the underground facility.

"Far field" means the portion of the geologic setting that lies beyond the disturbed zone.

"Floodplain" means the lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of offshore islands and including at a minimum that area subject to a one percent or greater chance of flooding in any given year.

"Geologic repository" means a system for the disposal of radioactive wastes in excavated geologic media. A geologic repository includes (1) the geologic repository operations area, and (2) the geologic setting.

"Geologic repository operations area" means an HLW facility that is part of a geologic repository, including both surface and subsurface areas, where waste handling activities are conducted.

"Geologic setting" or "site" is the spatially distributed geologic, hydrologic, and geochemical systems that provide isolation of the radioactive waste.

"High-level radioactive waste" or "HLW" means (1) irradiated reactor fuel, (2) liquid wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel, and (3) solids into which such liquid wastes have been converted.

"HWL facility" means a facility subject to the licensing and related regulatory authority of the Commission pursuant to Sections 202(3) and 202(4) of the Energy Reorganization Act of 1974 (88 Stat. 1244).[8]

"Host rock" means the geologic medium in which the waste is emplaced.

"Important to safety," with reference to structures, systems, and components, means those structures, systems, and components that provide reasonable assurance that radioactive waste can be received, handled, and stored without undue risk to the health and safety of the public.

"Indian Tribe" means an Indian tribe as defined in the Indian Self-Determination and Education Assistance Act (Public Law 93-638).

"Isolation" means inhibiting the transport of radioactive material so that amounts and concentrations of this material entering the accessible environment will be kept within prescribed limits.

[8] These are DOE "facilities used primarily for the receipt and storage of high level radioactive wastes resulting from activities licensed under such act (the Atomic Energy Act)" and "Retrievable Surface Storage Facilities and r[illegible] facilities authorized for the express purpose [illegible] subsequent long-term storage of high-lev[illegible] active wastes generated by (DOE), which are not used for or are part of research and developmental activities."

"Medium" or "geologic medium" is a body of rock characterized by lithologic homogeneity.

"Overpack" means any buffer material, receptacle, wrapper, box or other structure, that is both within and an integral part of a waste package. It encloses and protects the waste form so as to meet the performance objectives.

"Public Document Room" means the place at 1717 H Street NW., Washington, D.C., at which records of the Commission will ordinarily be made available for public inspection and any other place, the location of which has been published in the Federal Register, at which public records of the Commission pertaining to a particular geologic repository are made available for public inspection.

"Radioactive waste" or "waste" means HLW and any other radioactive materials other than HLW that are received for emplacement in a geologic repository.

"Site" means the geologic setting.

"Site characterization" means the program of exploration and research, both in the laboratory and in the field, undertaken to establish the geologic conditions and the ranges of those parameters of a particular site relevant to the procedures under this part. Site characterization includes borings, surface excavations, excavation of exploratory shafts, limited subsurface lateral excavations and borings, and in situ testing at depth needed to determine the suitability of the site for a geologic repository, but does not include preliminary borings and geophysical testing needed to decide whether site characterization should be undertaken.

"Stability" means that the nature and rates of natural processes such as erosion and faulting have been and are projected to be such that their effects will not jeopardize isolation of the radioactive waste.

"Subsurface facility" means the underground portions of the geologic repository operations area including openings, backfill materials, shafts and boreholes as well as shaft and borehole seals.

"Transuranic wastes" or "TRU wastes" means radioactive waste containing alpha emitting transuranic elements, with radioactive half-lives greater than five years, in excess of 10 nanocuries per gram.

"Tribal organization" means a Tribal organization as defined in the Indian Self-Determination and Education Assistance Act (Public Law 93-638).

"Underground facility" means the underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals.

"Unrestricted area" means any area, access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters.

"Waste form" means the radioactive waste materials and any encapsulating or stabilizing materials, exclusive of containers.

"Waste package" means the airtight, watertight, sealed container which includes the waste form and any ancillary enclosures, including shielding, discrete backfill and overpacks.

3. Section 60.10 is revised to read as follows:

**§ 60.10 Site characterization.**

(a) Prior to submittal of an application for a license to be issued under this part the DOE shall conduct a program of site characterization with respect to the site to be described in such application.

(b) Unless the Commission determines with respect to the site described in the application that it is not necessary, site characterization shall include a program of in situ exploration and testing at the depths that wastes would be emplaced.

(c) As provided in § 51.40 of this chapter, DOE is also required to conduct a program of site characterization, including in situ testing at depth, with respect to alternative sites.

(d) The program of site characterization shall be conducted in accordance with the following:

(1) Investigations to obtain the required information shall be conducted to limit adverse effects on the long-term performance of the geologic repository to the extent practical.

(2) As a minimum the location of exploratory boreholes and shafts shall be selected so as to limit the total number of subsurface penetrations above and around the underground facility.

(3) To the extent practical, exploratory boreholes and shafts in the geologic repository operations area shall be located where shafts are planned for repository construction and operation or where large unexcavated pillars are planned.

(4) Subsurface exploratory drilling, excavation, and in situ testing before and during construction shall be planned and coordinated with repository design and construction.

4. Paragraphs (c)(1), (c)(3), and (c)(13) of § 60.21 are revised to read as follows:

**§ 60.21 Content of application.**

* * * * *

(c) The Safety Analysis Report shall include:

(1) A description and assessment of the site at which the proposed geologic repository operations area is to be located with appropriate attention to those features of the site that might affect facility design and performance. The description of the site shall identify the limits of the accessible environment with respect to the location of the geologic repository operations area.

(i) The description of the site shall also include the following information regarding subsurface conditions in the vicinity of the proposed underground facility—

(A) The orientation, distribution, aperture in-filling and origin of fractures, discontinuities, and heterogeneities;

(B) The presence and characteristics of other potential pathways such as solution features, breccia pipes, or other permeable anomalies;

(C) The bulk geomechanical properties and conditions, including pore pressure and ambient stress conditions;

(D) The bulk hydrogeologic properties and conditions;

(E) The bulk geochemical properties; and

(F) The anticipated response of the bulk geomechanical, hydrogeologic, and geochemical systems to the maximum design thermal loading given the pattern of fractures and other discontinuities and the heat transfer properties of the rock mass and groundwater.

(ii) The assessment shall contain—

(A) An analysis of the geology, geophysics, hydrogeology, geochemistry, and meteorology of the site;

(B) Analyses to determine the degree to which each of the favorable and adverse conditions, if present, has been characterized, and the extent to which it contributes to or detracts from isolation;

(C) An evaluation of the expected performance of the proposed geologic repository noting the rates and quantities of expected releases of radionuclides to the accessible environment as a function of time. In executing this evaluation DOE shall assume that those processes operating on the site are those which have been operating on it during the Quaternary Period and superpose the perturbations caused by the presence of emplaced radioactive waste on the natural processes;

(D) An analysis of the expected performance of the major design structures, systems, and components, both surface and subsurface, that bear significantly on the suitability of the geologic repository for disposal of radioactive waste assuming the anticipated processes and events and natural phenomena from which the design bases are derived. For the purposes of this analysis, it shall be assumed that operations at the geologic repository operations area will be carried out at the maximum capacity and rate of receipt of radioactive waste stated in the application.

(E) An explanation of measures used to confirm the models used to perform the assessments required in paragraphs (A) through (D). Analyses and models that will be used to predict future conditions and changes in the geologic setting shall be confirmed by using field tests, in situ tests, field-verified laboratory tests, monitoring data, or natural analog studies.

* * * * *

(3) A description and analysis of the design and performance requirements for structures, systems, and components of the geologic repository which are important to safety. This analysis shall consider—(i) the margins of safety under normal and conditions that may result from anticipated operational occurrences, including those or natural origin; (ii) the adequacy of structures, systems, and components provided for the prevention of accidents and mitigation of the consequences of accidents, including those caused by natural phenomena; and (iii) the effectiveness of engineered and natural barriers, including barriers that may not be themselves a part of the geologic repository operations area, against the release of radioactive material to the environment. The analysis shall also include a comparative evaluation of alternatives to the major design features that are important to radionuclide containment and isolation, with particular attention to the alternatives that would provide longer radionuclide containment and isolation.

* * * * *

(13) An identification and evaluation of the natural resources at the site, including estimates as to undiscovered deposits, the exploration of which could affect the ability of the site to isolate radioactive wastes. Undiscovered deposits of resources characteristic of the area shall be estimated by reasonable inference based on geological and geophysical evidence. This evaluation of resources, including undiscovered deposits, shall be conducted for the disturbed zone and for areas of similar size that are representative of and are within the geologic setting. For natural resources with current markets the resources shall be assessed, with estimates provided of both gross and net value. The estimate of net value shall take into account current development, extraction and marketing costs. For natural resources without current markets, but which would be marketable given credible projected changes in economic or technological factors, the resources shall be described by physical factors such as tonnage or other amount, grade, and quality.

* * * * *

8. Paragraph (a)(2) of § 60.31 is revised to read as follows:

**§ 60.31 Construction authorization.**

* * * * *

(a) * * *

(2) The site and design comply with the criteria contained in Subpart E.

* * * * *

9. Paragraph (a)(2) of § 60.51 is revised to read as follows:

**§ 60.51 License amendment to decommission.**

(a) * * *

(2) a detailed description of the measures to be employed—such as land use controls, construction of monuments, and preservation of record—to regulate or prevent activities that could impair the long-term isolation of emplaced waste within the geologic repository and to assure that relevant information will be preserved for the use of future generations. As a minimum, such measures shall include—

(i) Identification of the geologic repository operations area by monuments that have been designated, fabricated, and emplaced to be as permanent as is practicable; and

(ii) Placement of records of the location of the geologic repository operations area and the nature and hazard of the waste in the archives of local and Federal government agencies, and archives elsewhere in the world, that would be likely to be consulted by potentional human intruders.

* * * * *

7. New Subpart E, "Technical Criteria," Subpart F "Performance Confirmation," Subpart G, "Quality Assurance" and Subpart H, "Training and Certification of Personnel" are added to 10 CFR Part 60.

**Subpart E—Technical Criteria**

Sec.
60.101 Purpose and nature of findings.
60.102 Concepts.

Performance Objectives

60.111 Performance objectives.
60.112 Required characteristics of the geologic setting.

**Ownership and Control of the Geologic Repository Operations Area**

Sec.

60.121 Requirements for ownership and control of the geologic repository operations area.

**Additional Requirements for the Geologic Setting**

60.122 Favorable conditions.
60.123 Potentially adverse conditions.
60.124 Assessment of potentially adverse conditions.

**Design and Construction Requirements**

60.130 General design requirements for the geologic repository operations area.
60.131 Additional design requirements for surface facilities in the geologic repository operations area.
60.132 Additional design requirements for the underground facility.
60.133 Design of shafts and seals for shafts and boreholes.
60.134 Construction specifications for surface and subsurface facilities.

**Waste Package Requirements**

60.135 Requirements for the waste package and its components.

**Performance Confirmation Requirements**

60.137 General requirements for performance confirmation.

**Subpart F—Performance Confirmation**

60.140 General requirements.
60.141 Confirmation of geotechnical and design parameters.
60.142 Design testing.
60.143 Monitoring and testing waste packages.

**Subpart G—Quality Assurance**

60.150 Scope.
60.151 Applicability.
60.152 Implementation.
60.153 Quality assurance for performance confirmation.

**Subpart H—Training and Certification of Personnel**

60.160 General requirements.
60.161 Training and certification program.
60.162 Physical requirements.

## Subpart E—Technical Criteria

### § 60.101 Purpose and nature of findings.

(a)(1) Subpart B of this part prescribes the standards for issuance of a license to receive and possess source, special nuclear, or byproduct material at a geologic repository operations area. In particular, § 60.41(c) requires a finding that the issuance of a license will not constitute an unreasonable risk to the health and safety of the public. The purpose of this subpart is to set out performance objectives and site and design criteria which, if satisfied, will support such a finding of no unreasonable risk.

(2) While these performance objectives and criteria are generally stated in unqualified terms, it is not expected that complete assurance that they will be met can be presented. A reasonable assurance, on the basis of the record before the Commission, that the objectives and criteria will be met is the general standard that is required. For § 60.111 and other portions of this subpart that impose objectives and criteria for repository performance over long times into the future, there will inevitably be greater uncertainties. Proof of the future performance of engineered systems and geologic media over time periods of a thousand or many thousands of years is not to be had in the ordinary sense of the word. For such long-term objectives and criteria, what is required is reasonable assurance, making allowance for the time period and hazards involved, that the outcome will be in conformance with those objectives and criteria.

(b) Subpart B of this part also lists findings that must be made in support of an authorization to construct a geologic repository operations area. In particular, § 60.31(a) requires a finding that there is reasonable assurance that the types and amounts of radioactive materials described in the application can be received, possessed, and disposed of in a repository of the design proposed without unreasonable risk to the health and safety of the public. As stated in that paragraph, in arriving at this determination, the Commission will consider whether the site and design comply with the criteria contained in this subpart. Once again, while the criteria may be written in unqualified terms, the demonstration of compliance may take uncertainties and gaps in knowledge into account, provided that the Commission can make the specified finding of reasonable assurance as specified in paragraph (a) of this section.

### § 60.102 Concepts.

(a) *The HLW facility.* NRC exercises licensing and related regulatory authority over those facilities described in section 202 (3) and (4) of the Energy Reorganization Act of 1974. Any of these facilities is designated an *HLW facility.*

(b) *The geologic repository operations area.*

(1) This part deals with the exercise of authority with respect to a particular class of HLW facility—namely a *geologic repository operations area.*

(2) A *geologic repository operations area* consists of those surface and subsurface areas that are part of a geologic repository where radioactive waste handling activities are conducted. The underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals, is designated the *underground facility.*

(3) The exercise of Commission authority required that the geologic repository operations area be used for storage (which includes *disposal*) of *high-level radioactive wastes (HLW).*

(4) HLW includes irradiated reactor fuel as well as reprocessing wastes. However, if DOE proposes to use the geologic repository operations area for storage of *radioactive waste* other than HLW, the storage of this radioactive waste is subject to the requirements of this part. Thus, the storage of *transuranic-contaminated waste (TRU),* though not itself a form of HLW, must conform to the requirements of this part if it is stored in a geologic repository operations area.

(c) *Areas adjacent to the geologic repository operations area.* Although the activities subject to regulation under this part are those to be carried out at the geologic repository operations area, the licensing process also considers characteristics of adjacent areas. First, there is to be an area within which DOE is to exercise specified controls to prevent adverse human actions. Second, there is a larger area, designated the *geologic setting* or *site* which includes the spatially distributed geologic, hydrologic, and geochemical systems that provide isolation of the radioactive waste from the accessible environment. The geologic repository operations area plus the geologic setting make up the *geologic repository.* Within the geologic setting, particular attention must be given to the characteristics of the host rock as well as any rock units surrounding the host rock.

(d) *Stages in the licensing process.* There are several stages in the licensing process. The *site characterization* stage, though begun before submission of a license application, may result in consequences requiring evaluation in the license review. The *construction stage* would follow, after issuance of a construction authorization. A *period of operations* follows the issuance of a license by the Commission. The period of operations includes the time during which *emplacement* of wastes occurs; and any subsequent period before permanent closure during which the emplaced wastes are *retrievable;* and *permanent closure,* which includes final backfilling of subsurface facilities, sealing of shafts, decontaminating and dismantling of surface facilities. Permanent closure represents the end of active human activities with the geologic repository operations area and engineered systems.

(e) *Containment.* Early during the repository life, when radiation and thermal levels are high and the consequences of events are especially difficult to predict rigorously, special emphasis is placed upon the ability to contain the wastes by waste packages within an engineered system. This is known as the *containment period.* The *engineered system* includes the waste packages as well as the underground facility. A *waste package* includes:

(1) The *waste form* which consists of the radioactive waste materials and any associated encapsulating or stabilizing materials.

(2) The *container* which is the first major sealed enclosure that holds the waste form.

(3) *Overpacks* which consist of any buffer material, receptable, wrapper, box or other structure, that is both within and an integral part of a waste packa[illegible]it encloses and protects the waste [illegible]r so as to meet the performance objectives.

(f) *Isolation.* Following the containment period special emphasis is placed upon the ability to achieve isolation of the wastes by virtue of the characteristics of the geologic repository. *Isolation* means the act of inhibiting the transport of radioactive material to the accessible environment in amounts and concentrations within limits. The *accessible environment* means those portions of the environment directly in contact with or readily available for use by human beings.

## Performance Objectives

### § 60.111 Performance objectives.

(a) *Performance of the geologic repository operations area through permanent closure.*—(1) *Protection against radiation exposures and releases of radioactive material.* The geologic repository operations area shall be designed so that until permanent closure has been completed, radiation exposures and radiation levels, and releases of radioactive materials to unrestricted areas, will at all times be maintained within the limits specified in Part 20 of this chapter and any generally applicable environmental standards established by the Environmental Protection Agency.

(2) *Retrievability of waste.* The geologic repository operations area shall be designed so that the entire inventory of waste could be retrieved on a reasonable schedule, starting at any time up to 50 years after waste emplacement operations are complete. A reasonable schedule for retrieval is one that requires no longer than about the same overall period of time that was devoted to the construction of the geologic repository operations area and the emplacement of waste.

(b) *Performance of the geologic repository after permanent closure.*—(1) *Overall system performance.* The geologic setting shall be selected and the subsurface facility designed so as to ensure that releases of radioactive materials from the geologic repository following permanent closure conform to such generally applicable environmental radiation protection standards as may have been established by the Environmental Protection Agency.

(2) *Performance of the engineered system.*—(i) *Containment of wastes.*[a] The engineered system shall be designed so that even if full or partial saturation of the underground facility were to occur, and assuming anticipated processes and events, the waste packages will contain all radionuclides for at least the first 1,000 years after permanent closure. This requirement does not apply to TRU waste unless TRU waste is emplaced close enough to HLW that the TRU release rate can be significantly affected by the heat generated by the HLW.

(ii) *Control of releases.*[a]

(A) For HLW, the engineered system shall be designed so that, after the first 1,000 years following permanent closure, the annual release rate of any radionuclide from the engineered system into the geologic setting, assuming anticipated processes and events, is at most one part in 100,000 of the maximum amount of that radionuclide calculated to be present in the underground facility (assuming no release from the underground facility) at any time after 1,000 years following permanent closure. This requirement does not apply to radionuclides whose contribution is less than 0.1% of the total annual curie release as prescribed by this paragraph.

(B) For TRU waste, the engineered system shall be designed so that following permanent closure the annual release rate of any radionuclide from the underground facility into the geologic setting, assuming anticipated processes and events, is at most one part in 100,000 of the maximum amount calculated to be present in the underground facility (assuming no release from the underground facility) at any time following permanent closure. This requirement does not apply to radionuclides whose contribution is less than 0.1% of the annual curie release as prescribed by this paragraph.

(3) *Performance of the geologic setting.*—(i) *Containment period.* During the containment period, the geologic setting shall mitigate the impacts of premature failure of the engineered system. The ability of the geologic setting to isolate wastes during the isolation period, in accordance with paragraph (b)(3)(ii) of this section, shall be deemed to satisfy this requirement.

(ii) *Isolation period.* Following the containment period, the geologic setting, in conjunction with the engineered system as long as that system is expected to function, and alone thereafter, shall be capable of isolating radioactive waste so that transport of radionuclides to the accessible environment shall be in amounts and concentrations that conform to such generally applicable environmental standards as may have been established by the Environmental Protection Agency. For the purpose of this paragraph, the evaluation of the site shall be based upon the assumption that those processes operating on the site are those which have been operating on it during the Quaternary Period, with perturbations caused by the presence of emplaced radioactive wastes superimposed thereon.

### § 60.112 Required characteristics of the geologic setting.

(a) The geologic setting shall have exhibited structural and tectonic stability since the start of the Quaternary Period.

(b) The geologic setting shall have exhibited hydrogeologic, geo-chemical, and geomorphic stability since the start of the Quaternary Period.

(c) The geologic repository shall be located so that pre-waste emplacement groundwater travel times through the far field to the accessible environment are at least 1,000 years.

## Ownership and Control of the Geologic Repository Operations Area

### § 60.121 Requirements for ownership and control of the geologic repository operations area.

(a) *Ownership of the geologic repository operations area.* The geologic repository operations area shall be located in and on lands that are either acquired lands under the jurisdiction and control of DOE, or lands permanently withdrawn and reserved for its use. These lands shall be held free and clear of all encumbrances. If

[a] The Commission specifically seeks comment on whether an ALARA principle should be applied to the performance requirements dealing with containment and control of releases. In particular, the Commission has considered whether the technical criteria should explicitly require containment to be for "as long as is reasonably achievable" and the release rate to be "as low as is reasonably achievable." Comments should address the merits of such a requirement, how to best frame it, and the practicality of its implementation.

significant, such as: (1) rights arising under the general mining laws; (2) easements for right-of-way; and (3) all other rights arising under leases, rights of entry, deed, patent, mortgage, appropriation, prescription, or otherwise.

(b) *Establishment of controls.* Appropriate controls shall be established outside of the geologic repository operations area. DOE shall exercise any jurisdiction and control over surface and subsurface estates necessary to prevent adverse human actions that could significantly reduce the site or engineered system's ability to achieve isolation. The rights of DOE may take the form of appropriate possessory interests, servitudes, or withdrawals from location or patent under the general mining laws.

**Additional Requirements for the Geologic Setting**

**§ 60.121 Favorable conditions.**

Each of the following conditions may contribute to the ability of the geologic setting to meet the performance objectives relating to isolation of the waste. In addition to meeting the mandatory requirements of § 60.112, a geologic setting shall exhibit an appropriate combination of these conditions so that, together with the engineered system, the favorable conditions present are sufficient to provide reasonable assurance that such performance objectives will be met.

(a) The nature and rates of tectonic processes that have occurred since the start of the Quaternary Period are such that, when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(b) The nature and rates of structural processes that have occurred since the start of the Quaternary Period are such that, when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(c) The nature and rates of hydrogeological processes that have occurred since the start of the Quaternary Period are such that, when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(d) The nature and rates of geochemical processes that have occurred since the start of the Quaternary Period are such that when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(e) The nature and rates of geomorphic processes that have occurred since the start of the Quaternary period are such that, when projected, they would not affect or would favorably affect the ability of the geologic repository to isolate the waste.

(f) A host rock that provides the following groundwater characteristics—(1) low groundwater content; (2) inhibition of groundwater circulation in the host rock; (3) inhibition of groundwater flow between hydrogeologic units or along shafts, drifts, and boreholes; and (4) groundwater travel times, under pre-waste emplacement conditions, between the underground facility and the accessible environment that substantially exceed 1,000 years.

(g) Geochemical conditions that (1) promote precipitation or sorption of radionuclides; (2) inhibit the formation of particulates, colloids, and inorganic and organic complexes that increase the mobility of radionuclides; and (3) inhibit the transport of radionuclides by particulates, colloids, and complexes.

(h) Mineral assemblages that, when subjected to anticipated thermal loading, will remain unaltered or alter to mineral assemblages having increased capacity to inhibit radionuclide migration.

(i) Conditions that permit the emplacement of waste at a minimum depth of 300 meters from the ground surface. (The ground surface shall be deemed to be the elevation of the lowest point on the surface above the disturbed zone.)

(j) Any local condition of the disturbed zone that contributes to isolation.

**§ 60.122 Potentially adverse conditions.**

The following are potentially adverse conditions. The presence of any such conditions may compromise site suitability and will require careful analysis and such measures as are necessary to compensate for them adequately pursuant to § 60.124.

(a) *Adverse conditions in the geologic setting.*

(1) Potential for failure of existing or planned man-made surface water impoundments that could cause flooding of the geologic repository operations area.

(2) Potential, based on existing geologic and hydrologic conditions, that planned construction of large-scale surface water impoundments may significantly affect the geologic repository through changes in the regional groundwater flow system.

(3) Potential for human activity to affect significantly the geologic repository through changes in the hydrogeology. This activity includes, but is not limited to planned groundwater withdrawal, extensive irrigation, subsurface injection of fluids, underground pumped storage facilities, or underground military activity.

(4) Earthquakes which have occurred historically that if they were to be repeated could affect the geologic repository significantly.

(5) A fault in the geologic setting that has been active since the start of the Quaternary Period and which is within a distance of the disturbed zone that is less than the smallest dimension of the fault rupture surface.

(6) Potential for adverse impacts on the geologic repository resulting from the occupancy and modification of flood plains.

(7) Potential for natural phenomena such as landslides, subsidence, or volcanic activity of such a magnitude that large-scale surface water impoundments could be created that could affect the performance of the geologic repository through changes in the regional groundwater flow.

(8) Expected climatic changes that would have an adverse effect on the geologic, geochemical, or hydrologic characteristics.

(b) *Adverse conditions in the disturbed zone.* For the purpose of determining the presence of the following conditions within the distrubed zone, investigations should extend to the greater of either its calculated extent or a horizontal distance of 2 km from the limits of the underground facility, and from the surface to a depth of 500 meters below the limits of the repository excavation.

(1) Evidence of subsurface mining for resources.

(2) Evidence of drilling for any purpose.

(3) Resources that have either greater gross value, net value, or commercial potential than the average for other representative areas of similar size that are representative of and located in the geologic setting.

(4) Evidence of extreme erosion during the Quaternary Period.

(5) Evidence of dissolutioning of soluble rocks.

(6) The existence of a fault that has been active during the Quaternary Period.

(7) Potential for creating new pathways for radionuclide migration due to presence of a fault or fracture zone irrespective of the age of last movement.

(8) Structural deformation such as uplift, subsidence, folding, and fracturing during the Quaternary Period.

(9) More frequent occurrence of earthquakes or earthquakes of higher

magnitude than is typical of the area in which the geologic setting is located.

(10) Indications, based on correlations of earthquakes with tectonic processes and features, that either the frequency of occurrence or magnitude of earthquakes may increase.

(11) Evidence of igneous activity since the start of the Quaternary Period.

(12) Potential for changes in hydrologic conditions that would significantly affect the migration of radionuclides to the accessible environment including but not limited to changes in hydraulic gradient, average interstitial velocity, storage coefficient, hydraulic conductivity, natural recharge, potentiometric levels, and discharge points.

(13) Conditions in the host rock that are not reducing conditions.

(14) Groundwater conditions in the host rock, including but not limited to high ionic strength or ranges of Eh-pH, that could affect the solubility and chemical reactivity of the engineered systems.

(15) Processes that would reduce sorption, result in degradation of the rock strength, or adversely affect the performance of the engineered system.

(16) Rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts.

(17) Geomechanical properties that do not permit design of stable underground openings during construction, waste emplacement, or retrieval operations.

**§ 60.124 Assessment of potentially adverse conditions.**

In order to show that a potentially adverse condition or combination of conditions cited in § 60.123 does not impair significantly the ability of the geologic repository to isolate the radioactive waste, the following must be demonstrated:

(a) The potentially adverse human activity or natural condition has been adequately characterized, including the extent to which the condition may be present and still be undetected taking into account the degree of resolution achieved by the investigations; and

(b) The effect of the potentially adverse human activity or natural condition on the geologic setting has been adequately evaluated using conservative analyses and assumptions, and the evaluation used is sensitive to the adverse human activity or natural condition; and

(c)(1) The potentially adverse human activity or natural condition is shown by analysis in paragraph (b) of this section not to affect significantly the ability of the geologic setting to isolate waste, or

(2) The effect of the potentially adverse human activity or natural condition is compensated by the presence of a combination of the favorable characteristics cited in § 60.122, or

(3) The potentially adverse human activity or natural condition can be remedied.

**Design and Construction Requirements**

**§ 60.130 General design requirements for the geologic repository operations area.**

(a) Sections 60.130 through 60.134 specify minimum requirements for the design of, and construction specifications for, the geologic repository operations area. Requirements for design contained in §§ 60.131 through 60.133 must be considered in conjunction with the requirements for construction in § 60.134. Sections 60.130 through 60.134 are not intended to contain an exhaustive list of design and construction requirements. Omissions in §§ 60.130 through 60.134 do not relieve DOE from providing safety features in a specific facility needed to achieve the performance objectives contained in § 60.111. All design and construction criteria must be consistent with the results of site characterization activities.

(b) Systems, structures, and components of the geologic repository operations area shall satisfy the following:

(1) *Radiological protection.* The structures, systems, and components located within restricted areas shall be designed to maintain radiation doses, levels, and concentrations of radioactive material in air in those restricted areas within the limits specified in Part 20 of this chapter. These structures, systems, and components shall be designed to include—

(i) Means to limit concentrations of radioactive material in air;

(ii) Means to limit the time required to perform work in the vicinity of radioactive materials, including, as appropriate, designing equipment for ease of repair and replacement and providing adequate space for ease of operation;

(iii) Suitable shielding;

(iv) Means to monitor and control the dispersal of radioactive contamination;

(v) Means to control access to high radiation areas or airborne radioactivity areas; and

(vi) A radiation alarm system to warn of increases in radiation levels, concentrations of radioactive material in air, and of increased radioactivity released in effluents. The alarm system shall be designed with redundancy and in situ testing capability.

(2) *Protection against natural phenomena and environmental conditions.*

(i) The structures, systems, and components important to safety shall be designed to be compatible with anticipated site characteristics and to accommodate the effects of environmental conditions, so as to prevent interference with normal operation, maintainence and testing during the entire period of construction and operations.

(ii) The structures, systems, and components important to safety shall be designed so that natural phenomena and environmental conditions anticipated at the site will not result, in any relevant time period, in failure to achieve the performance objectives.

(3) *Protection against dynamic effects of equipment failure and similar events.* The structures, systems and components important to safety shall be designed to withstand dynamic effects that could result from equipment failure, such as missile impacts, and similar events and conditions that could lead to loss of their safety functions.

(4) *Protection against fires and explosions.*

(i) The structures, systems, and components important to safety shall be designed to perform their safety functions during and after fires or explosions in the geologic repository operations area.

(ii) To the extent practicable, the geologic repository operations area shall be designed to incorporate the use of noncombustible and heat resistant materials.

(iii) The geologic repository operations area shall be designed to include explosion and fire detection alarm systems and appropriate suppression systems with sufficient capacity and capability to reduce the adverse effects of fires and explosions on structures, systems, and components important to safety.

(iv) The geologic repository operations area shall be designed to include means to protect systems, structures, and components important to safety against the adverse effects of either the operation or failure of the fire suppression systems.

(5) *Emergency capability.*

(i) The structures, systems, and components important to safety shall be designed to maintain control of radioactive waste, and permit prompt termination of operations and

evacuation of personnel during an emergency.

(ii) The geologic repository operations area shall be designed to include onsite facilities and services that ensure a safe and timely response to emergency conditions and that facilitate the use of available offsite services (such as fire, police, medical and ambulance service) that may aid in recovery from emergencies.

(8) *Utility services.*

(i) Each utility service system shall be designed so that essential safety functions can be performed under both normal and emergency conditions.

(ii) The utility services important to safety shall include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform their safety functions.

(iii) The emergency utility services shall be designed to permit testing of their functional operability and capacity. This will include the full operational sequence of each system when transferring between normal and emergency supply sources, as well as the operation of associated safety systems.

(iv) Provisions shall be made so that, if there is a loss of the primary electric power source or circuit, reliable and continued emergency power is provided to instruments, utility service systems, and operating systems, including alarm systems. This emergency power shall be sufficient to allow safe conditions to be maintained. All systems important to safety shall be designed to permit them to be maintained at all times in a functional mode.

(7) *Inspection, testing, and maintenance.* The structures, systems, and components important to safety shall be designed to permit periodic inspection, testing, and maintenance, as necessary, to ensure their continued functioning and readiness.

(8) *Criticality control.* All systems for processing, transporting, handling, storage, retrieval, emplacement, and isolation of radioactive waste shall be designed to ensure that a nuclear criticality accident is not possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. Each system shall be designed for criticality safety under normal and accident conditions. The calculated effective multiplication factor ($k_{eff}$) must be sufficiently below unity to show at least a 5% margin, after allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation.

(9) *Instrumentation and control systems.* Instrumentation and control systems shall be designed to monitor and control the behavior of engineered systems important to safety over anticipated ranges for normal operation and for accident conditions. The systems shall be designed with sufficient redundancy to ensure that adequate margins of safety are maintained.

(10) *Compliance with mining regulations.* To the extent that DOE is not subject to the Federal Mine Safety and Health Act of 1977, as to the construction and operation of the geologic repository operations area, the design of the geologic repository operations area shall nevertheless include such provisions for worker protection as may be necessary to provide reasonable assurance that all structures, systems, and components important to safety can perform their intended functions. Any deviation from relevant design requirements in 30 CFR, Chapter I, Subchapters D, E, and N will give rise to a rebuttable presumption that this requirement has not been met.

**§ 60.131 Additional design requirements for surface facilities in the geologic repository operations area.**

(a) *Facilities for receipt and retrieval of waste.* Surface facilities in the geologic repository operations area shall be designed to allow safe handling and storage of wastes at the site, whether these wastes are on the surface before emplacement or as a result of retrieval from the underground facility. The surface facilities shall be designed so as to permit inspection, repair, and decontamination of such wastes and their containers. Surface storage capacity is not required for all emplaced waste.

(b) *Surface facility ventilation.* Surface facility ventilation systems supporting waste transfer, inspection, decontamination, processing, or packaging shall be designed to provide protection against radiation exposures and offsite releases as provided in § 60.111.

(c) *Radiation control and monitoring.*—(1) *Effluent control.* The surface facilities shall be designed to control the release of radioactive materials in effluents during normal and emergency operations. The facilities shall be designed to provide protection against radiation exposures and offsite releases as provided in § 60.111.

(2) *Effluent monitoring.* The effluent monitoring systems shall be designed to measure the amount and concentration of radionuclides in any effluent with sufficient precision to determine whether releases conform to the design requirement for effluent control. The monitoring systems shall be designed to include alarms that can be periodically tested.

(d) *Waste treatment.* Radioactive waste treatment facilities shall be designed to process any radioactive wastes generated at the geologic repository operations area into a form suitable to permit safe disposal at the geologic repository operations area or to permit safe transportation and conversion to a form suitable for disposal at an alternative site in accordance with any regulations that are applicable.

(e) *Consideration of decommissioning.* The surface facility shall be designed to facilitate decommissioning.

**§ 60.132 Additional design requirements for the underground facility.**

(a) General criteria for the underground facility.

(1) The underground facility shall be designed so as to perform its safety functions assuming interactions among the geologic setting, the underground facility, and the waste package.

(2) The underground facility shall be designed to provide for structural stability, control of groundwater movement and control of radionuclide releases as necessary to comply with the performance objectives of § 60.111.

(3) The orientation, geometry, layout, and depth of the underground facility, and the design of any engineered barriers that are part of the underground facility shall enhance containment and isolation of radionuclides to the extent practicable at the site.

(4) The underground facility shall be designed so that the effects of disruptive events such as intrusions of gas, or water, or explosions, will not spread through the facility.

(b) *Flexibility of design.* The underground facility shall be designed with sufficient flexibility to allow adjustments, where necessary to accommodate specific site conditions identified through in situ monitoring, testing, or excavation.

(c) *Separation of excavation and waste emplacement (modular concept).* If concurrent excavation and emplacement of wastes are planned, then:

(1) The design shall provide for such separation of activities into discrete areas (modules) as may be necessary to assure that excavation does not impair waste emplacement or retrieval operations.

(2) Each module shall be designed to permit isolation from other modules if an accident occurs.

(d) *Design for retrieval of waste.* The underground facility shall be designed to—

(1) Permit retrieval of waste in accordance with the performance objectives (§ 60.111);

(2) Ensure sufficient structural stability of openings and control of groundwater to permit the safe conduct of waste retrieval operations; and

(3) Allow removal of any waste packages that may be damaged or require inspection without compromising the ability of the geologic repository to meet the performance objectives (§ 60.111).

(e) *Design of subsurface openings.*

(1) Subsurface openings shall be designed to maintain stability throughout the construction and operation periods. If structural support is required for stability, it shall be designed to be compatible with long-term deformation, hydrologic, geochemical, and thermomechanical characteristics of the rock and to allow subsequent placement of backfill.

(2) Structures required for temporary support of zones of weak or highly fractured rock shall be designed so as not to impair the placement of permanent structures or the capability to seal excavated areas used for the containment of wastes.

(3) Subsurface openings shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock over the long term. The size, shape, orientation, and spacing of openings and the design of engineered support systems shall take the following conditions into consideration—

(i) natural stress conditions;

(ii) deformation characteristics of the host rock under normal conditions and thermal loading;

(iii) The kinds of weaknesses or structural discontinuities found at various locations in the geologic repository;

(iv) Equipment requirements; and

(v) The ability to construct the underground facility as designed so that stability of the rock is enhanced.

(f) *Rock excavation.* The design of the underground facility shall incorporate excavation methods that will limit damage to and fracturing of rock.

(g) *Control of water and gas.*

(1) Water and gas control systems shall be designed to be of sufficient capability and capacity to reduce the potentially adverse effects of groundwater intrusion, service water intrusion, or gas inflow into the underground facility.

(2) Water and gas control systems shall be designed to control the quantity of water or gas flowing into or from the underground facility, monitor the composition of gases, and permit sampling of liquids.

(3) Systems shall be designed to provide control of water and gas in both waste emplacement areas and excavation areas.

(4) Water control systems shall be designed to include storage capability and modular layouts that ensure that unexpected inrush or flooding can be controlled and contained.

(5) If the intersection of aquifers or water-bearing geologic structures is anticipated during construction, the design of the underground facility shall include plans for cutoff or control of water in advance of the excavation.

(6) If linings are required, the contact between the lining and the rock surrounding subsurface excavations shall be designed so as to avoid the creation of any preferential pathway for groundwater or radionuclide migration.

(h) *Subsurface ventilation.* The ventilation system shall be designed to—

(1) Control the transport of radioactive particulates and gases within and releases from the subsurface facility in accordance with the performance objectives (§ 60.111);

(2) Permit continuous occupancy of all excavated areas during normal operations through the time of permanent closure;

(3) Accommodate changes in operating conditions such as variations in temperature and humidity in the underground facility;

(4) Include redundant equipment and fail safe control systems as may be needed to assure continued function under normal and emergency conditions; and

(5) Separate the ventilation of excavation and waste emplacement areas.

(i) *Engineered barriers.*

(1) Barriers shall be located where shafts could allow access for groundwater to enter or leave the underground facility.

(2) Barriers shall create a waste package environment which favorably controls chemical reactions affecting the performance of the waste package.

(3) Backfill placed in the underground facility shall be designed as a barrier.

(i) Backfill placed in the underground facility shall perform its functions assuming anticipated changes in the geologic setting.

(ii) Backfill placed in the underground facility shall serve the following functions:

(A) It shall provide a barrier to groundwater movement into and from the underground facility.

(B) It shall reduce creep deformation of the host rock that may adversely affect (*1*) waste package performance or (*2*) the local hydrological system.

(C) It shall reduce and control groundwater movement within the underground facility.

(D) It shall retard radionuclide migration.

(iii) Backfill placed in the underground facility shall be selected to allow for adequate placement and compaction in underground openings.

(j) *Waste handling and emplacement.*

(1) The systems used for handling, transporting, and emplacing radioactive wastes shall be designed to have positive, fail-safe designs to protect workers and to prevent damage to waste packages.

(2) The handling systems for emplacement and retrieval operations shall be designed to minimize the potential for operator error.

(k) *Design for thermal loads.*

(1) The underground facility shall be designed so that the predicted thermal and thermomechanical response of the rock will not degrade significantly the performance of the repository or the ability of the natural or engineered barriers to retard radionuclide migration.

(2) The design of waste loading and waste spacings shall take into consideration—

(i) Effects of the design of the underground facility on the thermal and thermomechanical response of the host rock and the groundwater system;

(ii) Features of the host rock and geologic setting that affect the thermomechanical response of the underground facility and barriers, including but not limited to, behavior and deformational characteristics of the host rock, the presence of insulating layers, aquifers, faults, orientation of bedding planes, and the presence of discontinuities in the host rock; and

(iii) The extent to which fracturing of the host rock is influenced by cycles of temperature increase and decrease.

**§ 60.133 Design of shafts and seals for shafts and boreholes.**

(a) *Shaft design.* Shafts shall be designed so as not to create a preferential pathway for migration of groundwater and so as not to increase the potential for migration through existing pathways.

(b) *Shaft and borehole seals.* Shaft and borehole seals shall be designed so that:

(1) Shafts and boreholes will be sealed as soon as possible after they have served their operational purpose.

(2) At the time of permanent closure sealed shafts and boreholes will inhibit transport of radionuclides to at least the same degree as the undisturbed mass of rock through which the shafts or boreholes pass. In the case of soluble rocks, the borehole and shaft seals shall also be designed to prevent groundwater circulation that would result in dissolution.

(3) Contact between shaft and borehole seals and the adjacent rock does not become a preferential pathway for water.

(4) Shaft and borehole seals can accommodate potential variations of stress, temperature, and moisture.

(5) The materials used to construct the seals are appropriate in view of the geochemistry of the rock and groundwater system, anticipated deformations of the rock, and other in situ conditions.

(c) *Shaft conveyances used in radioactive waste handling.*

(1) Shaft conveyances used to transport radioactive materials shall be designed to satisfy the requirements as set forth in § 60.13X for systems, structures, and components important to safety.

(2) Hoists important to safety shall be designed to preclude cage free fall.

(3) Hoists important to safety shall be designed with a reliable cage location system.

(4) Hoist loading and unloading systems shall be designed with a reliable system of interlocks that will fail safely upon malfunction.

(5) Hoists important to safety shall be designed to include two independent indicators to indicate when waste packages are in place, grappled, and ready for transfer.

**§ 60.134 Construction specifications for surface and subsurface facilities.**

(a) *General requirement.* Specifications for construction shall conform to the objectives and technical requirements of §§ 60.130 through 60.133.

(b) *Construction management program.* The construction specifications shall facilitate the conduct of a construction management program that will ensure that construction activities do not adversely affect the suitability of the site to isolate the waste or jeopardize the isolation capabilities of the underground facility, boreholes, shaft, and seals, and that the underground facility is constructed as designed.

(c) *Construction records.* The construction specifications shall include requirements for the development of a complete documented history of repository construction. This documented history shall include at least the following—

(1) Surveys of underground excavations and shafts located via readily identifiable surface features or monuments;

(2) Materials encountered;

(3) Geologic maps and geologic cross sections;

(4) Locations and amount of seepage;

(5) Details of equipment, methods, progress, and sequence of work;

(6) Construction problems;

(7) Anomalous conditions encountered;

(8) Instrument locations, readings, and analysis;

(9) Location and description of structural support systems;

(10) Location and description of dewatering systems; and

(11) Details, methods of emplacement, and location of seals used.

(d) *Rock excavation.* The methods used for excavation shall be selected to reduce to the extent practicable the potential to create a preferential pathway for groundwater or radioactive waste migration or increase migration through existing pathways.

(e) *Control of explosives.* If explosives are used, the provisions of 30 CFR 57.6 (Explosives) issued by the Mine Safety and Health Administration, Department of Labor, shall be met, as minimum safety requirements for storage, use and transport at the geologic repository operations area.

(f) *Water control.* The construction specifications shall provide that water encountered in excavations shall be removed to the surface and controlled in accordance with design requirements for radiation control and monitoring (§ 60.131(c)).

(g) *Waste handling and emplacement.* The construction specifications shall provide for demonstration of the effectiveness of handling equipment and systems for emplacement and retrieval operations, under operating conditions.

## Waste Package Requirements

**§ 60.135 Requirements for the waste package and its components.**

(a) *General requirements of design.* The design of the waste package shall include the following elements:

(1) *Effect of the site on the waste package.* The waste package shall be designed so that the in situ chemical, physical, and nuclear properties of the waste package and its interactions with the emplacement environment do not compromise the function of the waste package. The design shall include but not be limited to consideration of the following factors: solubility, oxidation/reduction reactions, corrosion, hydriding, gas generation, thermal effects, mechanical strength, mechanical stress, radiolysis, radiation damage, radionuclide retardation, leaching, fire and explosion hazards, thermal loads, and synergistic interactions.

(2) *Effect of the waste package on the underground facility and the natural barriers of the geologic setting.* The waste package shall be designed so that the in situ chemical, physical, and nuclear properties of the waste package and its interactions with the emplacement environment do not compromise the performance of the underground facility or the geologic setting. The design shall include but not be limited to consideration of the following factors: solubility, oxidation/reduction reactions, corrosion, hydriding, gas generation, thermal effects, mechanical strength, mechanical stress, radiolysis, radiation damage, radionuclide retardation, leaching, fire and explosion hazards, thermal loads, and synergistic interactions.

(b) *Waste form requirements.* Radioactive waste that is emplaced in the underground facility shall meet the following requirements:

(1) *Solidification.* All such radioactive wastes shall be in solid form and placed in sealed containers.

(2) *Consolidation.* Particulate waste forms shall have been consolidated (for example, by incorporation into an encapsulating matrix) to limit the availability and generation of particulates.

(3) *Combustibles.* All combustible radioactive wastes must have been reduced to a noncombustible form unless it can be demonstrated that a fire involving a single package will neither compromise the integrity of other packages, nor adversely affect any safety-related structures, systems, or components.

(c) *Waste package requirements.* The waste package design shall meet the following requirements:

(1) *Explosive, pyrophoric, and chemically reactive materials.* The waste package shall not contain explosive or pyrophoric materials or chemically reactive materials that could interfere with operations in the underground facility or compromise the ability of the geologic repository to satisfy the performance objectives.

(2) *Free liquids.* The waste package shall not contain free liquids in an amount that would impair the structural integrity of waste package components (because of chemical interactions or formation of pressurized vapor) or result in spillage and spread of contamination in the event of package perforation.

(3) *Handling.* Waste packages shall be designed to maintain waste containment during transportation, emplacement, and retrieval.

(4) *Unique identification.* A label or other means of identification shall be provided for each package. The identification shall not impair the integrity of the package and shall be applied in such a way that the information shall be legible at least to the end of the retrievable storage period. Each package identification shall be consistent with the package's permanent written records.

## Performance Confirmation Requirements

### § 60.137 General requirements for performance confirmation.

The geologic repository operations area shall be designed so as to permit implementation of a performance confirmation program that meets the requirements of Subpart F of this part.

## Subpart F—Performance Confirmation

### § 60.140 General requirements.

(a) The performance confirmation program shall ascertain whether—

(1) Actual subsurface conditions encountered and changes in those conditions during construction and waste emplacement operations are within the limits assumed in the licensing review; and

(2) Natural and engineered systems and components required for repository operation, or which are designed or assumed to operate as barriers after permanent closure are functioning as intended and anticipated.

(b) The program shall have been started during site characterization and it will continue until permanent closure.

(c) The program will include in situ monitoring, laboratory and field testing, and in situ experiments, as may be appropriate to accomplish the objective as stated above.

(d) The confirmation program shall be implemented so that:

(1) It does not adversely affect the natural and engineered elements of the geologic repository.

(2) It provides baseline information and analysis of that information on those parameters and natural processes pertaining to the geologic setting that may be changed by site characterization, construction, and operational activities.

(3) It monitors and analyzes changes from the baseline condition of parameters that could affect the performance of a geologic repository.

(4) It provides an established plan for feedback and analysis of data, and implementation of appropriate action.

### § 60.141 Confirmation of geotechnical and design parameters.

(a) During repository construction and operation, a continuing program of surveillance, measurement, testing, and geologic mapping shall be conducted to ensure that geotechnical and design parameters are confirmed and to ensure that appropriate action is taken to inform the Commission of changes needed in design to accommodate actual field conditions encountered.

(b) Subsurface conditions shall be monitored and evaluated against design assumptions.

(c) As a minimum, measurements shall be made of rock deformations and displacement, changes in rock stress and strain, rate and location of water inflow into subsurface areas, changes in groundwater conditions, rock pore water pressures including those along fractures and joints, and the thermal and thermomechanical response of the rock mass as a result of development and operations of the geologic repository.

(d) These measurements and observations shall be compared with the original design bases and assumptions. If significant differences exist between the measurements and observations and the original design bases and assumptions, the need for modifications to the design or in construction methods shall be determined and these differences and the recommended changes reported to the Commission.

(e) In situ monitoring of the thermomechanical response of the underground facility shall be conducted until permanent closure to ensure that the performance of the natural and engineering features are within design limits.

### § 60.142 Design testing.

(a) During the early or developmental stages of construction, a program for in situ testing of such features as borehole and shaft seals, backfill, and the thermal interaction effects of the waste packages, backfill, rock, and groundwater shall be conducted.

(b) The testing shall be initiated as early as is practicable.

(c) A backfill test section shall be constructed to test the effectiveness of backfill placement and compaction procedures against design requirements before permanent backfill placement is begun.

(d) Test sections shall be established to test the effectiveness of borehole and shaft seals before full-scale operation proceeds to seal boreholes and shafts.

### § 60.143 Monitoring and testing waste packages.

(a) A program shall be established at the repository for monitoring the condition of the waste packages. Packages chosen for the program shall be representative of those to be emplaced in the repository.

(b) Consistent with safe operation of the repository, the environment of the waste packages selected for the waste package monitoring program shall be representative of the emplaced wastes.

(c) The waste package monitoring program shall include laboratory experiments which focus on the internal condition of the waste packages. To the extent practical, the environment experienced by the emplaced waste packages within the repository during the waste package monitoring program shall be duplicated in the laboratory experiments.

(d) The waste package monitoring program shall continue as long as practical up to the time of permanent closure.

## Subpart G—Quality Assurance

### § 60.150 Scope.

(a) As used in this part, "quality assurance" comprises all those planned and systematic actions necessary to provide adequate confidence that the repository and its subsystems or components will perform satisfactorily in service.

(b) Quality assurance is a multidisciplinary system of management controls which address safety, reliability, maintainability, performance, and other technical disciplines.

### § 60.151 Applicability.

The quality assurance program applies to all systems, structures and components important to safety and to activities which would prevent or mitigate events that could cause an undue risk to the health and safety of the public. These activities include: exploring, site selecting, designing, fabricating, purchasing, handling, shipping, storing, cleaning, erecting, installing, emplacing, inspecting, testing,

LAW OFFICES
LOWENSTEIN, NEWMAN, REIS, AXELRAD & TOLL
1025 CONNECTICUT AVENUE, N.W.
WASHINGTON, D.C. 20036
202-862-8400





April 11, 1980

Chairman John F. Ahearne
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Chairman:

As the Commission has announced, the NRC Staff is preparing proposed technical criteria to be included in forthcoming regulations governing the geologic disposal of radioactive wastes (Subpart E - Technical Criteria of Proposed 10 CFR Part 60, Disposal of High-Level Radioactive Wastes in Geologic Repositories). In the course of this preparation, the NRC Staff has discussed the concepts it is incorporating into its proposals with interested agencies and organizations, including the Department of Energy, environmental groups and industry. We understand that the NRC Staff will be submitting a draft proposed regulation to the Commission for its approval and publication in the Federal Register relatively soon; perhaps next month.

We had an opportunity to discuss an early version of the draft technical criteria with the NRC Staff last October. We have been provided a more current version which still contains a number of concepts that we believe to be troublesome.

Although we realize that there will be an opportunity for public comment at such time as the proposed criteria may be approved by the Commission for publication in the Federal Register, we are writing this letter to you now because we believe that the Commission should be aware of certain basic problems <u>before</u> it makes a determination as to whether to issue a proposed regulation for formal comments.

Some of the problems identified below are so basic that we would urge the Commission to direct the NRC Staff to review these areas further and to develop revised proposed regulations which would be more consistent with a sound regulatory approach. In some areas it may be possible that the proposed regulations could be redrafted so as to include alternative approaches for public comments. We are concerned that if the proposed regulation is issued in its present form it will imply that the Commission has decided - albeit only tentatively for purposes of public comments - that the proposal reflects the Commission's current view of the appropriate regulatory approaches. We believe that if the Commission reviews these matters carefully at this time it will wish to avoid creating such a public impression.

We have two basic concerns with the draft regulation and the accompanying document entitled "Approach and Rationale." First, in our view, the proposal is largely inconsistent with the widely accepted "systems approach" to nuclear waste management. We believe it is essential that the NRC regulations define standards and criteria for the acceptable performance of an overall disposal system so that sound programmatic and implementing decisions can be made that result in a conservative approach to meeting performance requirements through an appropriate combination of natural and engineered components of the system. Instead of focusing on performance of the overall system, the proposed regulation, in its present form, specifies minimum or absolute requirements for various aspects of components of the system. Whether or not any of these requirements are individually justifiable, we are concerned that when imposed as a group upon a proposed system they will result in a set of unrelated, unrealistic requirements that are not based upon potential risk to public health and safety or the environment, and that may not be attainable in any one, specific geologic medium or site. In essence, they may amount to an unrealistic collection of redundant requirements which may conceivably be less conservative than appropriate requirements based on system performance. We urge the Commission to direct the NRC Staff to develop criteria and standards tied to a reference methodology for projecting repository performance that is delineated in a manner that bears a logical relationship to known risks (both radiological and non-radiological) from natural events and common activities.

Our second basic concern is that the proposal, in its current form, contains little analysis or rationale in support of the quantitative requirements to be imposed on components of the system, or on processes or conditions that may have some

potential impact on the system. Since the technical or other basis for the requirements is not set forth, it is difficult to evaluate the validity of the Staff's proposal. Moreover, in some instances, requirements are indiscriminately carried over from one area to another. For example, whatever may be the merits of a 2 km control zone for human activities, it is difficult to understand why the same area should be applied in order to preclude or avoid natural processes - a requirement which, in our view, would appear to be much more site dependent and, therefore, could vary under particular circumstances. Again, we urge the Commission to direct the NRC Staff to include in the proposed regulations only requirements for which the Staff can provide a meaningful analytical basis and rationale.

The Attachment to this letter contains a number of additional comments as examples of the types of problems we perceive in the Staff's current approach. We do not suggest that the Commission needs to review them in detail at this time; but they serve to buttress our view that the Commission should provide the NRC Staff with more explicit guidance as to both the objectives of the regulations, and the back-up that the NRC Staff should include for any proposal. For example, we believe that the NRC Staff's proposed lengthy retrievability requirement (see Item 4 of Attachment) not only has no appropriate basis, but will inevitably result in some compromise of containment-isolation integrity and, in addition, may also be misinterpreted as putting off disposal decisions to future generations.

The safe disposal of high level radioactive waste on a timely basis is a matter of transcendent importance. We believe that at each stage in the development of relevant regulations, the Commission will want to proceed in as careful, fully-considered manner as possible. It is in this spirit which we write you now.

We would be pleased, of course, to discuss our views on these subjects with the Commission or with the NRC Staff.

Sincerely,

EDISON ELECTRIC INSTITUTE

By Michael A. Bauser
Michael A. Bauser

MAB:cfw
Attachment

cc: Commissioner Joseph M. Hendrie
Commissioner Victor Gilinsky
Commissioner Richard T. Kennedy
Commissioner Peter A. Bradford
William J. Dircks, Executive
Director for Operations

## Examples of Specific Comments

1. Some of the requirements can be construed as unjustifiably precluding salt and basalt formations as potentially suitable for a deep geologic repository. (See proposed sections 60.122(b)(1)(ii), 60.122(b)(3)(iii), 60.122(b)(4)(ii), 60.122(b)(5).) Clarification and/or revision is needed to relate these requirements to acceptable system performance.

2. The limitation on annual release rate of radioactive material as proposed in section 60.111(b)(3) needs to be clarified (in addition to providing the analytical basis for the quantitative value). Such a requirement must bear some logical relationship to the potential for producing hazard rather than as an arbitrary expression of total inventory (e.g., is a release from a larger capacity repository a priori more acceptable than one from a smaller capacity one?).

3. The proposed regulations appropriately do not require the design to accommodate the effects of meteorite or aircraft impacts. They should similarly exclude from consideration geologic events (e.g., vulcanism, active faulting) that obviously will be extremely improbable at a suitable repository location.

4. The unduly lengthy retrievability requirement in proposed section 60.111(d) will inevitably result in some compromise of containment/isolation integrity. Not only does it violate a systems approach to attainment of effective radiological protection, it also re-raises the issue of putting off disposal decisions to future generations. The retrievability requirement needs much more careful and rigorous analysis before specifying any arbitrary requirement. One basis that should be included in such an analysis is the time

frame in which useful performance or test data and information may be acquired following waste emplacement.

5. 60.121(b): The purpose of the Control Zone (CZ) as stated in this section differs from its application in 60.122. The requirements for controlling human activities differ from the need to avoid natural processes, and the same dimension may not be appropriate for both. Indeed, the dimensions for avoiding some hazards will be different than for others. The vertical distance specified for the CZ would appear to allow directional drilling or mining below the actual repository. If this is intended, it should be clear that such activities must be shown not to compromise containment.

6. 60.122(c)(3)(i): Permeability of $1 \times 10^{-12}$ is below the resolution of most measuring equipment and likely would be difficult to demonstrate with confidence. Instead, there should be included a more reasonable limit that could be measured within the state-of-the-art. Furthermore, existing and anticipated hydraulic gradients are equally important to fluid movement and should also be addressed.

7. 60.122(d)(1): Investigations in the area extending 100 km or more from the site may be appropriate. However, it should be clear that the actual distance investigated would be determined by the location of conditions affecting the site. It may be necessary to investigate certain aspects of some sites at distances of more than 100 km while investigations of other factors or at other sites may be adequate at distances much less than 100 km.

UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY
Washington, D.C. 20451

DOCKET NUMBER
PROPOSED RULE PR-60 (2)
(45 FR 31393)

OFFICE OF THE DIRECTOR

DOCKETED
USNRC
MAY 14 1980
Office of the Secretary
Docketing & Service
Branch

April 11, 1980

Dear Mr. Ahearne:

The Arms Control and Disarmament Agency appreciates the invitation, extended in your letter of March 12, to contribute to the Nuclear Regulatory Commission's rulemaking proceeding on the disposition of radioactive wastes. Although ACDA has no direct programmatic responsibilities in this area, discussions related to the back end of the nuclear fuel cycle have important nuclear nonproliferation implications, and, as such, are of considerable interest to this Agency. Accordingly, we participated in both the International Nuclear Fuel Cycle Evaluation (INFCE) and Interagency Review Group (IRG) analyses of methods for managing and disposing of nuclear waste materials, including, especially, spent nuclear reactor fuel.

With respect to your first two questions, we note that the IRG and INFCE reports concluded that permanent disposal of radioactive waste is technically feasible, and that President Carter has established a schedule which calls for the first full-scale repository to be operational in the mid-1990's.

Your third question dealt with on-site storage of spent fuel in the event of the unavailability of an off-site capability at that time. We understand that the technology for storage of spent fuel in water-filled pools is well-established and has been proven through extensive experience. We know of no evidence that would preclude the use of this storage technology for extended periods. In addition, reliance on dry techniques for long storage periods also appears to be feasible.

We believe it would be useful to make several additional comments. As you know, for reasons associated primarily

Mr. John F. Ahearne
U.S. Nuclear Regulatory Commission
Washington, D.C.

4718..To OGC for Appropriate Action....Cpys to: RF...80-0783

with nuclear proliferation concerns, the U.S. Government has indefinitely deferred support for deployment of a domestic commercial reprocessing capability. As a consequence, consideration is being given to providing for both temporary storage and permanent disposal of high-level wastes in the form of spent fuel which has not been reprocessed. In a position fully supported by ACDA, the IRG found that "reprocessing is not required to assure safe disposal of commercial spent fuel in appropriately chosen geologic environments. Moreover, current United States repository designs are and will continue to be based on the ability to receive either solidified reprocessing waste or discarded spent fuel as a waste material." Thus the question of whether spent fuel is reprocessed or not should not affect conclusions about the availability of off-site disposal facilities for high-level radioactive wastes.

In the shorter term, the Administration is moving toward creation of an away-from-reactor spent fuel storage capability as a further measure for assuring that spent fuel can be safely contained in off-site locations.

Finally, we would like to point out the important nonproliferation implications of an early demonstration of methods for off-site storage and disposal of spent fuel. While the decision to defer commercial reprocessing in this country was based primarily on economic considerations, it was also intended to encourage other countries to consider such deferral. The success of such a policy is, of course, dependent on demonstrating the availability of alternative technologies for coping with the resulting accumulations of spent fuel being generated by operating nuclear reactors. The NRC rulemaking process will constitute an independent assessment of the viability in the U.S. of such alternative technologies, and it may stimulate other countries to consider permanent disposal options which do not require reprocessing.

We hope that these comments will be useful in NRC's rulemaking proceeding.

Sincerely yours,

S M Keeny, Jr.

Spurgeon M. Keeny, Jr.
Acting

JON HINSON
5th District, Mississippi

Committees
BANKING, FINANCE AND URBAN AFFAIRS
EDUCATION AND LABOR

# Congress of the United States
## House of Representatives
Washington, D.C. 20515

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April 16, 1980

DOCKET NUMBER
PROPOSED RULE PR-60 (3)
(45 FR 31393)

DOCKETED
USNRC
MAY 14 1980
Office of the Secretary
Docketing & Service
Branch

Mr. John F. Ahearne
Chairman
Nuclear Regulatory Commission
1717 H Street, NW
Washington, D.C. 20555

Dear Mr. Ahearne:

Please find enclosed a self-explanatory letter from Peter J. Walley.

I respectfully request a report on this matter. Thank you for your assistance.

Sincerely,

Jon Hinson, M.C.

JH/rl

4/24..To OGC for Direct Reply..Suspense: May 2.. Cpys to: EDO Docket, OCA to Ack...80-0830

MISSISSIPPI DEPARTMENT OF NATURAL RESOURCES
Office of Energy
P. O. Box 10536
Jackson, Mississippi 39209
(601) 961-5060

March 3, 1980

Secretary
Nuclear Regulatory Commission
Washington, D. C. 20555

Attn: Docketing and Services Branch

Dear Sirs:

RE: COMMENTS ON PROPOSED RULE FOR DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE (HLW) IN GEOLOGIC REPOSITORIES; PROPOSED LICENSING PROCEDURES

The present approach to the HLW Disposal process evidenced by the proposed licensing procedures outlined in FR.Vol 44, No. 236 is an action in the proper direction. The Mississippi Office of Energy supports the concept of the NRC's involvement in expanded site characterizations rather than provisional construction authorizations and in the review of the Department of Energy's plans for site characterization and site selection procedures, methods and criteria prior to the use of such procedures, methods, and criteria.

There are, however, several comments and questions that deserve additional attention:

1) It is most important at the state and local level that agency representatives and citizens in general have a clear understanding of the roles to be played by DOE, NRC, EPA, and other federal agencies that might be involved. The process now defined tends to cloud and distort the view as to these roles.

   Some overview of these relationships should be made an ongoing part of any state and local public hearing and/or meetings.

2) There are presently several site characterization decisions in progress by DOE, including three sites in Mississippi. The site characterization reports under the pre-application review should apply in retrospect to these efforts.

3) The site characterization report does not address directly the problems of site-related impacts, such as transportation, economic and social, on the local and state infrastructure and population. This should be specifically addressed in any site characterization report.

4) The contents of license applications require plans for coping with radiological emergencies. These types of plans place a considerable amount of responsibility for planning on the state and local governments. The extent and scope of the plans should be defined as in those regulations required for nuclear commercial power reactors

5) In the license amendment to decommission the description of the program for post-decommissioning monitoring should be more specific and require some minimum level of activit in perpetuity.

6) The general tone of the Subpart C--Participation by State Governments--gives the impression that state and local governments are that of observers and occasional participants provided they generate enough activity.

The consultation process should give the state a stronger, more formalized role in the activities of site characterization, particularly those that relate to site specific data as opposed to generic data. The concurrence part of the consultation and concurrence process would then be addressed by any state and/or federal laws in place. The consultation definition and process should be made clearer to the extent that the state has the procedure available to recommend specific courses of action whereupon the Director of the NRC's Office of Nuclear Materials Safety and Safeguards would respond in writing as to why a particular recommendation was not taken, if so. This would define the state participation program in a formal sense. This, of course, would then modify the approval of proposals process (Section 60.83.

Please be assured that Mississippi is vitally concerned with this process and will provide additional comments and concerns as the issue matures.

Sincerely,

Peter J. Walley
Director

PJW/js

cc: Governor William Winter
Attorney General William A. Allain
Mississippi Congressional Delegation

pt. 60

NASA

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator



APR 18 1980

The Honorable John F. Ahearne
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

DOCKET NUMBER
PROPOSED RULE PR-60 (4)
(45 FR 31393)

Dear Mr. Ahearne:

In response to your letter of March 12, 1980, concerning the proposed rulemaking related to safe disposal of radioactive wastes, we have no information that would modify the conclusions of the Report to the President by the Interagency Review Group (IRG) on Waste Management, TID-29442 March 1979. As a result of the IRG study, we consider it to be within the capability of the Nation to solve the waste problems.

Our internal review indicates that the subject of near-term disposal of nuclear waste lies outside of NASA's principle areas of expertise. Accordingly, we believe that it would be proper for us to defer to the judgment of others on the more immediate issues identified in your letter. For the longer term, as the Commission is aware, we are conducting an assessment of space concepts for nuclear waste isolation in support of DOE studies of alternatives in nuclear waste management. On the basis of these studies, we believe one technologically feasible future option may be permanent isolation of nuclear wastes in deep space.

We hope that you find this information useful.

Very truly yours,

Robert A. Frosch
Administrator

5/13/80 :rodv

Department of Energy
Washington, D.C. 20545

APR 18 1980

DOCKET NUMBER
PROPOSED RULE PR-60 (5)
(45 FR 31393)

DOCKETED
USNRC
MAY 14 1980
Office of the Secretary
Docketing & Service
Branch

Honorable Trent Lott
House of Representatives
Washington, D.C. 20515

Dear Mr. Lott:

Thank you for the opportunity to comment on Mr. Peter J. Walley's letter of March 3, 1980 to the U.S. Nuclear Regulatory Commission on their proposed procedures for licensing repositories for the disposal of high-level radioactive wastes. Many of his concerns were addressed by DOE and set forth in DOE's comments to NRC on the NRC proposed procedures. A copy of DOE's comments on the NRC proposed procedures is enclosed for your use in responding to Mr. Walley.

Some clarification of DOE's position may be useful with respect to the second and third itemized points of Mr. Walley's letter. On the second point, we certainly agree that the information presently being developed in site characterization studies underway should be included in reports filed with the NRC and fully intend to do so. An NRC opinion on the completeness of the characterization program would be welcomed and would be included in the planning of any additional tests.

On Mr. Walley's third point, the site characterization report might best, we believe, keep to technical issues related to public health and safety, in line with current recommendations that NRC emphasize those aspects of its oversight of nuclear matters. The socioeconomic and other community impacts mentioned by Mr. Walley would be analyzed in the documents required in compliance with the National Environmental Policy Act (NEPA) and would also be reviewed by the NRC and by State authorities.

Please contact me if I can be of further assistance.

Sincerely,

Original signed by
R. C. Dreschwald

Sheldon Meyers
Deputy Assistant Secretary
for Nuclear Waste Management

Enclosure

cc: w/o enclosure
J. Martin, Dir., Division of Waste Management, NRC
R. Minogue, Dir., Office of Standards Development, NRC

104 Neville Lane
Oak Ridge, TN 37830

DOCKET NUMBER PROPOSED RULE PR-60 (6)
(45 FR 31393)

May 21, 1980



Secretary of the Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Docketing and Service Branch

Gentlemen:

Subject: Proposed Draft Technical Criteria for 10 CFR Part 60

Given below are some comments on the proposed Draft Technical Criteria for 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," as published in Volume 45 of the Federal Register on May 13, 1980, at p. 31393 - 31408.

Subpart 60.2 Definitions

"Disposal" is stated to mean "permanent emplacement within a storage space with no intent to retrieve for resource values." I would suggest that "disposal" should mean emplacement with no intent to retrieve for any reason after decommissioning of the repository. "Disposal" should emphasize that a final decision has been made with respect to these wastes except for unforseeable circumstances that might occur within the repository prior to decommissioning.

"Important to safety" refers to "undue risk to health and safety of the public." Subpart 60.101(b) mentions "unreasonable risk to the health and safety of the public." Is there a difference between "undue risk" and "unreasonable risk" ? Why not use either term, but not both? In any event, the term(s) should be defined to provide more specific guidance in the evaluations that are to be performed in accordance with 10 CFR Part 60.

Subpart 60.111 Performance objectives

Suggested wording in (a)(1) is: ". . . reasonable assurance that radiation exposures and releases of radioactive materials are as low as reasonably achievable and in any event within the limits set forth in Part 20 of this Chapter." (underlined words added)

Subpart 60.122 Siting requirements

It is suggested that the words "Demonstration of" be omitted from (3)(ii) and (3)(iii).

acknowledged by card. 5/28/80: mdu...

Subpart 60.132 Design requirements

The word "practicable" is used in (a)(5)(ii). It should be defined, e.g., to include economic as well as technical and health and safety considerations. The word "feasible" could perhaps be used instead of "practicable." "Feasible" has been judicially defined with respect to OSHA standards for noise [Turner Co. v. Secretary of Labor and OSHRC, 7th Cir., 1977, 561 F.2d 82,85 (6 OSHC 1790)].

The phrase "essential to safety" is used in (a)(8)(iii). This should be defined or the previously defined phrase "important to safety" should be used instead.

Suggested wording in (a)(9)(ii)(a) is: ". . to insure that exposures are as low as reasonably achievable and in any event within the limits of Part 20 of this Chapter." Also, it would be useful to define what is meant by "significantly above background levels." Is this 25 percent greater, 50 percent greater, or what? "Small as compared with the natural background" has been suggested to be interpreted as the standard deviation of the natural background or about 20 millirems/year [H. I. Adler and A. M. Weinberg, Health Physics, 34, 719-720 (1978)]. (in suggested wording, underlined words added)

Subpart 60.133 Waste package and emplacement environment

Suggested wording in (c)(3) is: ". . . exposure to operational personnel will be as low as reasonably achievable and in any event not exceed the values in Part 20 of this Chapter; . . " (underlined words added)

In general, the proposed rules appear to be reasonable and to provide a good basis for high-level waste disposal. It is to be hoped that most of the emphasis will be on the characteristics of the site and not upon the engineered containment features.

Very truly yours,

Arvin S. Quist

Arvin S. Quist

DOCKET NUMBER PROPOSED RULE PR-60 (7)
(45 FR 31393)



Attention: Docketing Division, Samuel Chilk
U.S. Nuclear Regulatory Commission
Office of Public Affairs
Washington, D. C. 20555

June 11/1980

RE: Comments on NRC proposed rulemaking on Technical Criteria for regulating geologic disposal of high-level waste, release No. 80-92, Federal Register May 13,1980

Dear Sirs:

Objection is hereby given in to storing high level nuclear wastes in rock formations. Nuclear wastes should be secured to the best present state of the art, be that in glass, or in other containers, but always with the option of retrieval.

Geology is not an exact science. It is a science in a constant state of flux, evidenced in reality in continental drift. Some of the high level wastes proposed for disposal will require isolation from the environment for 100,000 years or more. Neither the USGS, nor the NRC, nor DOE can guarantee stability of geologic formations, much less predict where and when earthquakes can occur. Modeling for stable geological sites does not insure stability. Models only provide theoretical configurations.

In section 4. Treatment of Uncertainties you state "First, geologic disposal is an entirely new enterprise - no experience exists with geologic disposal." The USSR has attempted geologic disposal. Perhaps the NRC should await the results of their initial attempts before committing the U.S. to this "disposal" method.

Section 5. Human Intrusions. The NRC would not have to be concerned about human intrusions in any high-level nuclear waste repositbry IF you were completely honest in telling the public the dangers associated with these wastes both qualitatively and quantitatively. The NRC and DOE have been very remiss in this and have simply put off the problem by promising a waste management and/or disposal program always sometime in the future.

Section (7) Human Intrusion Problem. "Simply stated, human intrusion cannot be prevented;" If you canNOT keep humans from intruding, HOW can you possibly guarantee the stability of the geologic formation, or the expected behavior of a repository, or the waste/rock interaction? If humans, subject to will and reason, cannot be controlled, how do you expect a human to be able to control an inanimate rock formation?

High Level wastes should be kept, as stated above, in retrievable storage facilities, until a genuine disposal method is found, not a "disposal" that is simply one of "Out of sight, and (hopefully) out of mind". A genuine "disposal" method is one that would render the nuclear wastes completely harmless to man and his environment.

A. E. Wasserbach

A. E. Wasserbach
Box 2308 W. Saug. Rd.
Saugerties, New York 12477

Acknowledged by card. 6/13/80. mdu.

DOCKET NUMBER
PROPOSED RULE PR-60 (8)
(45 FR 31393)

June 13, 1980



Attn: Docketing and Service Branch
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

The following comments on your May 13, 1980 Federal Register notice are offered in the hope that they can be of some use in developing adequate criteria.

First, an observation. It seems that the very worst of all possible circumstances is where we now find ourselves. Because of delays in reprocessing and waste disposal, coupled with the ongoing military weapons program (and to a much lesser extent the civilian power program), we now have scattered throughout the country, millions of gallons of high level wastes and tons of plutonium and fission products. All this material requires continous monitoring and is subject to terrorism, war, natural disaster, and assorted accidents. This situation has already been allowed to continue too long, and is a major issue that should be addressed in any environmental impact statement for the technical criteria. It appears that almost <u>any</u> repository design based on storing insoluble wastes would have less long term impact and risk than our current practice.

Accordingly, in your criteria development please consider the following:

1. No environment can be controlled or assured for very long periods of time. Therefore the fuel reprocessing step should be calibrated so that the activity resulting from the actinide content of the finished waste form does not greatly exceed that in naturally occuring uranium or thorium ores. If this is done, the repositories would need no special considerations for the very long term, including the 10000 years mentioned in 60.122(a-2-iii). 500 years would be more reasonable, as a suggestion.

2. Large amounts of geologic survey work will be done to establish the stability and hydrology of a candidate repository formation. Since this will allow establishment of a high level of confidence in continued stability for a few hundred more years, the repository should then be allowed to accept any reasonably imobilized recoverable waste form such as fused ceramic glass, or even encased metal oxides. Best presently available technology should become the guideline, not some hypothetical future perfection which further delays efforts to clean up our present mess.

3. We already have a fission product and transuranic waste repository, namely the Nevada bomb test site. That repository does not seem to be regarded as a particularly serious hazard, and it has not been engineered for multiple barrier containment, or to prevent future human intervention. Therefore, while it is necessary to have some plan for this, it does not appear justified to study this aspect of the problem exhaustively as

read by card. 6/19/80. [illegible]

suggested in 60.122(1-3), nor to spend any major effort to validate the modeling of future conditions as called for in 60.122(a-6).

4. Since this is a waste repository, only packaging, not processing, of onsite waste should be required (60.132-b-5).

5. Per comment 3, major efforts to study alternative engineered barriers referred to in 60.132-C-2 do not appear reasonable or justified.

6. Section 60.132-D-1-iii does not seem creditable. If the mass of investigation done prior to the start of construction is not sufficient to generate the required confidence the site should be abandoned. No "pilot program" can prove what the site investigations didn't, unless it lasts hundreds of years.

7. Comparative evaluations of alternative waste forms for every repository, as called for in 60.133-a-1, are not justified. DOE should either specify allowable waste forms, or set specifications. In fact this appears to have done in (b), so (a) is entirely without merit.

In summary, the thrust of these comments is toward adopting criteria which tend to permit rather than hinder the development of a repository. The search for absolute perfection is futile, and dangerous, and will result in unjustified expenditures of public funds. Getting state agreement to site a repository could be made much easier, I suspect, by allowing them to charge "use fees" than it would by trying to convince them your criteria are perfect.

B.R. McElmurry
Chemical Engineer

BRM:klg

My address is:

Barry McElmurry
6000 Moongate Dr.
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THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

COLLEGE OF ENGINEERING
DEPARTMENT OF NUCLEAR ENGINEERING

DOCKETED USNRC
JUL 1 1980
Office of the Secretary Docketing & Service Br.
mdv

DOCKET NUMBER PROPOSED RULE PR-60 (9)
(45 FR 31393)

June 26, 1980

Secretary of the
Nuclear Regulatory Commission
Washington, DC 20555

Attn: Docketing and Service Branch

Dear Sir:

Attached are some comments and questions relative to 10 CFR Part 60 as requested on the Federal Register Vol. 45, No. 94, Tuesday, May 13, 1980.

The proposed regulation, in general, is comprehensive, well written and much needed.

Sincerely,

James G. McCray, Acting Director
Nuclear Fuel Cycle Research Program

JGM/km

Enc.

Acknowledged by card 7/1/80 mdv

Comments:

1. Ref §60.122 (a) (2) (i) and §60.122 (a) (8)

   100 kilometers is very arbitrary. The geologic setting could be such that the horizontal extent of investigations would be adequate within 25 kilometers of the operations area. The requirement should indicate detailed investigations to the horizontal extent necessary to define actual and potential, natural and human, impacts.

2. Ref §60.122 (b) (1) What about large populations?

3. Ref §60.122 (b) (2) (vii) Substitute "heat flux" for "gradient" in that gradients vary due to changes in thermal conductivity and boundary conditions.

4. Ref §60.122 (b) (3) What about endangered ecosystems or biota? What about archeological or historical sites?

823 Del Ganado Road
San Rafael, California 94903

DOCKET NUMBER
PROPOSED RULE PR-60 (10)
(45 FR 31393)

June 26, 1980

DOCKETED USNRC
JUL 1 1980
Office of the Secretary Docketing & Service Branch

Secretary
Nuclear Regulatory Commission
Washington, DC 20555

Attention Docketing and Service Branch

Dear Mr. Secretary:

10 CFR Part 60, Technical Criteria for Regulating Geologic Disposal of High-Level Radioactive Waste

This letter is written in response to your Advance Notice of Proposed Rulemaking on the above subject.

I would first like to generally concur and offer my compliments to your staff for an excellent development of the logic relative to a very difficult subject.

Next, I would like to offer the following major comments which I believe to be related to an omission rather than a comment on any one of the proposed criteria. This omission deals with the fact that it is fundamentally wrong to imply that we can predict everything that will occur, or all new factors or phenomena that we will ever discover during the radioactive decay period. However, such a problem is not new to the scientist, or engineer, except to the degree of time involved. The normal engineering solution to such a problem falls into two broad categories. The first category is to provide in the design, and in the construction of a facility, added margins of safety, or spare back-up equipment, which can be utilized when and if necessary. This first category is generally recognized in your criteria. The second category involves incorporation in the basic design, starting at its concept selection, of adequate bases by which future changes can be made to the facility to take care of any reasonably projected possible new factors or phenomena. As examples, the designer of a facility leaves adequate room so that a piece of equipment can be replaced — even though it may not be deemed important enough to have provided a spare, or to even have provided the needed crane. Thus, the distinction is the consideration of, and preservation of, possible future options as contrasted with those which should be fully incorporated into the facilities from the start.

Acknowledged by card 7/1/80 mdv

This logic leads one to further consideration at the concept selection stage of such future options as the reasonableness of diverting future groundwater flows, should they be found to occur, further sealing components that may have not been effectively sealed, and even the longer term recoverability concepts under extreme conditions. (It is also recognized that a strong emphasis on this latter item would lead in the direction of selecting a concept which makes such recoverability easier — i.e., probably the use of less depth, or even a surface final disposition concept. For this reason, I also would not favor the 300-meter minimum depth criteria.)

As a general strategy, I also believe that we ought not to be considering the subject as "disposal", which has a finality connotation that the above logic acknowledges we cannot accept, and which has a growing disfavor with the public. A more responsible scientific and engineering position to take is that we are providing for the "disposition" of wastes in a manner which will adequately store them until their inherent potentially harmful characteristics disappear. I would strongly recommend substitution of the word "disposition" for "disposal".

I also would like to offer the following more detailed comments:

(1) The criteria acknowledges the need to avoid resources that are economically exploitable, and includes as such a resource "... a high and anomalous geothermal gradient relative to the regional geothermal gradient". However, we also should acknowledge that the placement of heat-producing materials in a repository will build up the surrounding temperatures to a level that might be interpreted by a future explorer as just such an anomalous geothermal gradient. Thus, we must conclude that we can have administrative controls for longer than 100 years, or we must not entice the explorer by allowing temperatures to rise to the level that he might interpret as being of interest.

In this regard, it is perhaps important to categorize the wastes by a thermal characteristic, as well as the radioactive characteristics, with the distinction being the time period during which the surrounding media temperature will be increasing (due to a heat generation rate that is greater than the heat dissipation rate) and a time period after which the surrounding media will have essentially returned to normal background temperatures. (It always will be somewhat above ambient.)

(2) The requirement that radioactive waste "... can be retrieved for a period of 50 years after termination of waste emplacement operations, if the geologic repository operations area has not been decommissioned" and that they be able to be retrieved "... in about the same period of time as that during which they were emplaced" is a good general concept but likely will lead to problems as specifically worded.

(a) It is possible that a decision might be made to retrieve only a portion of the wastes, since over the emplacement period differing materials and techniques are likely to evolve.

(b) If the repository is decommissioned immediately after the placement of the first waste package, then there is no retrieval requirement. Further, if it is intended to accomplish such early decommissioning, then the requirement to design and construct a retrievability capability could be construed to not be required. This logic could be further extended all the way out to just short of the 50-year period.

(c) This requirement makes more difficult the backfilling of emplacement tunnels immediately after emplacement — say, with salt being excavated in other portions of the facility.

(d) I do not have facts, but I suspect removal will be considerably more complicated than placement and will require more time, especially if backfilling is conducted prior to decommissioning.

(e) To what extent must retrievability be achieved? Should there be a specification on residual radioactivity in the event of a waste package failure?

(f) What minimum conditions would lead to a requirement to conduct a retrieval operation, and who decides, etc.?

(g) In summary, while agreeing with the retrievability concept, I believe it important to recognize the dynamic nature of the emplacement operations, and to couple the retrievability requirement to them, rather than have a single simple 50-year rule.

(3) The requirement relative to the TRU waste release rate does not specify from where, or to where. Does the definition include the engineered barriers, or just the geologic barrier?

Thank you for the opportunity to offer these comments.

Very truly yours,

Gene H. Dyer

Gene H. Dyer
PE, Nuclear-234, California

PROPOSED RULE PR 60
(45 FR 31393)

ROBERT ABRAMS
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DOCKETED
USNRC
JUL 11 1980
Office of the Secretary
Docketing & Service
Branch

July 9, 1980

Secretary
Nuclear Regulatory Commission
Washington, D.C. 20555

Attention Docketing and Service Branch

Re: Technical Criteria for Regulating Geologic Disposal of High-Level Radioactive Waste; 10 CFR Part 60; 45 F.R. 31393 (May 13, 1980)

Dear Sir:

Enclosed please find comments of the Attorney General of the State of New York with respect to the above advance notice of proposed rulemaking.

Very truly yours,

EZRA I. BIALIK
Assistant Attorney General

EIB:mlr
Enc.

Acknowledged by card 7-11-80

DOCKET NUMBER
PROPOSED RULE PR 60 (11)
(45 FR 31393)

COMMENTS OF THE ATTORNEY GENERAL OF THE STATE OF NEW YORK ON NUCLEAR REGULATORY COMMISSION DRAFT TECHNICAL CRITERIA FOR REGULATING GEOLOGIC DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE; 10 CFR Part 60; 45 F.R. 31393 (May 13, 1980)



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Acknowledged by card. 7-11-80

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

| | | |
|---|---|---|
| In the Matter | : | |
| of | : | PR-50, 51 (44 F.R. 61372) |
| Proposed Rulemaking on Storage and Disposal of Nuclear Waste, 10 CFR Parts 50 and 51 (Waste Confidence Rulemaking) | : | |

STATEMENT OF POSITION OF
ROBERT ABRAMS, ATTORNEY
GENERAL OF THE STATE OF
NEW YORK

## SUMMARY

It is the position of Attorney General Robert Abrams that there is no factual basis today for confidence either that nuclear waste will be safely disposed of by any given date or that it will be safely stored indefinitely until it is disposed of safely. We urge the Commission to make a finding of no confidence on both disposal and storage, and, as a consequence, to discontinue the licensing of new nuclear plants until the waste problem has been resolved.

In order to make a finding of confidence at this time, the Commission, among other things, would have to conclude, from facts existing today, that all technical

Thus, "the fundamental principle guiding all Commission licensing actions is the paramount consideration of public safety." In the Matter of Nuclear Engineering Company, Inc., 9 NRC 673, 676 (1979).

A method of disposal can be called safe only if it gives assurance of total isolation from the environment for the million years or more that isolation is required (see pp. 11-12, below). As the National Academy of Sciences explained in a report prepared at the request of the Atomic Energy Commission:

> Unlike the disposal of any other type of waste, the hazard related to radioactive waste is so great that no element of doubt should be allowed to exist regarding safety... Safe disposal means that the waste shall not come in contact with any living thing.

(Ref. 6, p. 3)* (emphasis supplied). EPA recently affirmed the goal of complete isolation during the hazardous lifetime of the waste. 43 F.R. 53265 (Nov. 15, 1978).

In fact, a majority of this Commission, in the final Table S-3 rule, assumed that there would be absolutely no release of radioactivity from a permanent nuclear waste repository after sealing. 44 F.R. 45362 at 45367-9 (Aug. 2, 1979). The standard should be no weaker now that the NRC faces the task of regulating proposed repositories. No releases should be permitted.

* The list of references appears in the back of the attached Appendix, a copy of our Statement in the Commission's Waste Confidence Proceeding.

into the future from local geologic history alone is not a satisfactory basis for repository site selection." (Ref. 1, p. 3.1.22). Moreover, according to DOE:

> Much basic knowledge about geologic processes, their interactions and particularly their time of next occurrence is lacking for certain types of events over the time periods being considered. The events are those that would be possibly disruptive to a repository... It is questionable how much these problems can be resolved in the near future, and there will always be some uncertainty which must be considered in the repository design.

(Id., p. 3.1.50).

Earthquakes, of course, are important to be able to predict over a long future period, because a major breach of the repository as the result of a severe earthquake "would release enough radiation to make the site uninhabitable if the event occurs within the first few thousand years." (Ref. 29, p. 1-18). Our historical records of earthquakes, however, go back only 200 to 300 years (Ref. 4, p. 11; Ref. 5, p. 37). These records simply do not enable us to predict future earthquakes for thousands of years, let alone a million years. Nor are there reliable theories enabling us to make confident predictions of future earthquakes. See pp. 43-48 of the attached Appendix.

The problem of predicting seismic events is compounded because, as DOE recognizes, the building of a

repository could itself increase the risk of faulting:

> Fault movement could also result from repository placement in several ways: from changes in the stress field due to the geometry of the repository cavity, from added thermomechanical stresses due to heating, or from influx of water along a fault plane.

(Ref. 1, p. 3.1.27).

Long-term prediction of future meteorologic events, such as continental re-glaciation or changes in temperature or precipitation, is equally impossible. Similarly, as the NRC admits, future human intrusions into repositories "cannot be prevented." "In spite of all efforts to avoid sites which may prove attractive to humans, there may be deliberate or inadvertent intrusion." 45 F.R. 31398, col. 2. Therefore, the human intrusion issue is acknowledged to be "a difficult one that is far from having been resolved." Id. col. 3.

Because of these uncertainties, it is necessary, at the minimum, that repositories be designed and regulated to meet the highest conceivable standards, and that they have no known defects or problems. Even if the highest standards are met, that would hardly solve the uncertainty question. However, to compromise our standard at the outset, to accept repositories already known to have defects or problems, or known adverse conditions, is to invite disaster, because

they are more than likely to fail during the very long period under consideration.

Accordingly, the regulations should require total isolation, not isolation "within acceptable limits." § 60.2, p. 31399, col. 2. Routine radioactive releases from the repository within the limits in 10 CFR Part 20, as set forth in § 60.111(a)(1), p. 31400, col. 1, should not be deemed acceptable.

The draft regulations do not comport with the NRC's duty of regulating DOE's activities so as to assure public health to the maximum extent. Rather, they are written in such a way as to suggest a standard of expediency: whatever DOE can easily achieve will be deemed sufficient to satisfy the NRC, regardless of what is truly needed to protect the public today and in the future.

For example, waste packaging is required, with "reasonable assurance," to contain the radionuclides for the "first 1,000 years after decommissioning and for as long thereafter as in [sic] reasonably achievable." § 60.111(c), 31400, col. 1. In effect, whatever the state of the art may be will be accepted by the NRC, without further thought. Again, the underground facility must be designed to provide "reasonable assurance" of containment for the first 1,000 years "and as long thereafter as is reasonably achievable." Id., col. 2. Since

the waste is highly toxic for a million years, there is little point in using the 1,000 year period -- it is a mere one-thousandth of the relevant time period. The standard should be true isolation for the necessary period, not for a very small portion of the necessary period.

Other provisions in the draft are vague, subjective, relative and too weak to assure safety. For example, § 60.111 (c)(2)(i) requires that the environment for the waste packages "promotes the achievement of § 60.111(c)(1)" -- which is much weaker than requiring that it in fact achieve the requirements of that section. P. 31400, col. 1. Similarly, the draft does not require that the site assure isolation, but only that it "exhibits properties which promote isolation." § 60.111(c)(4)(ii), p. 31400, col. 2. Again, DOE's convenience, rather than public safety, appears to be the motivating factor behind the regulations.

2. The draft regulations do not adequately deal with the difficulty of predicting future geologic, meteorologic, and human events. Instead, they evade the issue, discussing some minor issues evidently thought to reduce the problem -- but these issues are so minor as to be of very little value when compared to the enormity of the problem. For example, the proposed answer to the human intrusion problem is to select

deep, "uninteresting" sites of little value in terms of what are now considered valuable resources. P. 31395, col. 3. While such steps may be better than nothing, their impact on reducing the uncertainty of intrusion over a million-year period is very small.

Moreover, the draft regulations seek to avoid the human intrusion problem by defining it away. The definition of "expected processes and events" very specifically excludes human intrusion, § 60.2, p. 31399, col. 1 -- despite the admission that such intrusion cannot be prevented. This defined term is then used repeatedly in § 60.111(c) to free DOE from the responsibility of avoiding human intrusion in meeting performance objectives. P. 31400, col. 1-2. Thus, the theory behind the regulations is to define away the problem of intrusion and forget about it for licensing purposes -- despite the real possibility that an intrusion will permit a large release of radioactivity.

Similarly, the draft regulations do not face the fact that we cannot predict geologic events far into the future. Rather, they talk about compensating for the uncertainty, by selecting "geologically simple sites," avoiding potentially adverse features, and placing "constraints" on design and performance of components. P. 31395, col. 3. But these minor steps hardly compensate for the large uncertainty, or even reduce it by any significant degree. As against the problem

of uncertainty over a million years, they are a frivolous response. Indeed, talk of selecting geologically "simple" sites is pure fantasy and misses the point, because there is no way to predict that such sites will remain simple or stable even for centuries, let alone a million years. See above, pp. 3-5.

The draft sidesteps the problems of uncertainty also by turning to models and engineered barriers, but neither of these is an adequate response. Models are acknowledged to be very indefinite, approximate and "qualitative" rather than quantitative. P. 31395, col. 2-3; p. 31397, col. 2-3. The models are also highly subjective, based not on facts but on "expert opinion," yet it is recognized that different experts may have differing opinions. P. 31397, col. 3. Additional problems with reliance on models are spelled out at pp. 50-54 of the Appendix annexed to these comments. To rely on subjective, qualitative models known to be inaccurate and uncertain, and based on insufficient data, to assure isolation for a million years appears to be reckless.*

The draft regulations also assume that engineered barriers "might be used to compensate for, reduce, or eliminate at least some of the uncertainties inherent in reliance on

* The term "qualitative model" itself is confusing and requires explanation, but in any case such a model does not appear to have any real value for the process of assuring isolation for a million years.

the geologic setting alone." P. 31396, col. 3. While engineered barriers might be of some benefit in the short term, they are not going to reduce long-term uncertainty. They could be built to last perhaps decades, or conceivably centuries, but probably no longer. They are of very limited value where the uncertainties against which they are designed to protect will last for a million years. Moreover, even if such barriers could be helpful in the short-term for a narrow, quantitative uncertainty, they are virtually useless when there is great qualitative uncertainty with respect to virtually every geologic, meteorologic and human element involved. If we knew what the future condition would be but were unsure of its precise dimensions, the problem would be somewhat easier. But we cannot predict even what type of conditions will exist, so we cannot begin to rely on engineered barriers to overcome the uncertainties.

## Specific Comments

3. The design requirements, § 60.132(a), pp. 31402-3, appear to contain special requirements for structures, systems and components "important to safety." While special treatment of items so classified is not new, it was criticized by the Kemeny Commission because the failure of items not so labeled can similarly have serious safety implications. Therefore, all items should be put to the more stringent requirements. The Kemeny Commission also criticized the NRC

requirement to analyze only "single-failure" accidents, noting that Three Mile Island was a multiple failure accident. The draft regulations, therefore, should not limit themselves to single-failure analysis. § 60.132(a)(8), p. 31403, col. 2. Indeed, during the course of a million years many multiple-failure accidents must be considered likely. This consideration also demonstrates the inadequacy of the criticality provision, § 60.132(a)(10), id., col. 3. During the course of a million years, "two unlikely, independent and concurrent or sequential changes" are not so unlikely.

4. In many places, the draft regulations require certain things for a period of only 1,000 or 10,000 years. Since the necessary isolation period covers the entire period of toxicity, one million years, the shorter time periods are irrelevant. Requiring isolation for 1,000 or even 10,000 years is far from adequate to assure public health and safety. As one court has noted:

> Plutonium is generally accepted as among the most toxic substances known; inhalation of a single microscopic particle is thought to be sufficient to cause cancer. Moreover, with a half-life of 25,000 years, plutonium must be isolated from the environment for 250,000 years before it becomes harmless.

Natural Resources Defense Council v. U.S. Nuclear Regulatory Commission ("NRDC v. NRC"), 547 F.2d 633, 638-9, rev'd and rem on other grounds sub nom. Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519 (1978) (footnotes omitted)

(emphasis added). Other components of high-level waste have half-lives much longer than plutonium, and may require isolation for a million years. Because nuclear waste contains such long-lived substances, DOE has acknowledged the need to isolate it for up to one million years. (Ref. 1, p. 1.9).

5. The definition section, § 60.2, includes in the term "accessible environment" only those aquifers which are presently used and have been designated by the Environmental Protection Agency as underground sources of drinking water. P. 31399, col. 1. An "aquifer" is then defined in terms of yielding "significant quantities of water to wells or springs." In view of the water shortages already experienced in some parts of the country and those which could arise in the future, the regulations should attempt a more comprehensive protection of groundwater from radiation -- encompassing even small aquifers not currently used or designated by the EPA.

Moreover, the draft regulations do not require, as they should, avoiding all sites near aquifers or lakes or rivers. See Appendix, p. 58. Rather, they omit this obvious requirement from § 60.122(b)(3), p. 31402, col. 1. In addition, the regulations should require abandonment of any site where aquifers are found, but fail to do so. § 60.132(c)(9), p. 31405, col. 2.

6. The draft provides that the activities authorized by a license should "not constitute unreasonable risk to the

health and safety of the public." P. 31399, col. 3. As in other NRC licensing matters, the degree of risk deemed unreasonable is not defined. It is worth noting, however, that the public's perception of risk differs from that of the technical community, which defines risk as the probability than an event (such as a major release of radioactivity from a repository) will occur multiplied by the expected consequences of the event. By this definition, if the probability is small enough the risk may be viewed as modest, despite the possibly calamitous consequences of an accident. But the public does not accept that reasoning. According to a report by Battelle Pacific Northwest Division:

> The general public often perceives the outcomes of an event to be more important than the probability.

Ref. 19, p. 14 (citation omitted). The NRC should learn to be responsive to the public's perception of risk.

7. The draft would require DOE to perform a resource assessment for the region of the proposed repository site "using available information". § 60.122(a)(8), p. 31401, col. 1. Yet DOE acknowledges that present levels of information on possible regions are inadequate. See pp. 65-67 of the attached Appendix. Because of the importance of a complete resource assessment for the human intrusion and other issues, DOE should be required to do further studies and testing, rather than limit itself to available information.

8. The regulations require DOE to design and construct surface facilities for retrieval of waste, but do not require storage capacity for all of the emplaced waste because "shipment offsite" is contemplated. § 60.132 (b)(2), p. 31403, col. 3 - p. 31404, col. 1. It is not clear, however, where the waste could be shipped offsite, or if any suitable site would exist. Even if one does exist, shipment of nuclear waste would be required, and that is very hazardous. Therefore, DOE should be required to have sufficient storage capacity in a safe, licensed storage facility at the repository site to permit prompt retrieval of all the waste in case DOE sees a need for retrieval, or the NRC orders it.

Also with respect to retrievability, the regulations require DOE to design the repository to permit retrieval for 50 years "if the geologic repository operations area has not been decommissioned." § 60.111(a)(b), p. 31400, col. 1. See also § 60.135, p. 31407, col. 2. While retrievability for at least 50 years may be desirable, it is not clear what period would be required in case the area has been decommissioned, or why a different period should be designated.

9. Various terms used in the draft regulations need to be defined. For example, DOE is required to establish that certain properties of the geologic environment "will not significantly decrease over the long term." § 60.111(c)(4) (i) and (ii), p. 31400, col. 2. The standard is very vague, and "long term" is not defined. Also undefined are "near field,"

in § 60.122(b)(2)(iv), p. 31401, col. 3, and "low population density," in § 60.122(c)(2)(v), p. 31402, col. 3.

10. The draft establishes a presumption against repository sites with potentially adverse conditions, but allows for a rebuttal of the presumption, § 60.122(b), p. 31402, col. 1. In view of the commitment to conservative planning expressed by DOE and NRC, any presumption based on the existence of adverse conditions should be irrebuttable.

11. The question is raised whether attempts should be made "to protect future generations from the deliberate intruder." P. 31398, col. 2. The answer, of course, is yes. Future generations should not be exposed to deadly radiation produced by our generation, even if one or more members of future generations act deliberately.

12. DOE is required by the draft to conduct site investigations so as to obtain the necessary information "with minimal adverse effects on the long-term performance of the geologic repository." § 60.122(a)(5), p. 31401, col. 1. The regulations should require that the investigation work have no adverse effects on the long-term performance, and certainly that it not breach the integrity of the repository.

13. In discussing emergency capability, § 60.132(a)(7), p. 31403, col. 1-2, the draft regulations do not require emergency plans for evacuating the surrounding population even

for the 10-mile area now being required for nuclear plants. Because of the serious consequences a repository accident could have, evacuation and other emergency planning no less than that required for power plants should be required for repositories.

14. As previously noted, p. 9, models are very inaccurate, uncertain and subjective, and therefore not reliable. For this reason it would be wrong to codify them in the regulations, as discussed beginning at p. 31397, col. 2.

NRC Environmental Impact Statement

15. The NRC environmental impact statement on the technical criteria should discuss, among other things: (i) worst possible accident scenarios and consequences for a repository, including multiple failure accidents; (ii) the extent to which the draft regulations assure true safety for the present and future generations; (iii) the environmental impacts of permitting regular releases of radioactivity from repositories, and of requiring less than total isolation of the wastes for the necessary one million years; and (iv) the environmental impacts of licensing repositories despite the fundamental uncertainties caused by our inability to predict

geologic, meteorologic and human events far in the future.

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