Comments by the National Council on Radiation Protection and Measurements

on August 1982 Draft of NRC

10 CFR Part 20 Revisions

The comments are divided into two parts, General and Detailed. Among the detailed comments are many minor corrections but there are some more major points as well. We have therefore marked the more important items, somewhat arbitrarily, with an asterisk. Also, the same comment may occur in more than one place.

General Comments

In our opinion this document is not as well written as it should be; it is unclear and even inconsistent in a number of key points. It purports to follow the ICRP philosophy of radiation protection but contains modifications that are not clearly identified, justified or explained, although they may perhaps be improvements. In the document, some assumptions are made about biological facts that are outside of the mainstream of present judgement in this area. Examples of each of these points will be presented, but without an attempt to include all comments that might fall under each item nor to arrange them in order of importance. Also a comment on a given statement is not necessarily made at all places in the document where it might have been. For convenience, each comment will be keyed to either the page and, if necessary, to the appropriate line or the page, paragraph and line of either the "Proposed Rulemaking" document or the "Part 20 draft" of August 1982. Thus, 2,4,1 means page 2, paragraph 4 line 1.

DS10 add: R. Baker 1/30 55

Lack of Clarity

As an example of the lack of clarity of the document, page 33 of the Part 20 draft, paragraph labeled (2) and footnote 3 might be cited.

Clarity is lacking on as fundamental an item as the limit of intake of radionuclides. Paragraph (2) and footnote 3 are under the heading "Permissible Levels of Radioactive Material in Effluents and Radiation in Unrestricted Areas". Presumably, the "permissible level" is specified as an annual limit. But here, the rules are modified by specifying an hourly limit as the average for one 2500th of a year. This is further compounded by suggesting an instantaneous rate limit equal to the average hourly rate. The latter two can only be appropriate as screening or alert levels. Certainly, the regulations must clearly distinguish between annual limits and alert levels. No confusion is permissible here!

Purporting to Follow ICRP

As as example of "purporting to follow ICRP philosophy", page 9 of the proposed rulemaking document might be cited. It says that, "the proposed revision would adapt (sic) the relative sensitivity values or weighting factors in ICRP publication 26." ICRP uses these factors to define the "effective dose equivalent", that is, the uniform whole body dose equivalent that would produce the same presumed effect as the non-uniform irradiation in a practical situation. ICRP has further said that the effective dose equivalent limit for irradiation, by an external source only, would be met if measurements of the deep dose equivalent index did not exceed the annual limit for the whole body and if the shallow dose equivalent index did not exceed the dose limit for the skin. The present document defines the effective dose equivalent for irradiation by external sources as the dose equivalent at 1

centimeter depth (the location of this depth on the human body or phantom is not given and in fact on page 27 of the Part 20 revision it speaks of a deep dose equivalent to the embryo/fetus without indicating how one makes such a determination when the embryo has dimensions of less than 2 centimetres). While the document indicates that the writers are in touch with international groups involved in recommendations in this area, it seems inappropriate to modify the meaning of a key term in the ICRP "system" without detailed exposition of the basis for the modification or a suitable authoritative reference to published work describing the reasons for this change in detail.

Risk Estimates as a Basis

More general concerns about the NRC's effort to revise 10 CFR Part 20 need to be expressed. The recommendations of the ICRP, as set out in ICRP Publication 26, are, already, more than 5 years old. One would hope that the NRC, in an undertaking as important as the revision of 10 CFR Part 20, would seek to utilize the most recent thinking and information available on radiation protection matters including any revisions of thinking in ICRP or elsewhere, including NCRP. A fundamental set of data for the implementation of the ICRP philosophy is the set of risk coefficients for the various organs. Page 8 of the Proposed Rulemaking document lists the various groups that have provided information on risk coefficients needed. However, no evidence is given of an attempt to analyze these data in order to ascertain the "best values" to be employed now. It is of interest to note that the referenced UNSCEAR 1977 document on page 414 paragraph 318, indicates a range of somatic risk coefficients for whole body exposure of from 0.75 to 1.75 x 10^{-4} rad $^{-1}$, but with a further notation that data yielding these numbers were for cancer mortalities induced at doses in excess of 100 rads of low LET

radiation. Furthermore, UNSCEAR points out that the risk coefficients may well be substantially less than these numerical values for the absorbed doses of interest in routine radiation protection. The cancer mortality risk coefficient from UNSCEAR should be compared with the ICRP value of 1.25×10^{-2} Sv^{-1}. Incidentally, ICRP Publication 27 gives a value of 1.00×10^{-2} Sv^{-1} for males and 1.40×10^{-2} Sv^{-1} for females (table 13, p.21) or 1.50×10^{-2} Sv^{-1} (legend to Figure 4 p.21) i.e. there is uncertainty in the ICRP values themselves. Additional differences exist in that UNSCEAR appears to regard the values as upper limits, while ICRP (Stockholm Statement 1978) gives them as "best" values. Further differences in risks for the sexes, relative risk vs absolute values appear in Beir 1980. Further data yet, expecially on some solid tumors, is now emerging in the recent RERF papers from Japan (Kato and Schull) including the risks of mental retardation after irradiation in utero. These matters are treated only cursorily or not at all when what is needed is a thorough current appraisal. Thus, an exposition of the basis for selecting the values used is important.

Biological Facts and Unsupported Assumptions

As an example of an unsupported assumption of biological facts page 19 (paragraph 20.102) (a) (1) (i) of the Part 20 draft might be cited. Here it is indicated that, if there is a conflict between minimizing individual and collective effective dose equivalents, one should prefer minimizing individual rather than collective effective dose equivalents. It is essential that the rationale for such a rule be provided. One could understand such a rule if the risk coeffient was continuously decreasing over the range of annual effective dose equivalents received by the group for which the collective effective dose equivalent is to be determined. However, for low-LET

radiations, a dose-rate effectiveness factor (reduction in the risk coefficient with decreasing rate) is thought to be from 2 to 10 as the doses drop from perhaps 50 or 100 rads at high rates to the order of a few rads or less. The data or theories giving a continuous reduction in the risk coefficients below values of a few rads for low LET radiation should be identified. One explanation for the experimentally observed 2 to 10 dose-rate effectiveness factors depends upon a presumed repair of an initial sub-lesion before a second energy deposition "fixes" the damage. If this is so, one should observe relatively few "fixings" below absorbed doses for which there is small possibility of more than one energy depositing particle traversing the sensitive site in a time short compared to the repair time. It would be unusual to expect two such traversals below a few tenths of a rad in a given year. If a second traversal is very unlikely, why should the dose-effect relationship be other than proportional? It would seem that another explanation for the presumed continued reduction in the risk coefficient with decreased dose would need to be given. What is the explanation for this presumed reduction in the risk coefficient?

Committed Dose Equivalent

The ICRP recommendations and the proposed rules in these documents indicate that the committed dose equivalent from an internally deposited radionuclide should be recorded for the year of the intake of the radionuclide. The "committed dose equivalent" from such an intake is the dose equivalent received for 50 years after the intake. When the effective half life is very long, the annual dose from this one year's intake falls only slowly with time over the 50 years. Thus, recording the committed dose equivalent for such a radionuclide in the year of the intake would mean that

the annual dose received for each year would be only 1/50th of that recorded for the year. We understand that many reviewers of previous drafts objected to such a requirement. The basis for the rejection of these views should be made evident. It is noted that the practice of making calculations in this way was common in earlier "MPC" days. What is different, now, however, is that it is proposed that these calculations become part of the dose limit in the year of intake; this is quite different.

SI Units

Another point of non comformance with ICRP (and ICRU) is the only partial use of SI units. Both International Commissions recommended their adoption and ICRP uses them virtually exclusively in protection matters. NCRP, in a report soon to be released also recommends their use. NRC has, of course, given the SI equivalent in their revision, but not in the proposed rule making. They could go further in the revision and give SI first, so that the document is in SI and the formerly used units in brackets instead of the other way around. Perhaps if NRC waits 2 years, as NCRP suggests below, they will have more courage to do so then.

The Timing of the Revisions of Part 20

It may be appropriate here to comment on the timing of these revisions. It has already been identified that there is no urgent need for the revisions because they make no major change in levels or practices. What are the advantages of waiting and for how long?

Advantages of waiting.

(1) Better risk estimates. These are, of course, continuously improving as our knowledge improves, but at the present are in a particular state of

flux, partly because of the revisions in the Japanese dosimetry (initiated incidentally by NCRP) but also because of the accumulation of the Japanese data itself and the changing appreciation of the comparative importance of relative vs absolute risk. The next four year accumulation of Japanese data (ending in 1982, analyses by end of 1983 perhaps) should be fairly definitive with respect to the relative ratio (to leukemia) of the solid tumors, a most important, indeed critical, ratio in the UNSCEAR estimates. This ratio may itself also be affected by the revisions in dosimetry. The revisions in dosimetry may also be available in 1984. Thus the situation with risk estimates should improve greatly in the 1984/85 time frame.

(2) ICRP and risk estimates. ICRP has conflicting statements about the meaning of its risk estimates and some confusion as to their values (even in 1977) which is noted above. Without a definitive statement about this, it is not possible to understand how to apply Q values for radiations other than low LET. Values of RBE at low doses are higher than currently assigned Q values, see for example, recent paper by W.K. Sinclair. How does NRC propose to handle this? It is a MAJOR problem.

(3) Also germane to the advantages of waiting is the opportunity to over come other difficulties with the ICRP 26 system, for example

(a) It is complex to apply

(b) It is uneven in its attempt to equate risks

(c) W_T's are not much use for external radiation, furthermore they may be subject to alteration as a result of increased understanding of the relative sensitivity of organs and they average the risks for both sexes for breast and gonads.

(d) Partial body exposure is ignored in spite of the complex detail of the W_T's.

(e) There is confusion on monitoring and recording levels which should be clarified. Also monitoring at or above 3/10 level of dose limits is not a good recommendation. It is noted that NRC did not use it, they use 1/10th but apparently only for whole body exposure. This is better, but possibly still not adequate when "average" occupational exposures is used as a justification of the dose limits.

(f) Better definition of the relationship between the badge reading and the organ dose is needed.

(4) NCRP is expected to produce a report on basic protection criteria during 1983. Although it will be too early to deal with the revisions in dosimetry and update in data from Japan, it will at least provide a good critique of current risk estimates, clarify the risk estimate base for low LET radiation and the Q base for other than low LET radiations and discuss acceptability. Hopefully, it will simplify the application of the principles both ICRP and NCRP believe in but will go much further than ICRP 26 could do at the time it was produced. Furthermore, we feel it represents the best scientific base the professional field in the USA can provide at this time. NRC should wait for it!

(5) ICRP will revise ICRP 26 in the period 1985-89. The revisions are already being talked about and many of them will deal with questions we have commented upon here. The ICRP revisions may be too far into the future but NCRP (item 4) will very probably introduce many valuable changes.

Although there has been a lot of talk about it, it is not clear how many countries are actually using ICRP 26.

These considerations suggest, that rather than waiting forever, NRC (and everyone else) might be in a much better position to be revising 10 CFR Part

20 about 2 years from now i.e during 1984. Considering the time already spent this seems to us to be worth waiting for.

Detailed Comments on Proposed Rule Making

Page 1 last paragraph and page 2 first paragraph. The first sentence invites presentation of additional information and comments on the proposed rule - and the last sentence wishes to hold to the "objectives of the rule". Does this mean that substantive comments will be considered only if they do not adversely effect the "objectives of the rule" (whatever that means) ?

3, line 6. Do the authors mean "but serious short comings remain" ?

3, line 9. Most people couldn't care less about whether the information was outdated. They would only be interested if newer information indicated substantial modifications over that provided by the present Part 20. By "substantial", one might denominate those that would require revision by at least a factor of 2.

3, para 3, lines 4-7. Insubstantial justification for revision.

3, para 3, lines 9 and 10. "but an RBE of 10 is used in the derivation of appendix B values now in force." ***

3, para 3, lines 10-12 Specific information about inadequacies of "Present Part 20" should be provided. Does it really "condone actions which cause exposures at the exposure limits." ***

3, last paragraph, first sentence This is apparently aimed at justifying recording by name all of the dose information for each individual occupationally exposed. First of all, one might question whether "it is difficult for the NRC to determine the adequacy of the protection for workers" in general from listings of the number of persons in various dose range ***

categories. It might be argued, however, that there is justification for examining the few people that are here categorized as "transient workers". However, this must be a very small percentage of the million or more workers who are categorized as occupationally exposed. Unless it can be shown that such transient workers comprise a substantial majority of those now categorized as occupationally exposed, such a brute force, expensive operation can not legitimately be justified. Furthermore, requirements can be placed on employers which NRC can check but without such detailed information as the names of individuals.

Furthermore, if no lifetime exposure limit or guidance is required, what is the justification for keeping records at all?

As an alternative, one could require that those persons receiving an average hourly dose above a certain value should be reported to NRC. One could select such people on the basis of the quotient of the effective dose equivalent they receive and the number of hours they work. Let us assume that the annual effective dose equivalent limit is 5 rems. If the worker is employed at an installation for 2000 hours and he received the limiting dose in a given year, his average dose equivalent rate would be 2 ½ mrem per hour. Suppose that each licensee were asked to not only provide statistical information on doses but also to identify by name those for whom the effective dose equivalent divided by the number of hours of work exceeded a few millirems per hour. This should identify all of those who are "transient workers" plus, perhaps, as much as 1 per cent who are not transient workers. It would seem that such a scheme would take only about one per cent of the work envisioned by the recommendation and probably could be justified at least until the magnitude of the problem is assessed.

The remainder of the words used to justify this large scale program are

not convincing. If there are additional points that have been missed in trying to intepret the words in this paragraph, we would be willing to consider the problem further.

4, 4, 2-4. It points out that the current Part 20 rules are based upon *** the "critical organ concept" and implies that this is bad. It is worthwhile to compare the doses received under this system and under the ICRP publication 26 system.

The enclosed Table I lists the annual doses for specified organs as given in the present Part 20 and in the ICRP Publication 26 as later modified. For comparison purposes the quarterly dose equivalents in the present Part 20 are multiplied by four to obtain an annual value. It is interesting to note that for uniform irradiation of the whole body, the levels are the same, assuming that in the current Part 20 "whole body exposure" means uniform whole body exposure. However, for irradiation of single organs, except for the lens of the eye, the value is 50 rems in ICRP 26, whereas for the active blood forming organs, the lens of the eye and the gonads, the limitation in the present Part 20 is 5 rems. One should note that the lens of the eye limit is 15 rems under the ICRP 26 recommendations. Furthermore, the current skin level is 30 rems compared to 50 rems from ICRP 26.

Thus, for irradiation by external sources, the lens of the eye will generally be the critical organ under the current rules. This must be so because the dose equivalent will generally decrease with depth in the body. Furthermore, the present rules would mean that, if the limit for the lens of the eye was met, the dose equivalent to deeper-lying organs such as the active blood forming organs and the gonads would, necessarily, be not more than 5 rems. The only situation not covered by "generally decrease" above is that for spallation reactions at large depths, but these are not treated by the draft revision of Part 20.

Table I - Comparison of present Part 20 and ICRP

dose equivalent limits in ICRP - 26

Organs or Tissue Exposed	Annual Dose Equivalent
Part 20 paragraph 20.101 (assume that 5(N-18) does not apply and that the annual dose equivalent is 4 times the quarterly limit)	
whole body, head and trunk; active blood forming organs, lens of eye or gonads	5 rems
hands and forearms; feet and ankles	75 rems
skin of whole body	30 rems
ICRP 26	
uniform whole body	5 rems
single organ except skin and lens of eye	50 rems*
lens of eye	15 rems*

*Subject to the limitation that the annual effective dose equivalent from all external-and internal-source irradiations shall not exceed 5 rems.

For irradiation of single organs by internal emitters the values in the current Part 20 are apparently based upon dose equivalent limits of 30 rems for the skin, thyroid and bone and 15 rems for organs other than these and the active blood forming organs and gonads. (Remember that the annual dose equivalent for these last two is five rems in the present system.) *** However later, on page 40, paragraph 2 lines 8 and 9 it appears that the values in Appendix B of the proposed Part 20 draft are for annual committed doses of 5 rems. Because of possible changes in our knowledge of physiological parameters since the production of Appendix B of the present Part 20 and the modifications indicated above in the organ doses for the same period, it is not possible to draw general conclusions on changes in what are now called DAC's. However, the use of 5 rems is not consistent with the ICRP philosophy outlined in Table 2 on page 19.

4, 4, 6-7. It is not clear what is meant by "adding doses from dissimilar exposures".

Pages 4 & 5. The need to consider non stochastic effects separately *** is an important disadvantage of ICRP 26.

5, lines 6 - 8. It is not clear why this statement is made here because on page 1 paragraph 1 line 3 to 5 it is stated that all *** recommendations under this NRC rule making must apply to licensees of the NRC. Presumably NRC, by issuing a license, has made this judgement and it should not be part of this document. (See Bulletin of the National Radiological Protection Board, Sept 1982, p6.)

5, line 10. In the footnote "technological" is included in the definition of ALARA, but in text "technological" is omitted.

5, line 11. Should be "effective dose equivalent"

5, line 12 "Appropriate circumstances" lacks clarity. Was it intended to mean, "the effective dose equivalent to individuals shall not exceed the appropriate limits".

5, 7, 1. Other forms of uneven treatment are evident in ICRP 26.

5, 7, 2-3. It is not clear what is meant by "a number of other changes that would be required otherwise."

5, 8, 1. Strengthening the reporting requirements is not an ICRP recommendation.

5, 8, 1-3. See comment above on "reporting by-name" requirements.

6, 1, 12-14. This implies that radiation protection is now *** inadequate. Furthermore, to what extent has this revision been responsive to comment. This should be documented.

6, 2. In a section entitled, "Radiation Protection Principles," the emphasis on "internal emitter" problems is misplaced. Protection against "internal emitters" constitutes only a small part of all radiation protection activities.

7, 1, 14. Not "need for" but "desirability"

8, 2, 1-3. Naively put!

8, 2, 17. "these weighting factors are presumed to represent"

9, 2, 3. "based primarily" ignores the fact that at least the dose rate reduction factor is based primarily on results of animal studies, and so are RBEs, as well as the presumed shape of the dose-effect curve.

10, 2, 2. "from uniform whole body"

10, 2, 4. Delete "two"

10, 2, 5 and 7. "irradiation of the gonads alone" and "caused by uniform irradiation".

10, 3, 2. "the annual effective dose"

11, 1. But for partial or whole body irradiation, the relation *** between the badge reading and the organ dose are ignored.

11, 3ff. It needs to be made clear how much of this is taken directly from ICRP and how much is basis for NRC's proposed action on 10 CFR Part 20.

11, 3, 3-4. Delete "unless a . . . is also assumed."

11, 3, line 6 - 9. "Effective dose equivalents at the annual limit for the entire population and for a lifetime is unacceptable." What is the next sentence supposed to mean?

11, 3, 11. "practicable (economic and social factors being taken into account) and"

Page 11 & 12. Quoting ICRP will not absolve NRC of either conducting *** their own or referencing someone else's recent appraisal of risk.

12, 1, 2. "risk with those of workers in non-radiation industries"

12, 1, 4. "due to occupational accidents does"

12, 1, 5. Insert: "of course, it is not known what the range of *** individual risks is in such safe industries. On the basis of present risk coefficients, and individual doses it appears that individual risks in the radiation industry may be up to about ten times the average in safe industries."

12, 1, 5-8. Background on these numerical values is needed.

12, 2, 1. "were to receive an annual effective dose equivalent of"

12, 2, 5. "mortality (to the individual exposed and to his offspring) per Sv equals 8×10^{-2} over the exposed individual's remaining lifetime."

12, 2, 7. "worker (at equilibrium, that is, after a time comparable to the maximum latency period) would"

12, 3, 1. "annual occupational effective dose equivalent values"

13, 2, 1. Even without required ALARA programs the average "badge reading" is the order of 1/10 of the current annual limit. Thus, it appears that ALARA programs already exist and are effective. Does NRC use this statement as justification for a legal requirement in regard to ALARA?

13, 3. Presumably annual effective dose equivalents to the public of more than 500 mrems from radon are not referred to because they are part of background even when enhanced.

13, 4, 1. What is meant by "whole body dose equivalent"; is this the effective dose equivalent?

13, 4, 3-4. "radiation-induced cancer and genetic effects in his offspring for two generations would"

13, 4, 8. "average annual non-radiation associated accident risks"

13, 5, 3. Define "reference level".

13, 5, 6 and 14, 1, 1. "the efforts being made to assure that this would not happen in the future. The 100-mrem....."

14, 2, 4. Provide explanation of how "the ALARA, and reference level features" and increased reporting requirements improve radiation protection.

14, last paragraph. Does this paragraph mean that when a group is licensed by the NRC, the NRC has made the judgement that there is justification for the irradiation as long as it is below the limit and ALARA. The last sentence is unclear.

14, 3, 3. "has some individual and/or public health"

15. ALAP preceded ALARA and it was NCRP.

15, 2, 1-2. There is much talk in this document about ALARA but there is confusion and apparent lack of specificity in the details of how an ALARA program for a given licensee is developed and eventually evaluated by NRC. Care needs to be taken to not vitiate the initiative of the licensee and the NRC should outline the means of their proposed evaluations. ***

15, paragraph 2, last sentence. How does one intepret this sentence? If it really means what it says there is no point in reading or commenting upon the next several paragraphs. Furthermore, it seems that any type of program developed by a licensee would have to be acceptable to NRC unless they considered their judgement to be better than that of the licensee. There is special difficulty with the paragraph on page 16 starting on line 3. Here it seems to say that NRC has made requirements without justifying them on the basis of ALARA. It is difficult to understand how NRC can justify requiring such a procedure if they can't operate the system themselves.

16, 2. Not well put

17, lines 9 and 10. "non-linear" is surely not correct near zero dose where most exposures hopefully are! Also there is some evidence that the risk coefficient for small absorbed doses of neutrons is larger than for somewhat higher doses? ***

17, 1, 14-16. See earlier general comment relating to page 19 of Part 20 draft. This also appears to be inconsistent with 17, 2, 4-6.

17, 2, 6ff. This sentence tells what NRC will do but not how it is to be done even though they require excruciating detail on what the licensee plans to do. The contents of the proposed regulatory guides must be given in some detail here.

18, 4, 1-3. Couldn't the eye sometimes be considered as a "remaining organ" in the sense of Table 1 on page 9?

18, 4, 4-5. Some justification for this deletion should be provided.

19, 1. It is recommended that a fresh look be taken at the presentation of the material in table 2. For example, the "or" in two places ***

in column one should be deleted (both the 5 rems in one year and 50 rems in one year apply). The first number is a stochastic limit and the second one is non-stochastic limit, for example, for the skin and the bone marrow contained in the "organ or tissue" column of Table 1. Furthermore, the footnote seems to require values of the "deep dose equivalent" at a depth of 1 cm in the head, in the trunk, in the thigh, and in the upper arm! Need we comment again on the difference between "deep dose equivalent" and "effective dose equivalent". Also, it is not clear what is meant by "for single event and annual limit". Does this mean that limit for "special exposure" plus routine exposure for year is twice the annual limit?

20, 1, 1. "would produce a dose equivalent not exceeding either"

20, 1, 3 and 4. Is it possible to make this statement? Are there any radionuclides that deposit in the lens of the eye only? If not wouldn't it be nice to say it? ***

20, paragraph 2 last sentence. If this document is to follow ICRP then according to ICRP publication 30, part I, Equation 2.2a, this should be effective dose equivalent instead of "deep dose equivalent." Deep dose equivalent is not useful for internal emitters. Even if it is 5 rems of effective dose equivalent, would this statement be true if the radionuclide irradiated only one organ and the limit for that organ was set by non-stochastic effects? ***

20, 3, 4-5. Justification for the proposed replacement should be provided.

20, 4, 3-4. Clarify "fractions" and use proper terminology for the limit.

21, column 2. In the first entry reference is made to "effective dose equivalent" and in the definition of terms "H_d" is called the "deep dose equivalent" (sic).

24, 1, 1-3. This statement reinforces the need to answer the question raised in comment on 20, 3, 4-5.

24, paragraph 2, 2. After "external exposure" add "in question and nothing for the rest of the year"

24, 3, 7. "deep dose equivalent"!

24, last paragraph, 4 and 5. Do you really mean "at 30 per cent"? Could you mean "at or above 30 per cent"?

25, paragraph 1. Can one perform an ALARA analysis if data are not available on individual doses below 10 per cent of the annual limit or 30 per cent of the ALI's?

25, 2, 1-2. It would be of interest to know how many of these values are lower by at least a factor of 2 ("lower" because you have said "restrictive values"). such a comparison was made at one time by David Sowby, possibly in an IAEA meeting in 1978.

25, 2, 5-8. If the new system is as effective as the old in handling mixtures and/or unidentified radionuclides, it should be made evident.

25, 2, 9-16. How frequently does one have metabolic information for the individual?

26, 1, 3. Does the computer object to being burdened?

26, 1, 7-9. The committed dose equivalent technique is not new. It has been with us for a number of years, but it has not been used in the sense that is now envisioned. This was said during the review of the last document. Past usage does not justify a modification of the intent at this point. The proposed usage improperly enhances the presumed risk (as indicated by the value recorded for the annual effective dose equivalent) from a given year's intake. It does this because some of the dose is delivered at an older age where latency becomes important for the expression of the effect. ***

27, 2, 8-13. This example indicates how inappropriate the use of committed effective dose equivalent is.

28, 3. Minors should be specifically excluded from radiation work as they are in old part 20! ***

28, 4. Not well written.

28, 5. "....is well established" True and getting worse, as judged by recent information on mental retardation. The 0.5 rem is NCRP not ICRP!

29, 2, 11-12 and 29, 3. What is the basis of the factor of two? ***

30, 2, 7. Where does this 1% come from? ***

31, 3ff. Why should a pregnant woman be considered for a "planned special exposure"? ***

32, last paragraph line 4. "limits before the end of the calendar year." Also a couple of lines later what is the justification for the 1 per cent?

33, 1, 10-12. What does this mean?

35, paragraph 2. An objection has been raised earlier to the requirement for dose records of all the occupational exposures of each person being sent to NRC. This might help to determine the extent of the "transient worker" problem, but it has little effect, except in terms of individual lifetime doses, on the evaluation of the radiation protection problem. It is not clear why this is important for all radiation workers. The method outlined earlier could provide much of the information for at least the most highly exposed persons involved in the lifetime dose problem.

36, 1. What about radon exposures of the public and 0.5 rem?

36, 2, 3-6. Hopefully it is not necessary to comment on this subject again.

37, paragraphs 2 and 3. Does "in the absolute sense" mean anything to

other readers? In this paragraph and the following ones in this subsection it is obvious that we now have a new proposed annual dose limit for members of the population but should "reference" level be "target" level or some such? *** Also, what is a "real person"? Further, why "for these reasons" when the reasons are not elucidated? Otherwise, this reference level is desirable. But, again, what about radon exposures of the public?

38, 3. Is there more justification in the Food and Drug Administration document for the "one in a million". For example, does the *** document indicate that there are background levels of carcinogens and that such background levels are responsible for only a fraction of the natural effect observed if one assumes proportionality between dose and effect? In addition, did the document treat the possibility of a larger multiplicity of exposure to different carcinogens? How does this number compare with the number of radiation sources to which a person may be exposed? One must question whether or not the FDA document provides sufficient rationale to justify a de minimis level as low as 0.1 millirem per year. Why is de minimis 1 mrem for the individual and 0.1 mrem for a population? If one neglects individual doses equal to or less than 1 mrem, then the average dose neglected is less than 1 mrem -- maybe 0.1 mrem -- but that doesn't mean that 0.1 mrem is de minimis for the population.

40, 1, line 4. The "therefore" is amazing but perhaps this whole thing is an example of poor writing more than anything else!

40, 2, 8-9. Before this point in the text <u>there seems to be no statement on the value of the (effective) dose equivalent</u> for which Appendix B is computed and worse, it is not indicated here that the effective dose equivalent is meant. What is meant by "equilibrium dose rate"? ***

41, 3, 3. "(2) to provide information for assessing the"

41, 3,4. Delete, "particularly the effectiveness of ALARA procedures."

41, 3, 6. Can one say "expected hazard"? It must be a "presumed hazard" based upon a linear interpolation. Wouldn't it be proper, however, to indicate "determined by the effective dose equivalent in comparison with the limit", instead of "determined by the expected hazard".

42, paragraph 2. Justification for the new requirements should be provided. Also, the ratio of the numerical values given in lines 4,5 and 6 to the value of the pertinent limit is not constant. Why, i.e., why is the internal limit (30%) different from the external (10%) for whole body? ***

42, 2, 9. "Whole body dose" is not defined for this document. ***

43, 2, 3 - 5. A statement similar to this is made in a number of places in this document. How frequently does one have metabolic data for the exposed person of interest - particularly at the low doses involved here? Also, the potential "restrictions on further employment" needs clarification.

44, 2, 6 - 8. It was interesting to find that "people do not ingest sewage for reasons other than the radionuclide content". This says that people do ingest sewage for radionuclide content!

45, 1, 2-5. Does this mean that the permissible concentrations in sewerage, even at the point of release, could not give more than 500 mrem in a year if ingested? If so, this certainly requires justification.

45, 2, 16-20. What is the justification for this requirement? Also, will it always be "two days", and when does one determine the quantity of unsealed material?

46, paragraph 3. Do lines 3 to 5 imply that film from film badges, for example, are to be saved? Such a requirement necessitates justification and, as this is difficult to provide, the requirement should be deleted.

48, last para, 3. "year from sources under the licensees control".

48, last para, 3 ff. There should be a justification for the effort to acquire this data because it would appear that each dose would need to be associated with a designated individual.

49, 2. This appears to require a central repository in NRC for all doses along with associated names. The rationale for such a requirement is not apparent.

50, paragraph 4 The first sentence is not clear. A number of people insist that the ICRP recommendations have not been adopted legally in most other countries, as is inferred here. Would it be possible to see a list of the countries which are actually using ICRP 26, together with copies of the actual legal implementation of the ICRP recommendations? We require references for similar scientific statements, why not have them here? Furthermore, on the first line of the next page it seems to indicate that UNSCEAR uses protection standards. Isn't it their job to provide risk estimates, but not to use protection standards? Could a reference be provided to support the present statement? ***

51, 1, 6-8. This seems to say that if we do not accept ICRP recommendations there will be an adverse impact on the United States international activities. On whom (in the U. S.) does such adverse impact fall and what would be the consequence? ***

51, 2, 12-13. Do the alleged differences have any substantial impact?

52, 2, 10. This seems to say that, even though the present proposed rule making has not been approved by NRC, there are members of NRC that are already working with the states to implement the proposed rule making. If this is so, why is it necessary to comment on this document - its approval is dictated!

54, 2, 3. Is there a need for the data on the 500 additional radionuclides?

55, 2, 11-12. According to page 40, paragraph 2, lines 8-10, the ALI's are generally based upon an annual dose equivalent of 5 rems. This does not seem to be consistent with the ICRP weighting factors.

55, 2, 12-17. Can examples be provided to substantiate this belief?

56, 1. Doesn't a "value/impact" statement need to be obtained before *** there can be a proposed rule making? To reverse this process is to prejudice the finding of the value/impact statement.

Detailed Comments Continued, on Part 20 Revision

1, 3ff. Rigorous scientific definitions should be provided, at least for quantities and units.

Also, under definitions shouldn't one include terms like "activity, activity median aerodynamic diameter, deep absorbed dose and DAC?"

2, 1. It is interesting to note that" radiation area" does not *** encompass those areas where the skin dose equivalent could be in excess of 0.25 mSv in an hour (as, for example, from beta rays or low energy gamma or x rays) but without exceeding the specified limits at a depth of one centimetre. Also should one consider the possibility of excessive doses to the lens of the eye.

2, 4, 6. "in a 40 hour workweek"

3, 1, 1-2. Dose this mean that a restricted area" for a given licensee is an "unrestricted area" for an employee of another licensee?

3, line 14. Delete "and the date of conception".

3, last paragraph. In a regulation, such loose statements as these *** are unacceptable.

4, 2, 2. "and all other modifying"

4, 2, 3-5. Delete

4, 3, 1. "(H_d) is the dose equivalent from external sources and is the do equivalent"

4, 3, 2 and 4, 4, 3 and 4, 5, 3. Where is this tissue depth measured? Could it be in the hand? (A statement on location might become important because of differences in back scatter) In the next sentence the depth could be in a finger.

4, 6, 1. How does one interpret "total"? Aren't these average values in each organ? In the third line it should be "material during a year". Also, in the second line, "organ or tissues of reference" need to be specified in the Part 20 draft.

4, 8. The effective dose equivalent has been defined by an international body (the ICRP). If what has been said earlier about acceptance of ICRP recommendations is true, it is generally accepted by all the countries of the world except the United States. In the draft it is proposed that this term be used in the United States but that the increment from external sources be defined as the dose equivalent at a depth of 1 centimetre! Doesn't that *** keep the United States out of step?

5, 3, 1-2. "individual in the course of"

5, 3, 9. Does one use radiation for prognosis?

5, 4, 3-5. Delete "or other source. . . controlled area." Also does one use radiation for prognosis?

5, 5, 1. "is the potential alpha energy concentrations from radon and its daughters. One working level is 1.3×10^5 MeV per liter of air."

6, 1, 1. "(WLM) is an"

6. "Dose Control" terms. Shouldn't one first define "annual

limit"? Then the derived limits could be developed, such as annual derived limit on intake, making it clear that these are of a lesser stature than the basic "annual limit". This does not mean only that paragraph (e) on page 7 should be moved to the start of this section. This is so because the proposed limit paragraph should be based upon the effective dose equivalent. One might suggest then, assessing compliance in terms of another quantity, but the legal limit is not set by numerical values of this alternate quantity. ***

6, 2, 1-9. These are fine words but they do not help licensee to develop a required program that would necessarily represent a unified approach throughout the radiation field. It appears that the NRC is interested in making the implementation of the ALARA philosophy a legal requirement. In order to have equal treatment of all licensees, the NRC must provide numerical values for the conversion from monetary cost of taking a protective action to the presumed biological effect that would result if the action was not taken. Such a numerical value will, of course, have to be given as a series of values depending upon the importance of societal considerations. When there is a legal requirement, the basis for assessment of compliance must be provided. In this instance, the conversion factors must be specified. (Also, delete last sentence.)

6, 3, 1. What is the basis for the change from "Annual Limit <u>on</u> Intake" (as used by ICRP) to Annual Limit <u>of</u> Intake"? This also applies, for example, to page 1, last line.

6, 3, 1-7. "means the derived amount of radioactive material (activity) taken into the body of an adult worker by inhalation or ingestion in a year that would meet the non-stochastic limit for organs and the stochastic effective dose equivalent limit (for the whole body)".

6, 5, 1-4. "De minimis exposures in this context are those small enough to be of no regulatory interest."

6, 5, 4-5. Delete "Any level . . . to be ALARA".

7, 1, 1-6. "Limits are numerical value of dose equivalent for non-stochastic erfects to the various organs and of effective dose equivalent for stochastic effects (for the whole body) which are not to be exceeded."

7, 1, 1-6. Doesn't one also have to give limits for the eye.

7, line 7. Delete.

7, line 10. Where is natural background in this context? ***

7, line 10ff. As exposure, which is the quantity for which the roentgen is the unit, is not defined, presumably it is not to be used in this document. Is this correct?

8, 3. The usual meaning of this term is not covered under *** "exposure". Actually the words "internal exposure" usually means "irradiation from a source within the body." One should probably also define what is sometimes call "external exposure." Here one really means "irradiation of the body by sources external to the body".

9, line 3. The next paragraph gives a general definition of radiation protection monitoring and the next three appear to be subdivisions of it.

9, line 5. "the measurement of radiation and amounts"

9, line 14ff. Rather than individual monitoring, wouldn't it be well to speak of personal monitoring and, to complete the picture, wouldn't it be well to add area monitoring.

9, line 21ff Is it really an evaluation of the radiation hazards or is it an evaluation of the radiation hazards in terms of some measureable (physically) quantity?

9, last line. Not defined under exposure. All of the cross *** references need to be checked!

10, line 4. Not defined under exposure.

10, line 5. Not defined under "Dose Control" terms.

10, 6. With this definition, one must be sure that doses and limits are not associated with persons (because "person" also means "corporation", etc).

10, 11, 2. Use of "adequate confidence" requires the NRC to specify permissible uncertainties in radiation measurements.

11, 1. "Radiation is energy transmitted through space. (a) Ionizing radiation is radiation with sufficient energy to produce ions."

11, 4, 2. "is not economically practicable or legal and"

11, 8, 1-2. "for the quantities used in the course of"

11, 8, 3. How does one intepret "whether or not there are limits for these quantities"? And in line 4, as the reference level is not a limit, wouldn't it better to call this a "screening" or "alerting" level.

12, line 8. "means a fictitious person defined in terms of the average anatomical" Also, add: "See ICRP Publication 23".

13. As there are so many difficulties with the present definitions, *** wouldn't it be well to use the generally accepted definitions and the symbols for quantities provided by professional organization. A similar recommendation applies to the definitions of units in section 20.4.

13, line 3ff. Why are mining, transportation and waste disposal *** excluded?

13, line 22. "absorbed dose. An absorbed dose of one gray"

13, footnote. "made using units in effect"

14, 1, 1-2. "absorbed dose. An absorbed dose of one rad" (for consistency).

14, 2. This is not the definition in ICRU Report 33 (1980) but from *** about 2 decades ago. One should first define the quantity exposure and then

the unit is given for that quantity so that one roentgen (of exposure) equals 2.58×10^{-4} per coulombs per kilogram (of exposure).

14, 2, 2-4. Only holds under conditions of equilibrium and assumes a value for the average energy required to produce an ion pair in air.

14, 3, 1. "equivalent. A dose equivalent of one sievert"

14, 4, 3. "roentgen of x rays or gamma rays"

14, 4, 4-7. Delete.

14, last four statements The first of these has to do with the quotient of dose equivalent and exposure. In order to obtain numerical values *** one needs to define the condition for the measurement of each. For the measurement of exposure the determination is made "free in air" in order to obtain the values in Table I and the dose equivalents are for the specified depths in a 30 cm diameter sphere of tissue equivalent material (electronic equilibrium is assumed). It is not clearly identified that this measurement is made free in air, and is <u>not</u> a badge reading on the body for which this is inapplicable. Thus this table is useful for area monitoring but not for personal monitoring devices.

For the other three statements the dose equivalent is obtained from a determination of the absorbed dose at a point and in the material of interest.

This assumes that the current Q values should be retained. Shouldn't *** consideration be given to modification of the numerical values?

14, 7, 2. "(if the quality factor, Q, for protons and neutrons is 10)".

14, 8, 2. "(the quality factor, Q, is 20)".

15, Table I. Define "ICRU sphere" and give reference.

15, Table I, column headings

1.0 cm	0.3 cm	0.007 cm
(deep dose equivalent)	(lens of eye)	(skin and extremities)

15, paragraph (b) It is not clear why the data are given so explicitly for photons but only one number is given here for neutrons. (When does one use this value and when the values in Table II. There cannot be a legal limit set by both.) Actually, the numerical value given depends upon the geometry of the phantom in which the determination is made, upon the energy of the neutrons and upon the degree of isotropy of the incident radiation. Presumably, the flux density is measured without the phantom in place. Such numerical values should have a reference. Also in line 5 it must be fluence rather than flux density. ***

16, table II It is essential to know the origin of this table and give the reference. It is of interest to note that the dose equivalent is not obtained at a depth of 1 centimetre but is the maximum value in a "30-centimetre thick tissue-equivalent phantom." It would also be nice to know the geometry of the phantom. Please note recent and higher values of RBE for neutrons. ***

17, lines 1 and 3. Neither "disintegration" nor "transformation" is a unit. The definition of activity includes the word "transition" rather than either "disintegration" or "transformation." (See ICRU Report 33.)

17, paragraphs (b) and (c) The unit for activity is s^{-1} (or becquerel) not dps.

18, Section 20.10. Natural background needs definition, e.g. does it include effective dose equivalent from radon? ***

18, fourth line from the bottom. Does one use radiation for prognosis? The same question arose at a number of other places in this document.

18, last sentence. Delete. This is gratuitous. Anyway, what about controllable natural sources?

19, 1, lines 4 and 5 "radiation work, a proportionality between dose"

19, paragraph (b) This sounds as though an employee, who at the time of irradiation is a member of the public (because he was exposed from some other licensee's radiation), could include such irradiation in his occupational dose! Furthermore, it seems that a person who is not "occupationally" exposed could receive an "occupational dose" (sic). Further, this seems to be a definition somewhat like that given on p.5. Clarity? ***

19, 3, 1-2. "dose to his employees and members of public"

19, Section 20, 102 (a), lines 1-5. "Each licensee shall assure that the dose from his licensed activity to (1) individuals . . . achievable (ALARA)."

19, Section 20, 102 (a) (1). See comment on this item under general comments given above.

20, line 3. Does "engineering controls" include structural shielding, for example?

20, Title of subpart C. Delete "and Reference Levels."

21, lines 3 & 4. This is apparently intended to define "whole body exposure". If so, what does this have to do with lines 1 and 2 on this page? Define whole body exposure first. What happened to "uniform" in ICRP 26 or is it meant that whole body exposure can be very non-uniform? Is the exposure of the upper arms equal to that of the whole body or should "or" in line 3 become "and"? Shouldn't there be "or" between head, trunk etc. What is the basis of these equivalences? ***

21, lines 9 to 15. What is the basis for this arrangement?

21, lines 16 to 18. "intake of uranium . . . week by an individual because of". Also this seems to imply that radiation exposures resulting from uranium need not be controlled. Is this the only element for which chemical toxicity is a problem.

21, line 19ff. Are accidents included? Also, where does this 1% come from? What is the origin of the logic here? It is not ICRP!

22, paragraph 20. 202 Does the employee have to agree to such a planned special exposure?

22, line 7. Delete

22, line 8. "licensee specifically"

22, paragraph "(d)" Would this mean that the limits for planned special exposures would be different in December than in January?

23, line 13. Delete "(external)" Also, shouldn't the regulations be explicit about what is required for less than 10% and 30%? Again, why the difference? ***

23, Section 20, 203 (a). What about via ingestion and wounds, in addition to inhalation?

24, Section 20, 204 (a), lines 1 and 4. "the effective dose equivalent."

24, Section 20, 204 (b), 5-6. One needs to be more specific in using the words "submersion dose equivalent." From the remainder of the sentence it appears that surface dose equivalent is meant. If so, how can such a measurement lead to comparison with the effective dose equivalent limit. ***

25, Section 20.205 What do sub-sub paragraphs (1) (2) mean? Are they consistent with the material on page 20 of "Proposed Rule Making?" Also, again the question of intake via routes other than inhalation could be raised.

26, 3, 1-3. Why isn't this statement incorporated in section 20.203? Also, are regulations provided prohibiting eating, drinking and smoking in areas containing radioactive materials?

26, paragraphs 4-8. More explicit information should be provided on when one or the other of these methods might be appropriate.

26, 9, 2. Does "not present" mean "reporting not required?" With the numerical values given in the next two sentences, do these create a de minimis level for occupational exposure?

27, Section 20, 206, lines 2 and 4. Is "minor" an adequate specification?

27, Section 20, 207 (b) (1). See questions under general comments on "deep dose equivalent".

27, Section 20, 207 (b) (2). Basis for selection of factor of two should be provided. ***

28, line 7. What is the origin of the 1%? This may be a good idea given all we know, but how is it arrived at? ***

28, Sections 20. 301 and 20. 302. Shouldn't this specify that compliance with these requirements is not the responsibility of the licensee? Also shouldn't exposures received as a patient be excluded?

28, Section 20. 302. "from exposures to external radiation and from intake of radioactive materials."

28, Section 20. 302 (a) This could be said somewhat simpler. If you take the inequality on page 23 with the addition of item (3) here on the left and make the righthand side 1/10 rather than one, you then obtain the equation on page 29, paragraph 3.

29, 2, 1. "Because the exposed population may include children, both"

29, definition of Σ_{ℓ} . If this sum is to be obtained, then proper subscripts are necessary on the components. What does "medical treatments" mean?

30, Section 20. 303. Reference level? Should it be target level. Can you then abandon 0.5 rem (5mSv)? The reference level 100 mrems seems to be a limit for an individual in the population from a single installation. Profusion of levels?

30 and 31. Couldn't the inequality on page 31 be obtained directly by dividing the the right hand side of the equation on page 29 by 5?

31, 1, 2. Why are the DAC's with their concomitant conservatism included here?

31, last paragraph. What is meant by "realistic site-specific" and "substantially"?

32, 1. Delete

32, (i) and (ii) It is not clear why these values can be different. If the lowest value recorded is one mrem, how does one get down to average effective dose equivalents as low as 1/10 of this?! Is it necessary to have two levels for regulatory purposes? Also, should (i) read, "dose estimate for any individual and"? Further, "per year" should be "in a year". Note that ICRP does not favor truncation of the collective dose because it describes the total detriment of the source. Why does NRC want to truncate it? Deminimis levels for individuals are quite a different matter. ***

32, Subpart E. This does not seem to take into account the possibility of ingestion of radionuclides on food.

33, 2, 1-5. How does one interpret "2 mrem per hour" when it is supposed somehow to be related to "annual limit of intake in an hour. An annual limit of intake divided by 2500 in order to obtain the intake limit for one hour is considerably more restrictive than the annual intake unless the concentration of each of the nuclides is constant through-out the year. Such "conservative" calculations - made into rules - are not well discussed in this document. Thus, condition (2) is more restrictive than condition (1). Further, the instantaneous rate given in footnote 3 is more restrictive still. They can not all be "limits". ***

33, 3, 1-3. The same conservatism is evident for this condition.

33, 4. Where is section 20. 103? Could this be 20. 102?

33, 6, 1-2. Couldn't this be incorporated into (a) on page 32.

34, 2. Is section (a) adequate when testing compliance? (Such surveys do not give personal doses unless all radiation levels in controlled areas are the same.)

34, 4. Shouldn't this be covered under quality assurance and frequency, accuracy and traceability requirements specified? The fact that the monitoring level for external exposure is 10% for whole body and 30% for organs is very confusing. ***

35, Section 20. 502 (a). See comment on "Proposed Rule Making" page 42.

(b). This difference, 30%, cf. external whole body, 10% is also confusing. Rationale?

36, Title of Subpart G. "Control of Exposure from External Sources in Restricted Areas."

36, line 8. What is the origin of 0.1 rem in 1 hour? ***

37, 1, 1. "does not hinder individuals in leaving"

37, 4, 4-6. "and (3) prevent increase of the radiation level above that given in (2) during the time the individual is in the area." Comment applies to other places in the draft too.

39, 8. What does this mean?

40, 4, 4-5. "to use protection factors other than those given in Appendix A on receipt"

41, Section 20, 802. Is "constant surveillance" practical?

43, Section 20. 903. Has NCRP Report No. 33, page 30 been considered?

44. What about labels for patients with radioactive materials in their body (see NCRP Report No. 37)?

46. Define "exempt."

46, paragraph (c) (1). "microcuries (22,000 per minute) per"

47 Top. Why is a de minimis amount not applied here where it is specifically useful?

48, paragraph (b). See comment on "Proposed Rule Making" page 45.

48, paragraph (b) (1). The units of Q_j must be the same as those of I.

49, 1. See comment on "Proposed Rule Making" page 45

49, 2, 1-2. "only in the amounts specified"

49, Section 201.1005 (a). "the following licensed material as if it were not radioactive:"

50, 4, 1. "determine dose from external sources and used"

51, 1, 1. "shall record the"

51, 3. If the 5(N-18) proration formula is eliminated and there is no lifetime limit on exposure, why are the previous exposures quantified? NCRP is in favor of records, kept by industry, but justification is weak unless there is some statement about the desirability of limiting lifetime doses. ***

52, 3. "The estimated amounts of the radionuclides providing significant exposures as a result of internal sources"

52, 6, 1. "record intakes by individual of less than". Delete: "provided . . . is included."

55 item (4). Is this at all levels and amounts including the lowest? What about de minimis given earlier?

56, 2, 1-5. In line 1, where is the dose equivalent obtained? In lines 3-4, what is an "absorbed dose equivalent"? If dose equivalent is meant, is it the maximum at any point, or the average for the entire portion of the body?

56, 4, 2. What is a "facility"? This comment also applies to other parts of the draft.

57, 2, 4-5. Is "dose equivalent" the average value or the maximum?

58, 9, 3. This indicates that limits may vary from licensee to licensee. This interpretation is reinforced by the first sentence in item (3) on this page.

59, 1, 1-3. Are these limits, designed for nuclear power operations, applicable to medical facilities? Also, does "general environment" include sewage systems?

60, Section 20. 1205. What is a "critical group"?

60, penultimate line. 0.5 mrem does not equal 5 mSv

61, Section 20. 1206. See previous comment on "Proposed Rule Making" page 3, last paragraph.

A-1, footnote b. How does this footnote apply to "Descriptions"? Perhaps it should read "When the description indicates "facepiece" then shaven faces are required.

A-2, footnote d, item 2 (a). "Only for individuals trained in respirator use and wearing properly fitted respirators that are used and" also, what is a "well-planned respiratory protective program."

A-3, footnote g. "This type of respirator." Also, define "high-toxicity materials".

Appendix B. The basis for the values given in this appendix should be provided. Also the introduction should say something about the oral ingestion values of ALI tabulated.

B-1, end paragraph 3. ALIs are not "non stochastic" they may be based on levels for a non stochastic effect.

B-1, table Label column 1, "Organ or Tissue".

B-2, 1, 3-6. Clarify.

B-3. Are the omission of, Boron 5, Helium 2, Lithium 3, Neon 10, Nitrogen 7, Oxygen 8 in the list of elements and the subsequent tables because they have only short lived radionuclides?

Because of the large number of comments on the text and because of their potential impact on the material in the appendices, no further detailed comments on the material in the appendices will be proferred at this time.

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