PDR M-25

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July 05, 1979

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JUL 16 1979
U. S. Nuclear Regulatory Commission
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Ross A. Scarano, Section Leader
Uranium Mill Licensing Section
Fuel Processing & Fabrication Branch
Division of Fuel Cycle & Material Safety
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Scarano:

Enclosed are our initial comments on the Draft Generic Environmental Impact Statement on uranium mills (NUREG-0511).

We have enjoyed reviewing this document and would like to provide additional comments if time permits at a later date.

Please feel free to contact us regarding our comments if you believe discussion of our comments may be of assistance to you.

Sincerely,

T. A. Wolff
T. A. Wolff
Environmental Manager

Enclosures

cc: G. Wayne Kerr, Office of State Programs

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General Comments

1. Several key sections of the GEIS are difficult to review because of the lack of documentation or, if references are given, the unavailability of the reference. The major conclusions of Chapter 6, for example, in which the radiological doses to the population from milling are calculated, are based on the results of the computer code UDAD. This code is presently unavailable for review. Several input values for the program are not given. The manual describing the code, reference number 22 in Chapter 6, is still in preparation. The overall methodology of the UDAD code is described in general terms in Appendix G, but this brief outline does not permit the detailed r view necessary to adequately evaluate this crucial element of the GEIS. Additional questions that remain concerning the UDAD code and its input parameters are discussed under General Comment 4 and also under Specific Comments.

The reference section for the "Summary" provides another example of the unavailability of references cited. Of the eleven references given, five are still in preparation, while another is only available in draft form. Many of these reports being prepared provide the data base for the GEIS project, and so are essential for an understanding of the rationale supporting the NRC's conclusions. Adequate evaluation of the GEIS is difficult when the results of field studies, referenced by the staff throughout the document, are as yet unavailable.

2. The model mill used in the document is not representative of a great part of the industry. This mill has a capacity of 1800 MT/day of ore. However, based on the reported maximum capacity figures submitted by the milling companies to the State of New Mexico as part of their radioactive material license applications, the average mill maximum capacity in New Mexico, where nearly half of the U.S. uranium ore is processed, is 4000 MT/day (based on the five mills now operating in New Mexico) or 3600 MT/day (based on the five operating mills and three proposed mills). This average capacity is about two times larger than the model mill capacity. Of the eight mills now operating or proposed for New Mexico, only one has a capacity less than that of the model mill.

The NRC apparently based its estimate of mill capacity from data in the table on page 3-5. This table should be revised to reflect current production. In particular, the expansion of the Anaconda mill to 5500 MT/day has not been included. The maximum capacities for New Mexico are given in the following table:

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MILL	MAXIMUM CAPACITY		AVE. AGE
Operating	(ST/Day)	(MT/Day)	(MT/Day)
Kerr McGee	7000		
United Nuclear-Homestake Partners	3500		
United Nuclear-Churchrock	4000		
Anaconda	6000		
Sohio	1660		
Subtotal	22,160	20,145	4029
Proposed			
Gulf	4200		
Phillips	2750		
Bokum	2200		
Subtotal	9150	8318	
TOTAL	31,310	28,463	3558

This change in scale could be significant, and affects many aspects of the evaluations in the GEIS, such as the magnitude of the environmental impacts, the size of the tailings piles, and resulting practicality of various stabilization techniques, etc.

Since the Grants Mineral Belt produces nearly 50% of all yellowcake produced in the United States, one would expect to find the area well represented in the design of the model mill. With respect to mill size, area topography, climate and the ecosystem, this was not the case.

In addition, a potential worst-case situation was proposed in the summary (Page 3) for the year 2000: twelve 1800 MT/day mills in a region having a 50 mile radius. These twelve mills would have a total production of 21,600 MT/day of ore. In regard to total production, this situation will soon exist, if it does not already, around Grants. The total maximum production capacity is about 20,000 MT/day at present, and could be 28,000 MT/day by the early 1980's if all presently proposed mills are licensed.

Presumably, total capacity will continue to increase and surpass the 12 mill cluster treated here. A true worst case situation should treat a mill cluster having a production capacity much larger than 21,6000 MT/day.

3. Some indication should be given to the anticipated errors or ranges for the various doses, concentrations and health effects calculated. What kind of precision and accuracy is expected of the UDAD code? Of the the source term estimates? Of the atmospheric radionuclide concentrations? Of the dose conversion factors? Of the deposition velocities? For example, on page 6-74, 72 premature deaths were predicted from continental environmental dose commitments from uranium milling. What is the range of this number taking all uncertainties into account? In order to have some feeling for the firmness of these estimates, their ranges should be calculated or some estimate of their variability expressed. In general, there is an overly detailed presentation of results that most likely cannot be justified by the precision and completeness of the associated data base.

Along these same lines, since the conclusions of the report depend to a great extent on the results of computer models, it would be very useful if field measurements around uranium mills were made and compared with model predictions in the GEIS. The confidence that one ultimately puts on the results of these models depends on how close the models reproduce actual physical conditions. Verification of model results by field measurement should be presentedin the document. These measurements should include:

a. source terms - Appendix G-1 uses theoretical estimates based on the physics of sand transport by wind (for particulates) and diffusion/emanation (for radon). How have measured source terms compared to these estimates?

b. radionuclide concentrations in air, soil and vegetation.

c. seasonal deposition velocities.

4. Some information essential to evaluate dose calculations have not been reported in the GEIS.

a. height of mixing levels used in UDAD. These are referred to on G-16, but the actual values are not given.

b. wind speed, wind direction, and frequency by stability class. The wind rose on page 4-3 has no stability class information, although it is implied on page G-15 that stability is needed by UDAD. Was D stability assumed for all calculations?

c. more specific information on the dose conversion factor calculations.

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5. The following potentially significant impacts have not been discussed:

a. non-radiological parameters. As noted in the GEIS many trace elements are contained in mill tailings. Some of these elements, such as selenium, arsenic, and lead, have been shown to exist in high concentrations in plants growing on tailings or tailings-contaminated areas. As these areas are available to cattle for grazing, there is a potential for entering the food chain leading to man. What is the impact on man and other ecosystem constitutents, of these elements transported by:

i.) windblown particulate material,

ii.) groundwater and surface water

through the inhalation and ingestion pathways. This analysis, as well as the analysis for radiological parameters, should consider all forms of transport and also be complete in the treatment of pathways.

b. Windblown tailings are reported to constitute an appreciable source of radon. To our knowledge, the GEIS only considered radon coming from the pile itself. Some discussion of the windblown material as a radon source would be appropriate.

c. The GEIS does not consider impacts on groundwater or surface water as radiologically significant (e.g., see page 6-22, no water pathways are shown). Groundwater monitoring data taken at private wells used for drinking water around a uranium mill near Grants, New Mexico have shown uranium concentrations up to 25 mg/l. This is more than 50% the 10 CFR 20 limit for natural uranium in unrestricted areas where MPC_w (U-nat) = 3×10^{-5} uCi/ml (45 mg/l). In addition, if it is assumed that an individual consumes 4 liters of water in two days at this concentration, some 100 mg of uranium would be ingested. This comes close to exceeding the two day ingestion limit of 150 mg recommended by the International Commission on Radiological Protection (see ICRP Publication 6). This indicates that mills could have considerable radiological impact on the groundwater, and that the water pathway should be considered. The implications for the 40 CFR 190 dose limit also should be discussed.

d. The GEIS did not consider the effects on the kidney in its evaluation. However, kidney is the critical organ for inhalation of uranium in soluble form. According to the footnote to Table G-5.2 (page G-43) yellowcake dust is 60% class D and 40% class W for uranium, therefore quite soluble. Effects on kidney should be discussed explicitly in the GEIS.

6. The NRC concept of long-term funding (Summary page 27, (8.2.2) and Section 143) necessitates only a one time charge of $250,000 (1975 dollars) after termination of a mill operator's decommissioning responsibilities and license. The amount of money is in our view totally inadequate and unsupported by any economic analysis.

The GEIS views long term funding as needed for periodic visual inspection of each site. This concept assumes that siting of current mills will be done in a manner so superior to past practices that extensive monitoring, active care, or remedial action, will not be required. In addition, the narrow GEIS concept of long term funding neglects such possible future requirements as fencing, detailed monitoring and repair, natural disasters, and unanticipated problems. New Mexico presently requires each mill to contribute \$.10/lb of yellowcake (U_3O_8) until a total of \$1,000,000 has been deposited for each mill. We do not believe the amount we are collecting which is nearly 5 times the NRC proposed fee is likely to be adequate.

We are enclosing a copy of testimony provided at a hearing held in 1978 in New Mexico on this issue for your study as well as a recently published study of "Continued Care of Uranium Mill Sites: Some Economic Considerations" by Winston Harrington, Research Associate, Jan. 1978, Resources for the Future, 1755 Massachusetts Ave., N.W. Washington, D.C. 20036.

7. The following comments were generated by Water Pollution Control Section (WPCS) staff, of the New Mexico Environmental Improvement Division and to a certain extent reflect comments previously submitted to NRC in a December 11, 1978, memorandum from Joseph A. Pierce, Chief, WPCS to Al Topp of the Radiation Protection Section. The discussions relating to ground water and ground water protection do not place this resource in proper perspective from a tailings management point of view. The most significant deficiencies in the ground water discussions may be summarized as follows:

a. While the document generally recognizes the importance of protecting ground water quality, there is no discussion of ground water flow systems as contaminant transport pathways. This is a fundamental point, the importance of which must be appreciated if adequate ground water protection is to be insured. Knowledge of where a tailings site lies with respect to local and regional ground water flow systems, coupled with knowledge of where present or future ground water withdrawal points are or will be located, is essential to any ground water protection effort. Ground water must be thought of as a contaminant transport pathway not unlike wind is viewed, with attenuation mechanisms and time/spacial factors obviously being quite different.

b. The GEIS offers no discussion of the importance of site selection as related to ground water protection. NRC staff seem to feel that the only way to mitigate adverse water quality impacts of tailings disposal areas is through alternate disposal schemes incorporating elaborate and costly engineering controls (see pp. 19, 23, 6-12, 8-18 and 12-20). This is simply not true, especially with respect to ground water protection which can, in many cases, be most effectively insured through judicious site selection to take advantage of favorable hydrogeologic conditions.

c. Uranium and nitrate are not mentioned as potentially important ground water contaminants from tailings retention areas. Data collected in New Mexico indicate that these constituents (particularly uranium) may indeed be some of the most significant contaminants impacting ground water quality down-gradient of tailings retention areas. (Please refer to General Comment 5.c.)

d. The GEIS does not specify Radon-222 as a potential water contaminant although it is discussed as an atmospheric pollutant. At this point in time, the study of Rn-222 in ground water is in its infancy. No data on Rn-222 in ground water appears in the appendices to the GEIS. Since atmospheric Rn-222 has been shown to have adverse health impacts, recognition should be given to the potential importance of Rn-222 as a water contaminant and provisions should be made to further investigate uranium milling as a souce of Rn-222 in ground water.

The following general comments, not relating specifically to ground water are offered:

1. NRC staff recommends the location of tailings disposal sites in areas undergoing active deposition where possible. If deposition is the active geomorphic process, material is being derived by erosion upstream, subject to subsequent deposition downstream. However, attention should be focused on the infrequent storm event, which although performing little total work within the watershed, may trigger a landscape response crossing a threshold that will establish erosion as the dominant physical process, rather than deposition. Additionally, a depositional environment that will favorably meet other NRC criteria is highly unlikely in the semiarid Southwest, where the landscape has been eroding at accelerated rates since the mid-to-late 1860's. Finally, in terms of ground water protection, areas of deposition will demonstrate higher seepage rates due to the collection and containment of water in low areas and a resultant increase in head which acts as a driving force for ground water recharge.

2. In Section 9.3.4, p. 9-13 of the GEIS a statement is made that surface water degradation resulting from runoff carrying contaminants deposited on the land surface by wind, seepage and evaporation processes would not likely be important. This conclusion appears to be pure conjecture, as no supporting evidence is set forth. Data recently presented at a public hearing in New Mexico indicated that, at certain sites this mode of transport may have very substantial impacts on surface water quality. The conclusion should be striken from the document unless substantial evidence exists to support it.

3. The GEIS in incomplete in its treatment of seismicity and faulting and associated problems in siting a uranium tailing disposal area. No placement of tailings impoundments near capable faults (the term active fault is no longer used) raises many other questions, such as,"What is a capable fault?", a question many seismologists, tectonicists and other earth scientists still ask. Primarily, our questions are concerned with current regulations for siting of nuclear reactors. NRC will have to decide whether a capable fault as related to siting nuclear reactors will have the same definition as when applied to the siting of tailings impoundments.

SPECIFIC COMMENTS

Forward

1. Page ii, 1st two sentences: Revising NRC regulations based on the conclusions of this draft statements does not seem to be a prudent course of action until comments have been received, evaluated, and a final document issued. These sentences appear to be telling reviewers that NRC has already determined what is necessary and comments on the draft are incidental.

2. Page ii, 3rd sentence from bottom: The project should not be considered as complete until the final document is issued.

Summary

1. Page 1, para. 2, line 3: Potential health risks and impacts from uranium milling are based on computer analysis for the GEIS. What actual health risks and impact of milling have been experienced? How do actual measurements around existing mills compare to the assumed model mill? How are the long latent periods associated with uranium milling potential health effects considered?

2. Page 1, para. 5, line 6: Continued surveillance of mill tailings disposal sites as recommended is not in agreement with tailings management performance objectives asking for elimination of on-going monitoring and maintenance.

3. Page 21, (6.1), line 4: Institutional control, such as an exclusion area around tailings impoundment areas, during active use and prior to final stabilization should be required to prevent any residential encroachment. Zoning requirements to prohibit residences near tailings impoundments could be used to insure the long term ability to meet the 10 CFR 20 and 40 CFR 190 limits.

4. Page 22, (6.2), 1st line: The tailings impoundment area should not be sited where its long term integrity requires additional engineered structures.

5. Page 21, (6.1), last para.: A surface exhalation radon rate of 2 pCi/m^2-sec. from a mill generating about 480 acres of tailings provides a yearly radon source of about 123 curies. If an estimated 80 mills (Summary p. 3) become operational by 2000 A.D., the stabilized tailings areas will contribute significant radon sources to the environment for a long period of time.

6. Page 23, (6.2), 1st 2 lines: If seepage does occur from a stabilized impoundment area, this would only be detected by a continuous monitoring program. Therefore, it appears that long-term protection of the environment from stabilized tailings impoundments should require on-going surveillance, monitoring, and active care.

7. Page 31, References: Five of the eleven references which are vital to a technical evaluation of the GEIS and the NRC regulatory proposals are identified as "in preparation". Thus, an adequate evaluation cannot be accomplished until these are available.

Section 2

1. A history of uranium milling operations, particularly one appearing in this GEIS, is certainly not complete without a discussion of how the industry was regulated and by whom.

2. Page 3, (2), para. 2., line 9: The assumption that the currently operating mills (some have been operating over 20 years on sites approved by AEC) will be continuing production indefinitely is questionable.

Section 3

1. Page 3 (3.1), line 7: While the base case in theory represents past milling practices, the obvious assumption by the reader is that this is the actual situation today. The base case is representative of the licensing practice of NRC's predecessor, AEC.

2. Page 3 (3.2), line 2: Thorium-230 should be included as a critical radionuclide. Its mpc for air in an unrestricted area is 8×10^{-14} uc/ml. This makes it one of the most restrictive mpc's listed for any radioisotope.

3. Page 5 (3.2), line 9: Analysis of radon from mine vents in the mill region should be included. This contribution could be significant, and without this analysis, the GEIS is incomplete.

4. Page 7, Table 2: Any credibility of a calculated 8.5 to 9.8 maximum premature death rate per year from the uranium industry mill tailings compared to the spontaneous cancer death rate per year of 470,000 to 750,000 (U.S. and North America) may be lost in the "noise level" of the calculation.

5. Page 9, (3.5): The last paragraph states that worst case accidents involving shipment of yellowcake in a populated area are expected to cause total exposures as much as 10 times that from a single mill's annual operation. However, NUREG-0525 (pages 9 and 10) states: "The low concentration of radioactivity conceptually renders the material (yellow cake) 'inherently safe', considering radiological effects of the material, because it is highly unlikely, under any circumstances arising in the transportation of these materials, including accidents in which the material is released to the environment, that a person could take in enough material to produce a significant radiological effect." The GEIS (NUREG-0511) and NUREG-0535 appear to be in conflict regarding the hazard potential due to yellowcake.

Section 4

1. Page 4-1 (4.1): No mention of Pasquill stability categories is made in the entire climate section on annual wind rose data.

2. Page 4-3 (4.1.4): Meteorological information should be much more complete in order to estimate dispersion of material and resulting dose. Stability class information and heights of mixing levels are both necessary. Wind frequencies, directions, and velocities by time of day and by month would permit additional precision in dose estimates.

3. Page 4-5 (4.3): The GEIS, in being truly generic, should take into account the meteorological implications of the complex terrain features which characterize a large fraction of the uranium milling industry's present physical environment. The topography of the model mill site is not representative of the areas where the major part of the country's yellowcake production actually takes place (Grants Mineral Belt). These areas have narrow valleys where differences in altitude between valley floors and nearby mesa tops are typically up to 1000 feet. This has important implications for meteorological modeling, as the topography may determine height of the mixing layers, channeling, night drainage flow, etc.

4. Page 4-11 (4.9.1.1): In the characterization of the regional ecosystem no threatened or endangered plant (floral) species are mentioned despite a very extensive federal list.

Although no other threatened or endangered bird species may occur in the region besides the prairie falcon, all hawks, owls, and vultures are protected by federal law (i.e , marsh hawks).

5. Page 4-11 (4.9.1.2): In Table 4.8 showing the energy partitioning of the site ecosystem, how can seed production (1.2×10^{10} J/ha) exceed primary production (5.2×10^{9} J/ha)?

Section 5

1. The term "model" mill was a poor choice of words in that it implies something to be imitated or emulated.

2. Page 12 (5.1), last paragraph: Elimination of the yellowcake packaging and drying would omit one of the major sources of potential radiological exposure at uranium mills. Why should there be an additional 60 mill sites (GEIS estimate) taking a yellowcake radiological insult because of a single conversion plant which should be converted to handling a "wet" input product? It is not at all clear that there is a signficiant high cost for "wet" shipment compared to dry and, also, when compared to the clean-up cost of an accidental spill of dry powder. NRC should consider requiring the Illinois conversion facility to accept slurry delivery of yellowcake.

3. Page 14, (5.2.1), "Active Care Mode": It is not all conclusive that the active care mode can be avoided. First, the radioactivity is in the thousands of curies; second, half-life of Th-230 (about 80,000 yrs.) will maintain the daughter products at a high level for a very long period;

third, in an erosional environment such as the western states have, continued surveillance is vital for long term control; fourth, no known man-made structure has survived one half-life of thorium. Therefore, it would appear that it would be very desirable to have an active care mode for tailings impoundment operated by governmental agencies.

4. Page 16 (5.2.1), lines 2 and 3): Caution should be exercised in ruling out a possible fixation scheme for tailings based on today's costs compared to other schemes. The actual costs in the future may shift drastically.

5. Page 17 (5.2.2), 1st line: It may not be a desirable principle to return the tailings disposal sites to conditions comparable to surrounding environs, but permanently remove this area from any possible potential harm to the public and use the active care mode.

6. Page 19 (5.2.3), line 1: Reducing the amount of moisture available to carry toxic contaminants away from the tailings impoundment appears to conflict with the level 2 proposal for 90% water coverage of tailings to meet the 40 CFR 190 25 mrem/yr requirement discussed in 5.1.

Section 6

1. This section and supporting appendices, do not make sufficiently clear that the radiological impact calculations, particularly the matter of conversion from exposure dose to absorbed dose and health effects, are highly uncertain and speculative. The uncertainties in the input data, computations, and effects data are so great that to compare 72 premature deaths from mills with 109 premature deaths from mines is nonsense. It would still be nonsense even if one talked about 70 and 110 which would at least acknowledge the uncertain nature of the numbers. The entire presentation, and poor use of significant digits, is misleading and, unfortunately, perhaps the most important factor upon which all of the GEIS recommendations, conclusions, and proposed regulations are based. The best, and most meaningful, use of the dose calculations is to compare and rank alternatives and to determine compliance with standards. The latter will, in the long run, be based on judgment heavily weighted by conservatism due to the acknowledged lack of hard data on health effects. As it is written the GEIS appears to attach far more signifance to the validity of the computations than is warranted.

2. Page 6-5, (6.2.2.2), para. 2): states that offsite land could be impacted by blowing tailings such that concentrations above background could extend for as far as one km past the piles edge. This comment contrasts with page 4 (fourth para. from bottom of page) which indicates that the limit (EPA 40 CFR 190) could not be met within about 4 km downwind from the mill. It is assumed that both entries refer to the same base data.

3. Page 6 (6.2.4.2.2), first para.: Radium and thorium are shown to not be mobile in ground water. However, uranium is mobile, and said to move at the same velocity as ground water (p. 6-7, last paragraph). Uranium levels in ground water should be discussed more thoroughly. Please refer to general comment 5.c.

4. Page 6-16 (6.2.6.1.2), Operation: Impacts to herbivores through uptake of toxic elements by vegetation is discussed, but fails to mention the equally important uptake mode via windblown adsorption of particulates onto the outer surfaces of plants during the operational mode of the model mill.

5. Page 6-17 (6.2.6.2), Aquatic: Given the great uncertainties in assessing impacts to an ecosystem from uranium mining and milling activities, it was unexpected to read that there would be "no impacts to aquatic biota during the construction or postoperational phases". Conceivably, runoff containing toxic materials from tailings piles could enter the middle reservoir and tributary river during periods of heavy precipitation. Reservoir dilution will, of course, minimize the potential effects, however, high concentration factors of certain toxic elements (i.e., Pb, Se, Zn) by aquatic ecosystem compartments will undoubtedly occur and can be considerable, thus contributing to significant higher trophic level accumulations.

6. Page 6-20 (6.2.8): In the second paragraph, it is inconceivable that "no exposure pathways have been identified which are different than, and would result in another species receiving doses significantly above those calculated for man outside the mill boundary", when small mammals are directly ingesting contaminated vegetation and burrowing in contaminated soils where hibernation could take place. In addition, small mammal ingestion of contaminated arthropods would also contribute to the overall dose. It is commonly understood that an ecosystem acts like a filter by diminishing the concentrations of most toxic material (especially the heavy metals) as they move from lower trophic levels to higher levels including man.

In the last paragraph, it's stated that a relatively small proportion of animals living within a tailings pile region would be affected (by radiation exposure and ingestion dose), and therefore, the total impact on the local biota, would be small. This is a completely unjustified assumption. Since the 100 ha tailings pile includes a 20 ha water cover and 10 ha wet area during operation, a considerable number of species from the entire region could be attracted to the pile as one of the few water sources despite low (or high) pH of discharge waters. After operation, the pile may still act as a water source by collection of rain water. Inactive leaching ponds in the Ambrosia Lake area have successfully developed advanced ecosystems.

7. Page 6-21 (6.2.8.2.2), second to last paragraph: What dose calculations have been performed showing that doses from the U-235 chain are inconsequential? Have the mobilities in ground water of members of this chain been evaluated? Since radioactivity accumulates in tailings piles into thousands of curies with approximately 5% due to U-235 daughters, the activity of U-235 will be significant and should be considered in the tailings stabilization plan.

8. Page 6-32 and 6-33 (6.2.8.2.4.4): Do the external doses in these tables include gamma radiation coming directly from the tailings pile? What is the effect of this direct external exposure, at .64 km, for example.

9. Page 6-34. The 10 CFR 20 limit for radon is given at 1000 pCi/m^3, and footnote C remarks that this is the appropriate value for radon in equilibrium with its daughters. But radon at 1000 pCi/m^3 corresponds to only .01 WL at equilibrium, one-third of the allowable limit. In addition, Footnote 3 to Appendix B of 10 CFR 20 states "These radon concentrations (i.e., 3000 pCi/m^3) are appropriate for protection from Radon-222 combined with its short-lived daughters". Wouldn't this imply that the 1000 pCi/m^3 is too low, and that the proper 10 CFR 20 limit is the one actually given in Appendix B.

10. Page 6-40 (6.2.8.2.5): The total given for the whole body, bone, and lung person-rems resulting from 15 years of model mill operation, do not reflect their inherent degree of precision, which are at best highly uncertain due to large inherent variabilities in a number of essential parameters used in calculating population dose commitments. A similar criticism is warranted for section 6.2.8.2.6 concerning health effects on man and estimates for premature deaths in various age cohorts (Appendix G-7). Fortunately, the last sentence of Appendix G-7 states a range of uncertainty for these specific genetic defect risks. Considering the fine detail in partitioning age cohorts, large uncertainties for risk from ill health for each cohort would be highly speculative based on all available incidence data.

11. Page 6-43 (6.2.8.2.7.1); The pulmonary dose from yellowcake in Table 6-19 (1.58 x 10^3) is 10 times that reported in Table 6-18 (1.58 x 10^2). Is there a misprint in an exponent?

12. Page 6-57 (6.3.6): On what basis is the conclusion that the impacts from 12 mills on terrestrial and aquatic biota will reach an ultimate magnitude of 12 times the impact from a single mill? What data indicates the relationship between number of mills and degree of impact to regional biota as being linear in nature?

13. Page 6-71 (6.4.3): In Table 6-37, footnote b, background lung dose commitment is given as 161 mrem/year. Does this value, to be consistent with footnote a., include both pulmonary and bronchial epithelium doses? How does that compare with the background dose commitment given in footnote b. of Table 6-28, where the lung dose is 704 mrem/year?

14. Page 6-73 (6.?.2): Thorium-230 is not listed as an important radionuclide with respect to health impacts despite having the lowest MPC in air (8 x 10^{-14} uCi/ml) of any nuclide associated with uranium milling. In addition, NRC Reg. Guide 1.109 lists a higher adult inhalation dose factor of 0.622 (mrem/pCi inhalded) for Th-230 than Rn-226 = 0.117. In fact, the Th-230 MPC in air is only slightly greater than for the plutonium isotopes.

Section 12

1. Page 12-20 (12.3.4), Seepage of Toxic Material: In the third paragraph, the staff concluded correctly that the "most effective way to reduce potential groundwater contamination and associated health effects is to reduce the amount of moisture available to carry toxic contamination". This statement is, however, inconsistent with previous statements concerning the placement of water on the pile to reduce the Rn-222 flux. We think the NRC staff is suggesting water on the pile during mill operation and then letting the pile dry out thereafter, however, this apparent confusion has not been adequately delineated into an overall feasible approach.

Appendix G

1. Page G-5, last sentence: It is assumed that 5% of the thorium activity is in the yellowcake for an acid leach mill. However, recent data from both Argonne National Laboratory and the Environmental Protection Agency indicate that the thorium activity is much lower, around .2%

2. Page G-17, last paragraph of section 2: This is a good example of the difficulty of reviewing the document without a copy of the UDAD being available. What is the "variable expression" being referred to here? How can the manner in which plume depletion was handled be evaluated unless it is described thoroughly?

3. Page G-37: Given the wind rose for the model mill on page 4-3, it is hard to see how the Ra-226 air concentrations (Figure G-4.15) would look like this. The air concentrations are almost at a minimum in the downwind direction (towards the ENE). Has the diagram been inadvertently rotated in printing?

In order to make these diagrams clear, it would be helpful to have "north" plainly marked.

4. Page G-40: It would be helpful to have some discussion of the features of these radon isopleths in the text. In particular, the peak radon concentration is to the SSE, while the wind rose actually indicates that the wind blowing in that direction (coming from NNW) is the least frequent found at the site. Stability class is also important in these calculations, but stability determinations are not given in the GEIS.

5. Page G-42: The two tables G-5.1 and G-5.2 do not agree for thorium. The text indicates that the primary difference between the tables is in assignment of solubility class. However, thorium is class Y in both tables, so thorium dose conversion factors (DCF) should not change. However, for a particle size of 5 um, the whole body DCF's are 101 (Table G-5.1) and 37.7 (Table G-5.2). Bone and lung are similarly different.

It would be helpful if the exact methodology used in calculating the DCF's were briefly indicated, rather than simply referencing the ICRP's Task Group Lung Model.

6. Page G-44: The GEIS is using a value of 5 rem/WLM in the radon DCF. The WL, since it has been derived for use in the special situation of uranium mines, need adjustment for use in non-working situations. The GEIS has already adopted one adjustment, in making allowance for different breathing rates in a uranium mine and otherwise. The following modification should also be included. The radon dose is a sensitive function of the number of unattached radon daughters. (See, for example, reference 6 of Appendix G). The number of unattached radon daughters in a mine, with an atmosphere containing a large amount of large size dust particles, could be considerably different from those in a home environment. The resulting dose equivalent could be accordingly quite different.

7. Page G-45: The external dose, especially close to the tailings pile, should include the gamma dose coming directly from the pile itself ("gamma shine"), as well as that from the cloud and ground concentrations. This is especially important for the individual at the fence location, only 100 m from the tailings pile. (Dose receptor "a" on page 6-23.)

8. Page G-58: The epidemological study of uranium miners, directed by Doctor Victor Archer, is seeing large increases in lung cancer in the low WLM categories. Dr. Archer now estimates some 30 lung cancers/yr/10^6 person-rem, three times higher than the number used by the GEIS. Since the principal exposure mechanism is through radon daughter inhalation at low concentrations, would not this risk estimator be the most appropriate one to use?