



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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June 30, 1989

OFFICE OF
THE ADMINISTRATOR

Honorable William K. Reilly
Administrator
U. S. Environmental Protection Agency
401 M Street, S.W.
Washington, D. C. 20460

Dear Mr. Reilly:

On April 26-28, 1989, the Radiation Advisory Committee of the Agency's Science Advisory Board met at the request of the Office of Radiation Programs (ORP) to consider the scientific merits of the Office's Background Information Document (BID) on the proposed regulatory action on radionuclides in the National Emissions Standards for Hazardous Air Pollutants (NESHAP).

The Committee gathered in an open meeting on the dates described, and heard testimony from a variety of individuals representing the interests of private, industrial and other governmental agencies to the proposed rule-making on radionuclides published in the Federal Register dated March 7, 1989. We are cognizant of the court-mandated constraints under which the rule-making had to be formulated, and commend the Office on the enormity of time and thought it has invested in the preparation of the document we reviewed. We recognize that the document we have seen is not the final version, and that some of the recommendations we offer in the report of our deliberations may have been anticipated and are being addressed.

Overall, we found the estimates of the health risk factors described in the Background Information Document acceptable; however, we do have reservations about the data and arguments used to derive the risks, and offer a series of recommendations for the document's improvement. These are appended to this letter along with a fuller report on our deliberations. However, we would like to call your attention to three issues which thread their way through most of our recommendations. These are (1) the need to use the most current, relevant data available as estimates of the parameters used in the modeling process, (2) the establishment of a clear demonstration of the objectives of the risk assessment and the relationship of the BID to the model used to derive the overall risks, the ultimate bases for the rule-making, and (3) the choice of the estimates of risk used to establish standards and compliance to those standards. We enlarge briefly on each of these in the paragraphs to follow.

(1) The Radiation Advisory Committee has urged the Office of Radiation Programs on previous occasions to be certain that the data used to derive their estimates of risk are the most current available, and wherever practicable to base their assessments on consensus documents such as those of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the National Academy of Science's Committee on the Biological Effects of Ionizing Radiation (BEIR), the International Commission on Radiological Protection (ICRP), and the National Council on Radiation Protection and Measurements (NCRP). Customarily, the Office has followed this advice; however, in the present instance, the consensus document that has been used, BEIR-III, is under revision to acknowledge the dosimetric changes and the further follow-up that has occurred in the studies of the atomic bomb survivors and the patients treated with ionizing radiation for ankylosing spondylitis. This revision should be available soon; however, there already exists a similar reassessment by the UNSCEAR (see UNSCEAR, 1988). We believe strongly that the credibility of the BID is compromised by its failure to reflect these recent developments and should be revised to incorporate the newer data and their assessments.

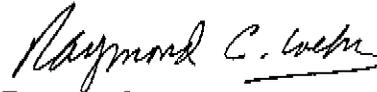
(2) It was difficult for the Committee to determine what the actual objectives of the risk assessment were, and we presume that if we experienced this difficulty, the public and the regulated community will have similar problems. For example, it is not clear whether the purpose of the risk assessment was to calculate doses and their health impacts on a hypothetical, maximally exposed individual to establish a conservative decision, or to obtain a best estimate of the dose and health implications for a real person or population. Accordingly, we have recommended that the first chapter of the Final BID state clearly and in detail the overall objectives to be accomplished by the risk assessment, and that each succeeding chapter culminate in a summary statement on how it relates to the stated objectives of the risk assessment.

(3) We recognize that risk assessment is at best a tenuous art, and that estimates of hazard are commonly dependent on a variety of assumptions, many of which are of uncertain reality. As a consequence, the Radiation Advisory Committee and the Science Advisory Board has repeatedly urged the use of best estimates and ranges in the specification of risk, and a detailed explanation of the uncertainties in the estimates themselves. It does not appear to us that this advice has been consistently applied in the BID. We reiterate, therefore, our recommendation that the Agency develop its overall risk assessment on the basis of best estimates of all of the parameters involved in the modeling process, and not merely some, and clearly describe the uncertainties and possible biases inherent in each estimate.

We note that this third recommendation is offered in the context of the assessment of risk to establish standards, where, in our view, best estimates should always be used for all variables in the modeling process. The establishment of compliance is another matter, we believe, and for demonstrating compliance at levels well below the standard, the use of conservative values in a model is acceptable. However, when models are used to demonstrate compliance close to the standard, best estimates of the site-specific parameters should be used to compare with the standard.

We appreciate the opportunity to examine the Background Information Document and its supporting material, and trust that you and the Agency will find our comments helpful. We would appreciate receiving in writing the Agency's reactions to our recommendations, and are ready to be of whatever further assistance in the promulgation of this rule-making you deem appropriate.

Sincerely,



Raymond C. Loehr, Chairman
Executive Committee



William J. Schull, Chairman
Radiation Advisory Committee

cc: Deputy Administrator
Assistant Administrator for Air
and Radiation
Director, Office of Radiation
Programs



**Report of the
Radiation Advisory
Committee**

**Review of the Office
of Radiation Programs
NESHAPS Background
Information Document**

ABSTRACT

On April 26-28, 1989, the Radiation Advisory Committee of the Agency's Science Advisory Board met at the request of the Office of Radiation Programs to consider the scientific merits of the Office's Background Information Document (BID) on the proposed regulatory action on radionuclides in connection with the National Emissions Standards for Hazardous Air Pollutants (NESHAP). Overall the Committee found the estimates of the health risk to be acceptable, however there were reservations about the the data and arguments used to derive the risks. The Committee recommended that the most current, relevant data be used such as that in UNSCEAR 88 and other consensus documents. The Committee reaffirmed its previous recommendation that best estimates be used along with ranges to specify the risks involved. The Committee recommended that the Agency update its exposure assessment models, consider the use of measurements when available, and in the long run become a state-of-the-art practitioner of environmental transport modeling.

NOTICE

This report has been written as part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide a balanced expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency; and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency or other agencies in the Federal Government. Mention of trade names of commercial products does not constitute a recommendation for use.

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ACRONYMS USED

AIRDOS -	Air Pathway Dosimetry
BEIR 80 -	Biological Effects of Ionizing Radiation - 1980
BEIR 89 -	Biological Effects of Ionizing Radiation - 1989
BID -	Background Information Document
CAP 88 -	Clean Air Package - 1988
COMPLY CODE -	Code Package for Clean Air Act Compliance
CRRIS -	Computerized Radionuclide Risk Investigation System
DREF -	Dose Rate Effectiveness Factor
DS 86 -	Dose System - 1986
Gy -	Gray
ICRP -	International Commission of Radiation Protection
MEI -	Maximally Exposed Individual
NCRP -	National Council on Radiation Protection and Measurement
NESHAP -	National Emissions Standards for Hazardous Air Pollutants
ORP -	Office of Radiation Programs
RAC -	Radiation Advisory Committee
RBE -	Relative Biological Effectiveness
RERF -	Radiation Effects Research Foundation
SAB -	Science Advisory Board
UNSCEAR 86 -	United Nations Scientific Committee on the Effects of Atomic Radiation - 1986
UNSCEAR 88 -	United Nations Scientific Committee on the Effects of Atomic Radiation - 1988
WLM -	Working Level Month

1.0 EXECUTIVE SUMMARY

The recommendations of the Radiation Advisory Committee from the review of the Office of Radiation Program's (ORP) Background Information Document (BID) for NESHAPS are listed below.

RECOMMENDATION 1: The first chapter of the Final BID should clearly state the overall objectives to be accomplished by the risk assessment. Each chapter should contain a summary statement on how it relates to the stated objectives of the risk assessment.

RECOMMENDATION 2: Best estimates of doses and risks, with appropriate uncertainty statements, should be used in all risk assessments. The best estimate should be statistically defined, according to the target population or individual and the shape of the uncertainty distribution should be used.

RECOMMENDATION 3: The basis for the nominal low LET risk value should be fully developed in the light of new risk estimates (UNSCEAR 1988) and, should include a comprehensive discussion of the dose rate effectiveness factor applied. (The range of uncertainty should also be expressed).

RECOMMENDATION 4: Organ cancer risks for low-LET radiation should be recalculated for the U.S. population according to the values in the UNSCEAR 88 report.

RECOMMENDATION 5: The BID should address the uncertainties in alpha emitters organ risks for which no direct information is available. The cancer risk of alpha emitters should be a priority matter for ORP in the future.

RECOMMENDATION 6: The EPA should rewrite the material on teratogenic risk to incorporate the newer analyses, including a discussion of thresholds in risk and their implications.

RECOMMENDATION 7: The EPA should update the material on genetic risks to include newer information from UNSCEAR 86 and UNSCEAR 88.

RECOMMENDATION 8: The BID should state explicitly which of the risks factors are used in the final risk assessment for rule-making.

RECOMMENDATION 9: In its assessment of the hazards of exposure to ionizing radiation, the Agency should consider the use of other measurements of detriment, particularly years of life lost or impaired.

RECOMMENDATION 10: In order to correct widely-recognized deficiencies in exposure assessment modeling, EPA should expeditiously complete the CRRIS model for calculating radiation

dose and risk, provide comprehensive documentation for it, make it available to SAB for technical review, provide it to the professional and regulated community for their use, and apply it to future revisions of NESHAPs and other radionuclide standards involving airborne releases of radioactive materials.

RECOMMENDATION 11: A major initiative should be to explicitly calculate the total uncertainty from all parameter values compare all models for completeness further compare measurements and model predictions, particularly as changes in models are implemented, and carry out sensitivity analyses to identify parameters for which better (i.e. less variable) data should be sought.

RECOMMENDATION 12: Uncertainty analysis should become a routine calculation that accompanies risk assessments.

RECOMMENDATION 13: Measurements or calculations prescribed for demonstrating compliance with the standards should be designed to provide best estimates, since there is no scientific basis for deliberately producing biased measurements.

RECOMMENDATION 14: Radon flux measurements should be obtained at times randomly throughout the year to obtain the best estimate of the annual average radon flux.

RECOMMENDATION 15: A provision should be added to the rule to permit the use of actual environmental measurements for demonstrating compliance with the individual dose limit.

RECOMMENDATION 16: EPA should use measured values of radon flux in (a) the immediate vicinity of uranium facilities and (b) on covered tailings to determine the net radon emission, from which the individual risk is calculated.

RECOMMENDATION 17: The proposed rule for controlling radon emissions from underground uranium mines on the basis of a stack height for all mines should be re-examined in light of the large uncertainties in local dispersion calculations.

2.0 INTRODUCTION

On April 26-28, 1989, the Radiation Advisory Committee (RAC) of the Agency's Science Advisory Board (SAB) met at the request of the Office of Radiation Programs (ORP) to consider the scientific merits of the Office's Background Information Document (BID) on the proposed regulatory action on radionuclides in connection with the National Emissions Standards for Hazardous Air Pollutants (NESHAP). Specifically, the Committee was requested to address five questions in its review of the aforementioned document (see Appendix C for a copy of the Memorandum of April 3, 1989 from Mr. Richard J. Guimond, Director, Office of Radiation Programs to Dr. Donald Barnes, Director, Science Advisory Board), namely,

1) Has the Office of Radiation Programs in the assessment of the hazards of exposure to ionizing radiation from naturally occurring radionuclides used the appropriate risks factors for low-LET radiation and for radon?

2) Has the Office provided adequate documentation of the methodology it has used in deriving the dose and risk estimates?

3) Has the Office adequately responded to the earlier recommendation of the Science Advisory Board to state clearly the objectives of risk assessment calculations?

4) Are the approaches to uncertainty analysis being taken by the Office, as described in the briefing materials, responsive to the concerns of the Science Advisory Board?

5) Are the changes discussed in the attached Memorandum dated March 31, 1989 responsive to the Science Advisory Board's concerns stated in letters to the Administrator dated September 9, November 10 and November 23, 1988?

The Committee met in public session on the dates described, and heard testimony from a variety of individuals representing the interests of the private sector, industry groups, and other governmental agencies concerning the proposed regulatory rule on radionuclides published in the Federal Register dated March 7, 1989. Much of this testimony was presented orally as well as in writing, and we are especially appreciative of this manifestation of public and private concern.

Our reactions to the specific charges placed before us, to the background document, and to other matters follow. We have organized our concerns and suggestions about the document under four broad headings, namely, (a) general remarks, (b) hazard identification, movement of radionuclides through environmental pathways, radiation dosimetry, (c) estimation of the risk of health effects, and finally, and (d) uncertainties of risk assessment.

3.0 GENERAL REMARKS

We recognize that the BID is not yet definitive, and that some of the recommendations we have made may have been anticipated by the Office of Radiation Programs in its preparations of the final BID.

We are also cognizant of the court-mandated constraints under which the Agency, and more particularly the Office of Radiation Programs, have labored in the development of the Background Information Document (BID). We are also aware of the enormity of the investment in time and thought in the current draft, and commend the Office for what it has achieved. However, we believe the document could be improved, and it is in this spirit that our comments are made.

3.1 Objectives of Risk Assessment

It was difficult for the Committee to determine what the objectives of the risk assessment were, and we presume that if we experienced this difficulty, the public and regulated community will have similar problems. For example, it is not clear whether the purpose of the risk assessment was to calculate dose and health impact to a hypothetical individual maximally exposed to establish a conservative standard for a regulatory decision, or to obtain a best estimate of dose and health implications to real people (individuals and populations) to guide in decision-making. These differences in purpose become intertwined at times, such as in the claim of "best estimate" of the dose to the "maximum exposed individual."

Worst-case scenarios must be used carefully. In this respect, we note the EPA's proposed guideline (53 FR 48830) which states that a "... legitimate use of worst-case scenarios is to determine if the exposure or risk is low enough even at this extreme so as to dismiss concern for this scenario. It is not legitimate to use a worst-case scenario to prove that there in fact exists a concern in a real population. In constructing a worst-case scenario, the assessor has usually added assumptions or used particular data points that bring into question whether the scenario actually represents the real world. If the exposure or risk value estimated by a worst-case scenario is high enough to cause concern, the assessor must re-evaluate the parameters used and perform reality checks before deciding a problem really exists."

Volume I of the Draft Environmental Impact Statement contains 7 chapters, but the objective(s) of each is (are) not stated either in the chapter or elsewhere. This is undoubtedly complicated by the inclusion of four options for decision (A, B, C, or D), and it may be essential to determine which option is used before issuing the Final Environmental Impact Statement (FEIS).

RECOMMENDATION The first chapter of the Final BID should clearly detail the overall objectives to be accomplished by the risk assessment. Each chapter should contain a summary statement on how it relates to the stated objectives of the risk assessment.

4.0 HAZARD IDENTIFICATION, MOVEMENT OF RADIONUCLIDES THROUGH ENVIRONMENTAL PATHWAYS

Estimation of dose entails a series of steps, in particular, hazard identification, the determination of the movement of radionuclides through environmental pathways, and ultimately the computation of dose. Three matters concern us about the manner in which the BID addresses these steps, namely, the nature of the models used in risk assessment and their role in the establishment of standards for compliance, the use of direct as contrasted with model-derived measurements of ionizing radiation

in the assessment process, and finally, biases in the data used to access exposure.

4.1 The Nature and the Role of Models in Risk Assessment

The Science Advisory Board has on several occasions in the past asserted and deplored the fact that EPA's radiation models for source terms, environmental transport, dose calculations, and risk calculations as being less than state-of-the-art. AIRDOS, in particular has several deficiencies, yet it forms the technical basis for much of the proposed NESHAPS for radionuclides, and is an option in the evaluation of compliance. While ostensibly a different model, CAP 88, was used for calculating environmental levels, ORP acknowledges that much of this model is based on the same systems contained in AIRDOS, and thus has similar deficiencies.

A new model called CRRIS that incorporates some state-of-the-art codes on sources and transport has been under development by ORP; however, to be considered truly current and suitable for comprehensive radiation risk computations, the code must be adapted to include dynamic models and additional important data files, and to provide a better output format. The CRRIS model was developed by Oak Ridge National Laboratory and it has been peer reviewed and tested, but it requires some further development and documentation for users. Since the proper modelling is of central importance to the development, implementation, and technical supportability of radionuclide NESHAPS, the Committee recommends the following:

RECOMMENDATION In order to correct widely-recognized deficiencies in exposure assessment modeling, EPA should expeditiously complete the CRRIS model for calculating radiation dose and risk, provide comprehensive documentation for it, make it available to SAB for technical review, provide it to the professional and regulated community for their use, and apply it to future revisions of NESHAPS and other radionuclide standards involving airborne releases of radioactive materials.

EPA must recognize in its rule-making that risk assessment modeling continues to change, and since the technical supportability of decisions on the control of radiation decisions is so dependent on such models, EPA should make the necessary commitments to replace CRRIS with new state-of-the-art models within five years.

4.2 Technical Basis of Uranium Fuel Cycle NESHAPS

The EPA has proposed to regulate air emissions from uranium fuel cycle facilities even though it has an existing standard, 40 CFR 190, which controls such emissions in addition to doses due to direct radiation and water pathways. The Committee notes several technical matters related to the NESHAPS for Uranium Fuel Cycle facilities, in particular:

- The NESHAP is less restrictive for organ exposures than 40 CFR 190, even if all the dose received by an individual were via the air pathway; therefore, it provides a smaller margin of safety,
- The NESHAP limits effective whole body dose due to air emissions to 10 mrem/yr which is less than the 25 mrem/yr required by 40 CFR 190 for all pathways,
- The NESHAP is addressed to the maximum exposed individual, which appears to be implemented on the basis of a hypothetical person; 40 CFR 190 addresses exposure to actual individuals. Thus the two standards have different technical requirements for their implementation, and in the instance of the NESHAP these have not been clearly nor completely stated.

4.3 The Use of Direct As Contrasted With Model-Derived Measurements of Exposure to Ionizing Radiation in Risk Assessment

The Science Advisory Board's advice on using "best estimates" for risk assessment is equally applicable to the measurements prescribed for demonstrating compliance.

RECOMMENDATION Measurements or calculations required for demonstrating compliance with the standards should be designed to provide best estimates, since there is no scientific basis for deliberately producing biased information.

Appendix B of the proposed rule includes methods for measurement and calculation of the mean radon flux. The method prescribed for phosphogypsum stacks involves separate measurements and calculations for regions of five different types, ranging from water-covered areas with an assumed flux of zero to loose and dry top surfaces where the flux may be highest. The Committee is pleased that this method includes a realistic area-weighted flux calculation. However, the prescribed measurement methods for both phosphogypsum stacks and uranium mill tailings piles after disposal include restrictions on measurements of radon flux (a) within 24 hours of a rainfall, (b) if the collector is surrounded by water, and (c) if the ambient temperature is below 35°F or if the ground is frozen.

RECOMMENDATION The radon flux measurements should be obtained randomly throughout the year to obtain the best estimate of the annual average radon flux.

For uncovered uranium mill tailings, the EPA makes a basic assumption that a radium-226 concentration of 1 pCi/g will result in a radon fluence rate of 1 pCi/m²-s (Vol. 1, p. 7-4). This value might be considered a reasonable assumption in the absence of data; however, data are available that indicate that the

actual radon emissions are significantly lower (Table 3-1, FEIS for Inactive Uranium Processing Sites, EPA 520/4-82-013-1).

RECOMMENDATION The actual data on radon flux should be used for calculating emissions from uncovered tailings.

4.4 Concentration Measurements

Measurements of sources and environmental concentrations are extremely important to EPA's stated intent to use "best estimates" of radionuclide concentrations in the environment, and population and individual risks. However, the EPA has made no provision in the proposed rule for demonstrating compliance by direct measurement, where that is possible, or for using measurements to establish the incremental source term in the case of radon from uranium mill tailings.

For facilities licensed by the Nuclear Regulatory Commission (NRC) (Subpart I), the proposed rule allows only two methods for determining compliance with a standard. One method is to use the COMPLY code, which at present is undocumented and cannot be modified to accommodate all site-specific information. If a facility cannot demonstrate compliance using the COMPLY code, an alternative approach is provided in Appendix E, which is based on concentration limits at the point of release. This approach is also totally dependent on environmental modeling. Because of the recognized large uncertainties and biases inherent in the present models, the committee does not believe that enforcement of an individual dose limit based totally on modeling is scientifically justified.

RECOMMENDATION A provision should be added to the rule to permit the use of actual environmental measurements for demonstrating compliance with the individual dose limit.

A second need for actual environmental data is for determining the incremental increase in exposure and risk from disposal of uranium mill tailings. EPA has calculated a risk of 2.1×10^{-2} for the individual who lives close to a tailings pile for 70 years, if the radon emission is exactly at the limit of 20 pCi/m²-s currently required by 40 CFR 192. This risk estimate is not a "best estimate" since it is based on a faulty assumption and unsupported by measured data. The limit in 40 CFR 192 is a design standard and actual tailings cover design have only been approved by the NRC when they have been sufficiently conservative to assure a high probability that the standard would be met. Consequently, the average emissions following disposal are expected to be much below 20 pCi/m²-s. This expectation could and should be verified by measurement. The assumption that the emission rate actually is 20 pCi/m²-s represents a bias in the risk estimate. However, for calculating the risk to an individual resulting from an industrial facility, only the net emission should be used.

The design-standard approach used in 40 CFR 192 was expressed as total (not net) emission, partly for convenience of design evaluation and partly in recognition that 20 pCi/m²-s is within the range of the natural radon flux from undisturbed soils in regions with commercially-viable uranium deposits.

4.5 Underground Uranium Mines

The EPA proposes to control risks from radon released by underground uranium mines by allowing a release rate via a 30-meter stack that is three times larger than allowed for a ground-level release. Because of the strong dependence of effective stack height on buoyancy and velocity of the exhaust, and on the roughness of the terrain in the immediate vicinity of the stacks, the accuracy of the dispersion calculations is questionable. However, for the two mines with the highest calculated risks to individuals, i.e. the Schwartzwalder and the Pigeon mines, the calculated concentrations are large enough to be verifiable by measurements. The predicted contribution from the Schwartzwalder to the nearest individual 1,400 meters away is 0.25 pCi/L (Table 11.8, BID Vol. 2, p. 11-17). This is sufficiently greater than the regional background, estimated to be 0.15-0.2 pCi/L, and measurement would be relatively easy. The same is true for the 0.12 pCi/L calculated at 3,900 meters from the Pigeon mine.

RECOMMENDATION Direct measurements should be made to verify or correct the dispersion calculations before adopting a rule that assumes the need for a 30-meter stack.

4.6 Biases in Exposure Assessment

The Committee and the Science Advisory Board have twice previously recommended (1,2) that the Agency should perform calculations that represent best estimates of the doses and risks from a particular activity. Indeed, the Agency's own guidelines (3) state the same preference for best estimates rather than worst-case analyses. However, these SAB recommendations and Agency policy have frequently been ignored in the preparation of the BID.

Although both the BID and the preamble to the proposed standards (4) state in several places that the calculated doses and risks are "best estimates," the Committee review has found that this is not an accurate description. Some of the biases are highlighted in Section 7 in Volume 1 of the BID, others are not. Biases that are notable are the following:

- 1) The choice of the 70-year exposure time and the assumption that the individual is outdoors the entire time. While lifetime occupancy of the same residence is possible, it is not the norm. Data are available from the Bureau of the Census that describe behavior of U.S. residents. These can be used to estimate the expected value of the risk, rather than the upper bound. Activity patterns for 56 population subgroups with hourly assignments to micro- environments and exercise levels (and

breathing rates) were developed for the Agency's analysis of carbon monoxide exposure (5). These published patterns provide the basis for estimating the average time spent outdoors and away from the home for the subgroups and the population as a whole. Similarly, some data are available on the relationship between outdoor concentrations of particles and those which are found indoors. In the preamble to the proposed standards it is argued that the 70-year exposure assumption doesn't overestimate the risk by more than a factor of two. Reference (6) suggests that best estimates of indoor particulate concentrations will be a factor of 3 or more lower than outdoor concentrations. Together these two factors could cause an overestimate of the dose and risk to the maximally exposed individual from releases of particles by a factor of 6 or more.

2) The assumptions made about release points are often biased to compute an upper bound rather than a best estimate of the dose to the maximally exposed individual. The Agency used 1-m or 10-m release heights for sources with stacks and vents that were known to be higher at several Department of Energy (DOE) sites. Hospitals, which are often large buildings were modeled using 6-m and 15-m release heights.

3) Another bias was in the source term for the large research hospital. The assumed releases did not include I-131 or other nuclides that are used for research and diagnostic tests.

4) When a survey of specific residences has not been made, it has apparently been assumed that an individual resides at the point of maximum off-site air concentration. The language in the BID does not make it clear what assumption was made in all cases.

5) No consideration seems to have been given to the effects of frozen ground and snow cover in winter, or wet surfaces during the spring.

6) The value assumed for f_1 , for uranium is a factor 14 greater than that recommended in a review of uranium metabolism (7).

We believe that the Agency is not following its own guidance (4,8) regarding biased estimates; in preparing the revised BID, the Agency should heed the following relevant quotations from that guidance. (These quotations all relate to the first bias cited above)

"Although the environmental media are primarily responsible for the wide dispersion of anthropogenic chemicals that reach the environment and sometimes serve as major reservoirs of pollutant residues, the mere presence of a substance within an environmental medium does not indicate the extent to which exposure might occur. It is worth emphasizing here that ambient concentrations of a pollutant are not exposures to a pollutant. Ambient pollutant levels can give distorted estimates of exposure levels for many pollutants by failing to account for other

sources of exposure. Moreover, ambient pollutant concentrations fail to account for time-activity patterns that affect exposure in segments of the population (i.e. there is no exposure if the organism is not present)." (Section 2.3.3 of References 8)

In the section titled, Predictive Exposure Assessment of Reference 8, the discussion includes the duration of the exposure as one variable to be assessed, and uses the following example: "Activity pattern data are used, or assumptions made, concerning the activities of the exposed individual, to determine what the parameters for contact rate and exposure duration will be for the scenario. For this scenario, assume the contact rate is two liters of tap water ingested daily, and that the individual lives at this location for 40 years (the exposure duration.)"

"One form of worst-case scenario is the so-called "maximally exposed individual" (MEI), which represents the single individual with the highest exposure... In most exposure assessments, adjusting all the parameters to their limiting values would maximize exposure results in a scenario that may not have any realistic chance of happening in the real world.... For this reason, the concept of "reasonable worst-case" scenarios is often used, where the exposures are high but the combination of parameters thought to be one which probably occurs in the actual population." (footnote 5, section 3.2.3 of reference 8)

RECOMMENDATION Best estimates of doses and risks with appropriate uncertainty statements should be used in all risk assessments. The best estimate should be statistically defined, according to the target population or individual and the shape of the uncertainty distribution.

5.0 ESTIMATION OF THE RISK OF HEALTH EFFECTS

Our remarks on the estimation of the risk of health effects focus on the following aspects of the Background Information Document (see specifically Chapter 6), namely, the risks associated with exposure to low-LET radiation, the radon risk, the genetic and teratogenic risks, the overall summary of risks, and finally, the use of descriptors of risk other than fatal cancers in future assessments.

5.1 Low-LET Radiation Risk

5.1.1 Nominal value for total cancer risk $400 \times 10^{-6} \text{ rem}^{-1}$

1) This nominal value is probably a fairly good "best estimate" in the light of recent revisions in risk estimates (UNSCEAR 88, BEIR 89), and is acceptable to the Committee.

2) The justification of this value is poor, however, because it is based on a high estimate derived from BEIR III data using a linear dose response model without a dose rate effectiveness factor (DREF) and relative risk projection.

3) The discussion is dated and does not present a good update based on UNSCEAR 88 which is now published. The update of the Hiroshima-Nagasaki data to 1985, including the revised dosimetry, is used only to derive uncertainties on the nominal values, which range from $1200 \times 10^{-6} \text{ rem}^{-1}$ on the high side to 120×10^{-6} on the low side. There is no recognition that if the same philosophy as used in deriving $400 \times 10^{-6} \text{ rem}^{-1}$ from BEIR 80 were used for the new revised data the nominal value would be $1200 \times 10^{-6} \text{ rem}^{-1}$.

4) A "best" value of $400 \times 10^{-6} \text{ rem}^{-1}$ can, however, be obtained by dividing $1200 \times 10^{-6} \text{ rem}^{-1}$ by a dose rate effectiveness factor of 3.

RECOMMENDATION The basis for the nominal low LET risk value should be fully developed in the light of new risk estimates (UNSCEAR 88) which includes a discussion of the dose rate effectiveness factor. (The range of uncertainty should also be expressed).

5.1.2 Organ risks

The relative risks of cancer in different organs are presented in Table 6-10 page 6-28 and are based on BEIR 80 and are thus very dated.

RECOMMENDATION Organ cancer risks should be updated for the U.S. population according to the UNSCEAR 88 report.

5.1.3 Alpha Organ Risks.

These cancer risks (Table 6-11, page 6-33) have the same ratios as the low-LET risks indicating that the same Relative Biological Effectiveness (RBE) (8) was used for all. This is probably unjustified since leukemia, for example is less frequently induced by alphas, while other alpha risks such as bone, lung and liver derive directly from data on exposures to alpha emitters.

In the case of tissues for which actual measurements are lacking, EPA has used the expedient of multiplying the risk factors for low-LET radiation by an estimated RBE of 8. This approach is open to criticism at two levels; namely, the spatial distribution of alpha-emitters in a tissue, and the short range of alpha particles. There is no assurance that the resulting risk coefficients for alpha particles are realistic. There is no information that might permit better estimates.

RECOMMENDATION EPA should acknowledge the dubious accuracy of the estimation procedures used here.

Given the linear assumptions from BEIR 80 an RBE of 8 is not unreasonable (20/2.5). However, when the more recent low LET risk of $400 \times 10^{-6} \text{ rem}$ is used as a best estimate consideration must be given to whether an alpha RBE of 20 should be used.

RECOMMENDATION The BID should address this matter and the determination of the true cancer risk of alpha emitters should be a priority matter for ORP in the future.

5.2 Radon Risk using a nominal value 360×10^{-6} WLM⁻¹ with a range from 160-720

1) The Committee has previously endorsed the approach used to derive this value, and still finds the value acceptable.

2) However, the Committee wishes to note it may be on the high side for two reasons. First, the National Council on Radiation Protection and Measurements (NCRP) value, which is the only one based on an absolute model (which has not been discredited), was not included in the averaging. Second, the treatment of children in the International Commission on Radiation Protection (ICRP) model may exaggerate the risk and this contributes to the average.

5.3 Genetic and Teratogenic Risk

5.3.1 Genetic Risks

1) Overall, this section states the uncertainties and ambiguities in the experimental and human data on mutagenesis well. It would profit nonetheless from references to UNSCEAR 86 and UNSCEAR 88 and further discussion of complexly inherited traits. The latter undoubtedly contribute the largest uncertainty to the projection of genetic risks.

2) The reason for an RBE of 2.7 for alpha genetic effects is not clear. It is said to be from BEIR 89 -- perhaps from high doses. Higher values of alpha RBE are generally found for mutagenesis (e.g., ICRP Publication 18) against chronic gamma rays.

5.3.2 Teratogenic Risks

1) This section, as noted for those on genetic and carcinogenic risks, is largely out of date. It focuses on the findings in Japan prior to 1985 which are based on the old dosimetry. There is no reference to the reanalyses of 1987 and 1988 (see Radiation Effects Research Foundation (RERF) Technical Reports 13-87, 2-88, 3-88 and 13-88). These broaden the nature of findings, and make more compelling the need for a discussion of thresholds.

2) Fortuitously, the risk of severe mental retardation, based on organ dose and a linear dose response model, is approximately the same under the two dosimetries. However, the DS86 doses suggest a threshold in the developmental period 8-15 weeks after fertilization in the range of 0.10 to 0.20 Gy.

3) Given the uncertainty of the existence of a threshold, the Committee agrees that the prudent course is to calculate risk

on the basis of a linear, no threshold dose response function. However, the conservative nature of this approach should be stressed more forcefully.

RECOMMENDATION This section as well as the one on genetic risks should be written to incorporate the newer analyses, and in the instance of the teratogenic risks, include a discussion of thresholds in risk and their implications.

5.4 Overall Summary of Risk

Table 6-25 on page 6-81 is a very useful table encompassing all the risks identified, including teratogenic, genetic and somatic. It is not clear which or whether all of these risks were used subsequently in the estimates of risk and deriving limit values or whether the fatal cancer risks only were used.

RECOMMENDATION The BID should state explicitly which risks factors are used in the modeling for final risk assessment.

5.5 Loss of Lifetime due to Cancers (or other Effects Induced by Radiation)

Many, if not all recent assessments of the health effects of exposure to ionizing radiation have examined the effect of dose on measures of detriment other than fatal cancers. This subject was not discussed in the BID but it could be a helpful consideration since the period of life lost may be a more meaningful index of the effect of radiation than fatal cancers. Years of life lost has the important advantage that absolute and relative projection models yield about the same result in terms of the collective years of life lost by a population.

RECOMMENDATION The Agency should consider the use of other measures of detriment, particularly years of life lost or impaired, in its assessment of the hazards of exposure to ionizing radiation.

6.0 UNCERTAINTIES IN RISK ASSESSMENT

On several occasions the Science Advisory Board has recommended improvements in the pathway models used by the EPA in the assessment of dose and greater attention to the quantification of uncertainty. Specifically, the 1988 report of the Subcommittee on Sources and Transport (2) provided the following comments:

- 1) EPA should quantify the uncertainty in the estimates for each source category in the assessment of dose, and define the "best estimate" in terms of relationship to the uncertainty distribution.
- 2) EPA should carry out parameter and pathway sensitivity analyses, whenever and wherever possible.

- 3) EPA should use Monte Carlo calculations or other state-of-the-art methods in its risk assessments.
- 4) EPA should discuss what potentially relevant parameters its models do not include.

The use and importance of uncertainty analyses should not be overlooked or minimized. They can, for example, provide supporting documentation to the risk assessment through a full disclosure of the current level of knowledge of parameter values. This would give a more scientifically defensible set of model results, and enhance the credibility of the modeling effort itself. For example, providing a complete uncertainty analysis can enable probabilistic statements of risk to be made, e.g. "the probability that the true dose (or risk) does not exceed a specified value is ..." Thus, maximally exposed individual can be defined by a percentile (e.g. 99th) of the probability distribution. High risk groups, e.g., individuals living near release points for long periods, simply have different point estimates of the residence time, but the same uncertainty of transport parameters and the risk to dose are used.

Because calculational methods are now available which can be used to propagate parameter uncertainties and variabilities, the EPA needs to use such methods to enhance their credibility. Moreover, it is imperative that the EPA be not merely a passive participant in these developments, but a leader in environmental transport modeling. The resources, particularly in computing, to accomplish this may not be trivial. Much progress has been made in this area, however, and it is now possible to implement stochastic simulation models on a range of sizes of computers, including desk-top models.

RECOMMENDATION In the long term, the Agency should become a state-of-the-art practitioner of environmental transport modeling.

It may be fruitful to review the components of uncertainty analysis; these include (a) error propagation, (b) sensitivity analysis and (c) model validation. The first of these has been discussed. It is important to bear in mind that uncertainty analysis is not performed just one time. It should be a tool which is continually available for assessments of new sites or recalculations of previously assessed sites using new data. Many valuable lessons can be learned from such analyses, and these have broad applicability to hazards other than just ionizing radiation. For example, sensitivity analysis can be used to direct research initiatives by identifying parameters or pathways which warrant further study.

We would like to provide some guidance on pursuing further improvements in uncertainty analysis. First, the effort should be coupled with that of improving models. Pathway models, designed for establishing compliance (e.g. those used in AIRDOS) may be less than complete. Examples are lack of building-wake

corrections, and, "second order ingestion pathways." Uncertainty analysis may have little meaning if the model is incomplete and not intended to yield best estimates. The commitment to perform uncertainty analyses must be simultaneous with a commitment to implement state-of-the-art realism in model structure and choice of parameter values. Although, it appears that the Agency intends to "give best estimates of radionuclide concentrations in the environment and individual and population risks" (54 FR 9616), current choices of model structures and parameter values do not always meet this goal.

Although the Agency has argued that performing uncertainty analyses would not result in any changes in rule-making, the choice of the central estimates, which is a part of the uncertainty analysis procedure, can substantially affect this. The addition of several "second order pathways" and/or modifications of several pathways, coupled with the selection of true "best estimates" of parameter values, may result in quite significant changes in dose (and risk) predictions. For the EPA to accurately claim it uses "scientifically accurate procedures in evaluating risks..." (45 FR 9649), would require the use of realistic models, realistic parameter values and propagating error terms. We do not believe that all of these criteria have been satisfied. In particular, we note some parameter values are biased and error propagation has not yet been routinely implemented.

RECOMMENDATION Major initiatives should include explicit calculation of uncertainties from all parameter values as well as comparison of all models for completeness.

The second component, sensitivity analysis, need not be discussed in detail here. It should be recognized, however, that sensitivity analysis can be relatively easily implemented with an uncertainty analysis.

RECOMMENDATION Sensitivity analysis should be used to identify parameters for which better (i.e. less variable) data should be sought or pathways which need further research.

The third component, model validation, is essential for credibility, in fact, determining that modeling procedures are "scientifically accurate" can only be verified by model validation. Air dispersion validation measurements were reported to the Sources and Transport Subcommittee in 1988. These efforts were commended, however, the description (54 FR 9618) that "as often as not, AIRDOS predictions are within a factor two of actual concentrations" leads one to believe that agreement was no better than chance would predict. These results should be examined more closely.

RECOMMENDATION Further comparison of model predictions with measurements should be planned, particularly, as changes in models are implemented.

The techniques of performing uncertainty analyses were described in "Guidelines for Estimating Exposures" (51 FR 34042-34054). The guidelines stress that "uncertainties, assumptions, and limitations" be identified and states that "evaluation of uncertainty is an important part of all exposure assessments." The uncertainties of parameters result not only from environmental variability but in addition, from seasonal variations in releases and the guidelines suggest this be examined and be a part of the total emission uncertainty. The Guidelines also state (51 FR 34048) that model results "must be compared to measurements and any significant discrepancies should be discussed." The analysis of exposures to populations should be presented with "an estimate of the uncertainty associated with them."

The guidelines further agree with recent SAB recommendations that characterization of uncertainty should include a discussion of limitations of data and justification for the model. Most importantly, "The Guidelines do not encourage the use of worst-case assessments, but rather the development of realistic assessments based on the best data available." It is important to estimate the level of uncertainty in risk assessments so that decisions based on risk assessment will reflect total uncertainty."

RECOMMENDATION Uncertainty analysis must become a routine calculation that accompanies risk assessments. This entails a full disclosure of model details and is preceded by full literature review of parameter values and the central estimates relevant to the assessment question.

We realize that this discussion of the need for uncertainty analysis is not new to the ORP. The space dedicated to this item here reflects the strength of our belief that it should be implemented.

The recent efforts to provide uncertainty analyses are acknowledged here as a strong preliminary step forward. The level of commitment to further this work is not clear, however. Further refinements would have greater value if accompanied by model improvements. Some saving of effort may be had if models are improved simultaneously with development of uncertainty analysis methods.

7.0 RESPONSES TO THE QUESTIONS OF THE ORP

We return now to the specific questions raised by the Office of Radiation Programs in the charge to the Committee, and to brief answers to each.

1) Has the Office of Radiation Programs in the assessment of the hazards of exposure to ionizing radiation from naturally occurring radionuclides used the appropriate risk factors for low-LET radiation and radon?

The nominal risk factors for low-LET radiation are reasonable, and those for radon are acceptable although they may be somewhat on the high side.

2) Has the Office provided adequate documentation of the methodology it has used in deriving the dose and risk estimates?

Documentation of the methods of deriving doses are generally good, but incomplete in a number of respects, such as the bases for the choice of the individual, hypothetical or real, whose dose is estimated, and a full description of the biases and uncertainties in the estimates used in the modeling itself.

Although the risk factors used for low-LET radiation and radon are acceptable, as previously stated, the arguments used to justify the low-LET risk estimates are based on consensus statements (BEIR 80) and data that are no longer current, and are inadequate in the Committee's view.

3) Has the Office adequately responded to the earlier recommendation of the Science Advisory Board to state clearly the objectives of the risk assessment calculations?

We have seen a dramatic improvement in the response to the SAB's concerns in the past six months, particularly with regard to uncertainty analyses. Recent advances in the latter area are a good example of the results that can be obtained through the dedication of resources. It should be noted, however, that a much greater effort in this regard was suggested by the 1984 SAB review, and had the Board's recommendations been implemented sooner progress at this point in time would have been greater. The effort expended by the contractor of ORP to produce simulations of AIRDOS is a worthwhile step forward. The Agency's commitment to the furtherance of this work is not clear, but it should not be allowed to lag.

4) Are the approaches to uncertainty analysis being taken by the Office, as described in the briefing materials, responsive to the concerns of the Board?

The current efforts to provide uncertainty analyses are a strong preliminary step forward. Further refinements are needed, however, and these will have greater value if they are accompanied by improvements in the underlying models. Pathway models designed for establishing compliance (e.g., those used in AIRDOS) could be improved through allowance for building-wake corrections, and "second order ingestion pathways." Uncertainty analysis may have little meaning if the model is incomplete and not intended to yield best estimates. The commitment to uncertainty analyses must be simultaneous with a commitment to implement state-of-the-art realism in model structure and choice of parameter values. Although, it appears that the Agency intends to use "best estimates of radionuclide concentrations in the environment and individual and population risks" (54 FR

9616), the current choices of model structures and parameter values do not always meet this goal.

5) Are the changes discussed in the attached Memorandum dated March 31, 1989 responsive to the Science Advisory Board's concerns stated in letters to the Administrator dated September 9, November 10 and November 23, 1989.

Within the time constraints imposed, ORP has made significant progress on SAB recommendations; however, as noted above, more work should be done on the BID before its final issuance. The indicated responses are generally appropriate; however, some of them state a commitment to several very important tasks within one to four years to satisfy SAB concerns and recommendations. While we acknowledge that proper completion of these tasks requires time not available for this specific rule, the Committee strongly recommends that the Administrator direct and support ORP efforts to complete the task force efforts, especially the ones on state-of-the-art models, specification of uncertainties in dose and risk estimates, and the basis and presentation of risk information. These activities have been recommended several times in the past only to be postponed by urgent situations; it is past time for EPA to complete these tasks so vital to providing a scientific basis for its actions

8.0 REFERENCES

- (1) Science Advisory Board Subcommittee on Risk Assessment for Radionuclides, Report on the Scientific Basis for EPA's Proposed National Emission Standards for Hazardous Air Pollutants (NESHAP) Standards for Radionuclides, Review of Assessment Methodologies, November 1988.
- (2) Sources and Transport Subcommittee of the Radiation Advisory Committee, National Emission Standards for Hazardous Air Pollutants (NESHAP) Standards for Radionuclides, Review of Assessment Methodologies, November 1988
- (3) Environmental Protection Agency, 40 CFR Part 61, National Emission Standards for Hazardous Air Pollutants; Regulation Radionuclides; Proposed Rule and Notice of Public Hearing, 54 FR 9612 (1989).
- (4) Environmental Protection Agency, Guidelines for Estimating Exposures, 54 FR 34042 (1986)
- (5) E. Anderson, N. Browne, S. Duletsky, J. Ramig, and T. Warn, Development of Statistical Distributions on Ranges of Standard Factors Used in Exposure Assessments, EPA Report PB815-242667 (1985).

- (6) J. Alzona, B. L. Cohen, H. Rudolph, H. N. Jow, and J. O. Frohlinger, Indoor-Outdoor Relationships for Airborne Particulates of Outdoor Origin, Atmospheric Environment, 13, (1979).
- (7) M. E. Wrenn, P. W. Durbin, et al., Metabolism of Ingested U and Ra, Health Physics, 43, 601 (1985).
- (8) Environmental Protection Agency, Proposed Guidelines for Exposure-Related Measurements, 53 FR 48830 (1988).
- (9) C. B. Nelson, Assessment of Atmospherically Released Radionuclides, Unpublished report of the Office of Radiation Programs.

APPENDIX A
TECHNICAL COMMENTS ON THE BACKGROUND
INFORMATION DOCUMENT

APPENDIX A

TECHNICAL COMMENTS ON THE BID

A. Atmospheric Dispersion Modeling

1. There are references throughout the document to the use of "site specific meteorological data" when, in fact, the meteorological data were obtained from airport locations which may or may not be representative of the site being evaluated. This approach is understandable in many of the specific cases because there are no onsite meteorological data that could be used. However, in Section 2 of Volume 2 the authors have clearly ignored available site specific data when making the evaluations. A tabulation of release locations from Section 2 and the Agency's sources of "site specific" meteorological data is attached. In addition to the lateral separation between the release points and the meteorological data collection point, there are questions about differences in terrain, elevation, and release height versus the height at which wind speed and direction were measured at the airports. Although the information is not provided, it is likely that releases from tall stacks were consistently evaluated using data collected much closer to the ground. Some of these choices of meteorological data sources are particularly remarkable: using data from Santa Fe to assess releases at Los Alamos; using data from Pocatello to assess releases at the Idaho National Engineering Laboratory, about 80 km away; data used for river valley and rugged terrain sites in Tennessee, Ohio, Kentucky, and Colorado. Many of the Department of Energy sites have routine meteorological data collection and analysis programs and would surely provide the raw data or previously compiled joint frequency distributions for appropriate release heights for 1986 that are needed for the assessment.

COMPARISONS OF PLANT AND METEOROLOGICAL DATA SOURCES FOR DOE SITES

<u>Facility Name/Location</u>	<u>Met. Data Source</u>	<u>Separation</u>	<u>Notes/Comments</u>
React. Met. Inc. Ashtabula, OH	Cleveland, OH	80	Both near Lake Erie
Los Alamos Nat'l Lab. Los Alamos, NM	Santa Fe, NM	36	Rug.;dH; data exist
Hanford Reser. Richland, WA	Moses Lake, WA	72	Site data exist
Oak Ridge Res Oak Ridge, TN	Knoxville, TN	27	Valley; site data exist
Savannah Rive Plant Aiken, SC	Augusta, GA	35	Site data exist
Feed Mat. Prod. Cntr. NW of Cincinn., OH	Covington, KY	35?	No site data
Brookhaven Nat'l Lab. Upton, Li, NY	Lawrence, NY	77	Site data exist
Mound Laboratory Miamisburg, OH	Dayton, Oh	16	No site data?
Idaho Nat'l Eng. Lab. Scoville, ID	Pocatello, ID	80	Site data exist
Law. Berk. Lab. Berkeley, Ca	Oakland, CA	21	No site data?
Paducah GDP McCracken Cty, KY	Paducah, KY	10?	No site data?
Law. Liv. Nat'l Lab. Livermore, CA	Fairfield/Travis	68	Site data exist
Portsmouth GDP Pike City., OH	Huntington WV	84?	No site data?
Argonne Nat'l Lab. Dupage City, IL	Midway Airport	21	Site data exist
Pinellas Plant St. Petersburg, FL	Tampa, FL	31	No site data?
Nevada Test Site Nye County, NV	Yucca Falls, NV	Amazing	Why this site? EPA Lab?
Knolls Laboratory West Milton, NY	Albany, NY	30?	No site data?
Battelle Mem. Inst. Columbus, OH	Columbus, OH	small	No site data?
Fermi Nat'l Lab. Batavia, IL	Midway Airport	41	No site data?
Sandia Nat'l Lab. Albuquerque, NM	Albuquerque, NM	small	No site data?
Bettis At. Pwr. Lab. West Mifflin, PA	Pittsburgh, PA	13	Allegheny Cnty. Closer?
Knolls laboratory Windsor, CT	Hartford, CT	8--10	No site data?
Rocky Flats Plant Highway 93	Stapleton Airport	30	Site data exist
Pantex Plant NE of Amarillo, TX	Amarillo, TX	30	No site data?
Knolls Laboratory Knolls, NY	Albany, NY	30?	No site data?
Ames Laboratory Ames, Iowa	Waterloo, IA	117	No site data?
Rocketdyne Los Angeles, CA	Los Angles, CA	?	LAX?

2. The dispersion model does not address wake effects due to large buildings or other objects. Such effects are important when the receptor is close to the source and the emission point is less than about 2.5 times the height of the obstacle. This situation occurs for maximally exposed individuals for releases from clusters of buildings (various types of production facilities), vent releases from power plants, hood and ventilation exhausts for hospitals, and releases from phosphogypsum stacks.

3. The treatment of uncertainties associated with EPA's AIRDOS atmospheric dispersion model is very brief (1 page) and ignores some key issues. (1) It is assumed that the basic modeling assumptions are satisfied when in many instances they are not. While some assessments deal with flat terrain, many involve wake dispersion, river valley flows, rugged terrain effects, and dispersion in urban areas. The output of a flat terrain, no obstacle, model must be viewed with some skepticism in these instances and the uncertainties of the predictions of that model are clearly higher than for the situation it was designed to address. (2) The cited uncertainty factors of 2 for distances less than 10 km and 4-10 for distances of 30-140 km are based on comparisons made using site specific meteorological data. The additional uncertainty associated with the application of wind speed and direction data collected at a point that is, for example, some 50,000 m east and 50 m closer to the ground than the release point is not addressed at all. Neither is the question of whether the flow regime at the airport is different because of river valley flow patterns or substantial differences in elevation. It is clearly misleading to the general reader and to the decision maker to present such calculations as "site specific evaluations" and to discuss the uncertainty of the results as if they were complete evaluations.

4. It is possible and in fact necessary to address these issues directly and to obtain quantitative information about differences in modeling and data sources. To initiate this process, we have obtained information for one site for illustration. The DOE report titled 1986 Environmental Monitoring Program Report for the HEL Site by D. L. Hoff, E. W. Chew, and S. K. Rope (DOE/ID-I 2082(86), dated May 1987) is the source of the dose estimates in items (1)--(3) below. (1) The onsite meteorological data for the HEL were used together with the 1986 effluent releases from the Test Reactor Area (TRA) and the Idaho Chemical Processing Plant (ICPP) to compute the maximum offsite dose using the AIRDOS-EPA computer code. The code predicted an external dose of 0.003 mrem and an effective dose equivalent of 0.005 mrem for a person living near Arco, Idaho throughout 1986. The point of maximum exposure was estimated to be 24 km west of the TRA-ICRP release locations. The releases are from stacks that are 76 and 62 m high at the two locations which are about 3 km apart in the south central portion of the INEL. (2) Calculations were also performed with the MESODIF dispersion code, which was developed

specifically for the HEL site and uses wind field data to predict dispersion over a large grid covering the site and adjacent areas. These calculations predicted that the maximally exposed individual during 1986 would have been located at Atomic City, about 20 km SSE of the release points, and would have received an effective dose equivalent of 0.1 mrem, with about 80% of the total (0.085 mrem) due to releases of Sb-125 from the ICRP. (3) Routine measurements of airborne radioactivity are made at Atomic City and those data were also used to compute the dose from Sb-125 at that location. The measured concentrations indicated a dose of 0.16 mrem from Sb-125 would have been received during 1986. Ingestion pathways, which would have added another 0.01 mrem to the total, were not included because the releases of Sb-125 occurred during the fourth quarter of the year when cows are not on pasture and vegetables are not growing in this area. The MESODIF model, using truly site specific data, predicted a dose that was within 50% of the more reliable estimate based on measured outdoor air concentrations. The collective dose for 1986 was estimated to be 0.64 person-rem; the calculation assumed continuous occupancy and no building shielding. (4) In Volume 2 of the BID, the 1986 HEL releases were used to calculate doses using AIRDOS and meteorological data from the Pocatello airport. Based on these calculations, the dose to the maximally exposed individual during 1986 was 0.025 mrem, with about half of the computed dose (0.012 mrem) attributed to immersion exposure due to argon-41. The total dose reported in the BID was about 5 times greater than the dose computed using the same model with appropriate meteorological data. However, part of the difference may be due to the assumption in the BID of a stack height of 1 m for these releases. The dose attributed to Sb-125 in the BID analysis of the maximally exposed person was 0.008 mrem, substantially lower than the best estimate of the true dose (0.16 mrem). This may be due to (i) spreading a release that occurred during the last quarter over the whole year or (ii) being misled as to the location of that maximally exposed person by using the wrong stack height or (iii) some combination of these and other factors. The collective dose estimated for HEL operations during 1986 was about 0.07 mrem, about a factor of 9 lower than the estimate derived from a truly site specific calculation. (5) These results are less encouraging than those given in the paper by Beal that was provided to the Sources and Transport Subcommittee members at the meeting in July of 1988 and indicates that much work remains to be done to assess the meteorological modeling uncertainty. Particular reasons for the observed differences may be difficult to unravel and are not the crucial aspect of the comment. Because DOE sites are required to use AIRDOS-EPA to assess compliance with the 25-mrem standard, the magnitude of the uncertainty introduced by the use of meteorological data from distant locations can be assessed. It's a safe bet that the Los Alamos staff didn't consider the Santa Fe airport a credible source of data and, instead, used onsite meteorological data to assess compliance. As a result, the EPA assessment results using Santa Fe airport data can be compared

with the doses predicted using the truly site specific meteorological data. The same comparisons could be made at the other DOE sites where collection of meteorological data is routine. It should also be noted that the set of (about 100) nuclear power plants provides an opportunity to determine the range and distribution of uncertainties associated with the use of airport rather than onsite meteorological data. An approach for sites having no onsite information would be to use data from two or more airports that are about equally unrepresentative and compare results of those calculations.

B. Deposition of Radioactive Material

The wide range of reported deposition velocities is cited on page 4-11 Vol 1. One reason for this is that the deposition velocity depends upon the chemical form of gases, such as iodine, and upon particle size. The method used by EPA to select appropriate deposition velocities for the various assessments is not discussed in the present draft. Appendix A to Volume 2 of the BID was not included so it was not possible to look at the input parameters on a case by case basis.

C. Dosimetry

1. The statement that no consideration is given to the effect of dose rate and dose fractionation appears to be out of place in the dosimetry section and is appropriately discussed in section 6.
2. It isn't clear from the discussion whether the "remainder" organs and tissues are identified by the EPA in the manner specified in ICRP Publication 26. The similarity (or difference) between the two approaches needs to be clarified.
3. On page 5-22 Vol 1, the footnote indicates that the value is for the short-lived nuclides of Pu (238, 240, 242) and that a different value is used for other transuranic nuclides. The ICRP has published, in ICRP Publication 48 (1986), recommended revisions for the values of f_1 for Pu and transuranic nuclides. Why has the EPA not adopted those recommendations?
4. The value of f_1 for uranium is out of date. In a review, conducted for the EPA, titled "Metabolism of Ingested U and Ra" (Health Physics, 48, 601 (1985)), Wrenn, Durbin et al. examined the human and animal data on gut-to-blood transfer of uranium and concluded that the most appropriate value of f_1 for low daily intakes of uranium was 0.014. In deriving their best estimate, they excluded one estimate of the human uptake fraction they felt was doubtful. Had it been included, the best-fit value would have been 0.018. Had all the human data simply been averaged (and the animal data ignored), the result would have been 0.031. The value recommended as the result of the review is a factor of 14 lower than the current EPA default value of 0.2.

5. The discussion of milk consumption rates on page 5-29 is inconsistent. In addition, the appendix indicates a default value of about 0.3 which differs from those discussed.

6. The assumption of a semi-infinite cloud for calculating doses due to gamma emitters that are airborne at downwind locations is not a good one. For locations near elevated release points, the predicted dose will be small because the concentration is small. However, the high energy gamma rays emitted from the overhead plume will contribute to the real dose and are totally ignored in the calculation. At greater distances, the dose will be overpredicted because the true cloud is of finite extent and much smaller than the cloud dimensions that are presumed by the stated assumption.

7. As the Radiation Advisory Committee has pointed out in the past, the choice of a static, rather than dynamic, model that does not recognize seasonal differences is far from the ideal approach to the dose assessment problem.

D. Uncertainties in Parameters and Models

1. The uncertainties in intake parameters (for cows and humans), differences in farming practices, and sources of food supply are not included in the list on pages 7-1 and 7-2.

2. The claim of "site specific" evaluations is made in several of the subsections; as noted above, this is not an appropriate description of the process when the meteorological data are taken from distant locations.

3. Most of the discussion is strictly qualitative and much of it has to do with the biases, rather than the uncertainties, of the calculations made in Volume 2 of the BID. Terms like "most limiting," "conservatively representative", "conservative assumption," "risks not underestimated", and "upper bound estimates" are found frequently in the discussion. While it is informative to know about these biases, they will not "average out" in the calculational process (contrary to the suggestion in Section 7. 10)

4. Some of the subsections contained no quantitative information about uncertainties. Even when measurement programs had been performed to quantify radionuclide source terms, the results were not analyzed statistically. The data on radon fluxes from gypsum stacks were not discussed in Section 7.6; there is no indication of whether the distribution of measurements was normal, log-normal, bimodal, or uniform. The same is true of the data on radon fluxes from surface uranium mines and of the underlying radium concentrations (Section 7.8).

5. The observed variations in the Po-210 release rates from elemental phosphorus plants are not discussed in Section 7.7. It is stated that the Source term is "not an important Source of

uncertainty" but that doesn't square with the measurement results. The text also states that the use of "site specific" meteorological data leads to small a uncertainty for that aspect of the assessment process. While that is a fortuitously true for the FMC plant (because the Pocatello airport happens to be close by), it is not true for the plants in Soda Springs, Idaho or Silver Bow, Montana and it would be surprising if it were valid for the Tennessee locations.

6. The uncertainties associated with the extrapolations made in the assessments are ignored completely. (a) A single "reference site" was used to assess the doses from about 100 operating nuclear power plants in the United States. The source term used for particular radionuclides was based upon a calculation of the geometric mean of the annual releases reported by the operating plants--apparently without regard to whether the plant operated for 3 days or 300 days during the year. The geometric standard deviations of many of the release rates assumed in Volume 2 are huge and clearly indicate a problem with the approach used. (b) The same sort of approach was used for coal-fired boilers. Even though the EPA maintains data bases on coal-fired boilers, careful site specific evaluations of subsamples of the two types of facilities were not made. Risks to the entire U. S. population were based on minimal evaluation and an extrapolation procedure that was not well defined. In any metropolitan area, the risks to individuals are undoubtedly due to more than one utility and/or industrial boiler; no assessment was made of the multiple source question.

E. Appendices to Volume 1, BID

The statement that the assessments for nearby individuals are intended to represent "an average of individuals living near each facility within the source category" is clearly inaccurate. One counter-example that springs immediately to mind is the placement of the "large hospital" in a rural section of Missouri where the nearest residents live 100-m from the 6-m stack (this is a single story large hospital building) and grow 70% of the family's vegetables, 44% of its meat, and 40% of its milk there. Are we to believe that the average individual living within one block of a "large hospital" has a large garden and cows? The area surrounding the NIH Clinical Center in Bethesda, Maryland is probably more typical of a large research hospital than that which was assumed. I suspect that identification of the 50 largest research hospitals in the U. S. would reveal that the vast majority are located in urban/suburban areas and are not surrounded by family farms.

Many of the parameters in Table A-2 have not been discussed in the presentation of the methodology in Section 4 of Volume 1. The appendix should use the same symbols employed in the text; do not use computer code variable names. The ratio of the stated

values for \bar{r} and Y_y for pasture is 0.57/0.28; for leafy vegetables, it is 0.20/0.72. In Section 4, it is implied that ratios between 2.2 and 3.3 will be used in the assessment.

It is difficult to agree that "the dose and risk estimates provided for each facility or release category should be considered a reasonable assessment which does not significantly underestimate or grossly overestimate impact and is of sufficient accuracy to support decisionmaking" (page C-1). Comments on the specific risk assessments in Volume 2 of the BID are provided below.

F. Volume 2, BID - General Comments

1. Many of the estimates of cost are incomplete and are therefore underestimates. The level of detail provided varies greatly by source category. The principal reference regarding costs for Section 2 "(Mo86)" is not included in the reference list (there are, however, several references listed which are never called out in the text). The basis for deciding when to consider dose reduction alternatives varies from category to category. In Section 2, it is clearly related to effective dose equivalent levels; however, in other sections, there is no estimate of effective dose equivalent (or even of lung dose) and the criteria appear to be risk level or number of predicted deaths.

2. The issue of exposure of the same populations to multiple sources is only addressed in the case of phosphogypsum stacks. However, the individuals exposed to radon from such stacks in Pocatello, Idaho are also exposed to effluents from an elemental phosphorus plant on an adjacent parcel of land. Individuals living near industrialized areas are no doubt exposed to effluents from more than one coal fired boiler (industrial and/or utility). No assessment of this type of multiple exposure is presented.

3. In many cases the wording does not make it clear whether the location of the maximally exposed individual has been identified or whether it is assumed that a person could live there. The wording of each assessment should be clarified to permit the reader to determine whether the doses calculated are to actual or potential residents.

G. BID, Volume 2 - Introduction

Statements on page 1-2 which reflect admirable goals unfortunately do not reflect the contents of the risk assessments. (1) "In making the risk assessments every effort has been made to assess facilities on a site-specific basis, using measured data for emissions and actual data on the configuration of the release point(s) and the locations of nearby individuals."

(2) "The intent of each assessment is to provide a realistic estimate of the exposures and risks actually received by individuals." Previous comments on the methodology and subsequent comments on specific analyses illustrate the inaccuracy of these statements.

H. Risk Assessments for DOE Facilities

1. There are numerous inconsistencies between tables in subsections of Section 2. The reason for this is not clear; the differences do not appear to be due to rounding. A tabulation is attached.
2. The fact that the meteorological data used are not "site specific" as claimed is addressed in comments on the Risk Methodology. Additional comments on the validity of various other site specific assumptions are presented below.
3. Tritium and Ar-41 contribute about 0.1 mrem/y to the total dose from Los Alamos facilities. Why are control technologies for those isotopes discussed? Much of the material on pages 2-32 to 2-35 is redundant.
4. The principal release point for the Hanford facility is stated to be 61-m above the ground; however, a stack height of 10-m was assumed in the risk assessment. It is not possible to determine whether the assumed 10-m stack height for Reactive Metals, Inc. is appropriate.
5. It is difficult to believe that a good approximation of the Y-12 stack height could not be determined. How was the other information--such as which building is the major effluent source, the effluent filtration systems, etc.--obtained? It is clear that the assumed flow rate of 200 cfm is an unrealistically low value. There are two values for U-234 in Table 2.5-1. Table 2.5-4 shows 6000 people with lifetime risks exceeding $1E-4$, but Table 2.5-3 indicates that the maximum lifetime risk is $8E-5$. The effectiveness of the proposed cleanup depends directly on the fraction that is tritiated water vapor; the basis for the statement that "much" of M is in that form is not given. The sum of the U-234 releases listed for individual Y-12 buildings disagrees with the value for the facility that is given in Table 2.5-1.

INCONSISTENCIES IN ESTIMATED MORTALITY FOR DOE SITES

	Deaths/year from Table 2.1-4 or Table 2.X-3	Deaths/year from Breakdown by level in Table 2.X-4	Corrected Values Tables 2.X-4
React. Met. Inc.	8E-4	8E-4	
Los Alamos Nat'l Lab.	3E-3	2E-3	
Hanford Reser.	1E-2	7E-3	
Oak Ridge Reser.	3E-2	5E-2	4E-2
Savannah River Plant	1E-1	6E-2	
Feed Mat. Prod. Cntr.	3E-3	3E-3	
Brookhaven Nat'l Lab.	1E-3	9E-4	1E-3
Mound Laboratory	1E-3	8E-4	
Idaho Nat'l Eng. Lab.	2E-5	3E-5	
Law. Berk. Lab.	3E-4	2E-4	
Paducah GDP	1E-5	7E-6	
Law. Liv. Nat'l Lab.	1E-3	8E-4	
Portsmouth GDP	9E-5	1E-3	
Argonne Nat'l Lab.	8E-5	3E-4	
Pinellas plant	2E-4	1E-4	
Nevada Test Site	3E-6	1E-6	
Knolls Laboratory	1E-5	4E-7	
Battelle Mem. Inst.	2E-6	2E-6	
Fermi Nat'l Lab.	1E-6	2E-6	
Sandia Nat'l Lab.	8E-6	4E-6	
Bettis At. Pwr. Lab.	1E-6	2E-5	
Knolls Laboratory	2E-6	2E-7	
Rocky Flats Plant	4E-6	6E-6	
Pantex Plant	1E-7	8E-8	
Knolls Laboratory	9E-7	1E-6	
Ames Laboratory	7E-8	5E-8	
Rocketdyne	3E-8	3E-8	

6. The first sentence of Section 2.6.5.1 contradicts material on the previous page and appears to be an unedited portion of the previous BID. Argon-41 contributes about 0.25 mrem/y to the total dose from SRP operations. Any reduction of those releases will have a small impact on the total dose to the Maximally exposed individual.
7. It is stated in Section 2.7 that releases are expected to be double the 1981 values. Examination of the previous BID shows that releases of U-234 and U-238 have both declined from 0.113 Ci/y in 1981 to 0.02 Ci/y in 1986. For some reason the doses did not decrease proportionately (88 mrem to the lung in 1981 to 19 mrem to the same tissue in 1986). The heading for the second column of Table 2.7-5 is inconsistent with the table title; the same dollar values are called "HEPA Filter Installation Cost" in Table 2.7-6. The first paragraph under Table 2.7-6 doesn't make sense. If the total costs equal AE costs plus all other costs and the AE costs are 25% of all other costs, then the total costs will be 5 times the AE costs.
8. It is not clear from the discussion on page 2-72 that the Ar-41 releases at Brookhaven were assessed using the BMRR stack height of 45 m (plus plume rise) or whether they were included with some other sources released at much lower levels (10-18 m).
9. Allied Chemical Corporation (page 2-77) has not operated the Idaho Chemical Processing Plant (ICPP) for years; the Argonne National Laboratory facilities are not discussed; the ATR power level is incorrect. The text contains three pages of largely irrelevant information about the Atmospheric Protection System, but fails to mention that the ICPP stack is 62 m high. Although uranium is not listed as an effluent in Table 2.10-1, the ICRP is selected as the representative site release point because it is "the major source of uranium" and a release height of 1 (one) meter is assumed. The major contributors to the computed dose were Ar-41, Sb-125, and Kr-88. The ground surface pathway is said to be the most important for the last two nuclides. Comparison of the BID and other assessments of the INEL releases using AIRDOS-EPA was provided in the comments on Risk Methodology. Table 2.10-4 shows risks to 50 people in the 1E-6 to 1E-5 range, but the risk to the maximum individual is given as 6E-7 in Table 2.10-3.
10. The assessment for Paducah used a 10-m stack, with a clearly arbitrary exhaust rate of 200 cfm. The purge vents at the Portsmouth facility were stated to be 23 m high, but a stack height of 10 m was used in the assessment. Table 2.14-4 shows 1700 persons with lifetime risks exceeding 1E-5 and 8900 persons with lifetime risks exceeding 1E-6; however, the risk to the maximally exposed person is given as E-7 in Table 2.14-3.
11. A 10-m stack height was assumed for the releases at Argonne National Laboratory; no information on actual stack heights was given. The predominant pathways are stated to be inhalation for

C-11 and immersion for tritium; the reverse is probably true. Table 2.15-4 shows 400 people with lifetime risks exceeding 1E-6, but the risk to the nearby individual is given as 1E-7 in Table 2.15-3.

12. Sixty-one percent of the dose from operation of the Battelle-Columbus facility is attributed to K-40. Many of the nuclides in Table 2.19-1 are naturally occurring. The fact that these nuclides were reported in effluent air samples doesn't mean that they are effluents due to facility operation.

I. NRC Licensed and Non-DOE Federal Facilities

1. Hospital stacks and vents are normally on top of the building and hospitals are typically multistory buildings. The assumption of a 6- or 15-m release height has no basis in reality. Nearby individuals within 100- or 150-m will clearly be in the building's wake.

2. The source term for the large hospital doesn't include I-131 or other nuclides that might be used for tests and research.

3. Section 3.3.2.2 states that "actual site data were used for the risk assessments" but the "stack heights used were all 15 m." Perhaps it is a remarkable coincidence. Tables 3-7 and 3-8 are not consistent; 2 E-4 is given as the maximum lifetime risk. Most of the dose from Facility D is due to noble gases; reducing the radioiodine dose by a factor of 100 would still leave an effective dose equivalent of about 7 mrem/y (for the assumed conditions).

4. Table 3-19 is not consistent with Table 3-18; Facility C has calculated lifetime risks greater than 1E-4.

5. There are no tables of numbers of people exposed at various lifetime risk levels for fuel fabrication, source material licensees, incinerators, or shipyards/DOD reactors.

6. Table 3-32 shows no risks above 1E-4 which is inconsistent with estimates presented previously and with the text on the same page (3-29).

J. Uranium Fuel Cycle Facilities

1. It isn't clear why the fuel fabrication facilities are not analyzed on a site by site basis. There are very few facilities compared to other source categories which are all analyzed on a plant by plant basis.

2. It is not reasonable to analyze only one "representative" of 100 reactors. In addition, one has only to look at the GSDs for the release rates (Tables 4-23 and -24) to realize that there are problems with this assessment. Apparently no consideration was

given to whether the reactor operated for a long or short period during the year, whether it was a new plant or an old one, etc. One of the features of AIRDOS is that many different radionuclides can be analyzed, so why were surrogates for radionuclides used? It isn't clear that the surrogate release values were chosen to be comparable on a dose equivalent basis. A reasonable sample of facilities should be analyzed on a site by site basis using a credible set of source terms. Onsite meteorological data are available at all the plants. In fact, analyses for all the plants have already been performed and can very likely be found in the same reports used to construct Table 4-31.

K. Elemental Phosphorus Plants

1. There is a wide variability in the measured Po-210 release rates from the calciners. For the FMC plant the three measured values were 394, 540, and 1208 uCi/h (per calciner). Two measurements were made at the Monsanto plant: 2900 and 172 uCi/h (per calciner) and two measurements were made at the Stauffer plant: 23 and 50 uCi/h (per calciner). This variability has been ignored in any discussions of uncertainty. The choices of release rates in Table 6-9 for the FMC and Monsanto plants appear arbitrary and are not based on the same plant operating times.
2. The baseline emission rates in Tables 6-17 and -18 for the Monsanto and Stauffer (MT) plants don't agree with the values assumed for the assessment (Table 6-9).
3. The term "Dp50" should be defined. It is presumably the 50% cutoff value for a particular stage of the cascade impactor.
4. In Table 6-4, the Po-210 release from FMC should be 8.0, not 8.6.
5. Indicate whether the distances to maximally exposed persons are real or potential. Table 6-12 reads like the distances are real, but the text says that those for Tennessee plants are assumed. Make it clear that Tables 6-13, -14, and -16 refer to assumed operation of plants that are now idle and unlikely to be restarted.
6. The discussion of control options is inadequate. The 1988 measurements were made to check the effects of changes to emission control systems. The FMC releases were higher than in 1983-84 while those at Monsanto were much lower. What control technologies were applied at these facilities?

L. Coal-Fired Utility and Industrial Boilers

1. The uranium content of coal given on page 7-11 is the median, not the average.

2. What is the meaning of the enrichment factor for the two radon nuclides in fly ash? Does it mean that the radon wasn't released during combustion the post-combustion concentration of radon in fly ash is 20 times greater than the original concentration in the coal?

3. While it is clearly not reasonable to expect the Agency to perform site by site evaluations of 1200 coal-fired power plants, the extrapolation from four facilities to 1200 seems to be inadequate. This may be due to the fact that the extrapolation procedure is not described explicitly. Similarly, the extrapolation for the industrial boilers is even greater and involves more uncertainty. It would be more appropriate to take a larger representative sample of both categories of boilers and to use those results to estimate the country wide impact of those facilities.

4. Other assessments of this question have been performed. The results of the EPA assessment should be compared to those and the differences between the results should be discussed and rationalized.

M. Inactive Uranium Mill Tailings

1. It would be useful to include the approximate doses to the lungs of the exposed populations in Table 8-4, so there will be a second point of comparison with the results presented in earlier sections. This addition would not change the basis for the risk assessment, but would provide a more understandable reference point.

2. It was suggested previously that there are probably high quality site specific measurements of airborne radionuclides at some of the locations considered in this section. However, no site specific measurement results were used in the assessment. No comparisons of calculated to measured concentrations have been made (at least none are discussed). The sources of meteorological data were described as site specific, but that is most likely not the case. The airports used as data sources were not specified.

3. No consideration seems to have been given to the effects of snow cover in winter or wet surfaces during the spring on the radon emission rate. The variability in measured emission rates merits discussion. The basis for the Agency's belief that the flux ratio they have chosen is the best estimate should be presented.

4. Release rates from UMTRAP sites are incorrectly estimated in the documents, based on current values from a Project that is quickly reducing radon releases from 24 of the tailings piles to an average of about 10 pCi/sq m/s. that error results in much higher release/risk estimates for tailings sites in general, and more restrictive NESHAP actions than necessary, or shown in the

last column of the Table or determined by the UMTRA project. By using an overestimate of final release rate from the piles (20 vs. 10 pCi/sw m/s), and by maximizing individual dose from that overestimate (stay time, etc.), EPA may require tailings pile remedial action in excess of that require by its own proposed rules concerning acceptable risk. As it stands today, UMTRAP will cost about 1.4 billion dollars to clean up 24 piles. It would be shame to spend even more on such cleanups, when the money could be used elsewhere to reduce significant risks. Again, since cost cannot be considered, there are definite construction risks associated with moving millions of cubic yards of material. These health risks could be weighed against radiation health risk reduction associated with decreasing the tailings pile final release limits. This might prevent excessive regulation.

EPA vs UMTRA Source Term Estimates

Site	Met data station	Release Pile area (m ²)	Nominal rate (Ci/yr)	UMTRA pile/site flux pCi/m ² s	flux pCi/m ²
Naturita	Grand Junction	9.3E4	5.9E1	20	46
Gunnison	Grand Junction	1.6E5	2.1E3	416	314
Maybell	Grand Junction	3.2E5	2.8E3	277	200
Mexican Hat	Farmington	2.8E5	6.8E3	770	667
Riverton ^a	Lander	2.9E5	5.1E3	558	0
Slick Rock (UC)	Grand Junction	2.4E4	5.3E2	700	113
Slick Rock (NC)	Grand Junction	7.7E4	1.9E3	782	113
Ambrosia Lake	Albuquerque	4.2E5	8.6E3	649	571
Falls City	San Antonio	5.9E5	8.4E3	451	189
Shiprock ^b	Farmington	2.9E5	0.2E3	20	20
Green River	Grand Junction	3.6E4	9.3E2	819	76
Grand Junction	Grand Junction	2.4E5	5.9E3	780	665
Lakeview ^b	Klamath Falls	1.2E5	7.7E1	20	8
Bowman	Dickinson	4.8E4	3.1E1	20	32
Belfield	Dickinson	3.2E4	0.02E3	20	61
Canonsburg ^b	Pittsburg	7.2E4	4.6E1	20	7
Durango	Farmington	8.5E4	1.9E3	709	671
Monument Valley	Farmington	1.2E5	1.9E2	50	54
Spook	Casper	2.0E4	2.2E2	349	320
Old Rifle	Grand Junction	5.3E4	1.7E3	1017	650
New Rifle	Grand Junction	1.3E5	3.6E3	878	760
Tuba City ^b	Farmington	8.9E4	2.6E3	926	9
Lowman	Boise	2.0E4	3.4E1	54	157
Salt Lake City ^b	Salt Lake City	4.0E5	2.6E2	20	20

^aRiverton tailings removed to Gas hills, buried beneath AML overburden, flux = 0.

^bCompleted sites, as-built disposal cell flux listed.

5. It is not clear that the dispersion of radon released from these large sources has been appropriately modeled. A footnote to Table 8-3 suggests that the model is inadequate for the task. The details of the modeling approach need to be presented and the strengths and weaknesses need to be discussed.

N. Licensed Uranium Mill Tailings Facilities

Most of the comments in the previous section apply to this section as well. In addition, some consistent rational basis for the cost estimates for the two sections is needed.

O. Risk Assessment for DOE Radon Sites

The value in the first line of page 10-2 should be 2240 Ci, not 1760 Ci.

P. Underground Uranium Mines

1. The sources of meteorological data were not given, but they may well not be at all representative of mines located in rugged terrain. Were terrain effects considered at all and, in particular, were they considered in the preparation of Table 11-8?

2. What determines when the "adequate radon emission reductions" mentioned on page 11-21 have been achieved.

3. Comparisons of calculated concentrations and monitoring data were previously recommended for this source category as well; however, nothing seems to have been done.

Q. Surface Uranium Mines

1. The basis for Table 12-5 must be explained. Is it based on mine area? The percentages given are in many cases inconsistent with the numbers of mines given in Table 12-2.

2. Define what is meant by gross and net radon emissions in Table 12-7. Why are there no U-238 releases from the operating mines in Table 12-8?

3. The demographic data upon which the assessment was based are not presented as they were in other sections.

4. Include approximate doses to the lung from radon to provide a reference for comparison to other assessments.

5. Portions of the radon concentration and exposure columns in Table 12-9 are inconsistent.

6. Are individuals or populations exposed to more than one mine in the same area? If so, that should be reflected in Table 12-11 or a similar table showing the total risk.

7. Because mine areas and/or radon fluxes are not given elsewhere, the cost data can't be related to anything else in the chapter.

R. Phosphogypsum Stacks

1. In Table 13-9, state the background concentrations that were measured and the measurement uncertainties.
2. Treating the stacks as point sources with a release height of 1 m is inappropriate. These are large area sources of significant height which represent obstacles to the air flow and should be treated as such. Wake diffusion in the lee of the stack will be an important consideration. The distances to the nearest receptor shown in Table 13-10 and in Appendix C are misleading; the individual is actually much closer to the pile (see pile dimensions in Table 13-B1).
3. Describe how the calculations that produced the results shown in Tables 13-DI through -5 were performed.

S. Other Issues

There are a number of issues of concern to the Board which, for want of adequate time the Office has addressed less fully than the Committee would want. One of these concerns the central issue of the uncertainty in the risk assessments. This uncertainty involves issues within and extraneous to the Agency itself. On the one hand, the method of extrapolating, or interpolating, as the case may be, the dose-response data presently available from the relatively new epidemiological studies.

APPENDIX B
MEMORANDUM FROM THE OFFICE OF RADIATION
PROGRAMS WITH THE CHARGE



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 3 1989

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Charge for Radionuclide NESHAP Review

FROM: Richard J. Guimond, Director
Office of Radiation Programs (ANR-458)

TO: Donald Barnes, Director
Science Advisory Board (A-101)

In response to the request by the Radiation Advisory Committee (RAC) of the Science Advisory Board (SAB) to review the draft BID, ORP has provided the following documents:

Federal Register Notice; March 7, 1989
Background Information Document; Volumes 1 and 2
Compliance Package

We expect the RAC to review these documents for technical content and provide pertinent recommendations. The draft BID has been revised by ORP to respond to the SAB recommendations to the extent possible within the time constraints imposed by a court-ordered mandate. We discussed our approach with the RAC at its meeting in January 1989. A summary of the major changes from previous ORP methodology and responses to specific SAB recommendations is attached.

We suggest that the following questions be addressed by the RAC in its review of our documents:

1. Has ORP used the appropriate risk factors for low-LET radiation and for radon?
2. Has ORP provided adequate documentation of the methodology used in deriving the dose and risk estimates?

ANR-460:T.MacLaughlin:db 3/31/89 (NEM,200 475-9610) Doc. NESHAPS

3. Has ORP adequately responded to the recommendation to clearly state the objectives of risk assessments calculations (see Preamble)?
4. Are the approaches to uncertainty analysis being taken by ORP, as described in the briefing materials, responsive to the concerns of the SAB?
5. Are the changes discussed in the attachment proper responses to the SAB concerns?

Attachment