

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)	
U.S. DEPARTMENT OF ENERGY)	Docket No. 50-537
PROJECT MANAGEMENT CORPORATION)	
TENNESSEE VALLEY AUTHORITY)	
(Clinch River Breeder Reactor Plant))	

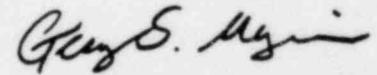
NRC STAFF'S UPDATED ANSWERS TO NATURAL RESOURCES
DEFENSE COUNCIL, INC. AND THE SIERRA CLUB TWELFTH SET
OF INTERROGATORIES TO THE NUCLEAR REGULATORY COMMISSION STAFF

Pursuant to the Licensing Board's Prehearing Conference Order of February 11, 1982, the Nuclear Regulatory Commission Staff (Staff) hereby updates its November 15, 1975 and February 3, 1977 responses to Intervenors' Natural Resources Defense Council, Inc. and the Sierra Club Twelfth Set of Interrogatories to the Nuclear Regulatory Commission Staff filed on June 14, 1976. Attached hereto are the Staff's answers to NRDC's and the Sierra Club's interrogatories, together with the affidavits of those individuals who participated in answering the interrogatories.^{1/}

In the April 14, 1982 Order following Conference with Parties the Licensing Board renumbered NRDC's contentions. When an old contention number appears in the interrogatory question or answer, the new contention number will be indicated in parentheses.

Respectfully submitted,


Bradley W. Jones
Counsel for NRC Staff


Geary S. Mizuno
Counsel for NRC Staff

Dated at Bethesda, Maryland
this 30th day of April, 1982

1/ The affidavits of Mr. Yaniv and Mr. Branagan are unsigned. However, a copy of their affidavits will be filed shortly.

NRC STAFF'S ANSWERS TO NRDC'S AND THE
SIERRA CLUB'S INTERROGATORIES

The NRC Staff has determined that previous Staff responses to Interrogatories 1 to 3, and 5 of Section I; and 1, 2, 5, 6, 10, 13 to 16, 18 to 27, 29 to 39 of Section II ; and 1 and 2 of Section VI are still applicable and need no updating.

The following Interrogatories are related to Contention 5 (renumbered as 4).

I. In response to Interrogatory III.6 of the Sixth set, the Staff stated parenthetically "It has been estimated that plutonium dispersed in a city having a high population density could result in one facility for each 15 grams dispersed."^{1/} [Footnote 1 refers to The Hazards In Plutonium Dispersal, B. L. Cohen, Institute for Energy Analysis, Oak Ridge, Tennessee, March 1975.]

Interrogatory 4

Is the Staff aware of any other assessments of the plutonium dispersal hazard made by person(s) other than Cohen? Please identify and briefly discuss the results quantitatively if possible, of each such estimate.

Response

While the Staff believes that its November, 1976 answer to this Interrogatory is correct, it is probable that there have been additional assessments of the plutonium dispersal hazard published since 1976. The Staff believes that it is unlikely that these publications would change any of the Staff's conclusions on this issue.

II. With respect to each of the following statements from the referenced report by Cohen, please provide the following information:

(i) Does the Staff agree with the statement, assumption or analytical approach taken. In answering this be responsive to Cohen's

claim that "All estimates will be based on the most probable combination of circumstances." (Cohen, p.1.)

(ii) Explain fully the basis for the Staff's answer to (i).

(iii) Where quantitative data are presented identify the uncertainties (quantitatively if possible) in the reported values.

(iv) Identify all documents and studies, and the particular parts thereof, relied upon by the Staff, now or in the past, which serve as the basis for the answers in (ii) and (iii). In lieu thereof, at the Staff's option, a copy of each such document and study may be attached to the answer.

(v) Identify all documents and studies, and the particular parts thereof, examined but not relied upon by the Staff, which pertain to the subject matter questioned. In lieu thereof, at the Staff's option, a copy of each such document and study may be attached to the answer.

(vi) Explain whether the Staff is presently engaged in or intends to engage in any further research or work which may affect the Staff's answer. Identify such research or work.

(vii) Identify the expert(s), if any, whom the Staff intends to have testify on the subject matter questioned. State the qualifications of each such expert.

For all the responses to interrogatories in this set the following are the answers to the requested parts in the Protocol for Discovery.

- iv) All documents and studies, and the particular parts thereof, relied upon by the Staff now or in the past which serve as the basis for the answer are mentioned in the direct answer to the question unless otherwise noted.
- v) There were no principal documents and studies specifically examined but not cited in (b) unless otherwise noted.
- vi) The Staff's November 15, 1976 response to this Interrogatory is amended by deleting the last sentence. The research study entitled, "Radiation Exposure and Risk Estimates for Inhaled Airborne Radionuclides", has been terminated. The research studies entitled, "Measurement Technology for Plutonium in Humans and the Environment", as well as the study entitled, "Health Effects of Industrial Exposure to Thorium" (which the Staff believes is the current version of the study identified as "Radiation Effects -- Safer Project Brief #1.299"

in the Staff's November 15, 1976 response) are continuing and have not yet been completed. The Staff does not expect the results of these research studies to affect the Staff's answer on these issues, since these research studies will not be completed in the near future.

- vii) At this time, the Staff has not determined who will testify on the subject matter questioned. Reasonable notice will be given to all parties after the Staff has made this determination. At that time, a statement of professional qualifications will be provided for each witness.

The Hazards of Plutonium Dispersal

Interrogatory 3

For ^{239}Pu in the lung, $E = 5.1 \text{ MeV}$, $Q=10 \text{ M} = 570 \text{ grams}$ (exclusive of blood), and the total dose delivered by the 60 percent of the Pu that is retained in the lung (i.e., pulmonary system) with a 500-day half-life is obtained by multiplying the dose rate per microcurie by $0.6 = 500/\ln 2$ which gives finally 2000 rem/microcurie as the total dose to the lung. (p.3)

Response

The Staff's November 15, 1976 Response to this Interrogatory is amended by including the following statement:

Although no formal adoption has been declared, a Q value of 20 is suggested for alpha particles. This would increase the dose equivalent per microcurie to the lung by a factor of 2, giving approximately 4000 rem/microcurie as the total dose to the lung.

Interrogatory 4

. . . the cancer risk of radiation to the lung as 1.3×10^{-6} /year-man-rem for adults, and five times less for children under age 10. (p.3)

Response

The Staff's November 15, 1976 response to this Interrogatory is amended by including the following statement:

According to BEIR III Page 327, the excess risk of lung cancer depends on age at diagnosis and the length of the latent period on age at irradiation. Utilizing values given in BEIR III we obtain a lifetime risk for a population (1976 age distribution) exposed to high LET radiation of about 30 lung cancers per 10^6 person-rem, using the values on p. 377 of the BEIR III report.

Interrogatory 7

For bone, $Q = 50$, $M = 5000$ grams, so after taking account of the fact that only 0.20×0.45 of the Pu reaches bone, the dose rate is calculated to be 81 rem/year-microcurie originally deposited in the lung. (p.3)

Response

The Staff's November 15, 1976 response to this Interrogatory is amended by including the following statement:

Using a Q value of 20 would double the dose equivalent-rate per microcurie to the bone giving 162 rem/year-microcurie.

Interrogatory 8

. . . the cancer risk to bone as 2×10^{-7} /year-man-rem; (p.3)

Response

The Staff's November 15, 1976 response to this Interrogatory is amended by including the following statement:

In BEIR III Page 417, the following linear risk coefficient is given for protracted high LET endosteal dose: 1×10^{-6} sarcoma/yr per person-rad. If $Q = 20$ then this translates to 0.5×10^{-7} sarcoma/yr per person-rem. For plutonium the endosteal dose is about 10 times the whole skeleton dose, so the values are similar to those in staff response.

Interrogatory 9

In applying these curves to estimate effects of inhalation, we will be using the adult inhalation rate; the exposure to the bone in later years is reduced if the material is inhaled as a child because of the lesser air volume inhaled, so a correction for this is applied to the bone cancer curve in Figure 2. (p.4)

Response

The Staff no longer believes that the last sentence in its November 15, 1976 response to this Interrogatory is correct. Accordingly, the last sentence of the Staff's previous response should be deleted.

Interrogatory 11

For liver, $Q = 10$, $M = 1800$ grams, and the cancer risk is estimated to be 6.7×10^{-8} /year-man-rem; (p.4)

Response

The Staff's November 15, 1976 response to this Interrogatory is amended by including the following statement:

Using a Q value of 20 would double the dose equivalent-rate to the liver. Also using, RFR III Page 380, gives as upper limit (based on thprotast patients) a high LET liver risk factor of 13×10^{-6} liver cancers per person-rad. With $Q = 20$ this translates to 0.65×10^{-6} liver cancers per person-rem, which is twice the value used previously. Thus, a factor of 4 increase in the risk could be used.

Interrogatory 12

. . . the total cancer risk for teenagers and young adults is about 9 percent per microcurie deposited in the lung, but the risks are reduced at younger and older ages such that if all ages between 0 and 70 are given equal weight, the average risk is about 4.7 percent. (p.4)

Response

The Staff no longer believes that the last sentence in its November 15, 1976 response to this Interrogatory is correct, since the statement is not applicable to high LET radiation. Accordingly, the last sentence of the Staff's previous response should be deleted.

Interrogatory 17

The ratio of material deposited to that in the lung is 1.6 for the naso-pharynx and 0.32 for the trachea-bronchia, so the dose to the bone and liver are increased by the factor $[1 + (1.6 \times 0.1/0.2) + (0.32 \times 0.5/0.2)] = 2.6$. (p.5)

Response

The Staff amends its November 15, 1976 response by stating that the value of $\frac{NP}{}$ equals 1.2, rather than 1.6 as originally stated. In addition, the final ratio is 2.4, rather than 2.6 as originally stated in its November 15, 1976.

Interrogatory 28

If plutonium is ingested, the probability of passage from the gastro-intestinal tract into the bloodstream is only 3×10^{-5} . . . (p.9)

Response

The Staff's November 15, 1976 response to this Interrogatory is amended by including the following statement:

ICRP 30 recommends $f_1 = 10^{-5}$ for oxides and hydroxides; 10^{-4} for other compounds.¹ This would result in doses that are $10^{-4}/3 \times 10^{-5}$ higher.

III. In a letter of July 14, 1975 from Dr. Karl Z. Morgan to Mr. Thomas G. McCreless of the NRC, Dr. Morgan made the following comments regarding Coher's analysis:

I believe my paper "Suggested Reduction of Permissible Exposure to Plutonium and Other Transuranium Elements" which is scheduled for publication in the Journal of American Industrial Hygiene in August or September 1975 (copy of galley enclosed) gives you a better idea of why I believe plutonium and the transplutonic elements are a greater risk than suggested by Bern.

I might add here a few additional comments as follows:

1. I think Bern in his Appendix A and Fig. 1 misinterprets or takes too literally statements in the BEIR report. I doubt seriously the overall cancer risk of children (10 y) is only 10% that of adults.
2. Bern ignores other cancers such as leukemia and this probably has a risk for young children that is 10 times that for adults.
3. There is no scientific basis for the assumption that the induction rate of lung cancer (1.3×10^{-6} c/person y) is maintained for only 30 years.
4. The factor of 3×10^{-5} uptake of Pu from the GI tract may be far too low for Pu when contained in the environment.
5. The dose should be calculated to the endosteal and periosteal tissues of the bone and to the red marrow and not averaged over the entire bone (7×10^5 g).
6. Lymph nodes and liver are probably the critical tissues at low protracted doses.
7. The risk per rem is greater for α -radiation at low doses and low dose rates.
8. Hot particles probably migrate sufficiently in the body to increase the risk (i.e. lessen the overkill and sterilization effects).
9. There is some evidence of spallation of the larger hot particles, thus extending the risk.

10. Roy Thompson et al. have observed tumors near the thoracic lymph nodes. These may be the result of dose delivered by the low efficiency x-ray from Pu (i.e. beyond the nodes where there is less overkill or cell sterilization).

With respect to the first paragraph above (beginning with, "I believe my paper . . .") and each of the 10 additional comments, (consider separately) please provide the following information:

- (i) Does the Staff agree with Morgan's criticism of Cohen's report, wholly or in part?
- (ii) Explain fully the basis for the Staff's answer to (i).
- (iii) If the Staff agrees with Morgan's criticism, what effect would this have on Cohen's estimate of one fatality per 15 grams of Pu dispersed?
- (iv) Identify all documents and studies, and the particular parts thereof, relied upon by the Staff, now or in the past, which serve as the basis for the answers in (ii) and (iii). In lieu thereof, at the Staff's option, a copy of each such document and study may be attached to the answer.
- (v) Identify all documents and studies, and the particular parts thereof, examined but not relied upon by the Staff, which pertain to the subject matter questioned. In lieu thereof, at the Staff's option, a copy of each such document and study may be attached to the answer.
- (vi) Explain whether the Staff is presently engaged in or intends to engage in any further research or work which may affect the Staff's answer. Identify such research or work.
- (vii) Identify the expert(s), if any, whom the Staff intends to have testify on the subject matter questioned.

For all the responses to interrogatories in this set the following are the answers to the requested subparts.

- iv) All documents and studies, and the particular parts thereof, relied upon by the Staff now or in the past which serve as the basis for the answer are mentioned in the direct answer to the question unless otherwise noted.
- v) There were no principal documents and studies specifically examined but not cited in (b) unless otherwise noted.

- vi) The Staff is not presently engaged in nor intends to engage in any further, on-going research program which may affect Staff's answer unless otherwise noted.
- vii) At this time, the Staff has not determined who will testify on the subject matter questioned. Reasonable notice will be given to all parties after the Staff has made this determination. At that time, a statement of professional qualifications will be provided for each witness.

Interrogatory 1

I think Bern in his Appendix A and Fig. 1 misinterprets or takes too literally statements in the BEIR report. I doubt seriously the overall cancer risk of children (<10 y) is only 10% that of adults.

Response

(i) The Staff does not know which statement in the BEIR I is referenced by Dr. Morgan. Appendix A and Fig. 1 of B. Cohen's paper do not address the cancer risk of children. The Staff could not find anywhere in Cohen's paper the statement that "the overall cancer risk of children (<10 y) is only 10% of that of adults."

(ii) No response required.

(iii) No response required.

(iv) BEIR I, BEIR III, ICRP-30.

Interrogatory 2

Bern ignores other cancers such as leukemia and this probably has a risk for young children that is 10 times that for adults.

Response

(i) The Staff agrees that Bernard Cohen did not include the risk of leukemia in his analysis. The Staff does not agree with the statement that the risk for young children is 10 times that for adults, since neither the

BEIR I or BEIR III models support a finding that the risk for young children to leukemia is 10 times that of adults.

- (ii) See response to (i) above.
- (iii) The Staff has not yet completed the analysis requested.
- (iv) BEIR I, BEIR III.

Interrogatory 3

There is no scientific basis for the assumption that the induction rate of lung cancer (1.3×10^{-6} c/person * y) is maintained for only 30 years.

Response

(i) The Staff agrees to this statement. According to BEIR III Page 327, the excess risk of lung cancer depends on age at diagnosis and the length of the latent period on age at irradiation. Utilizing values given in BEIR III we obtain a lifetime risk for a population (1976 age distribution) exposed to high LET radiation of about 30 lung cancers per 10^6 person-rem using the values on p. 377 of BEIR III. The value is very similar to one obtained using absolute risk factor of 1.3×10^{-6} cases per person-rem-year and lifetime plateau.

(ii) See response to (i).

(iii) In view of the fact that Cohen's risk estimate is only approximate, the slight changes in individual parameters in the calculation will have an insignificant effect on the approximate value.

(iv) BEIR I, BEIR III, ICRP-30.

Interrogatory 4

The factor of 3×10^{-5} uptake of Pu from the GI tract may be far too low for Pu when contained in the environment.

Response

(i) The Staff agrees with this statement. ICRP 30 recommends $f_1 = 10^{-5}$ for oxides and hydroxides; 10^{-4} for other compounds. This would result in doses that are $10^{-4}/3 \times 10^{-5}$ higher.

(ii) See response to (i).

(iii) See response to (i).

(iv) BEIR I, BEIR III, ICRP-30.

Interrogatory 5

The dose should be calculated to the endosteal and periosteal tissues of the bone and to the red marrow and not averaged over the entire bone (7×10^5 g).

Response

(i) The Staff agrees with this statement. For Pu the endosteal dose is about 10x the whole skeletal dose. Using the risk coefficients in BEIR III (p. 380) for protracted high-LET endosteal dose and the calculated endosteal dose, the resulting calculated risk of sarcomas is not significantly different than those presented in Cohen's article.

(ii) See response to (i).

(iii) See response to (i).

(iv) BEIR I, BEIR III, ICRP-30.

Interrogatory 6

Lymph nodes and liver are probably the critical tissues at low protracted doses.

Response

(i) The Staff does not know whether this statement refers to soluble or insoluble plutonium. The Staff also does not know what route of entry into the human body this statement assumes. Dr. Morgan does not provide any references to support this statement. The Staff cannot agree or disagree with the interrogatory unless specific passages from the referenced documents are cited.

(ii) No response required.

(iii) No response required.

(iv) BEIR I, BEIR III, ICRP-30.

Interrogatory 7

The risk per rem is greater for a-radiation at low doses and low dose rates.

Response

The Staff disagrees with the statement in interrogatory 7. The Staff notes the following from BEIR III (P. 2):

"The Committee recognizes that there is great uncertainty in regard to the shape of the dose-response curve for cancer induction by radiation, especially at low doses. Estimates of risk at low doses depend more on what is assumed about the mathematical form of the dose-response function than on the data themselves. Whenever possible, in estimating the cancer risk from low doses of low-LET radiation, the Committee has used a linear-quadratic dose-response model that is felt to be consistent with epidemiologic and radiobiologic data, in preference to more extreme dose-response models, such as the linear and the pure quadratic. The Committee recognizes that some experimental and human data, as well as theoretical considerations, suggest that, for exposure to low-LET radiation at low doses, the linear model probably leads to overestimates of the risk of most cancers, but can be used to define upper limits of risk. Similarly, the Committee believes that the quadratic model may be used to define the lower limits of risk from such radiation. For exposure to high-LET radiation, linear risk estimates for low doses are less likely to overestimate risk and may, in fact, underestimate risk."

- (ii) See response to (i).
- (iii) No response required.
- (iv) BEIR I, BEIR III, ICRP-30.

Interrogatory 8

Hot particles probably migrate sufficiently in the body to increase the risk (i.e. lessen the overkill and sterilization effects).

Response

See Denial of "Petition for Rulemaking", Federal Register, Vol. 41, No. 71, pp. 15371-15374.

- (ii) See response to (i).
- (iii) No response required.
- (iv) BEIR I, BEIR III, ICRP-30.

Interrogatory 9

There is some evidence of spallation of the larger hot particles, thus extending the risk.

Response

- (i-iv) See response to interrogatory 8.

Interrogatory 10

Roy Thompson et al. have observed tumors near the thoracic lymph nodes. These may be the result of dose delivered by the low efficiency x-ray from Pu (i.e. beyond the nodes where there is less overkill or cell sterilization).

Response

(i) Dr. Morgan does not provide any specific reference to support this statement. The Staff cannot agree or disagree with the interrogatory unless specific passages from referenced documents are cited.

- (ii) See response to (i).
- (iii) No response required.

IV. In the Staff's answers to Interrogatory III.7 of the Sixth Set, the Staff stated, "Hence, the Staff considered is prudent to maintain awareness of those dynamic factors at work in society which may necessitate changes to the present and currently foreseeable physical security requirements."

Interrogatory 1

Please identify "those dynamic factors" referred to above.

Response

The revised response to interrogatory III-7 of the Sixth Set does not contain this sentence however, the response to Question 20 in Interrogatory Set 23 addresses the Staff's position relating to continuing review of adequacy of physical security requirements.

R. Davis Hurt, MC&A Program Analyst, Division of Safeguards, Office of Nuclear Material Safety and Safeguards provided the answer to the question.

Interrogatory 2

What minimum changes in each of these factors does the Staff believe would "necessitate changes in the present physical security requirements."

Response

The revised response to interrogatory III-7 of the Sixth Set does not contain this sentence, however, the response to Question 20 in Interrogatory Set 23 addresses the Staff's position relating to continuing review of adequacy of physical security requirements.

R. Davis Hurt, MC&A Program Analyst, Division of Safeguard's, Office of Nuclear Material Safety and Safeguards provided the answer to the quesiton.

V. Interrogatory 1

In the Staff's answer to III-8 in the Sixth Set of Interrogatories to the Staff, quantify what is meant by "a relatively small number of persons."

Response

The revised response to interrogatory III-B set 6 does not contain the phrase "a relatively small number of persons". It should be noted that the Regulations [10 C.F.R. § 73.1(a)] do not quantify the threat.

Sarah A. Mullen, Safeguards Analyst, Division of Safeguards, Office of Nuclear Material Safety and Safeguards provided the answer to the question.

Interrogatory 2

Describe for each postulated threat analysis considered by the Staff precisely how, "Present security measures are expected to deter most attacks and to prevent the success of those that are attempted."

Response

The revised safeguards section of the CRBR EIS will assess the applicants' proposed safeguards measures in terms of whether they can be reasonably expected to prevent or deter sabotage of diversion.

R. Davis Hurt, MC&A Program Analyst, Division of Safeguards, Office of Nuclear Material Safety and Safeguards provided the answer to the question.

Interrogatory 3

Describe for each postulated threat analysis considered by the Staff how "existing measures are expected to prevent attempted diversion from within."

Response

The revised safeguards section of CRBR EIS will assess the applicants' proposed safeguards measures in terms of whether they can be reasonably expected to prevent or deter sabotage or diversion.

R. Davis Hurt, MC&A Program Analyst, Division of Safeguards, Office of Nuclear Material Safety and Safeguards provided the answer to the question.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

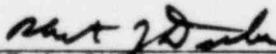
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UNITED STATES DEPARTMENT OF ENERGY) Docket No. 50-537
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TENNESSEE VALLEY AUTHORITY)
(Clinch River Breeder Reactor)
Plant))

AFFIDAVIT OF ROBERT J. DUBE

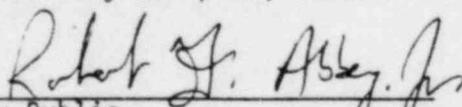
I, Robert J. Dube, being duly sworn, state as follows:

1. I am employed by the U.S. Nuclear Regulatory Commission as a Section Chief of Regulatory Activities and Analyses Section, Fuels Facilities Safeguards Licensing Branch, Division of Safeguards, Office of Nuclear Material Safety and Safeguards.
2. I am duly authorized to participate in answering Interrogatories in Section IV, #1 and #2; in Section V, #1 through #3 and in Section VI, #1 and #2 of the 12th Set and I hereby certify that the answers given are true to the best of my knowledge.



ROBERT J. DUBE

Subscribed and sworn to before me
this 28th day of April, 1982.



Notary Public
My Commission expires: July 1, 1982

ROBERT F. ABBEY, JR.
NOTARY PUBLIC STATE OF MARYLAND
My Commission Expires July 1, 1982

