March 14, 1994

Mr. John L. Meder, Senior Research Analyst
State of Nevada, Legislative Counsel Bureau
Legislative Building, Capitol Complex
Carson City, Nevada 89710

Dear Mr. Meder:

SUBJECT: RESPONSE TO QUESTIONS FROM SENATOR HICKEY OF JANUARY 6, 1994

This is in response to Senator Hickey's letter of January 6, 1994, to Philip S. Justus of my staff requesting information on several matters as follow-up to the information Dr. Justus provided in the meeting of the Nevada Legislature's Committee on High-Level Radioactive Waste held on November 12, 1993. The senator asked that our responses be provided to you so that you may distribute them to the Committee members. For your convenience, the senator's nine questions are repeated below and followed by the responses.

QUESTION 1. What is the overall mission of the NRC, and what is the agency's specific role in licensing a high-level radioactive waste repository?

RESPONSE: NRC's primary mission is to ensure that civilian uses of nuclear materials and facilities are conducted in a manner consistent with public health and safety, environmental quality, national security, and antitrust laws. The major share of the NRC's work is focused on regulating the use of nuclear energy to generate electric power. We are enclosing six copies of the NRC's latest Annual Report and its Information Digest. These documents describe the NRC's mission and how its mission is being accomplished.

NRC's specific role in licensing a high-level radioactive waste (HLW) repository is specified in the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974, as amended; the Nuclear Waste Policy Act of 1982; and the Nuclear Waste Policy Amendments Act of 1987. Additionally, NRC has promulgated regulations (Code of Federal Regulations, Title 10, Energy, Part 60, *Disposal of High-Level Radioactive Wastes in Geologic Repositories*) that specify criteria it will apply to various licensing actions that it may take.

The NRC's primary role in the HLW program is to issue and implement regulations, as necessary, to protect public health and safety. In addition, during pre-licensing of the geological repository, the NRC has an active and continuing interface and consultation role with DOE to ensure an ongoing understanding of the DOE repository program and early identification of regulatory concerns and issues within the program.

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QUESTION 2. What are the responsibilities and liabilities of the Federal Government for any problems that may occur on the repository site after it has been sealed?

RESPONSE: DOE will be responsible for the HLW repository as a licensee of the NRC until the license has been terminated as specified in 10 CFR §60.52. In addition, DOE may have additional responsibilities to meet standards that are adopted by the Environmental Protection Agency (EPA) pursuant to the Energy Policy Act of 1992. Under that act, the National Academy of Sciences (NAS) is to make findings and recommendations on standards, applicable to Yucca Mountain, as to whether it is reasonable to assume that a system for post-closure oversight can be developed, based on institutional controls, that will protect public health and safety; and EPA is to set standards based upon and consistent with the NAS findings and recommendations. Moreover, as required by NRC regulations, the controlled area must be under DOE's control, and DOE will have any legal obligations that may arise out of such control.

QUESTION 3. If the Federal Government does not accept responsibility and liability for any problems that may occur on the repository site after it has been sealed, who is responsible and liable?

RESPONSE: This question appears to raise issues that are outside the scope of NRC licensing jurisdiction. Presumably, such matters will be resolved in accordance with applicable general principles of law.

QUESTION 4. Which Federal agency is responsible for regulating military radioactive waste - the NRC, the Department of Energy, the Environmental Protection Agency, the Department of Defense, or other?

RESPONSE: The NRC has the authority to regulate the disposal (and "long-term storage") of military HLW to the extent specified by Section 202(4) of the Energy Reorganization Act of 1974, as amended.

QUESTION 5. Is military high-level nuclear waste to be placed in the repository?

RESPONSE: Yes, in accordance with the Nuclear Waste Policy Act of 1982.

QUESTION 6. If military nuclear waste is to be placed in the repository, will the military be required to meet the same standards as those set for civilian high-level nuclear waste?

RESPONSE: Yes. There is no distinction in 10 CFR Part 60 between military and civilian HLW.

QUESTION 7. If the military nuclear waste is to (be) placed in the repository, will there be any problems in placing military and civilian radioactive waste in the same repository?

RESPONSE: No regulatory or licensing problems are anticipated that will be significantly different between military or civilian HLW. The military HLW is expected to constitute only about 3% of the Curie inventory of HLW planned for storage in the HLW repository.

QUESTION 8. Will the amount of radiation exposure to workers at the repository be the same as that allowed workers on the Nevada Test Site?

RESPONSE: The Nevada Test Site (NTS) is not within the jurisdiction of the NRC, and we do not have the information on the allowable radiation exposures to NTS workers. However, NRC regulations limit the radiation dose a repository worker may receive to the same levels that the NRC generally permits in other licensed activities.

QUESTION 9. This question has been divided into three questions as follows:

QUESTION 9a. What is the standard for the amount of exposure allowed?

RESPONSE 9a: The dose limits in 10 CFR Part 20, *Standards for Protection Against Radiation*, will be applied to an NRC-licensed HLW repository during operation. The radiation dose limit for workers will therefore be 5 rem/year total effective dose equivalent (§20.1201). In addition, DOE will be required to keep exposures under that limit if it is practical to do so in order to achieve doses that are as low as reasonably achievable (ALARA) (§20.1101). The corresponding limit for individual members of the public at such a facility will be 100 mrem/year total effective dose equivalent (§20.1301). Public doses must also be kept ALARA (§20.1101). DOE will also be required to meet applicable EPA standards for environmental radiation protection.

QUESTION 9b. How was it (the amount of exposure allowed) established?

RESPONSE 9b: The NRC health-based dose limits quoted above are discussed in the "Supplementary Information" in the *Final Rule for Standards for Protection Against Radiation* issued by the NRC in 56 FR 23360 on May 21, 1991. (Part I, "Introduction," and Part II, "Developments Since the Proposed Revision Was Issued," of this document are also enclosed. See particularly §I.B, *Fundamental Radiation Protection Principles*.)

QUESTION 9c. If there is a different level of allowed exposure proposed for the repository and the Nevada Test Site, why?

RESPONSE 9c: As indicated in the response to Question 8, the NRC does not regulate the NTS, and we do not have the information on the allowable radiation exposures to NTS workers.

We are pleased that Senator Hickey considered Dr. Justus' presentation to the Committee concerning the activities of the NRC to be informative. We trust that these responses to his questions are satisfactory. For clarification or additional information on these matters, please contact Phil Justus at (702) 388-6125.

Sincerely,

/S/

B. J. Youngblood, Director
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

cc: w/o enclosures 1 and 2:
R. Loux, State of Nevada
T. J. Hickey, Nevada Legislative Committee
R. Nelson, YMPO
M. Murphy, Nye County, NV
M. Baughman, Lincoln County, NV
D. Bechtel, Clark County, NV
D. Weigel, GAO
P. Niedzielski-Eichner, Nye County, NV
B. Mettam, Inyo County, CA
V. Poe, Mineral County, NV
F. Mariani, White Pine County, NV
R. Williams, Lander County, NV
L. Fiorenzi, Eureka County, NV
J. Hoffman, Esmeralda County, NV
C. Schank, Churchill County, NV
L. Bradshaw, Nye County, NV

Enclosures:
1. Annual Report (6 copies)
2. Information Digest (6 Copies)
3. 56 FR 23360 (Parts I & II)

DISTRIBUTION - w/o enclosures 1 & 2 (HLWM 94-02)

CNWRA	NMSS R/F	HLPD R/F	LSS/LPDR/ACNW/PDR
Central Files	RBallard, HLGE	RWeller, HLGE	MFederline, HLHP
NEisenberg, HLHP	RNeel, HLHP	JSpraul, HLPD	On-Site Reps

* See previous concurrence

OFC	HLPD*	E	HLPD*	E	HLPD*	E	HLWM	E	HLWM	E
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Enclosure 3

Final Rule for Standards for Protection Against Radiation

Parts I and II

56 Federal Register 23360

May 21, 1991

NUCLEAR REGULATORY COMMISSION

10 CFR Parts 2, 19, 20, 30, 31, 32, 34, 35, 39, 40, 50, 61 and 70

RIN 3150-AA38

Standards for Protection Against Radiation

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

SUMMARY: The Nuclear Regulatory Commission (NRC) is revising its standards for protection against ionizing radiation. This action is necessary to incorporate updated scientific information and to reflect changes in the basic philosophy of radiation protection. The revision conforms the Commission's regulations to the Presidential Radiation Protection Guidance to Federal Agencies for Occupational Exposure and to recommendations of national and international radiation protection organizations.

EFFECTIVE DATE: This regulation becomes effective on (30 days after publication in the Federal Register). However, licensees may defer implementation of this rule until January 1, 1993. The information collection requirements are not effective until NRC publishes the OMB Clearance in the Federal Register (see § 20.1009).

ADDRESSES: Copies of documents relating to the proposed rule published on January 9, 1986 (51 FR 1092), or this document may be examined and copied for a fee in the Commission's Public Document Room at 2120 L Street NW. (Lower-Level), Washington, DC 20555.

FOR FURTHER INFORMATION CONTACT: Harold T. Peterson, Jr., Division of Regulatory Applications, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555, Telephone (301) 492-3640.

SUPPLEMENTARY INFORMATION:

I. Introduction

A. Purpose of the Revision

The purpose of this amendment to 10 CFR part 20 is to modify the NRC's radiation protection standards to reflect developments in the principles and scientific knowledge underlying radiation protection that have occurred since part 20 was originally issued more than 30 years ago. These developments not only include updated scientific information on radionuclide uptake and metabolism, but also reflect changes in the basic philosophy of radiation protection. Incorporation of these changes will ensure that part 20 continues to provide adequate protection of public health and safety.

It is also the purpose of this final rule to implement the 1987 Presidential guidance on occupational radiation exposure (see section II.D). The Atomic Energy Commission (AEC) and the NRC have followed past Federal radiation protection guidance, and conformance with the guidance is viewed by the Commission as being necessary to ensure that NRC licensees are using levels of protection comparable to those used by Federal agencies.

The AEC and the NRC have generally followed the basic radiation protection recommendations of the International Commission on Radiological Protection (ICRP) and its U.S. counterpart, the National Council on Radiation Protection and Measurements (NCRP), in formulating basic radiation protection standards. In 1977, ICRP issued revised recommendations for a system of radiation dose limitation. This system, which was described in ICRP Publication 26,[1] introduced a number of significant modifications to existing concepts and recommendations of the ICRP and the NCRP that are now being incorporated in the NRC regulations. In particular, this amendment to part 20 puts into practice recommendations from ICRP Publication 26 and subsequent ICRP publications. The Federal radiation protection guidance signed by the President on January 20, 1987, is also based upon the ICRP 1977 recommendations in ICRP Publication 26.

In adopting the basic tenets of the ICRP system of dose limitation, the Nuclear Regulatory Commission recognizes that, when application of the dose limits is combined with the principle of keeping all radiation exposures "as low as is reasonably achievable," the degree of protection could be significantly greater than from relying upon the dose limits alone.

B. Fundamental Radiation Protection Principles

The radiation protection standards in this final rule are based upon the assumptions that—

(1) Within the range of exposure conditions usually encountered in radiation work, there is a linear relationship, without threshold, between dose and probability of stochastic health effects (such as latent cancer and genetic effects) occurring;

(2) The severity of each type of stochastic health effect is independent of dose; and

(3) Nonstochastic (nonrandom) radiation-induced health effects can be prevented by limiting exposures so that doses are below the thresholds for their induction.

The first assumption, the linear nonthreshold dose-effect relationship, implies that the potential health risk is proportional to the dose received and that there is an incremental health risk associated with even very small doses, even radiation doses much smaller than doses received from naturally occurring radiation sources. These health risks, such as cancer, are termed stochastic because they are statistical in nature; i.e., for a given level of dose, not every person exposed would exhibit the effect. The second assumption means that when a stochastic effect is induced, the severity of the effect is not related to the radiation dose received. The third assumption implies that there are effects, termed nonstochastic effects, for which there is an apparent threshold; i.e., a dose level below which the effect is unlikely to occur. An example of a nonstochastic effect is the formation of radiation-induced cataracts of the eyes.

The above assumptions are necessary because it is generally impossible to determine whether or not there are any increases in the incidence of disease at very low doses and low dose rates, particularly in the range of doses to members of the general public resulting from NRC-licensed activities. It is firmly established, both from animal studies and human epidemiological studies (such as those of the radium dial painters, radiologists, and the atomic bomb survivors) that there is an increased incidence of certain cancers associated with radiation exposure at high doses and high dose rates. However, whether these effects occur at very low doses and, if they occur, whether their occurrence is linearly proportional to dose are not firmly established. This creates considerable uncertainty in the magnitude of the risk at low doses and low dose rates. There is no clear human evidence of radiation-induced genetic damage to the children of irradiated parents. Such effects are inferred from studies of mice and nonmammalian species (e.g., fruit flies).

In the absence of convincing evidence that there is a dose threshold or that low levels of radiation are beneficial, the Commission believes that the assumptions regarding a linear nonthreshold dose-effect model for

[1] Recommendations of the International Commission on Radiological Protection, January 13, 1977. ICRP Publication No. 26 (1977). (Available for sale from Pergamon Press, Inc., Elmsford, NY 10523.)

cancers and genetic effects and the existence of thresholds only for certain nonstochastic effects remain appropriate for formulating radiation protection standards and planning radiation protection programs.

C. Background

Standards for radiation protection were originally issued by the former AEC in the late 1950s (22 FR 548, January 29, 1957) and republished in 1960. These standards have been modifed since that time by a series of amendments relating to specific issues; however, no complete revision of part 20 has been made since the original standards were issued.

The NRC issued an advance notice of proposed rulemaking (ANPRM) in the Federal Register of March 20, 1980 (45 FR 18023). This ANPRM requested comments on possible topics in part 20 that should be revised. The responses received to this announcement were considered in the formulation of the proposed rule.

During the development of this rule, early comments from licensees, labor unions, public interest groups, other Federal agencies, and scientific organizations were solicited, discussed, and considered in formulating the proposed rule. In addition, the NRC staff has benefited from its participation in several public meetings held by the Environmental Protection Agency (EPA) in connection with the guidance for occupational radiation exposure. These amendments to part 20 and the Federal guidance on occupational exposure were developed in parallel and are both based primarily on the ICRP recommendations. The comments made in these EPA-sponsored meetings and those received by EPA on the draft guidance published by EPA in the January 23, 1981 Federal Register (46 FR 7836) were reviewed by the NRC staff and considered in preparing the proposed part 20.

The NRC published the proposed revision of the 10 CFR part 20 rule in the Federal Register on January 9, 1986 (51 FR 1092). More than 800 sets of public comments were received on the proposed revision. The public comments on the proposed revision were categorized, analyzed, and taken into account in developing the final rule. The principal public comments and the NRC staff responses to them are discussed in section VI.

II. Developments Since the Proposed Revision Was Issued

A. ICRP 1985 Paris Meeting

In March 1985, the International Commission on Radiological Protection (ICRP) held a meeting in Paris, France, to review the work of the various ICRP task groups and committees. One of the outcomes of this meeting was an ICRP statement [2] that the ICRP intended the principal dose limit for members of the general public to be 1 millisievert (100 millirems) in a year, rather than 5 millisieverts (500 millirems). This clarification has been taken into account for the limits adopted for members of the public in the final rule and is discussed more fully in the discussion on proposed § 20.301.

A second recommendation of the ICRP made at that time concerned the appropriate quality factor for converting the absorbed dose from neutrons (in rads or grays) to a dose equivalent (in rems or sieverts). The ICRP statement recommended increasing the quality factor for high-energy neutrons by a factor of 2. The quality factor for fast neutrons, for example, would be increased from 10 to 20. This change has the effect of doubling the apparent biological effectiveness of high-energy neutrons. For reasons explained in the discussion of quality factors (see the discussion of proposed § 20.4), the NRC has not adopted this recommendation in this final rule.

B. ICRP 1987 Washington Meeting

The primary focus of the statement issued by the ICRP following the 1987 meeting in Washington [3] was ICRP Publication No. 48.[4] That publication discussed higher transfer factors for transport of certain transuranic elements across the intestinal walls. These higher fractional absorption factors have been incorporated in revisions to the annual limits on intake (ALIs) and derived air concentrations (DACs) in appendix B to §§ 20.1001–20.2401 of this final rule. The changes resulting from the use of these revised factors would not change either the ingestion or inhalation ALIs for plutonium in the oxide or nitrate forms, but would lower the ALIs for other compounds or mixtures by a factor of 10. The transfer factor for the gut transfer of neptunium was found to be an order of magnitude lower than the value used in ICRP-30 and, consequently, the ingestion ALI can be increased by almost an order of magnitude. The transfer factors for americium, curium, and californium were found to be a factor of 2 higher than the ICRP-30 value so the ingestion ALIs are reduced by a factor of 2. Parameters applicable to inhalation ALIs and DACs are less affected by the new intestinal absorption factor than the ingestion ALIs as the transfer from the gastrointestinal (GI) tract to the blood for these radionuclides is generally far less significant than transfer from the lung to the blood.

C. ICRP 1987 Como Meeting

Following its 1987 meeting in Como, Italy, the ICRP issued a statement [5] that reviewed the existing estimates of the biological risks of ionizing radiation and, in particular, the preliminary data from the reanalysis of the Hiroshima-Nagasaki atomic bomb followup studies. Reanalysis of these data indicated that the risks from gamma radiation are approximately a factor of 2 higher than previous estimates for the general population and are also higher, but by a smaller factor, for workers. The ICRP concluded in 1987 that this information alone was "not considered sufficient at that time to warrant a change in the dose limits for occupational exposure and, for the general population, the increase in risk indicated by the new data is not considered to require an immediate change in the recommended dose limits, following the reduction by the ICRP (in 1985) in the principal limit from 5 to 1 mSv in a year (from sources other than medical and natural background radiation)." The ICRP also noted that the potential higher risks indicated by the reanalysis of the atomic bomb data should not be a major consideration as the dose limits should not be of primary importance in controlling doses if the principle of keeping radiation exposures "as low as is reasonably achievable" is being practiced. This position has since been modified by the ICRP 1990 Statement (see section II.I below).

[2] International Commission on Radiological Protection. "Statement from the 1985 Paris Meeting of the [ICRP]." British Journal of Radiology, Vol. 58, page 910; 1985; also Health Physics, 48(6): 828–829 (June 1985).

[3] International Commission on Radiological Protection. "ICRP Statement from 1987 Washington Meeting." Health Physics 53(3): 335–342 (1987).

[4] International Commission on Radiological Protection. "The Metabolism of Plutonium and Related Elements." ICRP Publication No. 48 (Available for sale from Pergamon Press, Inc., Elmsford, NY 10523.) (1986).

[5] International Commission on Radiological Protection. "Statement from the 1987 Como Meeting of the [ICRP]." Health Physics, 54(1): 125–132 (1988).

D. Federal Radiation Protection Guidance on Occupational Exposure

On January 20, 1987, President Reagan approved revised guidance to Federal agencies for occupational radiation protection. This guidance, which was published in the Federal Register (52 FR 2822; January 27, 1987), generally adopts the philosophy and methodology of ICRP Publications 26 and 30. The amendments to part 20 in this final rule were developed in parallel with the development of the guidance. Because of this parallel development, the proposed part 20 rule conformed with the draft Federal guidance available at the time the proposed part 20 rule was written. However, because of changes made to both the draft guidance and the draft part 20 revision, there were a few differences between the guidance in its final published form and the proposed part 20 revision. As discussed in the respective sections below, changes to the proposed rule have been made in order to implement the final version of the Federal guidance.

E. NCRP Report No. 91

On June 1, 1987, the National Council on Radiation Protection and Measurements (NCRP) issued a report [6] containing updated NCRP recommendations for radiation protection limits. These recommendations replace recommendations published in 1971. The majority of these recommendations are in accord with the 1977 recommendations of the ICRP and, consequently, were already reflected in the proposed part 20 rule. There are, however, several NCRP recommendations that were not in the ICRP-26 recommendations. These NCRP recommendations are:

(1) A general "guideline" that the cumulative effective dose equivalent to a worker should not exceed 1 times the worker's age in years; i.e., 1×N instead of the former 5(N−18) formula;

(2) Use of committed effective dose equivalent for planning purposes and the use of annual (rather than committed) doses for post-(internal) exposure control;

(3) A monthly dose limit as well as a limit on total gestation dose to the embryo/fetus;

(4) Adoption of a 0.1-rem (1 mSv) effective doses equivalent limit for exposure of the general public with the condition that the "site operator" assess the total exposure to the most exposed individual if estimated or measured exposures exceed 25 percent of this limit (25 millirems or 0.25 mSv per year);

(5) The use of "reference levels" set up by the radiation user below the regulatory limits;

(6) A Negligible Individual Risk Level of 1 millirem (0.01 mSv) per year. This level is the ". . . average annual excess risk of fatal health effects attributable to irradiation, below which further effort to reduce radiation exposure to the individual is unwarranted" (NCRP No. 91, p. 43).

These NCRP recommendations were issued after publication of the proposed part 20 rule and, consequently, there has not been an opportunity for public comment on them. For this reason, these NCRP recommendations are not being adopted in the amendments to part 20 presented in this final rule.

F. The 1988 Report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR-88)

The United Nations Scientific Committee on the Effects of Atomic Radiation has analyzed data on the sources and effects of atomic radiation and published a series of reports containing summaries of the sources of radiation, the doses received by workers and members of the general public from these sources, and an analysis of the potential health risks from exposure to ionizing radiation.

The latest report in this series is the 1988 report. The 1988 report [7] contains more recent information on the health risks of ionizing radiation determined from a reevaluation of the data on the survivors of the Hiroshima-Nagasaki atomic bombings. Based upon these data, the radiation risk at high doses and high dose rates is estimated to be 7.1×10^{-4} fatal health effects per rad (0.071 effects per gray). For estimating the risk from radiation doses below 100 rads, the UNSCEAR report recommended that a dose rate reduction factor be applied to account for the reduced effectiveness of lower doses and lower dose rates. This would lead to an estimated risk of fatality of between $(0.7 \text{ to } 3.5) \times 10^{-4}$ health effects per rad for low doses such as those encountered in routine occupational exposure and the even lower doses that might be received by members of the general public from NRC- (or Agreement State) licensed activities. The fatal cancer risk value associated with the 1977 ICRP recommendations,[1] is 1.25×10^{-4} (the proposed part 20 rule, 51 FR 1102, January 9, 1986) so that the risks as estimated by the 1988 UNSCEAR report for low doses are between 1.7 times lower to 2.8 times higher than the earlier ICRP estimate. Implications of an increased risk are discussed in section II.I.

G. The 1988 Report of the National Academy of Sciences' Committee on the Biological Effects of Ionizing Radiation (BEIR-IV) [8]

The 1988 BEIR-IV report supplements the 1980 BEIR-III report by providing a more detailed analysis of the risks from internal alpha-emitting radionuclides to complement the emphasis of the BEIR-III report on gamma and beta radiation. Revised risk estimates are given for intakes of radon, radium, polonium, thorium, uranium, and higher transuranic elements (e.g., plutonium).

The radionuclide given the greatest emphasis in the BEIR-IV report is radon (radon-222), the gaseous decay product of radium-226. The radon dose conversion factor in the BEIR-IV report for exposure conditions representative of those of the general public is consistent with the value used to derive the airborne effluent concentration limit for radon-222 in appendix B to §§ 20.1001-20.2401, table 2 of the amendments of 10 CFR part 20 contained in this final rule.

H. The 1990 Report of the National Academy of Sciences' Committee on the Biological Effects of Ionizing Radiation (BEIR-V) [9]

The BEIR-V report is another comprehensive reevaluation of the health risks of radiation exposure based upon the revised dose estimates for the survivors of the atomic bombings of Hiroshima and Nagasaki. The BEIR-V report gives risk estimates for leukemia and non-leukemia (solid cancers) that are about two to five times higher than the estimates in the 1980 BEIR-III report. The BEIR-V report gives the following factors as the principal reasons for this

[6] National Council on Radiation Protection and Measurements (NCRP). "Recommendations on Limits for Exposure to Ionizing Radiation." NCRP Report No. 91 (June 1, 1987). (Available for sale from the NCRP, 7910 Woodmont Avenue, suite 800, Bethesda, MD 20814-3095.)

[7] United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). "Sources, Effects and Risks of Ionizing Radiation, 1988 Report to the General Assembly, Sales Section, United Nations, NY 10017 (1988).

[8] National Academy of Sciences-National Research Council, Committee on the Biological Effects of Ionizing Radiation, "Health Risks of Radon and Other Internally Deposited Alpha-Emitters, (BEIR-IV)." National Research Council, National Academy Press, Washington, DC 20418 (1988).

[9] National Academy of Sciences-National Research Council, Committee on the Biological Effects of Ionizing Radiation, "Health Effects of Exposure to Low Levels of Ionizing Radiation, (BEIR-V)." National Research Council, National Academy Press, Washington, DC 20418 (1990).

increase: (1) Use of different dose-response and risk projection models, (2) revised estimates of the doses to the individual survivors of the atomic bombings in Japan, and (3) improved epidemiological data from additional years of followup studies since the BEIR-III report was completed in 1930.

The BEIR-V Committee uses the linear dose response model and the relative risk projection model to extrapolate the fatal tumor risk to future periods. The relative risk projection model assumes the risk to be proportional to the natural cancer incidence, which generally increases with age. Because of this dependence on age, the relative risk model generally predicts higher future (lifetime) risks than the absolute risk model which employs a constant added risk per year with increasing age. Estimates are given of the risk as a function of the time since the exposure occurred and the age and sex of the exposed person. The BEIR-V report, like the UNSCEAR-88 report, indicates that a reduction factor should be applied to the risk estimates derived from high doses and dose rates in order to apply them to low dose and low dose-rate situations. Although neither the BEIR-V report nor the UNSCEAR-88 report recommends a specific value for this factor, both reports indicate that this factor should be greater than 2 (larger reduction factors would give a lower risk per unit dose). Assuming a factor of 2 reduction in the risk estimates derived from high doses and high dose rates, BEIR-V would give a lifetime risk of a radiation-induced cancer fatality of about 4×10^{-4} fatal cancers/rem (0.04 per sievert) for workers and 5×10^{-4} per rem (0.05 per sievert) for the general population, the higher value for the public being associated with the higher sensitivity and the longer period of elevated risk associated with the younger ages present in the general population. The values of 5×10^{-4} is three times as large as the recommended value in the 1980 BEIR-III report and four times as large as the estimate in the 1977 ICRP-26[1] report (see section II.F).

The BEIR-V report also summarized the data on the frequency of severe mental retardation found in the children of Hiroshima and Nagasaki atomic bomb survivors. These children were exposed *in utero* at gestational ages of 8-15 weeks and the risk of severe mental retardation during this period is about 4×10^{-3} per rem with a possible threshold for the effect in the range of 20 to 40 rem. The risk of severe retardation was less during other gestational ages; there was no evidence of increased risk in survivors exposed earlier than 8 weeks or later than 26 weeks after conception.

The estimates of genetic effects to the offspring of irradiated individuals remained similar to those in the 1972 BEIR-I and 1980 BEIR-III reports. As radiation-induced inherited abnormalities have not been observed directly in humans, estimates of genetic effects have been based primarily upon experimental studies with mice. These studies suggest that it would take a dose of about 100 rads to double the natural frequency of genetically transmitted diseases.

I. ICRP 1990 Recommendations

On June 22, 1990, the International Commission on Radiological Protection issued a press release indicating that it would issue revised recommendations for radiation protection based upon the newer studies of radiation risks (such as those described in sections F, G, and H above). The press release indicated that the ICRP would recommend a reduction in the occupational dose limit from an equivalent of 5 rems per year to an average of 2 rems per year with some allowance for year-to-year flexibility. The ICRP dose limit for long-term exposure of members of the general public would remain equivalent to the level adopted in this amendment to part 20, 0.1 rem per year.

The Nuclear Regulatory Commission does not believe that additional reductions in the dose limits are urgently required by the latest radiation risk estimates. Due to the practice of maintaining radiation exposures ALARA ("as low as is reasonably achievable"), the average radiation dose to occupationally exposed individuals is well below the limits in either the previous or amended part 20 and also below the limits recommended by the ICRP. For example, in 1987 about 97 percent of the workers in nuclear power plants, industrial radiography, reactor fuel fabrication, and radioisotope manufacturing, four of the industries having the highest potential for occupational radiation exposures, received annual doses of less than 2 rems, which is the occupational limit proposed by the ICRP.

As a result of the application of the ALARA philosophy to effluent release standards in appendix I to 10 CFR part 50 for nuclear power reactors and EPA's 40 CFR part 190 for the uranium fuel cycle, doses from radioactive effluents from fuel cycle facilities are already much less than the 0.1 rem per year standard in this final rule. The 0.1 rem per year remains as the level recommended by the ICRP for protection of the general public.

Until the final ICRP recommendations are published, and the need for further revisions in NRC standards established, the Commission believes it would be advisable to proceed with the promulgation of the proposed dose limits, rather than deferring the dose reductions that are already associated with the amendments to part 20 in this final rule. The Commission will carefully review the final recommendations of the International Commission on Radiological Protection, the comments of the scientific community and others on these recommendations, and the ICRP response to these comments. In addition, the Commission staff will review the recommendations of other expert bodies, such as the National Council on Radiation Protection and Measurements, and participate in the deliberations of the U.S. Committee on Interagency Radiation Research and Policy Coordination and any interagency task force convened by the Environmental Protection Agency to consider revised Federal radiation guidance. Any future reductions in the dose limits by the Commission would be the subject of a future rulemaking proceeding.