50-322

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NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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DOCKETED USNRC DEC 1 1978 Office of the Secretary Docketing & Service Section

In the Matter of
LONG ISLAND LIGHTING COMPANY
(Shoreham Nuclear Power Station, Unit 1)
Docket No. 50-322

Dear Members of the Board:

By letter of April 25, 1978, the NRC Staff transmitted to the Atomic Safety and Licensing Board members and the parties in this proceeding a copy of the Commission's clarifying amendment to Table S-3 of 10 CFR Part 51 effective on April 14, 1978 (43 Fed. Reg. 15613). By that action, the Commission amended Table S-3 to remove the value contained in the Table for radon-222 and to clarify that Table S-3 did not include the health effects from the effluents there described.

The effect of that Commission action was to render Table 5.25 and the associated text of Section 5.7 of the Shoreham Final Environmental Statement*/ in error for these materials were based on Table S-3 prior to the Commission's amendment. The Staff has updated both Table 5.25 and the text of Section 5.7 to reflect the Commission's action in amending Table S-3 on April 14, 1978. Enclosed please find a copy of the revised material which supersedes the material presented in the Shoreham FES.

Sincerely,

Richard K Hoefling

Richard K. Hoefling
Counsel for NRC Staff

Enclosure as Stated

cc (w/encl.):

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*/ Final Environmental Statement related to operation of Shoreham Nuclear Power Station Unit 1, Long Island Lighting Company, October, 1977, NUREG-0285.

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5.7 URANIUM-FUEL-CYCLE IMPACTS

On March 14, 1977, the Commission presented in the Federal Register (42 FR 13803) an interim rule regarding the environmental considerations of the uranium fuel cycle. It is effective through March 14, 1979* and revises Table S-3 of Paragraph (e) of 10 CFR § 51.20.** In a subsequent announcement on April 14, 1978 (43 FR 15613), the Commission further amended Table S-3 to delete the numerical entry for the estimate of radon releases and to clarify that the table does not cover health effects. The revised table, shown here as Table 5, replaces Table 5.25 of the Shoreham FES. The interim rule reflects new and updated information relative to reprocessing of spent fuel and radioactive waste management as discussed in NUREG-0116, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle (Ref. 1), and NUREG-0216 (Ref. 2), which presents staff responses to comments on NUREG-0116. The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low and high level wastes. These are described in the AEC report WASH-1248, Environmental Survey of the Uranium Fuel Cycle (Ref. 3).

Specific categories of natural resource use are included in Table S-3 of the interim rule. These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high and low level wastes, and radiation doses from transportation and occupational exposures. The contributions in Table S-3 for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle), that is, the cycle that results in the greater impact is used.

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S-3 and the staff's analysis of the radiological impact from radon releases. For the sake of consistency, the analysis of fuel-cycle impacts has been cast in terms of a model 1000 MWe light-water-cooled reactor (LWR) operating at an annual capacity factor of 80%. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff conclusions would not be altered if the analysis were to be based on the net electrical power output of the proposed project.

The staff's analysis and conclusions are as follows:

A. Land Use

The total annual land requirement for the fuel cycle supporting a model 1000 MWe LWR is about 41 hectares (101 acres). Approximately 3 hectares (7 acres) per year are permanently committed land, and 38 hectares (94 acres) per year are temporarily committed. (A "temporary" land commitment is a commitment for the life of the specific fuel-cycle plant, e.g., mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.) Of the 38 hectares per year of temporarily committed land, 29 hectares are undisturbed and 9 hectares are disturbed. Considering common classes of land use in the U.S.,*** fuel-cycle land-use requirements to support the model 1000 MWe LWR do not represent a significant impact.

B. Water Use

The principal water-use requirement for the fuel cycle supporting a model 1000 MWe LWR is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43×10^6 m^3 ($11,373 \times 10^6$ gal), about 42×10^6 m^3 are required for this purpose, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about 0.6×10^6 m^3 per year and water discharged to ground (e.g., mine drainage) of about 0.5×10^6 m^3 per year.

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*The rule was originally effective through September 13, 1978, but the Commission, in an action effective September 14, 1978, extended the rule to this date.

**A notice of final rulemaking proceedings was given in the Federal Register of May 26, 1977 (42 FR 26987) that calls for additional public comment before adoption or final modification of the interim rule.

***A coal-fired power plant of 1000 MWe capacity using strip-mined coal requires the disturbance of about 81 hectares (200 acres) per year for fuel alone.

Table S. *Summary of environmental considerations for uranium fuel cycle*[1]

[Normalized to model LWR annual fuel requirement (WASH-1248) or reference reactor year (NUREG-0116)]

Natural resource Use	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
Land (acres):		
Temporarily committed[2]	94	
Undisturbed area	73	
Disturbed area	22	Equivalent to 110 MWe coal-fired powerplant.
Permanently committed	7.1	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired powerplant.
Water (millions of gallons):		
Discharged to air	159	=2 pct of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	124	
Total	11,373	<4 pct of model 1,000 MWe LWR with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of megawatt hours)	321	<5 pct of model 1,000 MWe LWR output.
Equivalent coal (thousands of MT)	117	Equivalent to the consumption of a 45 MWe coal-fired powerplant.
Natural gas (millions of scf)	124	<0.3 pct of model 1,000 MWe energy output.
Effluents—chemical (MT):		
Gases (including entrainment):[3]		
SO_x	4,400	
NO_x[4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases:		
F^-	0.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards—below level that has effects on human health.
HCl	0.014	
Liquids:		
SO_4^{-}	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3—600 ft^3/s. NO_3—20 ft^3/s. Fluoride—70 ft^3/s.
NO_3^{-}	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
Cl^-	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	0.4	
Tailings solutions (thousands of MT)	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills—no significant effluents to environment.
Effluents—radiological (curies):		
Gases (including entrainment):		
Rn-222	–	Presently under reconsideration by the Commission.
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	Principally from fuel reprocessing plants.
Ru-106	0.14	
I-129	1.3	
I-131	0.83	
Fission products and transuranics	0.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling—included in tailings liquor and returned to ground = no effluents; therefore, no effect on environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants—concentration 10 pct of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried on site):		
Other than high level (shallow)	11,300	9,100 Ci comes from low-level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground ~60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^7	Buried at Federal repository
Effluents—thermal (billions of British thermal units)	3,462	<4 pct of model 1,000 MWe LWR.
Transportation (person-rem): Exposure of workers and general public.	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

[1] In some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the Table. Table S-3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the uranium fuel cycle. These issues which are not addressed at all by the Table may be the subject of litigation in individual licensing proceedings. Data supporting this Table are given in the "Environmental Survey of the Uranium Fuel Cycle", WASH-1248, April 1974; the "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle", NUREG-0116 (Supp. 1 to WASH-1248); and the "Discussion of Comments Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle", NUREG-0216 (Supp. 2 to WASH-1248). The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the 2 fuel cycles (uranium only and no-recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of sec. 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A–E of Table S-3A of WASH-1248.

[2] The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services 1 reactor for 1 yr. or 57 reactors for 30 yrs.

[3] Estimated effluents based upon combustion of equivalent coal for power generation.

[4] 1.2 pct. from natural gas use and process.

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4% of the model 1000 MWe LWR discharges using once-through cooling. The consumptive water use of 0.6×10^6 m^3 per year is about 2% of the model 1000 MWe LWR consumption using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle used cooling towers) would be about 6% of the model 1000 MWe LWR consumption using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption are acceptable relative to the water use and thermal discharges of the proposed project.

C. Fossil Fuel Consumption

Electrical energy and process heat are required during various phases of the fuel-cycle process. The electrical energy is usually produced by the combustion of fossil fuel at conventional power plants. Electrical energy associated with the fuel cycle represents about 5% of the annual electrical power production of the model 1000 MWe LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.3% of the electrical output from the model plant. The staff finds that the direct and indirect consumption of electrical energy for fuel-cycle operations are small and acceptable relative to the net power production of the proposed project.

D. Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents with fuel-cycle processes are given in Table S-3. The principal species are SO_x, NO_x, and particulates. Based on data in a Council on Environmental Quality report,* the staff finds that these emissions constitute an extremely small additional atmospheric loading in comparison with these emissions from the stationary fuel-combustion and transportation sectors in the U.S., i.e., about 0.02% of the annual national releases for each of these species. The staff believes such small increases in releases of these pollutants are acceptable.

Liquid chemical effluents produced in fuel-cycle processes are related to fuel-enrichment, -fabrication, and -reprocessing operations and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table S-3 specifies the flow of dilution water required for specific constituents. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel-cycle operations will be subject to requirements and limitations set forth in an NPDES permit issued by an appropriate state or Federal regulatory agency.

Tailings solutions and solids are generated during the milling process. These solutions and solids are not released in quantities sufficient to have a significant impact on the environment.

E. Radioactive Effluents

Radioactive effluents estimated to be released to the environment from reprocessing and waste management activities and certain other phases of the fuel-cycle process are set forth in Table S-3. Using these data, the staff has calculated the 100-year involuntary environmental dose commitment** to the U.S. population. These calculations estimate that the overall involuntary total body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222) would be approximately 400 man-rem per year of operation of the model 1000 MWe LWR (RRY). Based on Table S-3 values, the additional involuntary total body dose commitment to the U.S. population from radioactive liquid effluents due to all fuel-cycle operations other than reactor operation would be approximately 100 man-rem per year of operation. Thus, the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is approximately 500 man-rem (whole body) per RRY.

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*The Seventh Annual Report of the Council on Environmental Quality, September 1976. Figures 11-27 and 11-28, pp. 238-239.

**The environmental dose commitment (EDC) is the integrated population dose for 100 years, i.e., it represents the sum of the annual population doses for a total of 100 years. The population dose varies with time, and it is not practical to calculate this dose for every year.

At this time Table S-3 does not address the radiological impacts associated with radon-222 releases. Principal radon releases occur during mining and milling operations and, following completion of mining and milling, as emissions from stabilized mill tailings and from unreclaimed open-pit mines. The staff has determined that releases from these operations per RRY are as follows:

Mining: (during active mining)	4060 Ci	(Ref. 4)
Mining: (unreclaimed open pit mines)	30 to 40 Ci/yr	(Ref. 5)
Milling and Tailings: (during active milling)	780 Ci	(Ref. 6)
Inactive Tailings: (prior to stabilization)	350 Ci	(Ref. 6)
Stabilized Tailings: (several hundred years)	1 to 10 Ci/yr	(Ref. 6)
Stabilized Tailings: (after several hundred years)	110 Ci/yr	(Ref. 6)

The staff has calculated population dose commitments for these sources of radon-222 using the RABGAD computer code described in NUREG-0002, Section IV.J of Appendix A (Ref. 7). The results of these calculations for mining and milling activities prior to reclamation of open-pit uranium mines and tailings stabilization are as follows:

Radon 222 Releases		Estimated 100-Year Environmental Dose Commitment (man-rem) per Year of Operation of the Model 1000 MWe LWR		
		Total Body	Bone	Lung (Bronchial Epithelium)
Mining	4100 Ci	110	2800	2300
Milling and active tailings	1100 Ci	29	750	620
Total		140	3600	2900

When added to the approximately 500 man-rem total body dose commitment for the balance of the fuel cycle, the overall estimated total body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000 MWe LWR is approximately 600 man-rem. Over this period of time, this dose is equivalent to 0.00002% of the natural background total body dose of about 3,000,000,000 man-rem to the U.S. population.*

The staff has considered health effects associated with the releases of radon-222, including both the short-term effects of mining, milling and active tailings and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. After completion of active mining, the staff has assumed that underground mines will be sealed with the result that releases of radon-222 from them will return to background levels. For purposes of providing an upper-bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that if all ore was produced from open-pit mines, releases from them would be 110 Ci/year per RRY. However, since the distribution of uranium ore reserves available by conventional mining methods is 66.8% underground and 33.2 open pit (Ref. 8), the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods in these proportions. This means that long-term releases from unreclaimed open-pit mines will be 0.332 x 110 or 37 Ci/year per RRY.

Based on the above, the radon released from unreclaimed open-pit mines over 100- and 1000-year periods would be about 3700 Ci and 37000 Ci per RRY, respectively. The total dose commitments for a 100-1000-year period would be as follows:

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*Based on an annual average natural background individual dose commitment of 100 mrem and a stabilized U.S. population of 300 million.

Time Span	Curies	Population Dose Commitments in Man-rem		
		Total Body	Bone	Lung (Bronchial Epithelium)
100 years	3,700	96	2,500	2,000
500 years	19,000	480	13,000	11,000
1,000 years	37,000	960	25,000	20,000

The above dose commitments represent a worst-case situation since no mitigating circumstances are assumed. However, state and Federal laws currently require reclamation of strip and open-pit coal mines and it is very probable that similar reclamation will be required for uranium open-pit mines. If so, long-term releases from such mines should approach background levels.

For long-term radon releases from stabilized tailings piles the staff has assumed that these tailings would emit, per RRY, 1 Ci/yr for 100 years, 10 Ci/yr for the next 400 years and 100 Ci/yr for periods beyond 500 years. With these assumptions, the cumulative radon-222 release from stabilized tailings piles per RRY will be 100 Ci in 100 years, 4,090 Ci in 500 years and 53,800 Ci in 1000 years (Ref. 9). The total body, bone and bronchial epithelium dose commitments for these periods are as follows:

Time Span	Curies	Population Dose Commitments in Man-rem		
		Total Body	Bone	Lung (Bronchial Epithelium)
100 years	100	2.6	68	56
500 years	4,090	110	2,800	2,300
1,000 years	53,800	1,400	37,000	30,000

Using risk estimators of 135, 6.9 and 22.2 cancer deaths per million man-rem for total body, bone and lung exposures, respectively, the estimated risk of cancer mortality due to mining, milling and active tailings emissions of radon-222 would be about 0.11 cancer fatalities per RRY. When the risk due to radon-222 emissions from stabilized tailings over a 100-year release period is added, the estimated risk of cancer mortality over a 100-year period is unchanged. Similarly, a risk of about 1.2 cancer fatalities is estimated over a 1000-year release period per RRY. When potential radon releases from reclaimed and unreclaimed open-pit mines are included, the overall risks of radon induced cancer fatalities per RRY would range as follows:

0.11-0.19 fatalities for a 100-year period
0.19-0.57 fatalities for a 500-year period
1.2 -2.0 fatalities for a 1000-year period

To illustrate: A single model 1000 MWe LWR operating at an 80% capacity factor for 30 years would be predicted to induce between 3.3 and 5.7 cancer fatalities in 100 years, 5.7 and 17 in 500 years, and 36 and 60 in 1000 years as a result of releases of radon-222.

These doses and predicted health effects have been compared with those that can be expected from natural-background emissions of radon-222. Using data from the National Council on Radiation Protection (NCRP, Ref. 10), the average radon-222 concentration in air in the contiguous United States is about 150 pCi/m^3, which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 mrem. For a stabilized future U.S. population of 300 million, this represents a total lung dose commitment of 135 million man-rem per year. Using the same risk estimator of 22.2 lung cancer fatalities per million man-lung-rem used to predict cancer fatalities for the model 1000 MWe LWR, estimated lung cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000 per year or 300,000 to 3,000,000 lung cancer deaths over periods of 100 and 1,000 years, respectively.

In addition to the radon-related potential health effects from the fuel cycle, other nuclides produced in the cycle, such as carbon-14, will contribute to population exposures. It is estimated that 0.08 to 0.12 additional cancer deaths may occur per RRY (assuming that no cure or prevention of cancer is ever developed) over the next 100 to 1000 years, respectively, from exposures to these other nuclides.

The latter exposures can also be compared with those from naturally-occurring terrestrial and cosmic-ray sources. These average about 100 mrem. Therefore, for a stable future population of 300 million persons, the whole-body dose commitment would be about 30 million man-rem per year or 3 billion man-rem and 30 billion man-rem for periods of 100 and 1000 years, respectively. These dose commitments could produce about 400,000 and 4,000,000 cancer deaths during the same time periods. From the above analysis the staff concludes that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared to dose commitments and potential health effects to the U.S. population resulting from all natural background sources.

F. Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S-3. For low-level waste disposal at land burial facilities, the Commission notes in Table S-3 that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, the Commission notes that these are to be buried at a Federal Repository, and that no release to the environment is associated with such disposal. NUREG-0116 (Ref. 1), which provides background and context for the high-level and transuranic Table S-3 values established by the Commission, indicates that these high-level and transuranic wastes will be buried and will not be released to the biosphere. No radiological environmental impact is anticipated from such disposal.

G. Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the model 1000 MWe LWR is about 200 man-rem. The staff concludes that this occupational dose will not have a significant environmental impact.

H. Transportation

The transportation dose to workers and the public is specified in Table S-3. This dose is small and is not considered significant in comparison to the natural background dose.

I. Fuel Cycle

The staff's analysis of the uranium fuel cycle did not depend on the selected fuel cycle (no recycle or uranium-only recycle), since the data provided in Table S-3 include maximum recycle option impact for each element of the fuel cycle. Thus, the staff's conclusions as to acceptability of the environmental impacts of the fuel cycle are not affected by the specific fuel cycle selected.

VI. REFERENCES

1. U.S. Nuclear Regulatory Commission, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle, NUREG-0116 (Supplement 1 to WASH-1248), October 1976.

2. U.S. Nuclear Regulatory Commission, Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle, NUREG-0216 (Supplement 2 to WASH-1248), March 1977.

3. U.S. Atomic Energy Commission, Environmental Survey of the Uranium Fuel Cycle, WASH-1248, April 1974.

4. U.S. Nuclear Regulatory Commission, In the Matter of Duke Power Company (Perkins Nuclear Station), Docket No. 50-488, Testimony of R. Wilde, filed April 17, 1978.

5. U.S. Nuclear Regulatory Commission, In the Matter of Long Island Lighting Company (Jamesport Nuclear Power Station), Docket No. 50-516, Deposition of Leonard Hamilton, Reginald Gotchy, Ralph Wilde and Arthur R. Tamplin, July 27, 1978, p. 9274.

6. U.S. Nuclear Regulatory Commission, In the Matter of Duke Power Company (Perkins Nuclear Station), Docket No. 50-488, Testimony of P. Magno, filed April 17, 1978.

7. U.S. Nuclear Regulatory Commission, Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light-Water-Cooled Reactors, NUREG-0002, August 1976.

8. U.S. Department of Energy, Statistical Data of the Uranium Industry, GJO-100(78), January 1, 1978.

9. U.S. Nuclear Regulatory Commission, In the Matter of Duke Power Company (Perkins Nuclear Station), Docket No. 50-488, Testimony of R. Gotchy, filed April 17, 1978.

10. National Council on Radiation Protection and Measurements, Publication 45, (1975).