August 30, 1974

SECY-A-75-20

ADJUDICATORY ITEM

SUMMARY SHEET

Subject: As-Low-As-Practicable Proceeding, RM-50-2.

Purpose: Preliminary draft Commission Decision.

Discussion: The attached preliminary draft is intended for discussion purposes only. It should be considered from the standpoint of the substantive determinations it contains, rather than from an editorial standpoint. Editorially, it is being substantially revised, in part on the basis of conversations between Dr. Bibb and the Solicitor's office. To expedite the decision-making process, we recommend Commission discussion of the consultants' substantive conclusions at an early date.

Scheduling: Commission consideration at an adjudicatory session on September 12, 1974.

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STATEMENT OF CONSIDERATIONS

August 16, 1974

THE STATEMENT OF CONSIDERATIONS

HISTORICAL BACKGROUND OF THE HEARING

The Atomic Energy Commission established, in Part 20 of its regulations, limits for radioactive emissions from licensed reactors.[1/] These limits were based on radiation guides and recommendations of the Federal Radiation Council (FRC),[2/] the National Council on Radiation Protection (NCRP) and the International Commission on Radiological Protection (ICRP). The FRC radiation protection guides, approved by the President in 1960 and 1961, limit dosages for individual members of the public to 500 millirems per year to the total body and bone marrow, 1500 millirems per year to the thyroid and bone. Average dose to the population is limited to 5 rems in 30 years to the gonads (or an annual average dose of 170 millirems per person averaged over the population). These guides and recommendations apply to exposures from all radiation sources other than the natural background[3/] and those employed in medical procedures. However, these FRC guides contain the further admonition that every effort be made to maintain radiation doses as far below the approved level as is practicable.

On December 3, 1970, the Atomic Energy Commission published in the Federal Register[4/] amendments to 10 CFR 50 that specified design and operating requirements for nuclear power reactors to keep levels of radioactivity in effluents as low as practicable.[5/] The amendments provided qualitative guidance,

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1/ 10 CFR 20.101 et. seq.

2/ The FRC's function were transferred to the Environmental Protection Agency pursuant to the President's Reorganization Plan No. 3 of 1970.

3/ Average total body doses due to natural background radiation in the United States are in the range of 100-125 millirems per year.

4/ 10 CFR 50.34a, 50.36a, 35 Fed. Reg. 18385.

5/ The term "as low as practicable" is defined in the regulation to mean "as low as practicably achievable taking into account the state of technology, and the ecoromics of improvements in relation to the benefits to the public health and safety and in relation to the utilization of atomic energy in the public interest.

but not numerical criteria, for determining when design objectives and operations meet the requirements for keeping levels of radioactivity in effluents as low as practicable.

The Commission noted, in its Statement of Consideration for those amendments, the desirability of developing more definitive guidance for definition of "as low as practicable" and that it was initiating discussions with the nuclear power industry and other competent groups to achieve this goal.

In the FEDERAL REGISTER on June 9, 1971 the Commission published[1/] for public comment proposed amendments to 10 CFR Part 50 that would supplement that part of the regulation with a new Appendix I to provide numerical guides for design objectives and technical specification requirements for limiting conditions for operation for light-water-cooled nuclear power reactors to keep radioactivity in effluents as low as practicable.

Subsequently, through notice[2/] published on November 30, 1971 in the FEDERAL REGISTER, the Commission announced a public hearing to commence in early 1972 on the matter of the proposed numerical guidance. The rule making hearing convened on January 20, 1972 before a Hearing Board consisting of Chairman Algie A. Wells, Esq., Dr. John C. Geyer, and Dr. Walter Jordan.

Appearing in the proceedings were the following 5 primary participants:

AEC Regulatory Staff
Consolidated National Intervenors
Consolidated Utility Group
General Electric Company
State of Minnesota

In addition, eighteen persons or organizations, including the Environmental Protection Agency, made limited appearances.

1/ 36 F.R. 11113.
2/ 36 F.R. 22775.

As originally conceived, the hearing was to have been strictly legislative in character. However, as a matter of discretion, the Commission provided[1/] for certain important adjudicatory features to be used in the rule making hearing. These features included the opportunity for questioning of the witnesses of other participants, requirements for participants to make appropriate documents available, and "to produce on request documents on which they rely". Moreover, the Commission provided that its "determination in the rule making proceeding will be supported by the record."[2/]

The hearing, beginning on January 20, 1972, continued intermittently for 17 hearing days until May 6, 1972, at which time proceedings were suspended for preparation of, and receipt of comments on, a Draft Environmental Statement (DES) and subsequent preparation of a Final Environmental Statement (FES). The DES concerning the proposed rule making was forwarded to the Council on Environmental Quality on January 15, 1973 and was circulated for comment to participants in the hearing and to interested Federal Agencies on January 16, 1973.[3/] Some 36 individuals or organizations submitted written comments on the DES.[4/] After receipt and consideration of these comments, the FES was issued on July 26, 1973. In November 1973, as provided for by the Commission, the public hearings were resumed for consideration of the (3 volume, 1400 page) Final Impact Statement and other aspects of the rule making which did not duplicate matters dealt with in the earlier phase of the hearing. Consolidated National Intervenors, who were

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1/ Supplemental Notice of Hearing dated Jan. 8, 1972 (37 F.R. 287).

2/ Supplemental Notice of Hearing dated Jan. 8, 1973, Rule 2 (37 F.R. 287).

3/ Notice of availability of the Draft Environmental Statement was published in the Federal Register for Jan. 16, 1973 (38 F.R. 1616

4/ See Final Environmental Statement; Volume III.

active during the first phase of the proceedings, chose not to participate in the environmental portion of the hearing on the ground that it had limited resources and "confidence in the ability of the Regulatory Staff to adequately protect the public interest."[1/] The evidenciary hearing was concluded on Dec. 6, 1973. The entire proceeding covered 25 days of public hearing and produced 4172 pages of hearing transcript and thousands of pages of written testimony and exhibits.

Each of the primary participants, other than the AEC Regulatory Staff, was encouraged to submit written Concluding Statements of Position following conclusion of the hearing. Each of the three primary participants and one limited participant filed such statements[2/,3/,4/,5/] on or before Feb. 1, 1974. After receipt and consideration of this material the AEC Regulatory Staff prepared its Concluding Statement,[6/] which contained a revised proposed Appendix I differing in several important regards as suggested by evidence at the hearing, from that originally proposed.[7/] The Regulatory Staff published, at the same time as an Appendix to its Concluding Statement, a set of draft regulatory guides for implementation of the revised proposed Appendix I.[8/]

Each of the primary participants was encouraged, as previously arranged,[9/] to submit written comments on the Concluding Statement of the Regulatory Staff. Two of the primary participants, the Consolidated Utility Group[10/] and the General

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1/ Letter of October 11, 1973 from Karin P. Sheldon to Hearing Board.
2/ Statement of Position by the Consolidated Utility Group, Jan. 19, 1974.
3/ Closing Statement of the General Electric Company, Jan. 21, 1974.
4/ Final Statement of Position of the State of Minnesota, Feb. 1, 1974.
5/ Final Statement of Position, Andrew P. Hull (Limited Participant), Jan. 30, 1974.
6/ Concluding Statement of Position of Regulatory Staff, Feb. 20,1974.
7/ See F.R. 11113.
8/ Draft Regulatory Guides for Implementation, Feb. 20, 1974.
9/ See Hearing Transcript, p .
10/ Reply of the Consolidated Utility Group to Concluding Statement of the Regulatory Staff, March 7, 1974.

Electric Company,[1] and two limited participants, the Environmental Protection Agency[2] and Dr. Andrew P. Hull[3] submitted such written comments.

Finally, the Commission arranged for[4] and, on June 6, 1974, heard Oral Argument from the Regulatory Staff, three primary participants (Consolidated Utilities Group, General Electric Company, and the State of Minnesota) and from one limited participant (Dr. Andrew P. Hull).

The Commission noted in the Notice of Proposed Rule Making[5] that:

> "The Commission has always subscribed to the general principle that, within established radiation protection guides, radiation exposures to the public should be kept as low as practicable. This general principle has been a central one in the field of radiation protection for many years. Operating licenses include provisions to limit and control radioactive effluents from the plants. Experience has shown that licensees have generally kept exposures to radiation and releases of radioactivity in effluents to levels well below the limits specified in 10 CFR Part 20. Specifically, experience with licensed light-water-cooled nuclear power reactors to date shows that radioactivity in water and air effluents has been kept at low levels - for the most part small percentages of the Part 20 limits. Resultant exposures to the people living in the immediate vicinity of operating power reactors have been small percentages of Federal radiation protection guides . . .

1/ Reply Statement of the General Electric Company, March 14, 1974.
2/ Letter with attachment, W. D. Rowe to L. Manning Nuntzing, received March 12,1974.
3/ Reply to the Concluding Statement of the Regulatory Staff, Andrew P. Hull, March 15, 1974.
4/
5/ 36 F.R. 22775.

"The amendments of Part 50 published on December 3, 1970, were intended to give appropriate regulatory effect, with respect to radioactivity in effluents from nuclear power reactors, to the qualitative guidance of the Federal Radiation Council that radiation doses should be kept 'as low as practicable'. The proposed guides set out below are intended to provide quantitative guidance to that end for light-water-cooled nuclear power reactors."

We conclude that, while we might possibly have differed with the Hearing Board on occasional procedural details, the Board exercised its discretion in an appropriate manner to develop a record -- tested by abundant cross examination -- that is more than adequate for formulation of a sound rule. Accordingly, and after careful consideration of the hearing record, we have adopted a new Appendix I to 10 CFR Part 50 in the form set forth below to provide numerical guidance for design objectives and limiting conditions for operation to meet the criterion "as low as practicable" for radioactive material in light-water-cooled nuclear power reactors.1/

1/ The words "as low as practicable" with the definition given in Footnote 5, supra has been used throughout the rule-making hearing and, for that obvious reason, we use that language and definition throughout this document. The Federal Radiation Council and the National Council on Radiation Protection use the same words and the same definition. The International Commission on Radiological Protection has, in recent years, preferred the wording "as low as readily achievable, economic and social considerations being taken into account." While individuals may well have a preference for either of these phrases, we believe that the intent of the two wordings is identical and that the two phrases are, for all practical purposes, synonymous.

BACKGROUND ON RADIATION PROTECTION

A. Radiation Protection Standards

Since its inception, the Atomic Energy Commission has, as a matter of policy, depended upon the recommendations of the International Commission on Radiological Protection (ICRP), the National Council on Radiation Protection and Measurements (NCRP), and since 1959, the Federal Radiation Council (FRC), for basic radiation protection standards and guidance. Standards of these groups are compatible. They have been used by the Commission as the basis for regulations and safety requirements in the AEC's regulatory program. The principles on which existing radiation protection standards are based are extensively discussed in the hearing record[1/,2/,3/] and are summarized by the FRC in their Memorandum for the President dated 18 May 1960 which provides official radiation protection guidance for Federal agencies as follows:

> "Basic biological assumptions. There are insufficient data to provide a firm basis for evaluating radiation effects for all types and levels of irradiation. There is particular uncertainty with respect to the biological effects at very low doses and low-dose rates. It is not prudent therefore to assume that there is a level of radiation exposure below which there is absolute certainty that no effect may occur. This consideration, in addition to the adoption of the conservative hypothesis of a linear relation between biological effect and the amount of dose, determines our basic approach to the formulation of radiation protection guides."

1/ NCRP Exhibit 1, The Development of Radiation Protection Standards, Lauriston S. Taylor, Feb. 16, 1972.

2/ Hearing Transcript 2034-2061 and 2274-2291.

3/ ALAP AEC Regulatory Exhibit 1 Tab 1.

As a result of the principles summarized above we, the Atomic Energy Commission, are faced with a situation in which no level of exposure to radiation can be considered to be without risk, and activities resulting in exposures to radiation should be carried out under conditions such that:

(a) the risks resulting from exposures to radiation are less important than the benefits to individuals and to society from activities which result in the exposures; and

(b) any further reductions in risk become less important than the effort that would be required to accomplish such reductions.

Taking into account these considerations, the standards groups (FRC, NCRP, ICRP) have recommended radiation protection guides, numerical maximum permissible doses for workers, limits for exposure to individuals in the population, and limits for average exposures to the total population. The numerical maximum permissible dose recommended for radiation workers is a working lifetime average of 5 rems per year to the total body; 30 rems in a year to the skin, bone, and thyroid; and 15 rems in a year to most other single organs.

The numerical dose limit recommended for individual members of the public varies to some degree among the three groups. The ICRP[1/] recommends annual dose limits of 0.5 rem to the total body, gonads, and red bone marrow; 3 rems to the skin, bone, and thyroid, except 1.5 rems to the thyroid of children up to 16 years of age, and 1.5 rems to other single organs.

The NCRP recommends[2/] an annual dose of 0.5 rem to the total body or any organ with the following qualifications:

1/ ICRP Publication 9, September 17, 1965.

2/ NCRP Report No. 39.

"It is, therefore, logical to consider 0.5 rem per year as an upper limit with very few exceptions. Special limits such as for skin or hands, should be set on a 'lowest practicable' basis rather than automatically at one-tenth the corresponding occupational limit. To have no organ or tissue exceed 0.5 rem per year is a reasonable target, but it is arbitrary, of course, and may not always be achievable."

The FRC has recommended[1/] a dose to the individual of 0.5 rem per year; 1.5 rem per year to the thyroid; 0.5 rem per year to the bone marrow; and 1.5 rem per year to the bone. The FRC provides no specific radiation protection guides with respect to other organs of the body.

All three of the standards groups have recommended that the average dose to the total population not exceed 5 rems in 30 years, which is an average annual per capita dose of 0.17 rem. These dose limits apply to the sum total of exposures from all sources of radiation other than natural background and those used in medical procedures. All of the standards groups emphasize that no one source of exposure should be permitted to contribute a disproportionate share of the total.

The standards groups have conditioned the numerical dose limits with qualitative guidance of which the following are typical examples:

From the International Council on Radiation Protection

"(52) As any exposure may involve some degree of risk, the Commission recommends that any unnecessary exposure be avoided and that all doses be kept as low as is readily achievable, economic and social considerations being taken into account..."

1/ FRC Reports 1 and 2, May 13, 1960 and September 1961, respectively.

2/ ICRP Publication 9 - Recommendations of the International Commission on Radiological Protection (Adopted September 17, 1965).

and from the Federal Radiation Council[1/]

"(5) There can be no single permissible or acceptable level of exposure without regard to the reason for permitting the exposure. It should be general practice to reduce exposure to radiation, and positive effort should be carried out to fulfill the sense of these recommendations. It is basic that exposure to radiation should result from a real determination of its necessity."

We, the Atomic Energy Commission, now adopt and as set forth below in Appendix I to 10 CFR Part 50, limits on dosages to individuals from effluents from light-water-cooled nuclear power plants that are markedly lower than indicated in the radiation protection standards described above. We do this because no one type of radiation source should be permitted to contribute a disproportionate share of the allowable dosage to the population and because experience has shown it to be practicable for radioactive materials in effluents from light-water-cooled power reactors to be maintained at these low levels. We wish to make emphatically clear that our setting of these markedly lower limits is not the result of any new evidence, discovered by us or by others, that would indicate that current radiation standards described above are in any way improper. Accordingly, the limits set in Appendix I, which apply only to radioactive materials in light-water-cooled nuclear power reactors - do not represent a change in the basic radiation protection standards.

1/ FRC Memorandum for the President - May 18, 1960.

B. The Linear Hypothesis

As the hearing record makes abundantly clear,[1,2,3] virtually all of the data showing real effects of radiation on the human population are derived from studies of persons exposed to doses greater than those that are presumable under current radiation standards and far greater still than the low doses projected from light-water-cooled power plants conforming with proposed Appendix I. Effects upon the human population of radiation dosage levels below 500 millirems per year are so small that they cannot be demonstrated with certainty. It is, accordingly, necessary to extrapolate by some model or hypothesis from the known effects at high dosages to the experimentally unobservable effects of small dosages.

Two hypotheses have been developed to predict whether or not effects occur from dosages at these very low levels. One holds that a threshold may exist at low dosages and dosage rates below which no damage occurs. A second, the so-called linear hypothesis, assumes that damage is proportional to dose down to zero dose levels. Neither hypothesis can be proved or disproved. Data on radiation effects on the human population are insufficient to demonstrate whether the magnitude of damage is or is not proportional to the magnitude of dose for all dose levels; if the linear hypothesis were true effects would be so slight at low doses that unmanageably large exposed populations would be required to demonstrate the effects in a statistically significant way.

1/ AEC Exhibit 2, Statement on the Somatic Effects of Ionizing Radiation, Leonard A. Sogan, Jan. 12, 1972.

2/ NCRPM Exhibit 1, The Development of Radiation Protection Standards, Lauriston S. Taylor, Feb. 16, 1972.

3/ CUG-T1, Statement on Behalf of the Consolidated Utilities Group, Morton I. Goldman, March 17, 1972.

National Intervenors (NI) sponsored testimony[1/] by Dr. Ernest J. Sternglass that would seem, at the least, to cause serious doubts as to the conservatism of the linear hypothesis. However, the record[2/,3/,4/] shows strong disagreement with this testimony; portions of the Sternglass calculations are shown[3/,4/] to contain serious errors. Moreover, careful examination[3/] of the same data used by Sternglass as well as of additional material appears to produce quite different conclusions. Accordingly, we find the NI testimony unpersuasive on this point.

The State of Minnesota also sponsored testimony[5/] to indicate that the linear hypothesis lacks any element of conservatism, but the State seems to suggest that the linear hypothesis should be used.

Neither General Electric Company (GE) nor the Consolidated Utilities Group (CU) spokesmen attacked the linear hypothesis directly, but both appear, at times, to challenge this assumption of a direct linear relationship between biological effect and amount of the dose. CU states[6/] "Proposed Appendix I fails adequately to reflect the negligible and possibly nonexistent biological impact to individuals and population groups of the dose levels at which its proposed numerical values are aimed. GE states[7/] "Indeed these dose levels are so low that increasing the levels by factors of 5 ∿ 10 would result in no detriment to the public and hence such an increase could be

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1/ NI-2 Summary Testimony of Dr. Ernest J. Sternglass, Marc 17, 1972.

2/ AEC-15 Rebuttal Testimony Concerning the Direct Testimony of Dr. Ernest J. Sternglass, Dr. Marvin Goldman.

3/ AEC-14 Rebuttal Testimony Concerning the Direct Testimony of Dr. Ernest J. Sternglass, Dr. Edythalina Thompkins.

4/ GE-2 Rebuttal Testimony, Dr. Richard I. Post, April 28, 1972.

5/ Minn-1: Testimony of Arthur R. Tamplin.

6/ Statement of Position by the Consolidated Utilities Group, Jan. 19, 1974, p. 8.

7/ Summary of General Electric Company Closing Statement, Jan. 21, 1974, p. 4.

justified, if necessary, on the grounds of administrative convenience alone." It is clear from these and similar statements from GE and CU that they are convinced that the linear model is excessively conservative.

Limited participant Andrew Hull presented testimony[1/] to indicate that the linear hypothesis overstates the population damage by a considerable and, perhaps, excessive margin.

Dr. Lauriston S. Taylor, President of the National Council on Radiation Protection and Measurements, stated of the linear hypothesis in his written testimony:[2/]

> "It is well known that such a simple relationship usually does not hold, and that simple extrapolations from high-dose effects to low-dose effects are most likely to err in varying degrees on the safe side; that is, the effects at low dose and low dose-rates will almost certainly be less than predicted on a basis of simple extrapolation. Such a model ignores the existence of dose-rate effects and, hence, biological recovery in a bio-system exposed to radiation. Nevertheless the model is useful for giving some kind of upper limit of dose effect."

We have, in keeping with the preponderance of evidence on the record, assumed the usefulness of the linear hypothesis that damage is proportional to dose at all levels. We do this, in common with the ICRP, the NCRPM and the FRT, to assure a reasonable conservatism in assessment of radiological damage; our

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1/ Final Statement of Position, Andrew P. Hull (Limited Participant), Jan. 30, 1974.

2/ Lauriston S. Taylor, "The Development of Radiation Protection Standards," NCRPM-1, February 16, 1972, pp. 19 and 20.

assumption, as theirs, implies no endorsement of the scientific validity of the linear hypothesis. Indeed, we recognize that assumption of this hypothesis deviates from the approach generally used in toxicology. We, nevertheless, accept the linear hypothesis, for purposes of this rule-making and at least until such time as an alternate hypothesis can be scientifically substantiated, because we firmly believe that it is prudent to assume a model that is likely to establish the maximum level of risk to the population. We believe that the actual risk associated with any small dose probably falls somewhere between zero and the level defined by the linear hypothesis.

C. Estimates of Risk from Radiation

If radiation effects are to be understood in proper perspective, it is important to remember that people are continually exposed to radiation from several natural sources. These sources include: cosmic radiation from outer space, radiation from natural sources in the ground and in the air, and radiation from within their bodies that has as its source the natural radioactivity in water and foods. The contribution from each of these sources varies, depending upon such factors as altitude, geographic location, personal habits of individual persons, and diet. Within the United States the average yearly exposure from all such natural sources is about 125 millirads. To this "background" (and inescapable) exposure the radiation dose from other human activities - principally that from medical x-rays - must be added. The average annual dose from medical x-rays in the United States is estimated to be approximately 150 millirads to the bone marrow and 90 millirads to the gonads.[1/] Accordingly, radiation exposure from human activities, coupled with that from natural sources, results in an average annual exposure to individuals in this country from all sources of approximately 300 millirads.[1/]

It is, of course, well known that exposure to very high levels of radiation produces biological effects that can be detected both in animals or in persons exposed (somatic effects) as well as in their off-spring (genetic effects).

Dr. Leonard A. Sagan[1/] and Dr. Dean A. Parker[2/] testified on behalf of the AEC Staff on the somatic and genetic risks, respectively, associated with low level radiation to population groups in the population dose ranges

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1/ ALAP AEC Exhibit 2, "Statement on the Somatic Effects of Ionizing Radiation," Leonard E. Sagan, Jan. 12, 1972.

2/ ALAP AEC Exhibit 3, "Statement on Genetic Effects of Ionizing Radiation," Dean R. Parker, Jan. 7, 1972.

estimated for Appendix I. Both stressed the absence of any scientific evidence of biological effect at these dose levels and both emphasized that their estimates were extrapolations from observed effects at dose levels many orders of magnitude higher. Both also stressed that their calculations were based on the conservative linear hypothesis that biological effects were linearly proportional to the dose received and were independent of dose rate.

On this basis Dr. Sagan concluded:

"For each one million people exposed to 1 millirad a maximum of 0.14 cases of cancer would occur during the lifetime of the exposed population,[2/] in addition to those which would normally be expected in a population exposed only to natural background radiation (about 250,000).

It is emphasized that the estimates discussed above are upper estimates based on highly conservative hypothesis. The true value for increase in incidence of cancer at these very low dose levels lies somewhere between zero and these upper estimates."

Similarly, Dr. Parker[1/] estimated the possible increase in congenital diseases associated with low level exposures to large population groups. Assuming 4 million live births per year in the United States, he concluded:

"With no added exposure, above natural background, the annual rate would be 240,000 ($6.0 \times 10^{-2} \times 4.0 \times 10^{6}$). After a single generation of exposure of the total population to an extra 1 mrem per year, this number would increase to nearly 240,002, and when equilibrium is

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[1/] ALAP AEC Exhibit 3, "Statement on Genetic Effects of Ionizing Radiation," Dean R. Parker, Jan. 7, 1972.

[2/] Application of the linear hypothesis would yield the result that exposure of 1 million people each to 1 millirad per year would cause an additional

reached after some 10-20 generations of exposure the incidence would plateau at about 240,016 ($6.0004 \times 10^{-2} \times 4.0 \times 10^{6}$).

I wish to temper this estimate by again stating that it is based on the assumption that linear extrapolation to low doses will truly predict genetic effects. The existence of dose-rate effects and other evidences of repair of premutational damage do not lend credibility to the supposition."

Both Dr. Sagan[1/] and Dr. Parker[2/] testified that if the average population dose were to be assumed to be 0.1 millirad or millirem, their calculation of biological effects would be lower by a factor of ten.

The State of Minnesota both in cross-examination of Dr. Sagan[3/] and in the direct testimony of Dr. Arthur Tamplin[4/] contradicted Dr. Sagan's position that effects on humans were observed only at dosages considerably higher than the radiation protection guidelines of 500 mm/year. Dr. Tamplin, primarily on the basis of publications of Stewart[5,6/] and MacMahon[7/] indicating an increase in childhood cancer and leukemia following in utero irradiation, presented evidence that effects on humans have been observed at dosage levels at or below the previous 500 millirem/year guideline dosage.

1/ Hearing Transcript, p. 1061.

2/ Hearing Transcript, pp. 1064-65.

3/ Hearing Transcript, pp 453-57.

4/ ALAP Minnesota Exhibit ?, Testimony of Arthur R. Tamplin.

5/ Stewart, A., and G. W. Kneal, The Lancet 1, 1185-1187 (1970).

6/ Steward, A., J. Webb, and D. Hewitt, Brit. Med. J. 1, 1495-1508 (1958).

7/ MacMahon, B., J. Natl. Cancer Inst., 28, 1173-1191 (1967).

In its Final Statement,[1] The State of Minnesota, relying upon the BEIR Report,[2] indicated risks differing slightly from those presented by Drs. Sagan and Parker. For example, Minnesota quotes:[3]

> "Such calculations based on these data from irradiated humans lead to the prediction that additional exposure of the U.S. population of 5 rem per 30 years could cause from roughly 3,000 to 15,000 cancer deaths annually, depending on the assumptions used in the calculations. The Committee considers the most likely estimate to be approximately 6,000 cancer deaths annually, an increase of about 2% in the spontaneous cancer death rate which is an increase of about 0.3% in the overall death rate from all causes."

And, in addition[4]

> "A major concern of the Subcommittee is the possible existence of a class of radiation-induced genetic damage that has been left out of the estimates. By relying so heavily on experimental data in the mouse we may have overlooked important effects that are not readily detected in mice, or the mouse may not be a proper laboratory model for the study of man."

It should be noted that the BEIR Report's "most likely estimate" of 6,000 additional cancer deaths annually per 200 million people exposed to 5 rem per 30 years is equivalent to 0.176 additional cancer deaths annually per million people exposed to 1 millirem per year; this figure agrees closely with Dr. Dagan's estimate of 0.14 additional annual cancer deaths per million people exposed to 1 millirad per year quoted above.

1/ Final Statement of Position of The State of Minnesota, Feb. 1, 1974, pp. 5-8.

2/ NAS-NRC, The Effects on Populations of Exposure to Low Levels of Ionizing Radiation (The BEIR Report), Report of the Advisory Committee on the Biological Effects of Ionizing Radiation, November, 1972.

3/ NAS-NRC, ibid, p. 2.

Some testimony[1] presented for National Intervenors, Incorporated (NI) gave a slightly different estimate of the risk to the population from low levels of radiation. In this testimony Dr. Edward P. Radford stated:

"On the assumption of the linear dose-response hypothesis a continuous exposure to 1 mrem/yr would on the other hand increase the cancer risk by only 0.004% to 0.02%, a risk which I believe any reasonable person would conclude to be sufficiently small to be considered negligible. The new proposed standards attempt to reach a level of risk which is still acceptable and yet not so unnecessarily restrictive as 1 mrem/yr would be.

Given this order of risk, the decision of the figure to adopt for acceptable levels of exposure to man becomes a matter of judgement. In my opinion the proposal of a whole body dose of 5 mrem per year is quite acceptable, and indeed may be too restrictive, if only because it will be difficult to monitor effluents at levels consistent with this low exposure rate."

Dr. Radford's testimony, both written and under cross examination[2,3] made clear, however, his personal[3] concern that present radiation protection standards may be too lenient: Dr. Radford stated:[1]

"From the most recent evidence of cancer risk to man, I consider that a continuous lifetime dose of 500 mrem per year would increase the risk of cancer by 2 to 10%, in my opinion an unacceptable risk to an individual not directly benefitting from the source of the risk."

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[1] ALAP NI Exhibit 3, Testimony for U.S. Atomic Energy Commission Hearings on Standards for Release of Radionuclides to the Environment from Nuclear Facilities.

[2] Hearing Record, pp. 2067-2068.

[3] Hearing Transcript, p. 2090.

It is clear from the record[1,2] that the numbers quoted immediately above are Dr. Radfords' own estimates[3] derived through his participation in preparation of the BEIR report whose conclusions (and the similarity of these conclusions to those of the Regulatory Staff witnesses) were briefly summarized above. It is also clear[3] that the phrase "new evidence" is intended to mean reworking and improved modeling of data already in the published literature, and that Dr. Radford's estimates do not differ substantially from those of Dr. Sagan and of the BEIR report.

Other testimony presented for National Intervenors[4] seemed to indicate considerably higher risks to the population from low levels of radiation. Dr. Sternglass asserts[4,5]

> "As will be shown below, all the recent statistical studies on large human populations carried out by a number of independent investigators not connected with any government agencies lead to approximately the same conclusion, namely that an additional dose of only 1 millirad per year from fission products in the environment or 1% of normal background radiation, leads to about a 1/4% of 1% increase in mortality rates both for the newborn and the total population."

and further,[4]

> "In effect, the data as summarized below suggest that the radioactive material created in the course of nuclear operations are somewhat more toxic than the radioactive elements normally found in our environment, since the typical background radiation of close to 100 mr per year is believed to be responsible for only some 5-20% of all chronic diseases,

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1/ Hearing Transcript, 2064.

2/ Hearing Transcript, 2090.

3/ Hearing Transcript, 2096-99.

4/ ALAP NI Exhibit No. 2. Summary of Testimony by Dr. Ernest J. Sternglass, March 17, 1972.

5/ Hearing Transcript, 1913-1919.

cancers and genetic defects, while the radioactive materials created in the course of nuclear operations seem to lead to a 25% to 100% increase in mortality for a similar annual dose of 100 millirad."

Again the record indicates strong disagreement with the conclusions of this testimony. Rebuttal witnesses[1,2,3/] seem to us to present and sustain the position that there are serious shortcomings in the statistical methods, the choice of data, and the interpretations indicated in this testimony. While we are aware that, as Dr. Sternglass and others point out, the developing embryo and the young are more sensitive to radiation than is the adult population, we are unable to give weight to the risk estimates provided by Dr. Sternglass.

Mr. Andrew P. Hull, a limited participant, also presented written testimony[4/] as to radiation risks. His calculations suggested that exposure of 2 million people to 1 millirem per year would produce a mortality rate of 0.2 per year and contrasted this value with the value of 400 per year from natural disasters.

In its Final Environmental Statement[5/] the AEC Staff based its estimates of the upper limit of biological risk on the BEIR report rather than on the testimony of Drs. Sagan and Parker noted above. However, the conclusions of the BEIR report are not, as suggested in the preceding paragraphs, substantially different from those of Drs. Sagan and Parker.

1/ ALAP Regulatory Staff Exhibit 15 Rebuttal Testimony Concerning the Direct Testimony of Dr. Ernest J. Sternglass, Dr. Marvin Goldman.

2/ ALAP Regulatory Staff Exhibit 14 Rebuttal Testimony Concerning the Direct Testimony of Dr. Ernest J. Sternglass, Dr. Edythalina Thompkins.

3/ ALAP G.E. Exhibit 2 Rebuttal Testimony, Dr. Richard I. Post, April 28, 1972.

4/ Final Statement of Position, Andrew P. Hull, Jan. 20, 1974.

5/ ALAP Final Environmental Statement, Wash-1258, July 1973, Vol 1, p

It is apparent that, although there are disagreements regarding the degree of conservatism in the calculations, and although the State of Minnesota warns[1/] "Prudent public health practice requires the upper limit estimate of effects in The BEIR Report to be used when setting standards and regulations," there seems to be a gratifying consensus as to the magnitude of the risks to the population from small levels of radiation.

Moreover, it seems to be very unlikely that effluents from light-water-cooled nuclear power plants will in the foreseeable future, if ever, expose the population at large to dosage levels as high as 1 millirem per year. Mr. Rogers and Dr. Gamertsfelder have stated[2/] that, assuming a 500 millirem per year dose from noble gases to the most exposed individual at the boundary,

> "[u]sing realistic population distributions and wind direction frequencies for 11 different power reactor sites, the theoretical average population dose rate for the whole population included within a circle with a radius of 50 miles of these plants would be approximately 1 millirem per year."

Thus, in terms of Appendix I's much lower dose objective to the "worst case" individual, the average annual dose from noble gases to the general population within 50 miles would be less than 0.05 millirem.

1/ Final Statement of Position of The State of Minnesota, Feb. 1, 1974, p 7.

2/ ALAP AEC Staff Exhibit 11, L. Rogers and C. Gamertsfelder, U.S.A. Regulations for the Control of Releases of Radioactivity into the Environment in Effluents from Nuclear Facilities 133 (1970).

Testimony by witnesses for the Utility group generally confirm that population doses from gaseous effluents would be in the range suggested by Mr. Rogers and Dr. Gamertsfelder. Dr. Walton A. Rodger's calculatinns,[1/] showed that for noble gases assuming 5 millirem to the worst case individually at the boundary, the average annual dose to the general population within 50 miles would be 0.02 millirem.

Dr. Morton I. Goldman's[2/] treatment of general population dose from gaseous effluents show that for over fifty plants evaluated, plant contributions to dose to the general population within 50 miles would average about 0.01 percent of background doses within the same region, and would correspond to a general population dose of about 0.01-0.014 millirem per year due to gaseous effluents.

As to contributions to general population dose from liquid effluent sources, Dr. Gamertsfelder in his written testimony[3/] and in his summary of that testimony[4/] estimated that the average annual dose to populations using drinking water from the natural bodies of water into which the effluents of currently operating reactors flow is less than 0.01 millirem. Dr. Gamertsfelder added that since populations near some reactors presently planned or under construction will be higher than the populations around existing

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1/ Statement of Position by Consolidated Utility Group, Jan. 19, 1974, p 22.

2/ ALAP UG-TI, Statement by Morton I. Goldman on Behalf of Consolidated Utilities Group, March 17, 1972, p 17.

3/ ALAP AEC Staff Exhibit 3,

4/ Hearing Transcript, pp 39-40.

plants, the total population dose could be higher than 0.01 millirem, provided these larger populations actually obtain their drinking water from the water bodies into which liquid effluents flow. Even for any planned sites where the general population doses from liquid effluents might be higher than 0.01 millirem, Dr. Gamertsfelder stated: "[i]t is not expected that the average annual whole body dose to individuals in a large population would be any larger than about 0.1 millirem for individual reactors operated within the proposed design objectives."

From the foregoing it seems clear that operation of light-water-cooled nuclear power plants - even in very substantial numbers - under the Appendix I guide lines should not expose the population to levels as high as 0.1 millirem per year. That fact when coupled with the risk estimates detailed above should lead to a very small (though not completely negligible), risk to the public health and safety.

BASIS FOR DESIGN OBJECTIVE VALUES

A. Dosage Limits or Dosage Plus Quantity Limits

The AEC Regulatory Staff originally contended that, although dosage levels to off-site individuals were the basic criteria for the design objectives, such dosage levels should be limited by specifying limitations on quantities and concentrations of radioactive materials in effluents from light-water-cooled nuclear power plants.[1/] For example, it was stated[2/]

> "As explained in the preamble to the Notice of Proposed Rule Making the design objectives are expressed in the proposed guide as limitations on quantities and concentrations of radioactive material in effluents. The power reactor and associated waste treatment equipment would be designed to make it unlikely that the specified quantities or concentrations would be exceeded during normal operation, including anticipated unusual occurrences. The specified quantities and concentrations would generally limit exposures to members of the public living near the site boundary to about 5 millirems per year from radioactive material in liquid effluents and about 5 millirems per year from radioactive material in gaseous effluents. As a practical matter it is not likely that a given individual would be exposed to both liquid effluents and gaseous effluents at a level approaching 5 millirems per year from each source."

and, further:[3,4/]

> "The basic criteria for the design objectives are the limiting dose of 5 millirems per year to individuals offsite from radioactive material

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1/ ALAP AEC Regulatory Staff Exhibit No. 1, Tab 1, pp. 13-19.

2/ Reference 1, this page, p. 13.

3/ ALAP AEC Regulatory Staff Exhibit No. 1, Tab 1, p. 14.

4/ Hearing Transcript pp 25-26.

in liquid effluents and 5 millirems per year to individuals offsite from radioactive material in gaseous effluents. The specified quantities and concentrations are substantially more conservative than would be required to meet these dose limiting criteria for many sites."

During, and as a consequence of, the Hearing the Regulatory Staff modified its position. The version of Appendix I presented in the Staff's Concluding Statement[1] no longer specified concentration limits on tritium and other radioactive materials released to the environment but did inlcude -- in addition to limitations to the dose to any individual in an unrestricted area -- limits upon the quantity of radioactive material (except tritium and dissolved gases) in liquid effluents and upon the quantity of iodine which could be released.

The Staff position that both offsite dose and quantity limitations should be required is clearly intended to remove the possibility that future land use patterns in the neighborhood of reactor sites might be prejudiced. The Staff states:[2]

"Basically at issue here is the extent to which site-released parameters should dictate design objectives and the nature of the assumptions that should be used with respect to those parameters, such as the present and future uses of the environment."

and:[3,4]

"It is the Staff's position, for example, that for purposes of design objectives for nuclear power reactors it is inadequate to base parameters only on uses of the environment as of the time the reactor is designed

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[1] Hearing Transcript pp 25-26.

[2] Concluding Statement of Position of the Regulatory Staff, Feb. 20, 1974, p 50.

[3] Ibid., p. 52.

[4] See also Hearing Transcript, pp 343-344.

and constructed. Rather, future uses of the environment should be taken into account and those uses not foreclosed by installing inadequate waste treatment systems based on offsite dose calculations that take into account only present uses of the environment."

and, further:[1/]

"If design objectives are based on estimates of individual doses offsite alone, failure to assume in models future uses of the environment could, for some particular sites where the site environs are not being used at time of construction of the reactor, result in designs of radwaste systems that do not use even the rudimentary, readily available technology to reduce releases so that large quantities of radionuclides could be released. As future uses of the site environs develop, backfitting might well be required to meet the dose objectives."

The General Electric Company (GE) argued consistently throughout the hearing[2,3,4,5] that specification of quantities and concentrations of emitted radioactive materials is unnecessary in light of the primacy of the dose criteria and is, furthermore, undesirable for several reasons. On this aspect of the original Appendix I, Mr. Smith testified[3/] as follows on behalf of the General Electric Company:

"The General Electric Company feels that Sections II-A and B of Proposed Appendix I, the sections containing the emission quantity and concentration guides, should be eliminated. Failing that, these quantity and concentra-

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1/ Concluding Statement of Position of the Regulatory Staff, Feb. 20, 1974, p. 53.
2/ ALAP GE Exhibit No. 1, March 17, 1972, pp 7-13.
3/ Hearing Transcript, pp 1435-36.
4/ Closing Statement of the General Electric Company, Jan. 21, 1974, p 13.
5/ Reply Statement of the General Electric Company, March 14, 1974, pp 43-48.

tion guides should at least be removed from their present position of prominence in Appendix I.

"We believe these changes are desirable, since first the quantity and concentration guides lack independent significance. They do not protect any public interest in their own right, but are merely offered as a shortcut means of demonstrating compliance with the dose objectives of Section II-C.

"Second, the quantity and concentration guides do not perform their intended function. That is, they do not provide any significant savings of calculational effort.

"Thirdly, if applied, the guides of Section II-A and B would lead to costly overdesign of nuclear power plant effluent treatment systems.

"And fourth, although they are intended to provide merely one alternative method of satisfying Appendix I, inclusion of the quantity and concentration guides is affirmatively undesirable, especially if they retain their present position of prominence. These guides will lead to substantial misunderstanding and confusion regarding compliance with effluent emission criteria. This confusion will inevitably adversely affect public acceptance of nuclear facilities, and it will distort the evaluation of plant applications during licensing."

GE continues to urge[1,2] that the remaining quantity limits be eliminated from Appendix I. They argue,[2] in the case of the limit upon radioactive materials in liquid effluents:

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[1] Closing Statement of the General Electric Company, Jan. 21, 1974, p 13.

[2] Reply Statement of the General Electric Company, March 14, 1974, pp 43-48

"....these limits are directed toward matters of completely subsidiary importance -- the absolute level of plant emissions -- rather than to the parameters of basic concern -- the levels of human radiation exposure resulting from LWR effluent releases and the measures appropriate to minimize these exposures. By imposing quantity limits in addition to the basis dose objectives, and applying "whichever [provision] is more restrictive" (Staff Concluding Statement, p. 55), the Staff's new recommendations jeopardize the advantages that the dose formulation would otherwise provide -- namely, an ALAP regulation that is fitted to the particular characteristics of individual plants and sites and that encourages the applicant's choice of a favorable site.

Second, the proposed quantity limits are ill-chosen in view of the Staff's underlying concerns. The stated basis for the 5 curie per year liquid effluent limit, as indicated in the Staff's Concluding Statement (pages 55-56), is the concern that releases satisfying the fundamental dose-limiting objective may nevertheless cause an undesirable long-term build-up of radionuclides in some circumstances. No such concern can justify the 5 curie limit, however, since there is no evidence in the ALAP record to indicate that any significant long-term build-up of radionuclides can occur as a result of LWR liquid releases."

and, with regard to the limit on quantity of radioiodine to be released, they stated:[1/]

"Likewise, the concern underlying the Staff's new 1 curie per year limit on I-131 releases seems to be a belief that, if limited only by a dose objective for radioiodine emissions, licensees will build and operate

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1/ Reply Statement of the General Electric Company, March 17, 1974, p 46.

reactors that 'do not use even the rudimentary, readily available technology to reduce releases' and consequently will 'release large quantities of [radio]iodine simply on the basis that no cows are located within many miles of the reactor at the time of construction.' The ALAP record, however, demonstrates that such an eventuality is not a realistic possibility with regard to BWR's."

The Consolidated Utilities Group (CU) also argued consistently that quantity and concentration limits be omitted from Appendix I. In its Concluding Statement[1/] CU argues as follows:

"Although there was uniform support for the belief that dose is and should be the primary basis for numerical guidance on the "as low as practicable" concept, there was also recognition of the administrative difficulty associated with practical application of the dose objective, since at the range of very small exposure levels contemplated under Appendix I, it is generally agreed that most doses are not subject to accurate measurement with presently available techniques and equipment. Consequently, from the standpoint of measurement and control, we have no quarrel with the principle that limits must be set on releases from specific nuclear power plants.

The important issue is therefore not whether the Commission should establish limits on radioactive effluents for inclusion in individual plant operating licenses, but how those limits are to be established. One approach, which we believe to be wrong, is to standardize effluent limits at a level which for most, if not all, plants would assure compliance with

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1/ Statement of Position by the Consolidated Utility Group, Jan. 19, 1974, pp 51-52.

Staff's sudden proposal that a 5 curie limit be superimposed on the 5 mrem dose objective as a limit in its own right."

And in its discussion of the limit on release of ^{131}I from each reactor, CU argues:[1]

"The Staff further proposes an over-ride limit on I-131 which can be released from each reactor of one curie per year. The proposal is new and has no foundation in the record of the proceeding. The Staff justification for adding this limit is in essence that there could be reactor sites so remotely located that the measures required to meet Appendix I dose objectives for the nearest individuals could be so minimal as not not to include even those augments which can be justified on the basis of total population dose reduction. As a practical matter we believe there will be very few sites at which this condition could occur."

The propriety of this emphasis on dose was strongly supported by Dr. Taylor, testifying[2,3] on behalf of NCRP, by Dr. Eisenbud,[4] who made a limited appearance on behalf of the Atomic Industrial Forum and by R. M. Hartman,[5] who made a limited appearance on behalf of Ebasco Services, Incorporated. The National Intervenors endorsed this position; Dr. Radford[6] stated that:

"The concept proposed by the Atomic Energy Commission that the standard should indicate an acceptable millirem dose per year... is superior to the idea of maximum permissible concentrations, formerly applied by the Atomic Energy Commission."

1/ Reply of Consolidated Utility Group to Concluding Statement of Regulatory Staff, March 7, 1974, p 13.

2/ Hearing Transcript, pp 1737-38.

3/ Hearing Transcript, pp 2055-56.

4/ Hearing Transcript, p 88.

5/ Hearing Transcript pp 109-116.

6/ ALAP National Intervenors Exhibit 2, p 2

In addition, limited participant Andrew P. Hull said in his final statement:[1/]

> "Furthermore, considering the highly variable nature of nuclear reactor sites, I believe that the specification of release and concentration limits, over and above an overall exposure limit, is also unwarranted and in many if not most cases would lead to significant expenditures for protection against non-existent or completely inconsequential risks."

On the other hand, the State of Minnesota has consistently argued[2,3,4/] that quantities and concentrations of radioactive material released should be minimized. Although it is clear that Minnesota's intent is the protection of individuals and especially those near nuclear facilities, the language recommended in its Final Statement[5/] suggests that Minnesota would give primary attention to quantities and concentrations of radioactive materials released.

We, the Atomic Energy Commission, certainly agree with the overwhelming preponderance of evidence upon the record that the primary purpose of Appendix I is the protection of the public from radiation dosages resulting from radioactive materials in effluents from light-water-cooled nuclear power plants. We further agree that Appendix I should be written to make clear the primacy of controlling such dosages. We agree that the Regulatory Staff was correct in removing the concentration limits for radioactive materials in liquid effluents from light-water-cooled nuclear power reactors from its version of recommended Appendix I.[6/] Whether limits upon quantities of radioactive materials to be released should be specified in addition to limits upon doses to people is a more complex qustion.

1/Final Statement of Position, Andrew P. Hull (limited Participant) Feb. 11, 1974, p 4.
2/Hearing Transcript pp 1778-1779.
3/Final Statement of Position of State of Minnesota, Feb. 1, 1974.
4/Final Argument Hearing Transcript pp 159-160.
5/Final Statement of position of the State of Minnesota, Feb. 1, 1974, pp 21-22.
6/Concluding Statement of position of the Regulatory Staff, Feb. 20, 1974, pp 11 and 26-27.

It is obvious that, especially at the low levels of Appendix I, many of the doses are not in themselves subject to accurate measurement with existing techniques and equipment. Consequently, the quantities and concentrations as well as the identities of the radioactive materials released must be measured, and the doses must be inferred by calculations from these data. This is, of course, a basis for argument for inclusion of limits upon such quantities in the rule. We are not, moreover, impressed with some of the arguments against inclusion of such limits. We are, for example, not persuaded of GE's claim[1/] that:

> "These guides [that is those containing quantity limits] will lead to substantial misunderstanding and confusion regarding compliance with effluent emission criteria."

We do find persuasive, however, the arguments advanced by GE[2/] and C[3/] that imposition of quantity limits of the magnitude proposed by the Regulatory Staff could jeopardize the advantages that the dose limitation would otherwise provide (namely a regulation that is fitted to the particular characteristics of individual plants and sites and that encourages the applicants choice of a favorable site). It is clear that the Regulatory Staff in stating[4/] about an earlier formulation of the rule

> "The specified quantities and concentrations are substantially more conservative than would be required to meet these dose limiting criteria for many sites."

recognize some validity to this argument. We have, accordingly, adopted an

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1/ Reference 3, page 27.

2/ Reference 2, page 28.

3/ Reference 1, page 30,

4/ References 3 and 4, page 25 of this Statement .

Appendix I that does not specify quantity or concentration limits for the effluents from light-water-cooled nuclear power plants. We expect, as recommended by CU,[1/] that limits on quantities of radioactive materials, other than tritium and dissolved gases in liquid effluents, would be incorporated in the technical specifications of the individual plant operating license.

Though we do not include quantity limits in Appendix I, we do agree with the Regulatory Staff argument that "it is inadequate to base parameters only on uses of the environment as of the time the reactor is designed and constructed." We certainly wish to assure that the rule cannot result in approval of "designs of radwaste systems that do not use even the rudimentary, readily available technology to reduce release ---." We do not believe that the nuclear industry has intentions of doing this, and we note that both GE and CU declare that nothing of the sort will be done. We consider it obvious, however, that our responsibilities to the people cannot be satisfied by an Appendix I that depends upon the continuing good will and good intentions of any other party. Accordingly, although we have not included quantity limits, we believe - as described in detail in a subsequent section - we have by another and more justifiable mechanism obtained the necessary protection for potential future uses of the environs.

[1/] Reference 1, page 30 of this Statement.

B. Individual vs Population Dose

The Consolidated Utility Group (CU) holds that the controlling consideration in establishing numerical dose objectives should be population rather than individual radiation exposures. In its Statement of Position[1/] CU states:

"2. The controlling consideration in establishing numerical dose objectives should be population rather than individual radiation exposures. At dose levels below accepted radiation standards, the levels of risk to individuals are negligibly small. Statistically significant risks can be calculated only for large population groups. For regulatory simplicity it may be desirable that Appendix I continue to express its design objectives in terms of off-site individuals. However, the choice of the individual dose objective, and of the individual to whom it applies, should reflect the paramount importance of the population dose objective and should not be more stringent than can be justified on a cost-benefit basis in terms of population dose reduction."

In spite of this contention CU, apparently for the sake of "regulatory simplicity," in its Statement of Position states its recommendations on design objectives in terms of dosage to individuals. CU would,however, make the individual dosage compatible with a primary population dose objective and would specify an individual other than the one "maximally exposed" for

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1/ Statement of Position by the Consolidated Utility Group, Jan. 19, 1974, p. 9.

the dosage calculation. To that end they state:[1,2]

> "We believe that if an individual dose is to be used, the proper approach is to consider first a population dose objective which can reasonably be justified as "practicable" on a cost-benefit basis and then to determine a compatible individual dose objective. The selection of an extremely low individual dose objective as an end in itself, without reference to population dose effects, cannot we believe be justified. It is even less justifiable when the individual chosen for dose estimating is one whose living and recreational habits, including food and water consumption, are wholly unrepresentative of the population group in the general vicinity of the plant."

and, in addition:

> "3. Dose Assumptions. In addition to requiring that realistic assumptions be used for individual dose calculations, Appendix I should specify that the individual selected for dose calculation be one whose living and recreational habits, including the source and quantity of his water and food consumption, are representative of a significant number of individuals living in the general vicinity of the plant."

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[1] Statement of Position by the Consolidated Utilities Group, Jan. 19, 1974, pp. 26-27.

[2] Ibid., p 69.

Limited Participant, Andrew P. Hull also favored primary consideration to total population dose and subordination of individual dose limits to that limit. In his concluding statement Dr. Hull states:[1/]

> "In my judgment, the available biological data do not justify going beyond the specification of an overall population limit. Since the benefit of a nuclear power plant is the amount of electricity generated, this population dose limit ought to be specified with relation to plant capacity rather than on a per plant basis. A logical scheme for such a limit was suggested in an earlier critique of Appendix I (Hull-1972). It was based on a proposed design guide of 2 man-rem per year per megawatt of installed electrical capacity. This would lead to an integrated dose of 2,000 man-rem for a typical 1000 MW(e) plant. At a risk level of 2×10^{-4} per man-rem, this would lead to an estimated risk of less than one additional cancer case per year per 1000 MW(e) plant. If the Regulatory Staff estimate that a 5 mrem/yr "boundary" limit would lead to 400 man-rems per year is accepted, then a boundary limit of 25 mrem/yr would be consistent with the proposed 2,000 man-rem population limit."

Ebasco Services Incorporated, as a limited participant, also argued that population dose should be recognized as an important factor in decisions regarding Appendix I. Mr. R. M. Hartman stated for Ebasco that, in his opinion, AEC had gone too far in details for implementing the dose limit to the nearest offsite individual and not far enough in considering the dose to a sizeable nearby population group. Mr. Hartman suggested:[2]

1/ Final Statement of Position, Andrew P. Hull (Limited Participant) Feb. 11,1974, p 4.

2/ Hearing Transcript, p 111.

"To consider population dose more specifically than the current appendix, we believe that the applicant should additionally be requested to realistically calculate man-rems to the population from plant releases in a 25-mile perimeter of the plant. Lower release quantities or concentrations (as derived from consideration of dose to the nearest off-site individual) would be necessary if it appears that such releases would result in greater than 0.1 man-rems/yr per MWT reactor power level during normal operation."[1/]

General Electric (G.E.), on the other hand, would specify the numerical guides for the nearest neighbors. In its Closing Statement GE affirms:[2/]

> "1. Dose Objectives. The ALAP numerical guides should be established in terms of dose-limiting objectives for the nearest neighbors of light-water reactors and should equal one percent of the present Federal Radiation Council Guides for the whole body and each body organ. Specifically, the objectives should be 5 millirems per year for the total body, 15 millirems per year for the thyroid and 30 millirems per year for the skin."

[1/] Hearing Transcript p, 114.

[2/] Closing Statement of the General Electric Company, Jan. 21, 1974, p. 13.

The State of Minnesota clearly supports the position that individual dosage levels and not the average doses to a large population should be the controlling factors. In this connection, Minnesota quotes[1] from the Federal Radiation Council[2]

"Especially, it is noted that the use of the average figure, as a substitute for evidence concerning the dose to individuals, is permissible only when there is a probability of appreciable homogeneity concerning the distribution of the dose within the population included in the average."

and states:[1]

"The important point here is that, in keeping with the American tradition of the importance of the individual, no one (and one might add no one's off-spring) should be required to assume a disproportionate amount of the risk."

The AEC Regulatory Staff has taken the position that, while average population exposure is important and should be minimized, primary attention must be given to limitations upon dose to individuals living in close proximity to the reactor site.[3] The records shows that this position has not substantially changed throughout the hearing. In Oral Argument, Mr. Rogers stated[4] for the Regulatory Staff

"I think the primary objective of the regulation is, number one, to reduce the exposures and the risk to individuals, actual individuals that exist at the present time near the site, to as low as practicable levels."

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[1] Final Statement of Position of the State of Minnesota, Feb.1, 1974, pp. 12-13.

[2] FRC, Background Material for the Development of Radiation Protection Standards, Report No. 1, May 13, 1960, p. 27.

[3] See, for example, AEC Staff Exhibit No. 1, Tab 1, Jan. 7, 1972 and, AEC

and, in its Concluding Statement the Staff noted[1/]

"The individual living near the power plant is most concerned about the risk to himself and his family, not the average exposure to the general population."[1/]

The Staff has further indicated that exposures to potential future users of the environs of nuclear reactor facilities must be considered. Mr. Rogers stated[2 3/]

"At the same time I think you must take into account the exposure to potential individuals, and by that I mean future users of the environment. I don't think that you can assume that the environment is not going to change and is not going to be used in the future; and I think that the proper approach is to base design objectives and limiting conditions of operation on the basis that the environment will be used in the future."

We, the Atomic Energy Commission, agree with the Regulatory Staff's position that, though the population dose is important and should be minimized, the primary thrust of Appendix I should be protection of those individuals who live near the light-water-cooled nuclear power plant facility. It seems quite clear that if such "maximally exposed" individuals are suitably protected dosage levels to the public at large will be very low.[4/] We further agree, as stated above[5/] with the Regulatory Staff position that account must be taken of potential near neighbors of the facility and that future users of the immediate reactor environs should not be prejudiced by emissions from the reactor facility.

[1/] Concluding Statement of Position of The Regulatory Staff, Feb. 20, 1974, pp 47-48.

[2/] Oral Argument Transcript, p 23-24.

[3/] ALAP Regulatory Staff Exhibit 1, Tab 1, p 14.

[4/] See Section C, Estimate of Risk from Radiation p. 15. above.

[5/] See page of this Statement.

C. Direct Gamma Radiation from Nuclear Power Reactor and Associated Equipment

The State of Minnesota takes the position that Appendix I boundary dose calculations should specifically include the contributions from "gamma shine".[1/] Consolidated National Intervenors[2/] also raised this point concerning radiation other than that from radioactive materials in effluents from light-water-cooled nuclear power reactors. An early position of the Environmental Protection Agency (EPA)[3/] also included the suggestion that direct gamma radiation should be considered; EPA apparently no longer holds this view since it states:[4/]

> "We recognize that the scope of the present rulemaking is limited to material effluents, and that for this reason did not address the issue of direct and indirect gamma radiation from onsite locations. We suggest the Commission deal with this category of exposure through early issuance of limiting criteria for doses to such radiation."

Experience to date has shown that the highest radiation dose rate at the site boundary is generally less than 10 millirems per year from this source and that, since this dose rate decreases rapidly to negligible levels with distance from the site boundary, this source contributes only a fraction of a man-rem per year to the population dose.[5/]

This Hearing has been concerned from the beginning with keeping "as low as practicable" the risks to the public from radioactive materials in effluents from light-water-cooled power reactors. Moreover, as the Regulatory Staff

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1/ Final Statement of Position of the State of Minnesota, Chapter II E, Part 3, Feb. 1, 1974.

2/ Anthony Roisman to Mr. Algie Wells, et al., Feb. 15, 1972, p 6.

3/ Final Environmental Statement, Wash. 1258, July 1973, Vol. 3, pp 263-264.

4/ W. D. Rowe, PhD to Mr. L.Manning Muntzing, Received March 12, 1974, p 3.

5/ Concluding Statement of Position of the Regulatory Staff, Feb. 20, 1974, p. 65.

testified[1/] proposed Appendix I was not intended to include direct radiation from the nuclear facility.

We, the Atomic Energy Commission, agree completely that such direct or scattered gamma radiation from the turbine building and from waste storage tanks and other equipment containing radioactive material should continue to be taken into account in the licensing process and should be carefully controlled by proper design and operation of the reactor and associated equipment. It may be appropriate to issue further guidance on levels "as low as practicable" from this radiation source, but such guidance should clearly be separate from Appendix I.

D. Occupational Radiation Exposure

The Consolidated Utility Group (CU), the American Industrial Forum (AIF), and to a lesser extent the General Electric Company, show concern about the possible effect of proposed Appendix I on occupational exposure. The AIF in its comments on the Draft Environmental Statement says:[2/]

> "Another area where the Draft Environmental Statement appears to be particularly negligent is in its lack of consideration of occupational radiological exposures and potential increases in these exposures with implementation of proposed Appendix I. We feel that increases in exposures to on site personnel could be substantial with the additional holdup and storage of radioactive materials in conjunction with meeting provisions of proposed Appendix I."

1/ Hearing Transcript, pp 595-598.

2/ Final Environmental Statement, Wash-1258, July 1973, Vol. 3, p 98.

In its closing position statement,[1] CU concludes that:

"There is a serious danger that the reduction in off site doses sought to be accomplished by proposed Appendix I will be more than offset by an increase in occupational exposure."

The General Electric Company closing statement,[2] in objecting to equipment required as a result of "farfetched assumptions," comments:

"Such equipment could, in fact, produce a net increase in the exposure of the human gene pool to radiation by increasing the doses to the employees of the LWR facility."

These positions of CU and GE seem to be based to a substantial extent on the testimony of Dr. Morton I. Goldman[3,4] concerning likely increases in occupational exposure due to augments to radwaste systems and of the relative importance of such radiation exposure compared to radiation exposure to the population. In his testimony Dr. Goldman asserts[5] "Thus the International Commission for Radiation Protection considers that the occupational population dose may be about 10 times as significant as that to the general public"... and Dr. Goldman seems to base much of the thrust of his testimony on his belief that such is the case. Dr. Goldman gives as the basis for his view an excerpt from a publication[6] of the International Commission Radiation Protection.

1/ Statement of Position by the Consolidated Utility Group," Docket No. RM-50-2, Jan. 19, 1974, p 17.

2/ Closing Statement of the General Electric Company, Docket No. RM-50-2, Jan. 21, 1974, p 34.

3/ Additional Testimony of Dr. Morton I. Goldman on Behalf of the Consolidated Utility Group (Part 1) Occupational Exposure, Docket No. RM-50-2.

4/ Hearing Transcript pp 3605-3614 and 3999-4048.

5/ Additional Testimony of Dr. Morton I. Goldman on Behalf of the Consolidated Utility Group (parts 1 and 2) Docket No. RM-50-2.

6/ ICRP Publication 22, paragraph 18.

"(18) It is then helpful to express the population dose not only in man-rems, but also in social and economic terms, for example, in terms of detriment or monetary units, so that the advantage of a reduction in collective dose can be compared directly with the detriment or cost of achieving this reduction. In this way, the methods of Appendix III can be directly applied. In the region of individual dose near the dose limit, the need for the additional effort can be indicated by arbitrarily increasing the monetary equivalent of the man-rem, perhaps by a factor of 10 or so. Some published estimates of the possible monetary equivalent of the man-rem are given in Appendix II."

The record[1/] seems to make clear that Dr. Goldman has misinterpreted the intent of the pertinent Paragraphs of the International Commission for Radiation Protection document. We believe that, without such a factor to give increased weight to occupational exposure, the data presented[2/] do not support the conclusion that the probable impact of Appendix I on occupational exposure will outweigh the probable reduction of exposure to the population.

In assessing the probable impact of Appendix I on occupational exposure, the AEC Regulatory Staff attempted an analysis of data equivalent to that presented by Dr. Goldman. It was found that no conclusions were warranted on the basis of the data, and that a more detailed evaluation was necessary.

The staff proceeded to study occupational exposure by visiting eleven selected operating nuclear power plants, reviewing exposure records, and holding discussions with utility personnel.[3/] This study suggested that augmentation of the radwaste treatment systems to meet the objectives of

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1/ Hearing Transcript pp 4015-4018.

2/ "Additional Testimony of Dr. Morton I. Goldman on Behalf of the Consolidated Utility Group (Parts 1 and 2) Docket No. RM-50-2.

3/ Charles A. Willis, "A Study of the Occupational Radiation Exposure Due to Radwaste Treatment Systems at Nuclear Power Plants," Docket No. RM-50-2,

proposed Appendix I might be expected to increase occupational exposure by, some 7 percent. Of more significance was the observation that little if any of the increase in exposure would be unavoidable. Much of the occupational exposure in nuclear power plants is due to such things as inadequately shielded tanks, lack of access for maintenance, lack of remote controls, and lack of remote viewing equipment. The general conclusions of the AEC Regulatory Staff, which seem not to be challenged in the replies by the Consolidated Utility Group[1] and by General Electric[2] to the Concluding Statement of Position of the Regulatory Staff, are that "implementation of Appendix I need not significantly increase occupational exposure."[3]

We, the Atomic Energy Commission, nevertheless, continue to be concerned about the level of occupational exposure in nuclear power plants, and steps are being taken to reduce occupational exposures to levels that are "as low as practicable." Regulatory Guide 8.8, issued in July 1973, details the occupational exposure control information that should be provided in license applications. This information is now being reviewed in the licensing process, and applicants are being asked to improve plans, procedures, and designs where appropriate to reduce exposure. The SAR Standard Format document is being revised to increase emphasis on occupational exposure control. Thus, the importance of keeping occupational exposure "as low as practicable" is recognized, and progress is being made toward that objective, but we do believe that implementation of Appendix I is compatible with the reduction of occupational exposure.

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[1] Reply of the Consolidated Utility Group to Concluding Statement of the Regulatory Staff, March 7, 1974.

[2] Reply Statement of the General Electric Company, March 14, 1974.

[3] Concluding Statement of Position of Regulatory Staff, Docket No. RM-50-2, Feb. 20, 1974, p 64.

. Per Site versus Per Reactor

The AEC Regulatory Staff has, throughout the hearing, taken the position that the design objective doses should be those resulting from radioactive materials in effluents from all light-water-cooled power reactors at a site.[1,2] The State of Minnesota, apparently on the ground that "...no group of individuals should be expected to assume a disproportionate amount of the radiation risk" supports this position.[3]

Both the General Electric Company (GE) and the Consolidated Utility Group (CU) recommend that the design objective dose values apply only to individual reactors and not to all reactors on a site. CU, in its Concluding Statement,[4] argues:

> "Under proposed Appendix I the limitations on dose are applicable to the combined releases for all reactors on a single site. At the dose levels contemplated in the proposed rule (particularly with respect to gaseous releases), the effect of a site limitation will be to discourage and possibly prevent the placing of multiple reactor units on a single site. It will also work an unnecessary hardship on existing multi-unit stations, including several three or four unit stations which are now planned or under construction.
>
> We believe there are strong economic and environmental reasons for encouraging maximum utilization of existing sites and the planning and development of new sites for two or more reactor units. Obvious economic advantages lie in the sharing of a large tract of land, in the sharing of facilities, and in the sharing of much of the expense

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1/ ALAP AEC Regulatory Staff Exhibit 1, Tab 1

2/ Concluding Statement of Position of Regulatory Staff, Feb. 20, 1974, p 61.

3/ Final Statement of Position of the State of Minnesota, Feb. 1, 1974, p 17.

4/ Statement of Position by the Consolidated Utility Group, Feb. 19, 1974, pp 57-58.

of site investigation, engineering, licensing, construction management and operating supervision. Environmental advantages flow from minimizing the inevitable environmental impacts associated with the development of new industrial sites."

CU would apparently place no limit - other than that obtained by the "per reactor' limit - on doses from multi-reactor sites, but they insist:[1]

"The resulting offsite dose to individuals living near multi-unit sites would still be a small fraction of Part 20 limits and generally accepted radiation standards and constitute a trivial incremental risk to their health."

In its Reply Statement,[2] CU points out that, while the proposed limits on doses from liquid effluents may not prove unduly burdensome for multi-reactor sites, the limits on doses from noble gases and iodine may severely limit the number of reactors at a site unless stacks and, for some cases, rad-waste augments which it considers unjustified on a cost-benefit basis are employed.

GE argues[3] that per-reactor application of the guides is justified by the ALAP cost-benefit considerations that control Appendix I and points[3,4,5] out that the Regulatory Staff has performed no cost-benefit analyses indicating the contrary.

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[1] Statement of Position by the Consolidated Utility Group, Feb.19, 1974, p 16.

[2] Reply of Consolidated Utility Group to Concluding Statement of the Regulatory Staff, March 7, 1974, pp 21-25.

[3] Reply Statement of the General Electric Company, March 14, 1974, p. 32.

[4] Hearing Transcript 3479-80 and 3482.

[5] Hearing Transcript 3486-87.

GE contends[1] that:

"..... a per-reactor design objective guide that is 'as low as practicable' for a single reactor--and the numerical guides of Appendix I meet and surpass that standard--will remain as low as practicable even if several reactors are congregated on a single site. On the same reasoning, equipment augments unjustified on a cost-benefit basis for a single reactor can never be justified on a cost-benefit basis for multiple reactor facilities.* Indeed, the environmental and other advantages of multi-reactor siting suggest that, if anything, more lenience should be allowed for per-reactor emissions from a multi-reactor facility since these advantages will off-set any added per-reactor radiological detriment, and the added leniency would encourage the desirable clustering of power generating installations.

* Scale economies beyond the two-unit facilities analyzed in the ALAP-FES are unlikely in view of plant availability considerations, plant physical size parameters, and other factors."

Nevertheless - and to some extent in spite of this argument - GE would place an additional limit on the dosage levels for a multi-reactor site. In its Closing Statement, GE recommends:[2]

"For any combination of nuclear power reactors on one site, on adjacent sites, or on nearby sites, the applicant or applicants shall, in addition, provide reasonable assurance that the total incremental annual exposure (from either airborne or waterborne effluents) to any individual in unrestricted areas will not exceed four (4) percent of the

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[1] Reply Statement of the General Electric Company, March 14, 1974, p 33.

[2] Closing Statement of the General Electric Company, Jan. 21, 1974, p. 28.

Federal Radiation Protection Guides, as set forth in Federal Radiation Council Reports Numbers 1 and 2, May 13, 1960 and September 1961, for doses to the total body or any organ."

and further states:[1/]

"Both the Consolidated Utility Group and G E took the position in the ALAP hearings that the Appendix I numerical guides must make special allowance for multi-reactor installations at a single site in order to preserve the overall environmental and economic advantages of minimizing the total number of power generation sites. The FES analyses, even when carried out with a "best-estimate" dose evaluation, show that application of ALAP design objectives as overall site limits, regardless of the number of reactors present, may limit the number of units on a site

below that number that may be desirable for environmental and economic reasons. Such a forced geographic distribution of reactor sites of one or two units each will not reduce total population radiation dose from LWR effluents; in fact, it could increase total population dose if the distributed sites in toto have a lesser degree of local isolation than would the probably more favorable sites that would be selected for multi-unit use.

Allowing the nearest neighbor dose resulting from waterborne or airborne effluents from a number of closely-located light-water reactors, each meeting the regular single-reactor ALAP guides, to approach four (4) percent of the Federal Radiation Protection Guides would

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1/ Closing Statement of the General Electric Company, Jan. 21, 1974, pp 28-29.

still limit such doses to a small fraction of permissible dose and a fraction of natural background exposure, and it would keep them within the variation in natural background radiation within the United States.

Overall, the proposed multi-unit dose objective recognizes the more desirable environmental characteristics, the greater electrical power contribution, and the reduced overall site investigation and licensing time inherent in multi-unit siting, and it preserves these benefits without sacrificing considerations of minimizing public radiation exposure. The proposal also addresses the subject of total dose to individuals from nearby but separate sites, which was not covered in proposed Appendix I. The recognition in 10 CFR 50.34a that "as-low-as practicable" must be defined "in relation to the utilization of atomic energy in the public interest" requires allowance of slightly increased, but still trivial, exposures in order to achieve a doubling or tripling of electrical output at a site and the other environmental advantages of multiple unit siting."

Our examination of the record indicates that none of the other parties in this hearing has directly addressed this question of whether the limits should be based on a per reactor or per site basis. National Intervenors[1/] (in its belief that, since the AEC could not prove that radiation at any level is harmless, we should permit no radiation releases at all) would seem certainly to prefer

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1/ Anthony J. Roisman to Algie A. Weils, et al., Feb. 15, 1972.

whichever limitation is the more stringent; this would presumably imply a preference for a stringent limit upon emission from all reactors at a site. Dr. Andrew P. Hull, who has, as indicated above,[1] advocated limits based primarily upon dosages to the population at large and who has suggested 2 man-rem per 1000 MW(e) as a limiting design objective, seems to favor a per reactor limitation. A similar observation may be made concerning the testimony of Mr. R. M. Hartman in a limited appearance for Ebasco Services, Incorporated,[2] who recommended that a limit of 0.1 man-rem per 1000 MW(t) be employed as a limit on population dosage.

It is our belief that there are genuine advantages to the utilization of atomic energy in the public interest from grouping of light-water-cooled nuclear power reactors on sound sites, that Appendix I should certainly not discourage such a practice, and that the Hearing Record clearly does nothing to refute this view. We have, accordingly, written Appendix I so that the design objectives and limiting conditions of operation are applied to each light-water-cooled nuclear reactor.

We are mindful of, and have sympathy for the position, expoused by the State of Minnesota, that "no group of individuals should be expected to assume a disproportionate amount of the radiation risk." But it must be obvious that such a situation, however desirable, can seldom if ever be realized on earth. Even if radioactive releases (or, for that matter potentially harmful materials released from any other nuclear or non-nuclear facility) were kept "as low as possible" near neighbors of the facility would assume a disproportionate share of the risk. It is clearly our responsibility, however, to assure that the risk, disproportionate though it may be, is "as low as is practicable." To that end we have, as set forth below, set -- in addition to the restrictions on

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[1] Final Statement of Position, Andrew P. Hull (Limited Participant) Feb. 11, 1974, p 4.

on each light-water-cooled nuclear power reactor -- stringent, but we believe justifiable, limits upon the dosages to individuals from radioactive materials in effluents from all light-water-cooled nuclear reactors capable of affecting those individuals.

SELECTION OF SPECIFIC DESIGN OBJECTIVE VALUES

A. Cost Benefit Considerations

The general benefits to be derived through generation of electricity from light-water-cooled nuclear power plants is not a consideration in the decisions concerning Appendix I. Such benefits and the associated costs are a real consideration in the process of licensing and siting of power stations. The cost-benefit balance appropriate to decisions regarding Appendix I deal with the costs for and the benefits from installation of sophisticated radwaste treatment systems. This need to balance the cost for each incremental reduction in dose and the benefit to protection of human health and well being from the resultant reduction in risk is clearly inherent in any judgment of whether a given dose level is "as low as practicable." For such decision making both sides of the cost-benefit balance should be expressed in commensurate units such as dollars.

1. Worth of a man-rem

The Regulatory Staff agrees with the desirability of doing this[1/] but have in practice been very reluctant to assign a dollar value to a man-rem for this purpose. The Staff states[1/]

> "There is no agreement on monetary values for reduction of risk to human life or to suffering or how such values should be applied. It is not possible to reflect properly the worth of reduction of risk to human life in monetary terms since there are overriding moral values that cannot be quantified."

[1/] Final Environmental Statement, Wash. 1258, July 1973, Vol. 1, p 8-3.

The Staff cites[1] the several published estimates for worth of a man-rem; these range from about $30 to $980 per man-rem. They note that[2]

> "The majority of the estimates were in the range from $100 to $600 per person-rad. No values have been suggested for dose to single organs such as the thyroid. However, the relative risk of the dose to the thyroid compared to dose to the total body would suggest a lower value for a person-thyroid-rem than for a person-rem."

but continue to make clear the fact that they do not endorse any absolute value for the worth of a dose reduction. For example they state[3]

> "At the same time it must be recognized that many aesthetic, human and environmental factors are not quantifiable and must be given weight in the decision-making process by informed, though subjective, judgments. Thus, references to dollar cost per unit of reduction of dose used by the staff in the FES and in the record of the hearing are intended for comparison purposes only without implication of recommended absolute monetary value worth of such dose reduction."

In spite of this reluctance the Staff states[1]

> "In spite of the inherent difficulties in the direct use of monetary values, it appears useful to express, to the extent practicable, both costs of reduction of risk and benefits to society from such reduction in monetary units as at least one of the factors to

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1/ Final Environmental Statement, Wash 1258, July 1973, Vol. 1, pp 8-2,-3

2/ Ibid. pp 83.

3/ Concluding Statement of Position of Regulatory Staff, Feb. 20, 1974, p 43.

be considered in arriving at judgments on reducing risk to "as low as practicable levels."

In both the Final Environmental Statement[1/] and its Concluding Statement[2/] the Staff does calculate, from its estimates of rad-waste system costs and the resultant reduction in population dose, values for cost per man-rem reduction. They do not, however, appear to accept or reject radwaste systems because of the cost of such reduction.

Indeed, it is clear from the testimony[3/] that the Staff would leave to us, the Atomic Energy Commission, the decision as to dollar value of the man-rem to be used and the extent to which such a value would be given weight along with other considerations in the decision.

The Consolidated Utility Group (CU), on the other hand, did choose[4,5,6/] a value for the worth of a man-rem. For CU, Dr. Walton Rodger stated[5/]

> "You may duck the issue all you want but in order to make a meaningful cost-benefit analysis you simply have to 'bite the bullet' and assign a value to a man-rem. We recognize that this isn't easily done, that there are great subjective factors involved, and that this is an area in which reasonable persons may reasonably disagree. Nonetheless we chose a value. We chose $1000/man-rem (and 1/3 of that for a man-thyroid rem). The FES quotes a number of estimates for this value ranging from $10 to $980 with most being in the range of $100 to $600. A very current new estimate is $250. We deliberately

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1/ Final Environmental Statement, Wash 1258, July 1973, Vol. 1, p 8-2.

2/ Concluding Statement of Position of Regulatory Staff

3/ Hearing Transcript pp 3472-73.

4/ ALAP UG Exhibit No. 5, Additional Testimony of Dr. Walton A. Rodger on Behalf of the Consolidated Utility Group, No. 9, 1973.

5/ ALAP UG Exhibit No. 6, Summary of Additional Testimony dated Nov. 9, 1973, of Dr. Walton A. Rodger on Behalf of the Consolidated Utility Group, p 2.

6/ Hearing Transcript pp 3913-15.

chose a value above the range quoted for two reasons:

1) to be conservative in our assessment of the value of augments,

2) to make allowance for "overriding moral values" and other intangibles which are hard to quantify."

As the record makes clear[1,2/] these values of $1000 per man-rem and $333 per man-thyroid-rem represent no independent assessment but were obtained by CU simply by taking a value somewhat higher than the range of values suggested by the several studies cited.[3/]

The General Electric Company, while generally accepting the cost-benefit analyses presented by CU, seems to have made no recommendations for the worth of a man-rem.

The State of Minnesota also made no assignment or decision as to worth of a man-rem.[4/] Minnesota has argued consistently that releases of radioactivity should be minimized but has not really tied this recommendation to the resultant dose effects nor has it made cost-benefit analyses in support of its recommendations.[4/] However, it seems clear from the record that the State of Minnesota would put a high value on the worth of a man-rem. In its Final Statement, it states:[5/]

"Minnesota also believes that the actual costs, as described by both AEC witnesses and the utilities, seem less reasonable than when expressed in terms of their impact on individual consumers. Testimony by a Minnesota witness[*/] showed that typical augments might

[*/] Supplement Testimony for the State of Minnesota at the Atomic Energy Commission's Rulemaking Hearings, "As Low As Practicable," by Kenneth Dzugan.

[1/] Hearing Transcript pp 3944-45.

[2/] Statement of Position by Consolidated Utility Group, Jan. 19, 1974, p 31.

[3/] Final Environmental Statement, Wash 1258, July 1973, Vol. 1, p 82-83.

[4/] Hearing Transcript pp 1778-1779.

[5/] Final Statement of Position of the State of Minnesota, Feb. 1, 1974, p. 14.

represent an addition of several percent to the average residential user's cost. Minnesota believes such increments in cost are reasonable, when they go to protect the public health. Minnesota urges the Commission to consider the cost-benefit analyses of both the regulatory staff and the utilities in this light."

We certainly agree with the Regulatory Staff and with the Consolidated Utility Group that there are great subjective factors to be considered in any judgment of the worth of a man-rem. On the other hand, it is clear that a dollar figure for such worth is necessary for the cost-benefit analysis that must form a part of the basis for the decision as to the specific minimal guides of Appendix I. After careful consideration of the several points of view expressed in the record, it seems to us prudent to recommend that the worth of a man-rem be assigned the value of $1500 and the worth of a man-thyroid-rem be assigned the value of $500. Accordingly, we so recommend and these values will be used where appropriate in cost-benefit considerations for this Appendix I. It will develop, in a later section of this Statement of Considerations, that a meaningful cost-benefit study can be made only for the dose benefit to a large population. It seems manifest to us that those augments to a rad-waste system that have a favorable cost-benefit ratio for reduction of dose to the population at large should be required of all light-water-cooled power reactors. We have already decided[1/] that those individuals living near to the light-water-cooled power reactor must be properly protected. Accordingly, as we argue below, installation of equipment with a favorable cost-benefit ratio for dosage to the population at large is necessary, but it may, in several cases, not be sufficient to satisfy the requirements of Appendix I.

1/ Page of this Statement of Consideration

2. Cost of Radwaste Systems

During the initial phase of the ALAP Hearing (prior to May 6, 1972) the Regulatory Staff presented little information,[1,2] and that of a preliminary and fragmentary nature, concerning the costs of radwaste systems. Information concerning costs of radwaste systems was presented, in this initial hearing phase, by the Consolidated Utility Group,[3,4] and, to a limited extent, by General Electric.[5] Dr. Walton Rodger, who alone presented what might fairly be called a comprehensive formulation of costs[3] and of annualized costs[4] during this period stated:[6]

"It is my opinion that:

1) the cost estimates given by the Staff are low by factors of from two to ten depending on the assumptions and models used;

2) the cost per unit reduction ($/man-rem per year) are quite out of proportion with the biological significance of a man-rem;

3) the augments (and costs) considered by the Staff do not touch the miscellaneous sources."

Publication by the Staff of the Draft Environmental Statement, its consideration of the many diverse comments upon this document, and subsequent publication of the Final Environmental Statement were important steps in providing a basis for proper costing of radwaste systems and for cost-benefit analyses. Comments upon the Draft Environmental Statement showed, as might have been expected, some disagreement with the estimated costs of radwaste equipment.

1/ ALAP Regulatory Staff Exhibit 1 Tab 2, p a1 and Tables 12 and 13.

2/ Hearing Trasncript 536-590

3/ Statement of Dr. Walton A. Rodger on Behalf of the Consolidated Utility Group, Dated March 17, 1972 and incorporated in Hearing Transcript pp 1748-1752.

4/ Supplemental Statement, Dr. Walton Rodger on Behalf of the Consolidated Utility Group, April 26, 1972, incorporated in Hearing Transcript p 2753.

5/ ALAP General Electric Company Exhibit 3, April 26, 1972, Items 4 and 5.

Consolidated Edison Company of New York, Inc. stated[1] that cost estimates in the Draft Environmental Statement seemed to be generally lower than their experience would indicate and showed a few specific examples where the estimated costs appeared to be low by at least 3-fold.

The Consolidated Utility Group (CU) in its comments on the Draft Environmental Statement stated:[2]

> "The DES has presented, we believe, a reasonably good set of cost estimates for the additions proposed for the various cases discussed. To the extent possible we have tried to cross check these cost estimates against other estimating procedures and against actual installed equipment of similar design. We conclude that the cost values presented are generally on the low side of the expected range but not drastically so. We believe that all of the costs should be increased by 10 to 20% largely because we do not believe that the estimates presented in the DES properly reflect the increasing demands of the Directorate of Licensing for higher code classifications and increased quality control. These requirements typically can add from 50 to 100% to the cost of individual equipment pieces."

However, CU argues strongly that the cost picture is badly distorted by using - as was done in the Draft Environmental Statement and the Final Environmental Statement - a two reactor site in which much of the radwaste equipment was shared between the two reactors. CU argues[3] that the suggested capital cost savings can be realized only if two reactors are built at the same site and at approximately the same time.

1/ Final Environmental Statement, Wash 1258, July 1973, pp 311-312.

2/ Ibid., p 243.

3/ Final Environmental Statement, Wash 1258, July 20, 1973, p 244.

After publication of the Final Environmental Statement CU stated:[1]

"The costs presented in the FES appear to be almost a factor of two lower than those of the DES and we can no longer avoid taking issue with the Staff cost estimates. Our criticism of FES costs fall into the following categories, each of which is discussed more fully below:

1) Specific cost items omitted from the FES analyses.

2) Comparison of certain key components between DES and FES.

3) Comparison of specific FES equipment cost estimates with actual experience.

4) Comparison of the ratio of bare equipment cost to installed cost with actual experience and with current estimating practice.

5) Omission in the FES of adequate provision for the additional utilities and services required by the suggested augments.

6) Lack of redundancy in the FES -- redundancy required both by operating and licensing considerations.

7) Inadequate provision of the FES cost estimates for present day quality assurance requirements.

8) Seriously inadequate provision for operating labor in the O&M sections of the FES cost analyses."

After a detailed elaboration of these several points, the conclusion is drawn:[2]

"From all of the foregoing we conclude that there is no possible way in which the various FES cases could be built and operated at less than twice

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[1] Hearing Transcript p 3909, Additional Testimony of Walton A. Rodger on Behalf of the Consolidated Utility Group, Nov. 19, 1973, pp 38-39.

[2] Ibid., 3909, page 51.

the costs allowed for in the FES. Taking into consideration the need for redundancy and the fact that the FES estimates are based on two reactors built simultaneously and sharing radwaste equipment, a more likely cost is three to four times that given in the FES."

In its Concluding Statement CU continues to maintain[1] its belief "that the cost of installing and operating waste treatment systems has been understated perhaps by a factor of 3 or 4."

The Regulatory Staff, on the other hand continues to defend the cost estimates presented in the Final Environmental Statement (FES). In its Concluding Statement the Staff points out that the CU data was based on "industrial experience" and included overtime and other exceptional factors, that CU included backfitting experience,[3,4] and included optional redundant equipment. The Staff argues[2] that none of these items should be included in cost of radwaste systems for cost-benefit analysis.

The Staff did include redundant components in costing the radwaste systems in the Draft Environmental Statement but, at least partly because of criticisms in comments on the DES, removed such redundancy from the systems evaluated in the Final Environmental Statement.[5] The Regulatory Staff says of optional redundant equipment:[5]

> ".....which is not required for meeting ALAP or licensing requirements and therefore should not be included in costs for meeting dose reduction in cost-benefit analyses."

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[1] Statement of Position by the Consolidated Utility Group, Jan. 1974, p 36.

[2] Concluding Statement of Position of the Regulatory Staff, Feb. 20, 1974, pp 43-45.

[3] Hearing Transcript p 3975.

[4] Hearing Transcript p 3985.

[5] Concluding Statement of Position of the Regulatory Staff, Feb. 20, 1974, pp 44-45.

CU, on the other hand, takes the position:[1]

"It is not the practice of utilities to install such systems without the provision of adequate redundancy for safe and reliable operation nor is it likely in actual practice that AEC license conditions would permit them to do otherwise. The technical specifications of existing licenses as well as the proposed Appendix I limiting conditions of operation could force the shutdown of a nuclear power plant in the event of an outage of important radwaste systems. For most radwaste systems, a utility simply cannot afford to allow operation of the plant to depend on the availability of a simple piece of radwaste equipment."

After consideration of the several differences between the Staff and the CU estimates, the Staff believes[2] "that there are no significant unexplained differences with respect to cost estimates."

We, the Atomic Energy Commission, believe after consideration of the record that the Staff cost estimates for construction and operation of radwaste systems may be low by an appreciable amount but that these estimates by the Staff are quite unlikely to be in error by factors of 3 or 4. It seems to us that to the extent -- and only to the extent -- that equipment redundancy is required by the licensing process the cost of such redundant items should be included in the total costing of the system. It seems equally clear that the additional costs, if any, due to increased attention to quality assurance should be included in

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[1] Additional Testimony of Dr. Walton A. Rodger on Behalf of Consolidated Utility Group, Nov. 9, 1973, p 49.

[2] Concluding Statement of Position of the Regulatory Staff, Feb. 20, 1974, p 45.

the radwaste system costs. On the other hand, it does not seem reasonable to include costs of overtime or other special features that may have, in specific instances, contributed to higher than normal costs of installation. On the other hand, the costs of operation of the augmented equipment should be realistically estimated; such estimates should include reasonable allowances for maintenance of equipment and for the increased work force and payroll based, insofar as is possible, on actual experience as this experience exists or becomes available.

We note and are impressed with the CU conclusion[1,2] that even though the Regulatory Staff's cost estimates are low by some factor this difference makes little if any change in the list of radwaste augments that are justifiable on a cost-benefit basis. Dr. Rodger states:[1]

> "Some of the augments which appear 'justified' using FES values might become 'unjustified' if the costs doubled or trebled, but the degree of 'unjustification' would not become so great as to give rise to conclusive arguments that any of the augments listed in Exhibits II and III should be removed."

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[1] Hearing Transcript p 3912, Summary of Additional Testimony Dated November 9, 1973 of Dr. Walton A. Rodger on Behalf of the Consolidated Utility Group, Nov. 28, 1973, p 9.

[2] Hearing Transcript 3927-3928.

3. The Cost Benefit Balance

Though the costs of installation and operation of radwaste systems were, as indicated above, a matter of controversy, an even more fundamental difference of opinion existed (primarily between the Regulatory Staff and the Consolidated Utility Group) over the manner in which cost-benefit balancing was to be done.

In effect, the Regulatory Staff has, for each effluent type, added the several radwaste augments as a unit to the base case dual light-water-cooled nuclear power reactor system.[1,2] From estimates of the cost of the radwaste augment package and calculation of the resulting decrease in radiation exposure to the population the Staff obtained a value in dollar cost per man-rem of resulting reduction in population dose. The Staff also included[1,2] in the total cost of the radwaste system the cost of the residual population dose; for this calculation the Staff showed costs resulting from a wide range of dollar values for cost of a man-rem of radiation exposure. This added cost, which is very small for all except quite unacceptable sets of radwaste augments, seems not to have been objected to by other parties who replied to the Staff's Concluding Statement.

After publication by the Staff of the Final Environmental Statement, the initial position of CU included a real objection to the Staff's choice of the base case radwaste systems. In his written testimony, Dr. Walton A. Rodger characterized as "completely unrealistic" the base case radwaste systems for PWR liquids[3] and for BWR liquids.[4] He also argued that the base case for

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1/ Final Environmental Statement, Wash 1258, July 1973.

2/ Concluding Statement of Position of the Regulatory Staff, Feb. 20, 1974.

3/ Hearing Transcript p 3909, Additional Testimony of Dr. Walton A. Rodger on Behalf of the Consolidated Utility Group, Nov. 9, 1973, p 25.

4/ Ibid., p. 32.

PWR gases was unrealistic[1] but stated that the base case for BWR gases was reasonably representative of an unaugmented BWR.[2] In the Summary of this testimony Dr. Rodger made the same claim of "unrealism" for the base case PWR and BWR liquid radwaste systems[3] but suggested that the base case gaseous radwaste systems for both reactor types were reasonable.[4] In response to questioning, Dr. Rodger stated that the degree of unrealism for the PWR base case gaseous radwaste system "is not really enough to argue about."[5]

It is clear that if the base case radwaste system were improperly chosen so as to lead to large (calculated) doses to the population the subsequent cost-benefit balance might show that unrealistically expensive radwaste augments could be justified. This could be true especially if the cost-benefit balance were done by considering several radwaste augments as a unit. We believe that the record shows clearly that the base cases for gaseous radwaste systems are not unrealistic. It is entirely possible that the liquid radwaste base cases selected by the Staff are somewhat unrealistic in that they do not represent the systems employed in modern light-water-cooled nuclear power systems. However, as it will develop in the following discussion, this "unrealism" - if it exists - has little or no effect upon the actual cost-benefit conclusions.

The major thrust of the CU argument against the Staff's cost-benefit balance, however, concerns the practice of adding the several radwaste augments to the base case as a unit. As Dr. Walton Rodger stated for CU:[6]

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[1] Hearing Transcript p 3909, Additional Testimony of Dr. Walton A. Rodger on Behalf of the Consolidated Utility Group, Nov. 9, 1973, p 8.

[2] Ibid., p 16.

[3] Hearing Transcript p 3912, Summary of Additional Testimony dated November 9, 1973, of Dr. Walton A. Rodger on Behalf of the Consolidated Utility Group, Nov. 28, 1973, p 4.

[4] Ibid., p 6.

[5] Hearing Transcript p 2950.

[6] Hearing Transcript p 3909, Dr. Walton A. Rodger, Nov. 9, 1973, p 1.

"One of the major comments which the Utility Group made concerning the cost-benefit analyses of the Draft Environmental Statement was that the data were presented in such a manner as to hide the extraordinarily high ratio of cost-to-public benefit received for most of the components of the cases which were chosen for presentation. In the preparation of the Final Environmental Statement the Staff not only ignored this comment, they went even farther in masking the fact that some of the additional treatments proposed are vastly more expensive than others. This was done by eliminating even the rudimentary case-by-case differential costs which were included in the DES."

In the Summary of his written testimony[1/] Dr. Rodger stated:

"The thrust of the Testimony which we filed on November 9, 1973 was to break down into their component parts the cost-benefit analyses presented in the FES. The first purpose for doing this was to demonstrate that while some augments to the gaseous and liquid radwaste systems of PWR and BWR are justified on a cost-benefit basis, others are not. In fact many of the augments considered in the FES result in the expenditure of incredibly large numbers of dollars for every dollar of value returned. The "lumped" approach used in the FES cost-benefit analyses completely hides this fact."

In effect, Dr. Rodger used the Regulatory Staff's dose calculational models and the Staff's values for annual releases of radioactivity and annual costs for the radwaste augments and conducted the cost-benefit study by adding

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[1/] Hearing Transcript p 3912, Summary of Additional Testimony Dated Nov. 9, 1973 on Behalf of the Consolidated Utility Group, p 1.

augments individually and sequentially to the liquid, the noble gas, and the iodine and particulate radwaste systems.

By this technique of sequential addition of the most effective radwaste augment (so that in effect each addition constitutes with the other augments already present a new base case to which the next is added) the cost-benefit evaluation can show the true worth of each individual augment.

We, the Atomic Energy Commission, must agree that the cost-benefit balancing methods employed by CU are superior to the approach used by the Regulatory Staff. Accordingly, where Appendix I, below, directs that augments that show a favorable cost-benefit ratio for reduction of population dose be included in the radwaste systems for light-water-cooled power reactors, we intend that the worth of the augment be assessed by this procedure.

In the cases, and it appears that there are several, where the radwaste system consistency of all items showing this favorable cost-benefit balance for decreased dosage to the population will also ensure that doses to individuals near the light-water-cooled nuclear power reactor facility is within the design objective guides no further augments appear necessary or desirable. Where such a system, and it also appears that there may be several such cases, does not meet the design objective guides for doses to neighboring individuals then additional augments are required even though they cannot be shown by this or other techniques to have a favorable cost-benefit ratio.

B. Choice of Specific Design Objective Guides

In its original version of Appendix V the Regulatory Staff proposed to limit the annual dose to any individual from radioactive materials in both liquid and gaseous effluents from all light-water cooled power reactors on a

site to 5 millirems to the total body or to any organ.[1,2]

General Electric (GE) has recommended that the design objective dose values for each light-water-cooled nuclear power reactor be modified to 1% of the FRC radiation protection guides. GE states[3]

"1. Dose Objectives. The ALAP numerical guides should be established in terms of dose-limiting objectives for the nearest neighbors of light-water reactors and should equal one percent of the present Federal Radiation Council Guides for the whole body and each body organ. Specifically, the objectives should be 5 millirems per year for the total body, 15 millirems per year for the thyroid and 30 millirems per year for the skin."

The Consolidated Utility Group indicates in its Statement of Position[4]

"2. Dose Levels. We strongly urge at a minimum the adoption of 1% of ICRP values for individuals in the general population, including ICRP values for organs other than the whole body. The individual thyroid dose objective should be changed to 15 mrem for children and 30 mrem for adults, and the individual skin dose should be changed to 30 mrem. If undue costs and restrictions on siting are not to be incurred, (i.e. selection of a more representative individual for dose calculations and limitations of doses from radioactive effluents on the basis of each reactor instead of a site limitation). If neither of these recommendations is accepted, a very much larger increase in permissible individual thyroid dose will be required to avoid the addition of expensive iodine

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1/ ALAP AEC Staff Exhibit 1 Tab 1.

2/ Concluding Statement of Position of the Regulatory Staff, p 48.

3/ Closing Statement of the General Electric Company, Jan. 21, 1974, pp 12, [illegible], 28.

4/ Statement of Position by the Consolidated Utility Group, Jan. 19, 1974, pp 68, 69.

control and treatment systems which are entirely unwarranted in terms of population dose reduction."

The State of Minnesota in its Final Statement appears to endorse the original Regulatory Staff position to limit the annual dose from all reactors at a site to 5 millirem to the total body or any organ.[1/] Douglas LaFollette has also indicated his strong support of this position.[2/]

Several other suggestions were made. The Tennessee Valley Authority suggested[3/] that "the costs and consequences of achieving 1% of Part 20 limits should be carefully balanced against the costs and consequences of achieving instead, for example, 10% of Part 20 limits." Dr. Merril Eisenbud suggested on behalf of the Atomic Industrial Forum the value, 5 millirem to the whole body, gonads or bone marrow and 15 millirem to all other organs.[4,5/] National Intervenors,[6/] while agreeing that it is technologically possible for plants to be operated at 1% of Part 20 limits argues that no radioactive discharges should be permitted. At the other extreme, G. Hoyt Whipple[7,8/] considers that numerical guide lines other than those given in 10 CFR Part 20 are unnecessary since "the interpretation of 10 CFR Part 20 by the nuclear industry has resulted in performance so excellent that there is no need for further incentive."

Andrew P. Hull, who was a limited participant throughout the hearing, argued[9/] that a boundary limit of 25 millirems per year whole body dose would be consistent with his proposed population dose of 2000 man-rem per year limit for population dose from each 1000 MWe reactor.

1/ Final Statement of Position of the State of Minnesota, Feb.1, 1974, pp 8 and 17.
2/ Final Environmental Statement, Wash-1258, July 1973, Vol. 3, p 38.
3/ Ibid. p 314.
4/ Ibid. p 96.
5/ Hearing Transcript, p 86, Statement by Merril Eisenbud, p 5.
6/ Anthony Z. Roesman to Algie A. Well et al., Feb. 15, 1972, p 7.
7/ Final Environmental Statement, Wash. 1258, July 1973, Vol. 3, p 94.
8/ Testimony of G. Hoyt Whipple on the Proposed Appendix I to 10 CFR Part 50

In its Concluding Statement the Regulatory Staff agrees that the limiting dose for all light-water-cooled nuclear power reactors on a site to the thyroid should be changed from 5 millirems to 15 millirems per year and states:[1/]

"As a practical matter the dose to the child's thyroid is controlling for purposes of design objectives and operational control. The Staff's recommendation is based on evidence developed in the record that shows that a design objective of 5 millirems per year is not practicable at this time with respect to the state-of-technology and costs of iodine removal equipment for those sites where milk cows graze in the near vicinity of the site."

In the same Concluding Statement[1/] the Regulatory Staff also recommends that:

"the skin dose due to external exposure from beta and gamma radiation released in gaseous effluents should be changed from 5 to 15 millirems per year because it is not practicable to design to limit the beta dose to 5 millirems per year."

The Regulatory Staff continues to recommend that the design objective dose from radioactive materials in liquid effluents from all light-water-cooled nuclear power reactors at a site be kept at 5 millirems per year to the total body or to any organ.[2/] The Staff argues that both the Consolidated Utility Group[3/] and the General Electric Company[4/] agree that this design objective is practicable for liquid effluents.

1/ Concluding Statement of Position of the Regulatory Staff, Feb. 20, 1974, p 49 and pp 25-30.

2/ Concluding Statement of Position of the Regulatory Staff, Feb. 20, 1974, p 50.

3/ Hearing Transcript pp 3996-3998.

4/ Closing Statement of the General Electric Company, Jan. 21, 1974, p 16.

However, in its Reply[1/] the Consolidated Utility Group stated:

"In our testimony at the hearing on the FES, due to time limitations, we confined our comments on the liquid cases to River Sites. We have now been able to analyze in detail the liquid cases for both PWR's and BWR's for all three site regimes and for both once-through cooling and cooling towers. It is true that for River Sites, for either PWR or BWR and for either cooling mode, there is no cost penalty, over and above costs of augments which are justified on a population cost-benefit basis, to meet a limit of 5 mrem/year to an individual even using the Staff's conservative dose models. When the analysis is expanded to include Lake and Seacoast Sites, however, this is no longer true. Using the Staff's models, bases, and cost estimates, additional augments, over and above those which can be justified on a cost-benefit basis, are required to meet the design objective dose of 5 mrem/year for the following combinations:

Reactor Type	Regime	Cooling Mode
PWR	Lakeshore	Cooling Tower
PWR	Seacoast	Cooling Tower
BWR	Lakeshore	Cooling Tower
BWR	Seacoast	Once-through
BWR	Seacoast	Cooling Tower

The dominance of cooling tower cases in the above listing reflects the smaller discharge streams and therefore higher concentrations of radionuclides in those streams. These higher concentrations in turn increase the dose to the "maximum individual" reflected in Staff models."

[1/] Consolidated Utility Group Reply

1. For Individual Light-Water-Cooled Nuclear Power Reactors

We have decided, largely in recognition of the relative weighting of total body and organ dose limits recommended by the FRC, the ICRP and the NCRP, to adopt as our basic design objective guides the limits for dosages to individuals from effluents from each light-water-cooled nuclear power reactor of 5 millirem per year to the total body, 30 millirem per year to the skin and 15 millirem per year to the thyroid. Such adoption, which is only partially responsive to the recommendations of the Regulatory Staff, essentially adopts as the design objective guide for an individual light-water-cooled nuclear power reactor a value equivalent to 1% of the FRP standards.

For liquid effluents the design objective limits the radioactive material that may be released from each light-water-cooled nuclear power reactor to that annual total quantity that will result in an annual dose to any individual in unrestricted areas not in excess of 5 millirems to the total body, 30 millirems to the skin, and 15 millirems to any other organ. It is assumed that rivers are used as sources of drinking water and rivers or other pertinent bodies of water are used as sources of fish or other seafood unless positive evidence to prove otherwise is provided. The models also assume (as discussed in more detail under Implementation, below) that near neighbors of the light-water-cooled nuclear power reactor include individuals with habits differing significantly from the average. We believe that the record indicates that it is practicable to meet this design objective and that for many if not all reactor sites this design objective can be met with radwaste systems which show favorable cost-benefit balance for reduction of dosage to the general population.

The design objective to control external exposure from gaseous effluents has been expressed in terms of a limitation on the annual dose rate due to gamma radiation or beta radiation from each reactor at or beyond the boundary of the site. This design objective, in effect, provides flexibility for considering site-related meteorology and the distance from the reactor to the site boundary, but requires the assumption be made that people may live just outside the site boundary. The specified dose rates of 10 millirads per year for gamma radiation and 20 millirads per year for beta radiation would normally be considered to meet the objective of limiting doses to individuals in unrestricted areas to not more than 5 millirems to the total body and to less than 30 millirems to the skin. Provisions are made to decrease this annual dose rate if, for a particular site, there are special circumstances that necessitate such a decrease to assure that an individual in an unrestricted area shall not receive more than 3 millirems total body exposure. Provision is made to permit increase in this release rate should special site characteristics or circumstances indicate that such increase will not lead to individual dosages above 5 millirems per year to the total body or 30 millirems to the skin. In practice, such an increase seems unlikely to be invoked since the additional requirement for all radwaste equipment with favorable cost benefit balance for decrease of population dose is expected to be controlling. We believe that the record indicates that this design objective is practicable for individual light-water-cooled power reactors at essentially all sites.

The design objective for radioiodine and radioactive material in particulate form was, as indicated in many places in this statement, probably the most difficult issue in this proceeding. The design objective has been set

to insure that emission of radioiodine and radioactive material in particulate from each light-water-cooled nuclear power reactor shall not result in an annual dose for any individual in unrestricted areas from all pathways of exposure in excess of 15 millirems to any organ. For virtually all cases the thyroid dose will be the only one of real consequence from this source.

As indicated in detail under Implementation, below, the design objective quantity is to be calculated at the location of the nearest milk cows that are actually present at the time of design and construction of the reactor. The design objective is not required to be based on an assumption that cows are present where there is potential pasture land in the vicinity of the reactor if they are not actually present at the time of design and construction of the reactor. The future uses of the environment with respect to food pathways will be protected by the limiting conditions of operation that require monitoring and surveillance programs that are designed to identify changing land uses with respect to food pathways that may result in exposure from iodine. Appropriate control measures, including the modification of land uses, would be required if monitoring programs during operation indicate that the design objective guide levels are being exceeded.

As a further requirement in addition to the design objective guides described above, the radwaste systems shall include all items of reasonably demonstrated technology that can effect reductions in dose to the general population for costs not in excess of $1500 per man-rem or $500 per man-thyroid-rem. Such a provision will assure that selection of a very large and isolated site cannot justify release of large quantities of radioactive materials and, especially radioiodine, simply because no substantial individual doses would result.

2. Multiple Light-Water-Cooled Nuclear Power Reactor Systems

In a previous Section of this Statement of Considerations we announced, after consideration of the several points of view in the Record, a decision in favor of design objective guides to be met by each light-water-cooled nuclear reactor with an additional limit upon releases by all such reactors on a site or on nearby sites. To this end, Appendix I, which we now adopt, would require the applicant to provide reasonable assurance that the proposed reactor, in combination with all other light-water-cooled nuclear power reactors on the site and on nearby sites, would meet the several design objectives. In this rule "other light-water-cooled nuclear power reactors" is to mean light-water-cooled nuclear power reactors for which applications have been filed with the Commission for construction permits and which are expected to operate while the proposed reactor operates.

As indicated in detail in a preceding portion of this Statement of Considerations[1/] the AEC Regulatory Staff and the Statement of Minnesota have consistently favored design objective guides that would limit releases from all reactors on a site. CU and GE have favored guides on a per reactor basis, and all other participants (though one can infer a preference in this matter) have remained silent upon this question.

The Consolidated Utility Group argues for no additional limit on radioactive releases other than that imposed by the per-reactor limit. General Electric, on the other hand, suggested[2/] that:

> "For any combination of nuclear power reactors on one site, on adjacent sites, or on nearby sites, the applicant or applicants shall, in addition, provide reasonable assurance that the total incremental annual

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1/ BASIS FOR DESIGN OBJECTIVE VALUES: D. Per Site versus Per Reaction, pp 47-53.

2/ Closing Statement of the General Electric Company, Jan. 21, 1974, p 28-29.

exposure (from either airborne or waterborne effluents) to any individual in unrestricted areas will not exceed four (4) percent of the Federal Radiation Protection Guides, as set forth in Federal Radiation Council Reports Numbers 1 and 2, May 13, 1960 and September 1961, for doses to the total body or any organ."

We, the Atomic Energy Commission, are convinced, as stated in a previous section of this Statement, that the Record amply justifies design objective guides for multi-reactor sites that differ from those for an individual light-water-cooled nuclear power reactor. However, the Record scarcely addresses the question of - and presents little if any specific information concerning - the quantitative evaluation of what such limits should be. It is, accordingly and after careful consideration of the Hearing Record, necessary that we use our collective judgement upon this question and/we pronounce a decision that must be, to some extent, an arbitrary one.

We believe that the design objective guides proposed by the General Electric Company -- that is that the releases from a site and from nearby sites should be permitted to be as much as 4 times the permitted releases per reactor - are too liberal to be construed as "as low as practicable." We have instead chosen to set the limits upon all light-water-cooled nuclear power reactors on a site and on nearby sites in the following way:

For liquid effluents the calculated annual quantity of all radioactive material above background to be released from the proposed reactor in combination with all other light-water reactors on the site or on nearby sites must not result in an estimated annual dose for any individual in unrestricted areas from all pathways of exposure in excess of 10 millirems to the total

body, 60 millirems to the skin, or 30 millirems to any other organ. This guide - which effectively limits the dosage to an individual from all light-water-cooled nuclear power reactors capable of giving him an appreciable dosage to twice the permitted level from a single reactor - seems to us, after consideration of the Record to be readily achievable at most if not all sites.

The design objective guides for release of the noble gases to unrestricted areas from all light-water-cooled nuclear power reactors on a site or on nearby sites are also set at values that are twice the values for an individual reactor of this type. As in the case for individual reactors, there are provisions for increasing or decreasing this release rate for noble gases should special circumstances permit such an increase without exceeding an individual dose of more than 5 millirems to the total body or more than 30 millirems to the skin or should special circumstances require such a decrease to insure that no individual should receive a dose in excess of 10 millirem to the total body. We believe that the Record substantiates the view that these design objectives are practicable for virtually all sites and combination of sites. We are also of the opinion that increases in release rates permitted under special circumstances indicated above will seldom occur since the requirement that radwaste systems include all augments justifiable on a cost-benefit basis for total population exposure will generally be controlling.

The design objective values for release of radioactive iodine and radioactive material in particulate form from all reactors on a site or on nearby sites have been set to assure that no individual receive from this

source organ doses in excess of 45 millirem per year. This value is equivalent to three (3) times the design objective guide for an individual light-water-cooled nuclear power reactor. This guide is somewhat more liberal (3x rather than 2x) than those for liquid effluents and for noble gas effluents because the Record makes abundantly clear that for most sites this guide is by far the most difficult to meet. It seems to us that, while there may well be several sites when this guide will require radwaste augments over and above those justifiable on a cost-benefit basis for doses to the total population, this guide as stated will not unduly restrict grouping of light-water-cooled nuclear power plants on favorable sites.

The language of this portion of the rule is such, and we the Atomic Energy Commission intend, that the burden of compliance should be upon the applicant for (an) additional reactor(s) at a site or at a nearby site. Should the applicant have control of (own) the "other light-water-reactors" he would clearly have a choice as to the extent he wished to change their radwaste systems to ease the requirements upon the new reactor(s) entering the complex. Should the applicant be proposing a reactor on a site nearby to other light-water-cooled nuclear reactors that he does not control he would of necessity have to show that his proposed reactor would meet not only the design objective guides for individual reactors but would not result (in combination with others already approved, planned, or operating) in releases above the design objective guides for the total system. Since a separation distance of a very few miles seems adequate in nearly all cases to avoid appreciable additive effects for dosage to any individual, it does not seem to us likely that this rule will often prevent use of generally favorable sites by applicants.

C. Baseline In-Plant Control Measures

In the revised version of Appendix I included in its Concluding Statement, the Regulatory Staff introduced for the first time in this Hearing the position that exceptions to certain of the numerical guides for design objective values would be allowed if certain "baseline in-plant control measures" were proposed by the applicant in his radwaste system design.[1/] Those exceptions were available for liquid radwaste systems and for systems for control of radioiodine and radioactive materials in particulate form.

The Staff's proposed design objective guides for liquid effluents are set forth in the following:[2/]

"A. For radioactive material above background[*/] in liquid effluents to be released to unrestricted areas:

1. The calculated annual total quantity of all radioactive material from all light-water-cooled nuclear power reactors at a site should not result in an annual dose or dose commitment to the total body or to any organ of an individual in an unrestricted area from all pathways of exposure in excess of 5 millirems; and

2. The calculated annual total quantity of radioactive material, except tritium and dissolved gases, should not exceed 5 curies for each light-water-cooled reactor at a site.

*"Background," means the quantity of radioactive material in the effluent from light-water-cooled nuclear power reactors at a site that did not originate in the reactors."

1/ Concluding Statement of Position of the Regulatory Staff, Feb. 20, 1974, pp 26,27 and 30.

2/ Ibid. pp 26-27.

3. Notwithstanding the guidance in paragraph A.2, for a particular site, if an applicant for a permit to construct a light-water-cooled nuclear reactor has proposed baseline in-plant control measures*/ to reduce the possible sources of radioactive material in liquid effluent releases and the calculated quantity exceeds the quantity set forth in paragraph A.2, the requirements for design objectives for radioactive material in liquid effluents may be deemed to have been met provided:

a. the applicant submits an evaluation of the potential for effects from long-term buildup in the environment in the vicinity of the site of radioactive material, with a radioactive half-life greater than one year, to be releases; and

b. the provisions of paragraph A.1 are met.

*Such measures may include treatment of clean liquid waste streams (normally tritiated, nonaerated, low conductivity equipment drains and pump seal leakoff), dirty liquid waste streams (normally non-tritiated, aerated, high conductivity building sumps, floor and sample station drains), steam generator blowdown streams, chemical waste streams, low purity and high purity liquid streams (resin regenerate and laboratory wastes), as appropriate for the type of reactor."

It is clear from this proposed rule that incorporation of these baseline in-plant control measures would permit annual releases of more than 5 curies of radioactive material (other than tritium and dissolved gases) per reactor. However, the Staff has not proposed exceptions to the dosage limit even if these measures are used. We, the Atomic Energy Commission do not believe that inclusion of "baseline in-plant control measures" would justify an increase in the permitted design objective values, which we have set for dosages to individuals, nor do we believe that the record would justify such an action. Accordingly, and since we have already (as described above) removed the quantity limits from

IMPLEMENTATION OF NUMERICAL GUIDELINES

The numerical guidelines of Appendix I, when applied in accordance with the conditions specified therein, are a quantitative expression of the meaning of the requirement that radioactive material in effluents released to unrestricted areas from light-water-cooled nuclear power reactors be kept as low as practicable. These guidelines, particularly with respect to design objectives, are expressed as specific numerical limits for three types of effluents. The numerical aspects of this translation of the basic rule of Section 50.34a, standing along, are clearly a compromise of the rule, in the sense that a quantitative level that might be precisely as low as practicable in one case would not necessarily be so in another. The numerical guidelines were chosen on the basis that the record shows these limits to be practicably achievable for almost all cases to which we consider them applicable. Furthermore, in view of the elements of conservatism and realism inherent in the evaluations presented in the proceeding, we believe the record supports the conclusion that the maximum individual exposure likely to ensue from operation of a single nuclear power reactor in conformance with Appendix I is sufficiently small that no additional expense could be justified for reducing the exposure of an individual further.

It must be understood, in discussing the matters of calculational conservatism and realism, that Appendix I means, implicitly, that any facility that conforms to the numerical and other conditions thereof is acceptable without further question with respect to Section 50.34a. It is just as essential that Appendix I be understood as not implying, conversely, that any facility not conforming is necessarily unacceptable. Thus the numerical guidelines are, in this sense, a conservative set of requirements, and are indeed based upon conservative evaluations.

The numerical guideline values were adopted in the light of numerous evaluations of typical nuclear plants at various types of sites. These evaluations, presented by various parties, were based upon calculations of radiation doses, which generally could be understood as estimates of the level of exposure of individuals in the general public from assumed releases of radioactive material. Similar estimates will have to be made on a case-by-case basis by applicants for licenses for light-water-cooled nuclear power reactors in order to establish appropriate design objectives.

It is evident from the record that numerical estimates of radiation exposure may vary widely, depending upon the particular assumptions made. These assumptions involve the selection of appropriate mathematical expressions of natural phenomena, including the assignment of numerical values to the parameters contained in the expressions. Inasmuch as results of calculations can vary widely, an issue has been raised by some participants as to how the numerical guidelines may be implemented in consonance with the process of their adoption. The necessity and importance of adequate attention to numerical calculational procedures was expressed by Dr. Walter H. Jordan, a member of the ASLB:[1/]

> "[t]he interpretation of Appendix I is almost going to be as important a factor in what is practicable as the regulation itself."

Some parties proposed that Appendix I include guidance on implementation in order to assure that applicants have the opportunity of using reasonably realistic assumptions in their procedures for estimating radiation exposure.[2/,3/,4/] The necessity of explicit guidance is suggested on the argument that the procedures used by the Staff for calculating doses show a predisposition to make unnecessarily

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1/ Tr 2547-48.

2/ Closing Statement of the General Electric Company, pp 26-45.

3/ Statement of Position by the Consolidated Utility Group, pp 13-14, 71, and A-4.

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conservative assumptions. A typical expression of such an argument is the statement of General Electric:[1/]

> "In spite of the evidence submitted by the ALAP participants, and in spite of the admissions of the Regulatory Staff, the draft Regulatory Guides circulated by the Directorate of Regulatory Standards with the Staff's Concluding Statement confirm the previously evidenced tendency toward the use of overly conservative calculational assumptions."

The methods described in the Final Environmental Statement and in draft Regulatcry Guides attached to the Staff's concluding statements are opposed in some particulars;[2/] furthermore it was also argued that the Staff has, in the course of reactor licensing actions, generally been quite conservative in its quantitative assessment of effluent controls

Particular areas of controversy shifted as the proceeding progressed. Both General Electric and the Utilities summarized their areas of concern with regard to conservatism in closing statements as follows:[3/] CU states;

> "Examples of overly conservative assumptions and models used by the Staff are difficult to extract unambiguously from the record for two basic reasons:
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> (a) the time spanned by these proceedings has resulted in some changes in the assumptions apparently used; and
>
> (b) it is not clear whether or not models and assumptions used in the FES are also intended by the Staff to be applicable to the analysis of individual applications in the implementation of Appendix I."

[1/] Reply Statement, page 10.

[2/] Closing Statement of General Electric and Statement of Position by CU above. See also Testimony GE Exhibit 6, and GE Exhibit 7, and Oral Argument, TR 110-127.

[3/] Statement of Position, page 44.

General Electric:[1]

"Examples of overly conservative implementation methods likely to be employed for Appendix I--as they have been in current project licensing--include excessive source-term assumptions with regard to radioiodine emissions; neglect, with regard to such emissions, of their chemical form, actual release points and modes, and expected plume behavior; overestimation of deposition rates and retention factors for radioiodine on forage; and postulation of nonexistent dairy cows and unrealistic milk consumption patterns."

Following the filing of the Regulatory Staff's concluding statement, General Electric noted important improvements in the Staff's proposed Appendix I, including some dealing with calculational models; but they maintained that

"[t]he first--and in our view the most serious -- defect of Revised Appendix I is the continued absence of any guidance therein for the implementation of the Regulation. Revised Appendix I still fails to specify whether the calculational assumptions and models to be employed in implementation are to be established on a continuing 'conservative' basis or, as GE urges, on the basis of best-estimates of the relevant physical phenomena."[2]

The Staff argues neither for nor against including guidance or calculational assumptions in Appendix I, although in testimony the Staff's principal witness concedes:[3]

"....there are particularly critical points that have been raised in the hearing in specific areas with respect to implementation where perhaps at the time of issuance of Appendix I, some specific point needs to be pretty well pinned down at that point."

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[1] Closing Statement, page 5.

[2] Reply Statement, pages 2-3.

The Staff observes that Minnesota advocated including a "standard set of models and input data" in the Regulation while both General Electric and Consolidated Utilities suggest that "models, assumptions and parameters" be put into Regulatory Guides.[1/]

We believe the evidence at hand supports the decision to include Commission guidance respecting the use of conservative or realistic calculational procedures in the application of the numerical guides for design objectives. We wish to summarize the matters involved in reaching this conclusion and in applying the guidelines in accordance with Commission intent.

Calculational procedures used, in the application of Appendix I, for making the numerical estimations of radiation doses have been variously called by such terms as "calculational assumptions and models", "models and input data," "assumptions and models" or simply "models." Such procedures require the skillful use of mathematical expressions characterizing natural phenomena. It is also evident that such expressions are generally expected to yield quantitative results which are, at best, approximations to reality. Simpler models, for example, ones which would not embody any facility for taking into account differences in plant design, would not be expected to produce estimates as close to reality for a wide variety of designs as would more complex models.

Calculational procedures used for dose estimations in essence describe, albeit approximately:

(1) sources of radioactive materials and the pathways inside a plant by which such materials are released;

(2) the natural processes by which released material is transported through the environs; and

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[1/] Concluding Statement, Regulatory Staff, page 74 and State of Minnesota, Final Statement, page 11.

(3) the model receptor, that is, a real or hypothetical individual ultimately exposed to radiation.

The selection of specific models for each of these three portions of the procedure involves two types of determinations. First one must select models and data which represent the situation deemed to be important. For example, the choice of a hypothetical receptor rather than an existing individual might reflect, in part, the intent to use the guidelines as a mechanism to provide for future changes in occupancy of areas near the site. The Regulatory Staff properly identifies this as a means of expressing Regulatory intent:

> "It is the Staff's position, the example, that for purposes of design objectives for nuclear power reactors it is inadequate to base parameters only on uses of the environment as of the time the reactor is designed and constructed. Rather, future uses of the environment should be taken into account...."[1/]

Secondly, models and data must be found which represent the physical phenomena involved with some useful precision. Conflicting views have been advanced, in evidence and in argument, on all portions of the calculational procedures and for both types of selections.[2/]

It was observed by both General Electric and Consolidated Utilities that considerable progress toward agreement on models was made in the course of the proceeding, although the intent of the Staff in future implementation of the numerical guidelines on a case-by-case basis remained in doubt after the Staff's Concluding Statement was filed.[3/] We believe we have developed a suitable resolution of the differences for all practical purposes, although we realize

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1/ See Closing Statement, page 52.

2/ Note particularly the citations above to testimony, closing statement and argument of General Electric Statement of Position by Consolidated Utilities.

3/ General Electric, Reply Statement, page 2.

that some other set of guidelines might have served our purpose and pleased one party or the other more. Our resolution strongly favors the suggestions that calculational methods be realistic, which in turn has influenced our adoption of particular numerical guideline values for dose objectives. This resolution, thus, has been a strong factor in our reconciliation of the differences among parties as to those values; for GE states in their reply to Concluding Statement of the Staff:[1/]

> "The evidence is clear that, realistically applied, the dose objectives now presented in Revised Appendix I can be met without reliance on exceptions or special provisions...."

The essence of our conclusions on calculational procedures to be used in determining design objectives is given in the five following points, which we neither presume nor intend to be uniform in detail or comprehensive.

1. An applicant should be free to utilize as realistic a model for characterizing natural phenomena, including plant performance, as he considers useful. An applicant may take into account situations not adequately characterized by a standard model with respect to specific features of plant design, proposed modes of plant operation, or local natural environmental features which are not likely to change significantly during the term of plant operation.

General Electric notes several effects that should be recognized,[2/] and we restate some of them here to illustrate natural phenomena which might be partially or entirely neglected in standard models but properly considered:

radioisotopic composition of effluents;

[1/] Reply, page 24.

[2/] Concluding Statement, pages 28-32.

radioactive decay of released nuclides prior to exposure of the receptor;

waterway flow and the associated diffusion and dilution;

removal of radioactive material from solution or suspension in the water by sedimentation or other naturally occurring mechanisms or by water treatment processes;

exposure modes and occupancy or use factors;

release conditions (to the atmosphere) including elevation of release point, effluent stream buoyancy and momentum, and building geometry;

local meteorological and aerodynamic conditions influencing airborne effluent plume dispersion;

beta and gamma radiation energies for the radioisotopes released and the associated dose effects;

chemical form and physical behavior of the effluent constituents;

plume elevation, size, and depletion; shielding effects;

partitioning, filtration, and other retention and depletion effects;

deposition rates and velocities for the various chemical forms of released radioiodine on off-site vegetation, ground, and other surfaces, with appropriate apportionment to the vegetation of its capture fraction; and

weathering and other loss factors for radioiodine on grass and other vegetation.

Clearly other natural phenomena must be adequately taken into account in models used for determining design objectives. These are sufficiently established in practice that they need not be repeated here.

Although both General Electric and Consolidated Utilities asserted that the Regulatory Staff's intentions are uncertain, we believe the Staff is agreeable to accepting realistic models different from standard models. In their Concluding Statement the Staff quoted from the official statement published with each Regulatory Guide:[1/]

1/ Concluding Statement, page 83.

"Regulatory Guides are not substitutes for regulations and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission."

As further evidence of this disposition of the Staff (but not of the validity of their model) we further note that the Staff stated, in the written response to our request during Oral Argument:[1/]

"Additional data available from staff measurements at BWRs (Ref.4) but which were not received in time for inclusion in the parameters and bases given in WASH-1258 indicate that iodine releases from the radwaste building are greater than that calculated by the Staff's model and that the model should be revised....

In summary, the Staff has attempted to develop a model which realistically assesses the iodine releases from proposed reactors using data obtained from operating reactors where possible."

We particularly expect all parties to licensing actions to which Appendix I applies to note both the potential utility of Regulatory Guides and their subordinate status relative to Commission regulations and opinions. We believe the testimony of Staff witnesses in this proceeding might, by some reasonable persons, indeed be construed as indicating that the Staff has been excessively zealous in applying Regulatory Guide models.

It seems reasonable to expect the Staff to be willing to freely consider case-by-case deviations from standard models, for they state:[2/]

[1/] AEC Regulatory Staff's Response to Commission's Request During Oral Argument page 28.

[2/] Ibid., pages 37-38.

"There are many factors which influence the release aerodynamics for effluents emitted from roof vents. Some of these are shape and size of the reactor facility building complex, position of natural draft cooling towers, position of vents within the complex, local terrain conditions, and plume rise due to momentum and buoyancy. While it is agreed that at every site there are circumstances which will permit the vent plume to escape wake cavity mixing, these circumstances are not readily definable for many sites from existing data. Therefore, a general procedure, which is customarily described in Regulatory Guides, cannot be incorporated into Regulatory Guide 1.DD at this time. However, as with all Regulatory Guides, an adequately substantiated departure from the models presented in the guide will be accepted on a case-by-case basis."

2. Where selection of data is strictly a matter of interpreting experimental evidence, both applicant and the regulatory staff should utilize prudent scientific expertise to select those values which would be expected to yield estimates nearest the real case.

The matter of how to deal with uncertainties in choosing data has been an implicit part of the evaluations made by participants in the proceeding. The data used by the staff in the evaluations presented in the Final Environmental Statement were considered by General Electric and Consolidated Utilities to be seriously conservative.[1,2,3,4] The staff has conceded that conservatisms existed and were being re-evaluated continually.[5] It is our judgment,

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[1] General Electric Closing Statement, pp 5 and 29 to 43.

[2] Testimony of Ned R. Horton, GE Exhibit 6.

[3] Statement of Position, Consolidated Utilities pp 13-14 and 42 to 50.

[4] Tr 3909.

[5] Staff Response in discussion, Point 1, supra.

in consideration of the detailed discussions of the models and data in testimony, in closing statements, and in oral argument, that specific models and data should not be standardized by incorporation in Appendix I, as proposed by Minnesota.[6/] Neither do we intend to judge in this decision which of the many controversial parameter values would be particularly appropriate for use in implementing the design objective guidelines. We believe that the opportunity to modify models and data as new experimental information comes to light is a persuasive argument for permitting this matter to be dealt with by the preparation of Regulatory Guides and by case-by-case evaluations.

3. If approximations implicit in a model may produce a deviation from the true result the direction of which is either uncertain or would tend to underestimate dosage or if available experimental information leaves a substantial range of uncertainty as to the best estimate of some parameter values, or both, data should be chosen so as to make it unlikely, with all such deviations and uncertainties taken into account together, that the true dose would be underestimated substantially.

Two potential sources of deviation from a realistic dose estimate are of concern here. One is the self-inflicted use, at an applicant's discretion, of a simplified model which necessitates, in all propriety, the use of some conservatism in setting design objectives. The other is the existence, in spite of the best efforts of all parties, of experimental uncertainties respecting the selection of certain parameter values.

Mathematical models describing the various sequences of natural phenomena which relate radiation dose to releases of radioactive material

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6/ Concluding Statement, p 11.

vary in detail and complexity. This has been frequently observed in this proceeding. Through circumstances peculiar to his case one applicant may be able to present to the Regulatory Staff adequate support for his proposal through the use of simple models and conservative parameter values, while another applicant could not prove his case so easily. There is no regulatory necessity for performing the most realistic dosage estimates that are technologically achievable, if a less complex and less expensive analysis can be made to demonstrate compliance with licensing requirements. The use of the simpler procedure may, however, introduce a wider range of uncertainty in estimated doses than a more complicated analysis. Hence the proper choice of parameter values for a simple calculation might be more conservative than values used in a more precise calculation.

The matter of dealing with uncertain data was discussed at several points in the Oral Arguments.[1/] There was an apparent reluctance to express, in concise language, a general definition of the degree of conservatism or realism considered appropriate or a precise definition of "best estimate." We, also, are reluctant to propound a precise general rule on this point, because the circumstances of application vary too widely to permit us to do so. The record shows that the quality and quantity of experimental data are far from uniform from case to case, site to site, and phenomenon to phenomenon.

We believe the record contains adequate evidence that sufficient data exist for making all the necessary dose estimates, although there are uncertainties respecting many of the parameters. Values that would be appropriate are sometimes said to lie between an "upper bound" and "lower bound",

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[1/] Oral Argument Tr 21, 35-40, 104-110, and 129-130.

or, in some cases, the value would lie somewhere among scattered experimental data points. The Oral Argument exemplifies the difficulty of stating a precise rule for dealing with such uncertainties but supports the propriety of striving for realism while maintaining some sense of conservatism. The Regulatory Staff's attitude is:

> "....that we do not take a thorough conservative upper bound or the lower bound consistently on these parameters."[1]

Later, in the course of lengthy discussion Mr. James M. Smith of General Electric explained:[2]

> "If you have a nine- ..t pathway, you may have to use averages to come up with a reasonable best estimate throughout the entire pathway. If your pathway is much simpler, involving only one or two factors, then there may be some justification for being on the conservative side of the mean."

The models described in the record of the hearing and the evidence and arguments advanced with regard to numerical estimation of dosage lead us to the conclusion that one should try to attain realistic estimates, but where uncertainties exist one should choose calculational procedures that are unlikely to produce substantial underestimates. We believe, furthermore, that it is in the best interest of the public to make realistic estimates, even with uncertain data, and to depend upon the programs for improving models and data, particularly programs of in-plant measurements, to determine whether proper case-by-case design decisions were made.[3]

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[1] Mr. Lester Rogers, Oral Argument TR 38. "Bound" was transcribed as "band".

[2] Oral Argument TR 129-130.

[3] See Staff's Concluding Statement, pages 60-61.

Surveillance and quantitative monitoring of effluents are required by existing regulations; additional guidelires for collection of data, for each operating plant, have been proposed for and are included in Appendix I.

4. The models used in describing effluent releases should take into account all real sources and pathways within the plant; and the estimated releases should be characteristic of the expected average releases over a long period of time, with account taken of normal operation and anticipated operational occurrences over the lifetime of the plant.

The record is free from significant controversy as to the general model of an operating plant that should be assumed for the purpose determining design objectives. The schedule of operation assumed by an applicant, if it turns out to be unrealistic, may later impose some inconvenience or expense on him through the influence of limiting conditions of operation adopted in accordance with Appendix I. This possibility is one to which the applicant would normally be sensitive but would not diminish the protection of the public from the effects of radioactive discharges.

5. The model of the exposed individual and the assumed characteristics of the environs with respect to human occupancy and to land and water use should be determined in each case in accordance with the intent indicated below for each particular category of effluent for which design objective guidelines are given.

a. For design objectives affected by assumptions as to consumption of water or food (other than fresh milk) produced in the environs one should consider the model individual to be that hypothetical individual who would be maximally exposed with account taken only of such potential occupancies and usages as could actually be realized during the term of plant operation.

b. For design objectives affected by exposure as a direct result of human occupancy (immersion exposure) the model individual should be the hypothetical individual maximally exposed with account taken only of such potential occupancies, including the fraction of time an individual would be exposed, which could actually be realized during the term of plant operation.

We are persuaded by the evidence that at most sites, with realistic modeling of the natural phenomenon affecting these exposure pathways, design objectives based upon reasonable occupancy times and intake values could conform to guideline values at reasonable cost of control, even for a hypothetical receptor.[1/] Consolidated Utilities presented substantial evidence, as an extention of Staff evaluations presented in the Final Environmental Statement, to establish a level of effort they consider to be "justified on a cost-benefit basis." They conclude[2/]

"For both PWR and BWR liquid effluents waste treatment augments, with the addition of the augments listed above which appear to be justified on a cost-benefit basis in terms of population dose reduction, the individual whole body dose objective of 5 mrem from liquid effluents is also met. None of the other augments considered in the Final Environmental Statement are either justified or necessary."

This conclusion and the further conclusions of Consolidated Utilities in this same place[3/] with respect to justification of noble gas effluent controls, when

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1/ See General Electric Reply, page 24.
2/ Statement of Position, p 33.
3/ Statement of Position, items 2 and 3, pages 33-34.

considered with the numerical guidelines of Appendix I now issued, point to a fortunate capacity to control effluents from the light-water-cooled reactors in most expected circumstances on the gasis of a hypothetical individual. We considered the possibility of specifying that all design objectives be determined solely on the gasis of actual human occupancy at the time of plant design such as was proposed by Consolidated Utilities.[1/] To adopt guidelines which would leave generally all consideration of future use of the environs to post-licensing regulation would be unwise in the instances where it has been clearly shown that an accommodation of reasonable potential future uses can be accomplished at reasonable cost. This is the case for all effluents except radioactive iodines and particulates released to the atmosphere. We believe the record shows it would be better in these instances to determine the design objectives with respect to potential future uses. This not only takes the economic balance into account but also the less tangible but equally important values of environmental quality and protection of the individual.

We have taken into account the fact that the analyses which have led to such a general conclusion were based upon conservative hypotheses. We are mindful as already mentioned, that the numerical guidelines cannot coincide exactly with the effects of measures that are "as low as practicable" in every case. Therefore, the Appendix I guidelines should not and do not prohibit an applicant who may have difficulty complying with the guidelines with respect to these exposure pathways from proceeding on the basis of Section 50.34a alone. We anticipate that some special circumstances may arise which would make it advantageous to the applicant to base his case upon a cost-benefit analysis.

1/ Statement of Position, items 2 and 3, page A-4.

We believe this option will provide adequate relief in such a case, for the Consolidated Utilities stated:[1]

"We would not, of course, object to a requirement that all in-plant control measures which can be justified by a cost-benefit analysis for a particular site be included."

General Electric described their conception of proper use of exceptions to design objective guidelines as follows:[2]

"Such exceptions should be restricted to unusual situations and effects not reflected in the standard itself or in the decisional processes leading thereto. Thus, for example, exceptions might properly be incorporated in Appendix I for the special cases of:

(1) currently operating reactors for which the cost-benefit status of equipment augments is highly site-dependent and differs substantially from that for plants in the design stage,

(2) multi-reactor sites as to which certain environmental and economic considerations not fully explored in the ALAP proceeding may apply on a case-by-case basis, or

(3) unique or highly unusual sites or reactor installations. Such exceptions should not, however, be a major intended means of avoiding the clearly unjustifiable operation of general standards for large numbers of plants whose characteristics were fully explored in the ALAP proceeding and were, in fact, taken as the norm for the Staff's testimony and Environmental Statements."

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[1] Statement of Reply, page 10.

[2] Reply,, pp 23-24.

There is substantial controversy in the record on the proper assumptions respecting such factors as the location of the source of drinking water, the habitat of fish caught and consumed locally and individual intake of water, fish, and other foods. Some of these assumptions, in our view, are in the realm of natural phenomenology and, therefore, should be dealt with in accordance with points 1 to 3, supra. For example, dilution of effluents in receiving waters, fish habits, and normal human intakes of food and water should be considered on the basis of experimental evidence scientifically evaluated.

We do believe, however, that the particular habits of the hypothetical receptor should take into account a reasonable and real departure of the habits of people from the average. We would not think it reasonable, on the other hand, to assume bizarre characteristics as those of a hypothetical gardener, who receives all of his fresh vegetables from a hypothetical fence-post garden and consumes them immediately upon harvesting without washing or other processing, as was assumed for some of the evaluations of the Final Environmental Statement.[1/] Such extreme assumptions have served their purpose in simplifying the evaluations involved in reaching a decision on Appendix I but would not be appropriate in case-by-case implementation of the guidelines.

We doubt that we differ much in this regard with the recommendation of Consolidated Utilities, who stated:[2/]

> "In our view the off-site individual selected for determining the limiting dose should instead be one whose living and recreational habits, and whose water and food consumption habits, are representative of a significant number of persons living in the area of maximum exposure. Further, the dose calculational models used in estimating doses to such an individual should be as realistic as possible."

[1/] Tr 3402-3, 3429-30.

[2/] Statement of Position, pages 43-44.

With realistic calculational models, food chains, and occupancy taken into account, we believe the record shows that one should and can account for persons who are not average, even in a local sense.

c. For design objectives relative to thyroid dose as affected by consumption of milk the iodine pathway through the environs of a plant and the characteristics of the model receptor should be essentially as they actually exist at the time of licensing.

There was strong agreement among participants throughout much of the hearing that the iodine pathway leading to thyroid exposure through consumption of milk would be the most difficult one to accommodate in the context or originally proposed numerical guidelines for establishing design objectives. At this time it is still an exceptional case. The estimated economic costs of instituting in-plant controls of iodine emissions are high enough to change the overall balance of the decision in favor of requiring that only actually existing food pathways need to be taken into account. Of course this does not deny any applicant the privilege of assuming more conservative hypothetical pathways and thus avoiding the task of keeping up in detail with future changes in the environs.

—Many elements of conservation estimates of radiation exposure discussed in points 1 to 4 supra, were of serious concern to the parties only with respect to the iodine-milk-thyroid pathway. The implementation guidance respecting attainment of more realistic estimates will permit many plants to conform to the thyroid dosage guidelines irrespective of whether a real or hypothetical environmental pathway is the basis of design objectives. Nevertheless, on the basis of present knowledge of the entire pathway from in-plant source to receptor, there would be many plants that could not meet the numerical guideline on the basis of a hypothetical food pathway to an individual without in-plant controls the cost of which of which outweighs the incremental benefit to the population at large.

In adopting this guidance for radioactive iodines and particulates discharged into the atmosphere we have considered the following special questions:

Is every individual adequately protected from excessive exposure?

Is individual freedom of access and use of unrestricted areas assured?

Is the likely cost of implementation in this way less than that of providing additional in-plant controls at the outset?

Is the possible future curtailment of productivity of the environs justifiable?

The record supports an affirmative answer to each of these questions. Individual protection of real persons is no less than that provided for other effluents. Special requirements for surveillance are included to detect, before significant exposure could occur, any important changes in land usage. If such changes were to occur the licensee, not the member of the public, would be obligated to control emissions or other elements of the exposure pathway in such a way as to maintain individual exposures in conformance with design objective guidelines. Thus an individual would be free of any infringement upon his rights to use the environs.

The practicability of deferring some controls until real necessity is eminent is evident from the evaluations of the Staff, General Electric, and Consolidated Utilities. Such a course was recommended in the Closing Statement of these three parties. General Electric expresses the principle arguments in one place as follows:[1/]

1/ Closing Statement, page 35. See also further argument on pp 39-41.

"In the extremely rare instance where, after licensing, plans are developed and actions are taken to bring about such production and consumption patterns, doses as large as those predicted by the Staff will, in all probability, still not result because the design margins customarily built into LWR equipment will normally cause actual emissions to remain below their design basis values....Even if doses exceeding the numerical guides should result, reasonable and inexpensive steps would almost certainly be available at that time to reduce such exposures without the necessity of expensive equipment augmentation such as that which the Staff's approach would mandate in each instance during initial plant construction."

Furthermore the evidence shows that with additional experience and data from operating plants the most likely result will be that estimates based upon present-day source models and assumptions are unrealistically high.[1/] This factor will be of transitory value, however, in providing a buffer against having to backfit; because, as models used at the time of plant design become more realistic there is less chance of proving significant improvement in computational methods with further experience. It is our judgment, therefore, that the most beneficial use of resources in control of these particular effluents will be attained by permitting the use of actually existing food pathway in determining design objectives.

It should be noted that it would be permissible for a licensee to effect compliance with Appendix I by making arrangements with persons holding land rights in the vicinity of a nuclear plant so as to control or restrict the production and consumption of milk. The impact of any such controls as might be needed to comply with the guidelines on the potential productivity of a local region would, at worst be negligible.

GUIDES ON TECHNICAL SPECIFICATIONS

FOR LIMITING CONDITIONS FOR OPERATION

Section 50.36a(b) of 10 CFR Part 50 provides that licensees shall be guided by certain considerations in establishing and implementing operating procedures specified in technical specifications that take into account the need for operating flexibility and at the same time assure that the licensee will exert his best efforts to keep levels of radioactive materials in effluents as low as practicable. The Appendix I that we adopt provides more specific guidance to licensees in this respect.

We expect that the annual releases of radioactive materials in effluents from light-water-cooled nuclear power reactors can generally be maintained within the levels set forth in the foregoing as numerical guides for design objectives. It is certainly expected that the licensee will, under all circumstances, exert his best efforts to keep levels of radioactive materials in effluents from light-water-cooled nuclear reactors within the design objective guides. At the same time the licensee should, in our opinion, be permitted some flexibility of operation, consistent with sound considerations of public health and safety, to assure that the public is provided with a dependable source of power even under unusual conditions of operation that may temporarily lead to releases of radioactive materials higher than those specified as the design objective guides.

The Regulatory Staff has consistently argued[1,2] that such operating flexibility is necessary, especially in view of the very low release levels inherent in their versions of Appendix I. As the Record shows, there is considerable disagreement as to the need for- and/or to the quantitative

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[1] ALAP Regulatory Staff Exhibit 1 Tab 1.

[2] Concluding Statement of Position of the Regulatory Staff, pp 32 and 68-70.

nature of - such operating flexibility.

The Consolidated Utility Group has argued[1] that "the degree of operating flexibility provided in proposed Appendix I is too restrictive and may threaten power system reliability." Dr. Merril Eisenbud, appearing for the Atomic Industrial Forum, also indicated that the action levels proposed by the Regulatory Staff were unduly restrictive.[2] The Gulf General Atomic Company[3] also has argued that insufficient operational flexibility is provided as has the Bechtel Power Corporation.[4] Similar arguments were presented by Ebasco Services.[5] In addition, the American Electric Power Service Corporation[6] would permit the radioactive release limits of 10 CFR Part 20 to serve as action limits to insure adequate operating flexibility.

On the other hand, National Intervenors, Inc. contended that no provisions for operating flexibility were necessary or desirable.[7] Moreover, the State of Minnesota in its Final Statement[8] argues that there has been no showing by the utilities of a need for operating flexibility that such provisions for operating flexibility should be deleted, and that the numerical guides for design objectives should be treated as maximum limits never to be exceeded.

1/ Statement of Position of Consolidated Utility Group, Jan. 19, 1974, p 16.

2/ Hearing Transcript, p 86, Statement by Merril Eisenbud, p 6.

3/ ALAP Final Environmental Statement, Wash01258, July 1973, p 61.

4/ Ibid., pp 91-92.

5/ Hearing Transcript, pp 109-116.

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7/ Anthony Roisman to Algie A. Wells et al., Feb. 15, 1972.

8/ Final Statement of Position of State of Minnesota, Feb. 1, 1974, pp 4-5.

We, the Atomic Energy Commission, agree with the Regulatory Staff that experience has shown that there will be variations in fuel element performance and in radwaste equipment performance, that these variations may, on a transient basis, result in levels of radioactivity in effluents that exceed the design objective numerical guide values, and that operational flexibility, within the very low ranges of release rates involved is necessary in order that nuclear reactors have a high degree of reliability. We, accordingly, reject the arguments to the contrary presented by Consolidated National Intervenors and by the State of Minnesota. We are almost equally unimpressed with the arguments of the several parties whose position is that the proposed limiting conditions for operation are too restrictive.

Accordingly, in the Appendix I that we adopt we have set the guide on technical specifications for limiting conditions, for operation of light-water-cooled nuclear power reactors as follows:

For any individual light-water-cooled nuclear power reactor the licensee shall, if the quantity of radioactive material actually released in effluents to unrestricted areas during any calendar quarter is such that the resulting radiation exposure - estimated on the same basis as the design objective exposures - would exceed one half the design objective estimated annual exposure, make an investigation to identify the causes for these high release rates, define and initiate a program of action to correct the situation, and report these actions to the Commission within 30 days of the end of the calendar quarter.

For individual light-water-cooled nuclear power reactors, the Commission will take appropriate action to assure that release rates are reduced if (1) the quantity of radioactive material actually released during any calendar quarter is such that the annual exposure, estimated on the same basis as the

design objective exposures, would exceed twice the design objective annual exposure, or (2) if the quantity of such radioactive material actually released in effluents to an unrestricted area during any consecutive 12 months is such that the resulting radiation exposure - estimated on the same basis as the design objective exposures - would exceed four times the design objective exposure values.

It is intended that the limitations described immediately above shall apply to each light-water-cooled power reactor. We have, in addition, placed a further restriction upon all light-water-cooled nuclear power reactors on a site or on neighboring sites. This limit seems to us to be practicable since it is deemed likely that individual reactors will need the advantage of this operating flexibility for only a relatively small fraction of their operating time and all reactors on a multi-reactor site could scarcely be presumed to require this operating flexibility provision simultaneously. Accordingly, we have decided that the licensee shall make an investigation to idenfity the causes for the increased release rates, define and initiate a program of corrective action, and notify the Atomic Energy Commission if the quantity of radioactive materials from all light-water-cooled reactors on a site or on nearby sites during any calendar quarter is such that the resulting radiation exposures during that quarter exceed 75 percent of the estimated design objective exposures.

The Commission will take appropriate action to assure that release rates are reduced if the quantity of radioactive materials actually released in effluents to unrestricted areas from all light-water-cooled nuclear power reactors on a site or on nearby sites during any calendar quarter are such that (1) the resulting radiation exposure would exceed the estimated annual design objective exposure or (2) that the quantity of radioactive material actually released in

any consecutive 12 month period from all light-water-cooled nuclear power plants or on site or on nearby sites is such that the resulting radiation exposure would exceed twice the annual design objective exposure.

These provisions will, we believe, assure the necessary flexibility for operation of light-water-cooled nuclear power reactors both alone and in combination while at the same time assuring that radiation exposures to individuals in the vicinity of such nuclear reactors will be, at the most, a small fraction of those permitted by present radiation protection standards.

The licensee is required, in addition, to conduct an appropriate surveillance and monitoring program to provide data on quantitatives of radioactive materials released in liquid and gaseous effluents to assure that the provision of this Appendix I are met, to provide data on measurable levels of radiation and radioactive materials in the environment to evaluate the relationship between quantities of radioactive materials released and radiation dosages to individuals, and to identify changes in the use of unrestricted areas to permit modifications in monitoring the doses to individuals from principal pathways of exposure.

It is further provided that if the data developed in the surveillance and monitoring program described above show the relationship between quantities of radioactive materials released in effluents and the dose to individuals in unrestricted areas is significantly different from that assumed in the calculations used to determine design objective limits the Commission may modify the quantities in the Technical Specifications defining the limiting conditions for operation in a license authorizing operation of the light-water-cooled power reactor.

SURVEILLANCE AND MEASUREMENTS IN OPERATING PLANTS

Experience with operating nuclear power reactors of the light-water-cooled type and measurement of effluents from these plants was recognized by the Commission as one of the substantial bases on which the as low as practicable provisions of 10 CFRPart 50 were proposed and adopted in 1970.[1/] The quantitative data that can be acquired in the future through programs of measurement and seuveillance in the plant as well as in the environment have been noted by several participants as being of special importance in implementing the "as low as practicable" policy and Appendix I.

Quantitative measurement of radioactive materials released in effluents has always been required of persons licensed to operate nuclear power plants. Indeed, the amendments to Part 50 published December 3, 1970, require that all such licensees periodically report to the Commission "the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents....and such other information as may be required by the Commission to estimate maximum potential annual radiation doses to the public resulting from effluent releases."[2/]

It is clear that information derived from actual observation and measurement of environmental factors should be an essential part of the data supplied the Commission pursuant to paragraph 50.36a(a)(2) cited above. This position was strongly advocated by Dr. Edward P. Radford in testimony offered on behalf of National Intervenors.

"In my opinion the proposal of a whole body dose of 5 mrem per year is quite acceptable, and indeed may be too restrictive, if only because it

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[1/] 35 F.R. 5414 and 18387.

[2/] 10 CFR 50.36a(a)(2).

will be difficult to monitor effluents at levels consistent with this low exposure rate."[1/]

He further stated:

"[I]f we cannot measure the effluents from a power plant that are relevant to the human dose at these low dose-rates, low total cumulative doses,... then we have lost control of them because we are simply asking someone to produce an environmental effect that is not measurable, almost.

So the tenor of some of my later remarks in my testimony reflect this concern, that unless we can actually define the environmental radiation exposures in a way that can be translated into human doses, we have not necessarily made a step forward."[2/]

Finally, Dr. Radford was asked:

"[Do you] believe that as an adequate measurement technique is to establish quantities in concentration levels that the reactor itself might generate, and then to calculate from those quantities and calculations what the dose might be, at the boundary, taking into account the -- what we call -- site dependent characteristics?"

to which he replied:

"My answer to that question is no, I do not, emphatically."[3/]

This preference for measured confirmation of estimates was held also by General Electric. With regard to observations that could be made at an operating plant they state:

"The surveillance and monitoring approach for potential sensitive exposure pathways is entirely feasible for LWR stations in general,

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[1/] National Intervenors' Exhibit 3, page 3.

[2/] TR 2072.

[3/] TR 2077.

and it would provide a means for refining and correcting the Staff's conservative calculational models."[1/]

General Electric also advocates that the backfitting decisions be made on the basis of results of on-site and off-site monitoring.[2/]

The evidence is convincing that further measurements relating actual releases of radioactive materials to individual radiation exposure will be of substantial value. Measured levels of environmental radioactivity are generally small in comparison with values calculated from known or pressured release rates.[3,4/] The Staff's models for estimating radiation exposure are continually subject to revision as new data become available.[5/] Mr. Rogers testified for the Staff:

"So our plan is to issue specific guidance with respect to the models which would be used in implementing Appendix I. I am not sure exactly what form those models would take because I think there is little question but that the models will change as new information becomes available."[6/]

The conservatism of calculational models necessitated by lack of data on which to substantiate more realistic models induces a strong economic incentive to seek, in some cases, more experimental measurements of important parameters.[7/]

1/ Closing Statement, p 41. See also supporting testimony of General Electric (Mr. James M. Smith), Exhibit 7.

2/ Closing Statement, pp 55-56.

3/ Consolidated Utilities, Statement of Position, p 36.

4/ General Electric, Reply, pp 16-18.

5/ Staff's Concluding Statement, p 16.

6/ TR 3409.

7/ GE Concluding Statement, p 5. Consolidated Utilities, Statement of Position pp 13-14, Item 7.

to be included in technical specifications. The manner and timing for applying the additional guidelines of Appendix I to various cases are matters which stimulated considerable debate in the proceeding.

The essence of the Staff's position is:[1/]

"...that the limiting conditions for operation described in Section IV of Appendix I be applicable upon publication to technical specifications included in any license authorizing operation of a light-water-cooled nuclear power reactor constructed pursuant to a construction permit for which application was filed on or after January 2, 1971. For all other operating licenses, technical specifications in conformity with the guides in Section IV should be developed within 24 months from the effective date of Appendix I and included in any license authorizing operation of a light-water-cooled nuclear power reactor. The amendments to Part 50, Sections 50.34a and 50.36a requiring that levels of radioactivity in effluents from light-water-cooled nuclear power reactors be kept as low as practicable have been in effect for more than three years and substantial progress has been made by licensees in augmenting radwaste systems. It is the Staff's view that 24 months is a reasonable period of time to complete modifications that may be required to meet the Appendix I limiting conditions of operation to be included in technical specifications of operating licenses."

General Electric, in its reply to this Staff proposal, commented only on the merits of backfitting, that is augmenting of plants already constructed or in operation with additional control equipment. They argue:[2/]

[1/] Concluding Statement, pages 73-74.

[2/] Reply, pages 34-35.

Furthermore, the information on the quantities of radioactive material in effluents of these plants indicate no need for any precipitous action that would be applicable to all existing plants alike.[1/] These two factors lead us to conclude that the licenses for existing plants should be considered case-by-case. As noted elsewhere in this statement, the design objective guidelines of Appendix I do not preclude an applicant from prosecuting his case on the fundamental definition of the term "as low as practicable" in Section 50.34a(a). Under the terms of Appendix I as presently adopted a person holding a license to operate an existing plant has, inherently, no less right to follow such a course. Hence, it is unnecessary, and would be redundant, to include any statement for this special case specifically permitting a case-by-case evaluation. Likewise, we consider it superfluous to state, in the detail suggested by General Electric,[2/] the methods that would be permissible as bases for establishing design objectives. We agree that it would be preferable to base evaluations of design objectives upon actual operating experience with the reactor in question in cases where substantial relevant information has been accumulated during plant operations.

The scheduling of compliance with Section 50.36a in the light of the new guidance of Appendix I is a further matter for which varying resolutions were proposed. All parties considering this point in concluding statements agreed that guidelines with respect to both design objectives and limiting conditions for operation should be applicable, as soon as effective, to all cases for which an application for a construction permit was filed on or after January 2, 1971. For all other cases, the Staff originally proposed a 36 month

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[1/] AEC Exhibit 27.

[2/] Closing Statement, pages 54and 56.

period for compliance and finally proposed a 24 month period.[1,2] General Electric proposed that 36 months be allowed for compliance;[3] while Consolidated Utilities would set no deadline except for a 12-month period within which holders of permits or licensees would have to file plans with the Commission.[4]

In view of the facts already asserted, that there is no hazard presently and generally being imposed by plants which were not licensed in accordance with the specific proposed guidelines of Appendix I, we have concluded that it is reasonable to allow twelve months for development and submission of plans for Commission approval and thirty-six months for complete conformity of operating reactors, with allowance for any unusual delay for Commission review. In arriving at these time allowances we have little factual evidence from any party as to the time actually needed. The information in the Staff's Concluding Statement on the actions of licensees to comply with "the Staff's interim licensing design objectives and guidelines" would have been of little value for this purpose, even if it had been undisputed or a part of the evidentiary record.[5] We believe, however, that with official notice being taken of the times actually elapsed from dates of application to dates of issuance of permits and licenses, the period allowed for compliance is adequate.

1/ 36 FR 11113.

2/ Concluding Statement, p 35.

3/ Closing Statement, pp 54-57.

4/ Statement of Position, pp A7-A8.

5/ See Concluding Statement, p 73 and Annex.

APPLICATION OF APPENDIX I TO OTHER FACILITIES

The State of Minnesota,[1] expressed disappointment that Proposed Appendix I applied only to light-water-cooled nuclear reactors. Minnesota argued that the types of waste generated by other nuclear facilities are similar to those of light-water-cooled reactors and that the cleanup technology considered in the hearing could also be used at facilities of other types. They believe that the record would support a Commission decision to "make the dosage limitations of Proposed Appendix I applicable to other facilities in the uranium fuel cycle."[1]

National Intervernors, Inc. (NI) also addressed this point through testimony of Dr. Edward P. Radford[2,3] who stated:[2]

> "The proposed standards are to be applied only to nuclear power plant operations, and commercial fuel reprocessing plants have not been included. This omission is serious, and because of it we have the anomaly that the Dresden, Illinois nuclear power plants presumably will have to meet these new standards, while the Midwest Fuel Reprocessing Plant less than a mile away would be permitted to release radionuclides in accordance with the old standards."

Several parties, including the Division of Health of the State of Florida,[4,5] Dr. Michail McClintock,[6] Wisconsin State Senator Douglas Lafollette[7], and the State of New York,[8] in their comments on the Draft Environmental Statement also

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1/ Final Statement of Position of the State of Minnesota, Chapter IIA, Feb. 1, 1974.

2/ AIAP NI Exhibit 3, Testimony for U.S. Atomic Energy Commission Hearings on Standards for Release of Radionuclides to the Environment from Nuclear Facilities, Edward P. Radford, M.D.

3/ Hearing Transcript, 2065-66.

4/ Final Environmental Statement, Wash-1258, July 1973, Vol. 3, p 30.

5/ Ibid., p 46.

6/ Ibid., p 36.

7/ Ibid., p 38.

8/ Ibid., p 115.

or after January 2, 1971, the application must also identify the design objectives, and the means to be employed, for keeping levels of radioactive material in effluents to unrestricted areas as low as practicable.

Section 50.36a contains provisions designed to assure that releases of radioactive material from nuclear power reactors to unrestricted areas during normal reactor operations, including expected operational occurrences, are kept as low as practicable.

This Appendix provides numerical guides for design objectives and limiting conditions for operation to assist applicants for, and holders of, licenses for light-water-cooled nuclear power reactors in meeting the requirements of Sections 50.34a and 50.36a by assuring that the radiation exposure to individuals as a result of radioactive material in effluents released from these facilities to unrestricted areas be kept as low as practicable. Design objectives and limiting conditions for operation conforming to the guidelines of this Appendix shall be deemed to comply with the as low as practicable requirements of 10 CFR Sections 50.34a and 50.36a. The guides presented in this Appendix are appropriate only for light-water-cooled nuclear power reactors and not for other types of nuclear facilities.

SECTION II. GUIDES ON DESIGN OBJECTIVES FOR LIGHT-WATER-COOLED NUCLEAR POWER REACTORS LICENSED UNDER 10 CFR PART 50

The guides on design objectives set forth in paragraphs A and B of this section may be used by an applicant for a permit to construct a light-water-cooled nuclear power reactor as guidance in meeting the requirements of 50.34a(a).

A. The applicant shall provide reasonable assurance that the following design objectives will be met.

gaseous effluents as low as practicable if the applicant provides reasonable assurance that the proposed higher quantity will not result in an estimated annual external dose to any individual in unrestricted areas in excess of 5 millirems to the total body or 30 millirems to the skin.

3. The calculated annual total quantity of all radioactive iodine and radioactive material in particulate form above background to be released from each light-water-cooled nuclear power reactor in effluents to the atmosphere will not result in an estimated annual dose or dose commitment for any individual in unrestricted areas from all pathways of exposure in excess of 15 millirems to any organ.

4. In addition to the provisions of subparagraphs A.1,A.2, and A.3 above, the applicant shall include in the radwaste system all items of reasonably demonstrated technology that, when added to the system sequentially and in order of diminishing cost-benefit return, can effect reductions in dose to the general population for costs not in excess of $1500 per man-rem or of $500 per man-thyroid-rem.

B. The design objective guides of subparagraphs A.1, 2, 3, and 4 of this Section shall apply separately to each light-water-cooled nuclear power reactor. In addition, the applicant shall provide reasonable assurance that the proposed reactor, in combination with all other light-water-cooled nuclear power reactors on the site and on nearby sites will meet the following design objectives.[1/]

[1/] "Other light-water-cooled nuclear power reactors" means, for the purposes of this paragraph, light-water-cooled nuclear power reactors for which applications have been filed with the Commission for construction permits and which are expected to operate while the proposed reactor operates.

1. The calculated annual total quantity of all radioactive material above background to be released from the proposed reactor in combination with all other light-water-cooled nuclear power reactors on the site and on nearby sites in liquid effluents to unrestricted areas will not result in an estimated annual dose or dose commitment for any individual in unrestricted areas from all pathways of exposure in excess of 10 millirems to the total body, 30 millirems to any organ and 60 millirems to the skin.

2.a. The calculated annual total quantity of all radioactive material above background to be released from the proposed reactor in combination with all other light-water-cooled nuclear power reactors on the site and on nearby sites in liquid effluents to unrestricted areas will not result in an estimated annual air dose at any location near ground level which could be occupied by individuals in unrestricted areas in excess of 30 millirads for gamma radiation and 60 millirads for beta radiation.

b. Notwithstanding the guidance of subparagraph B.2.a above:

(1) The Commission may specify, as guidance on design objectives, a lower quantity of radioactive material above background in gaseous effluents to be released to the atmosphere if it appears that the use of the design objectives in that subparagraph is likely to result in an estimated annual external dose to any individual in unrestricted areas in excess of 15 millirems to the total body; or

(2) Design objectives based upon a higher quantity of radioactive material above background in gaseous effluents to be released to the atmosphere than the quantity specified in that subparagraph may be deemed to meet the requirements for keeping levels of radioactive material in gaseous effluents as low as practicable if the applicant provides