NUREG-0880
Revision 1
For Comment

Safety Goals for Nuclear Power Plant Operation

U.S. Nuclear Regulatory Commission

Office of Policy Evaluation

NOTICE

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Office of Policy Evaluation
U.S. Nuclear Regulatory Commission
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ABSTRACT

This report presents and discusses the Nuclear Regulatory Commission's, "Policy Statement on Safety Goals for the Operation of Nuclear Power Plants." The safety goals have been formulated in terms of qualitative goals and quantitative design objectives. The qualitative goals state that the risk to any individual member of the public from nuclear power plant operation should not be a significant contributor to that individual's risk of accidental death or injury and that the societal risks should be comparable to or less than those of viable competing technologies. The quantitative design objectives state that the average risks to individual and the societal risks of nuclear power plant operation should not exceed 0.1% of certain other risks to which members of the U.S. population are exposed. A subsidiary quantitative design objective is established for the frequency of large-scale core melt. The significance of the goals and objectives, their bases and rationale, and the plan to evaluate the goals are provided. In addition, public comments on the 1982 proposed policy statement and responses to a series of questions that accompanied the 1982 statement are summarized.

TABLE OF CONTENTS

I. INTRODUCTION

In February 1982, the Commission issued a FOR COMMENT version of NUREG-0880 entitled, Safety Goals for Nuclear Power Plants: A Discussion Paper. That report contained a proposed policy statement on safety goals for nuclear power plants and an accompanying Federal Register Notice. The draft report also contained a discussion of how the proposed qualitative goals and associated numerical guidelines were developed and a discussion of the alternative goals and guidelines that were considered. The Federal Register Notice solicited public comments on the proposed policy statement.

In response to the public comments on the proposed policy statement and the issue-oriented questions, the Commission issued a revised policy statement on safety goals for the operation of nuclear power plants for a two-year evaluation period. The Commission also issued an evaluation plan which describes the activities to be performed during the period of evaluation of the safety goals and solicited comments on the evaluation plan. This revised version of NUREG-0880 contains the revised policy statement with the additional views of Commissioners Gilinsky, Ahearne, and Asselstine, the evaluation plan, an abstract of the public comments on the initially proposed policy statement, and a Federal Register Notice. This report also contains a discussion of the modified qualitative safety goals and quantitative design objectives and a discussion of the changes from the proposed policy statement.

This report has been prepared at Commission request by the Office of Policy Evaluation. Other NRC staff members have contributed to this report.

II. DISCUSSION

A. Purpose and Scope

In its response to the recommendations of the President's Commission on the Accident at Three Mile Island, the Nuclear Regulatory Commission (NRC) stated that is was "prepared to move forward with an explicit policy statement on safety philosophy and the role of safety-cost tradeoffs in the NRC safety decisions." The policy statement presented here is a step in that direction. Current regulatory practices are believed to ensure that the basic statutory requirement, adequate protection of the public, is met. Nevertheless, current practices could be improved to provide a better means for testing the adequacy of and need for current and proposed regulatory requirements. The Commission believes that such improvement could lead to a more coherent and consistent regulation of nuclear power plants, a more predictable regulatory process, a public understanding of the regulatory criteria that the NRC applies, and public confidence in the safety of operating plants. The statement of NRC safety policy expresses the Commission's views on the acceptable level of risks to public health and safety and on the safety-cost tradeoffs in regulatory decisionmaking.

The policy statement focuses on the risks to the public from nuclear power plant operation. These are the risks from release of radioactive materials from the reactor to the environment from normal operations as well as from accidents. The Commission will refer to these risks as the risks of nuclear power plant operation. The risks from the nuclear fuel cycle are not included in the safety goal. These have been considered in their own right and determined to be quite small. They will continue to receive careful consideration. The possible effects of sabotage or diversion of nuclear material are also not presently included in the safety goal. At present there is no basis on which to provide a measure of risk on these matters. It is the Commission's intention that everything that is needed shall be done to keep such risks at their present, very low, level; and it is our expectation that efforts on this point will continue to be successful. With these exceptions, the Commission intends that the risks from all various initiating mechanisms be taken into account to the best of the capability of current evaluation techniques.

In the evaluation of nuclear power plant operation, several types of releases are considered by the NRC staff. The risks to the public resulting from operating nuclear power plants are addressed in current NRC practice as follows. Before a nuclear power plant is licensed to operate, NRC prepares an environmental impact assessment which includes an evaluation of the radiological impacts of routine operation of the plant and accidents on the population in the region around the plant site. The assessment is subjected to public comment and may be extensively probed in adjudicatory hearings. For all plants licensed to operate, NRC has found that there will be no measurable radiological impact on any member of the public from routine operation of the plant. (Reference: NRC staff calculations of radiological impact on humans contained in Final Environmental Statements for specific nuclear power plants, e.g., NUREG-0779, NUREG-0812, and NUREG-0854.)

The objective of the Commission's policy statement is to establish goals which limit to an acceptable level the radiological risk which might be imposed on the public as a result of nuclear power plant operation. While this policy statement includes the risks of normal operation, normally expected transients, design-basis accidents, and severe accidents, the Commission believes that risks from routine emissions are small and therefore does not believe that they need to be routinely analyzed on a case-by-case basis in order to demonstrate conformance with the safety goals.

Because the specific licensing and other regulatory decisions pertinent to nuclear power plants are often expressed in terms of operational directives (that is, they are usually related to prescriptive requirements on design, hardware, procedures, etc.), the bases for the decisions are generally described in issue-specific terms rather than in terms of NRC's underlying safety philosophy. The nature of these directives contributes to the difficulty in understanding the Commission's interpretation of "adequate protection."

A great deal more is known today about nuclear reactor technology than was known in the early 1960's. Safety reviews have become complicated and usually entail sophisticated technical analyses. Yet, inevitably, uncertainties remain. There are "unresolved safety issues," and major research and development programs continue within both NRC and the nuclear industry to enhance and confirm the safety of some plant systems and to improve safety evaluation methods. A Commission statement on safety policy for nuclear power plants may be useful in setting priorities for allocation of resources and in evaluating the need for new regulatory requirements or for retaining existing ones.

B. Past and Present Regulatory Assumptions and Practices

The basic principles of regulatory practice consistent with the statutory mandates of the Atomic Energy Act and inherent in the safety approach which has been followed since the early 1950's are summarized below:

- Absolute safety or "zero risk" is not legally required (Ref. 1). The Atomic Energy Act refers to "adequate" rather than "absolute" protection of the public health and safety. There is risk in nuclear power, just as there is risk in all technologies, including competing energy technologies, as well as in every personal activity in which people engage. The intent of Congress expressed in that legislation is that nuclear power be developed under a licensing system for safe commercial use to generate electricity.

- The Commission's continuing practice of conservatism and use of the defense-in-depth concept is intended to provide an extra margin of protection. Nuclear power plants have been designed, constructed, and operated so as to provide an extra margin of safety for unforeseen events. Because of the complexity of nuclear power plants and the limited operating experience with them, it has been reasonable to assume that not all potential failure and accident scenarios, including ones that could present significant radiological hazards, have been identified. Potential failures and accident scenarios continue to be studied in order to improve knowledge of reactor safety.

Regulatory decisions are made on the basis of best available evidence despite the presence of residual uncertainties. This approach has involved striking a balance between the degree of uncertainty and the potential radiological consequences of a decision made under uncertainty. In cases where the uncertainty regarding radiological hazard has been sufficiently great, the potential source of the hazard has not been permitted.

In particular, the Commission's regulation of radiological hazards for nuclear power plants has evolved since the early 1960's into a complex system of binding rules (10 CFR Chapter 1, primarily 10 CFR Parts 20, 50 and 100) and supplementary regulatory guidance (usually in the form of regulatory guides). At its most fundamental level, the approach which has been and is being used requires plants to be constructed and operated in a manner consistent with sound engineering practice. Sound engineering practice as applied to nuclear power plants is embodied in a defense-in-depth concept. This concept involves quality assurance and control in plant design, construction, and operation to reduce the likelihood of accidents; installation of backup systems to nullify the consequences of malfunctions in important plant systems and to prevent individual malfunctions from escalating into major accidents; and installation of engineered safety features to confine the consequences of certain postulated major design-basis accidents to minimize effects on the public health and safety. The Commission has emphasized the siting of nuclear plants in less populated areas and discouraged siting in locations near natural or man-made hazards. More recently, the Commission has also emphasized the requirement of reasonable assurance that adequate protective measures can and will be taken by the licensee and the State and local authorities in the event of accidents more serious than design-basis accidents.

C. Development of This Statement of Safety Policy

The Commission's policy statement is intended for use in guiding future NRC regulation of nuclear power plants. However, it should be emphasized that the Commission's policy statement will not replace NRC's rules in 10 CFR Chapter 1. Existing statutes require nuclear plant operations to provide adequate protection to the public health and safety, and authorize the NRC to take actions to minimize danger to life or property.

In developing the policy statement, NRC has solicited and benefited from the information and suggestions provided by public comment and workshop discussions. In the fall of 1980, the Commission instituted a project to state explicitly the level of protection which it believed adequate to ensure public safety with regard to nuclear reactor accidents and, to that end, published a Plan for Developing a Safety Goal (Ref. 3). In accordance with that plan, the Commission subsequently issued a preliminary statement of policy considerations which may enter into an articulation of the NRC's statement of its safety goal. The Commission's statement, along with a more detailed discussion, was published as the report Toward a Safety Goal: Discussion of Preliminary Policy Considerations (Ref. 4). This report included a brief summary statement published in the Federal Register which invited comment on all aspects of the subject. This report, issued in March 1981, was discussed at an NRC-sponsored workshop in Palo Alto, California, on April 1-3, 1981.

This first workshop illuminated many important issues of safety goal formulation, including both quantitative and qualitative elements and economic, ethical, social, and political issues as well as technical considerations. An Approach to Quantitative Safety Goals for Nuclear Power Plants (Ref. 5), the quantitative safety goal proposal submitted to the Commission in October 1980 by the Advisory Committee on Reactor Safeguards "to serve as one focus for discussion," was used at that workshop as one example of a concrete application of the concepts discussed.

A second NRC-sponsored safety-goal workshop was held in Harpers Ferry, West Virginia, on July 23-24, 1981 (Ref. 6). That second workshop had a more specific focus, a draft paper entitled Discussion Paper: Safety Goals for Nuclear Power Plants (Ref. 7). The workshop addressed a reference safety-goal statement in this paper and explored significant alternatives. Like the first workshop, it featured discussions among knowledgeable persons drawn from industry, public interest groups, universities, and elsewhere, and representing a broad range of perspectives and disciplines.

In February 1982, the Commission issued for comment NUREG-0880, Safety Goals for Nuclear Power Plants: A Discussion Paper (Ref. 7). The Commission also published in the Federal Register a proposed policy statement on safety goals for nuclear power plants (47 FR 7023, February 17, 1982). The Federal Register notice solicited public comments on both the proposed policy statement and the report discussing the development of the proposed policy statement (NUREG-0880). It also posed a series of questions on basic issues involved in developing the policy statement. In response to this notice, the Commission received 161 written comments.

The Commission also held a series of one-day public meetings around the country to receive comments on the proposed safety goals. A transcript was prepared for each meeting. The number of comments received at these meetings are as follows:

Location	Date	Number of Oral Statements
Atlanta, Georgia	April 26, 1982	24
Boston, Massachusetts	April 29, 1982	27
Los Angeles, California	May 3, 1982	43
Chicago, Illinois	May 5, 1982	30
	Total	124

The breakdown of the written comments and the comments from the public meetings are as follows:

Category	Number
Individuals	137
Public Interest & Citizens Groups	64
Utilities and Industry	36
Employees of Federal Agencies and National Laboratories	15
University Representatives	7
Consultants	6
Elected Representatives	6
Professional Societies	5
State & Local Agencies	4
Foreign Governments	4
Labor Union	1
TOTAL	285

After consideration of the public comments, including comments from the Commission's Advisory Committee on Reactor Safeguards, suggestions from the NRC staff, and revisions to the safety goal policy statement proposed by the Commission's Office on Policy Evaluation in July 1982, the Commission has decided to issue the policy statement reproduced in Section IV of this report for a two-year evaluation period. The Federal Register Notice accompanying the policy statement is reproduced in Section III of this report. The plan for evaluation of the policy statement, which was prepared by the NRC staff, is presented in Section VII and summaries of the public comments are presented in Sections VIII and IX of this report. Based upon the experience gained during the evaluation period, the Commission will issue its final safety goals policy statement.

III. FEDERAL REGISTER NOTICE FOR SAFETY GOAL DEVELOPMENT PROGRAM

The Nuclear Regulatory Commission hereby publishes a Policy Statement on Safety Goals for the Operation of Nuclear Power Plants. The Policy Statement contains preliminary safety goals and preliminary numerical design objectives that are intended to be consistent with the goals. The goals and objectives are preliminary in that they are subject to change at the end of a two-year evaluation period that is discussed below. The Commission previously published a Proposed Policy Statement on Safety Goals for Nuclear Power Plants and solicited comments (47 FR 7023, February 17, 1982). In response to these comments the Commission has revised the policy statement.

The Commission is also publishing the staff's Evaluation Plan that will be used during the two-year evaluation period. Comments are solicited for this plan. The Commission has chosen a 90-day period for receipt of public comments.

The Commission also announces the start of the two-year period of evaluation for the Safety Goal Policy Statement. The staff's Evaluation Plan is an initial description of the activities to be performed during the evaluation period. The Commission has not issued this document for public comment prior to this time.

The early evaluation activities to be performed will include an assessment of the public comments received on the Evaluation Plan and the preparation of a report to the Commission on these comments. The Commission is particularly interested in comments on the extent to which the Evaluation Plan establishes a foundation for the development of an implementation plan at the conclusion of the evaluation period. That implementation plan would prescribe how final safety goals and numerical design objectives would be used in the regulatory process. The evaluation period will also include an assessment of the preliminary safety goals and design objectives. The Commission would like comments on this aspect of the Evaluation Plan as well.

It should be noted that, during the evaluation period, the preliminary safety goals and preliminary numerical design objectives will not replace the NRC's reactor regulations. Rather, NRC will continue to use conformance to regulatory requirements as the exclusive licensing basis for plants. One of the activities during the evaluation period will be to examine the extent to which the preliminary formulation of the goals and objectives, as well as possible techniques to use them, reflect the experience gained with the Commission's deterministic requirements.

The Commission recognizes that some probabilistic risk analyses have already been performed for individual nuclear plants and that safety inferences might be made as a result of comparing the results of these analyses to the preliminary design objectives. The Commission cautions against the use of such inferences to reach bottom-line safety conclusions. The Commission believes that existing requirements contained in current regulations are adequate to protect the public health and safety.

The Evaluation Plan stresses caution in making comparisons or safety inferences because collections of such analyses may not have been performed on a consistent basis and because of the large uncertainties inherent in the existing probabilistic risk assessments. In particular, there are uncertainties in the source term that represents the amount of radioactive material that may be released from the reactor containment in a severe accident. Therefore, during the evaluation period, NRC will strive to set forth more consistent analytical bases and improve the treatment of uncertainties in the calculations, including use of a new source term which is currently being developed. NRC will also reassess the probabilistic risk assessments that have already been performed and compare the results to the preliminary safety goals and design objectives.

At the conclusion of the evaluation period, the Commission will consider if any revisions are necessary before the issuance of a final Policy Statement and a plan for its implementation. The documents that result will take into account the comments received from the public and the experience gained during the evaluation period.

Further information on the Commission's safety goal development program may be obtained by contacting either Dennis Rathbun or Jerry Wilson at the Office of Policy Evaluation, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555 or phoning (202) 634-3295. Written comments should be addressed to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch, and should be received by June 8, 1983.

A report which discusses the revisions to the Policy Statement will be published within a few weeks as NUREG-0880 Revision 1, Safety Goals for the Operation of Nuclear Power Plants. A copy of NUREG-0880 Revision 1 will be available for inspection at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C. Single copies of NUREG-0880, Revision 1 also will be available upon written request and at no cost. Requests should be made to the NRC-GPO Sales Program, Attention: Sales Manager, Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, D. C. 20555 (Phone (301) 492-9530). Copies also may be purchased from the NRC-GPO Program and the National Technical Information Service, Springfield, Virginia 22161.

Dated at Washington, District of Columbia, this 8th day of March, 1983.

For the Nuclear Regulatory Commission

Samuel J. Chilk
Secretary of the Commission

IV. POLICY STATEMENT ON SAFETY GOALS FOR THE OPERATION OF NUCLEAR POWER PLANTS

I. INTRODUCTION

A. Purpose and Scope

In its response to the recommendations of the President's Commission on the Accident at Three Mile Island, the Nuclear Regulatory Commission (NRC) stated that it was "prepared to move forward with an explicit policy statement on safety philosophy and the role of safety-cost tradeoffs in the NRC safety decisions." This policy statement is a step in that direction.

Current regulatory practices are believed to ensure that the basic statutory requirement, adequate protection of the public, is met. Nevertheless, current practices could be improved to provide a better means for testing the adequacy of and need for current and proposed regulatory requirements. The Commission believes that such improvement could lead to a more coherent and consistent regulation of nuclear power plants, a more predictable regulatory process, a public understanding of the regulatory criteria that the NRC applies, and public confidence in the safety of operating plants. This statement of NRC safety policy expresses the Commission's views on the acceptable level of risks to public health and safety and on the safety-cost tradeoffs in regulatory decisionmaking.

This policy statement focuses on the risks to the public from nuclear power plant operation. These are the risks from release of radioactive materials from the reactor to the environment from normal operations as well as from accidents. The Commission will refer to these risks as the risks of nuclear power plant operation. The risks from the nuclear fuel cycle are not included in the safety goal. These have been considered in their own right and determined to be quite small. They will continue to receive careful consideration. The possible effects of sabotage or diversion of nuclear material are also not presently included in the safety goal. At present there is no basis on which to provide a measure of risk on these matters. It is the Commission's intention that everything that is needed shall be done to keep such risks at their present, very low, level; and it is our expectation that efforts on this point will continue to be successful. With these exceptions, it is our intent that the risks from all various initiating mechanisms be taken into account to the best of the capability of current evaluation techniques.

In the evaluation of nuclear power plant operation, several types of releases are considered by the staff. The risks to the public resulting from operating nuclear power plants are addressed in current NRC practice as follows. Before a nuclear power plant is licensed to operate, NRC prepares an environmental impact assessment which includes an evaluation of the radiological impacts of routine operation of the plant and accidents on the population in the region around the plant site. The assessment is subjected to public comment and may be extensively probed in adjudicatory hearings. For all plants licensed to operate, NRC has found that there will be no measurable radiological impact on any member of the public from routine operation of the plant. (Reference: NRC staff calculations of radiological impact on humans contained in Final Environmental Statements for specific nuclear power plants, e.g., NUREG-0779, NUREG-0812, and NUREG-0854.)

The objective of the Commission's policy statement is to establish goals which limit to an acceptable level the radiological risk which might be imposed on the public as a result of nuclear power plant operation. While this policy statement includes the risks of normal operation, as well as accidents, the Commission believes that risks from routine emissions are small and therefore does not believe that they need to be routinely analyzed on a case-by-case basis in order to demonstrate conformance with the safety goals.

B. Development of This Statement of Safety Policy

In developing this policy statement, the Commission has solicited and benefited from the information and suggestions provided by workshop discussions. Two NRC sponsored workshops have been held, the first in Palo Alto, California, on April 1-3, 1981 and the second in Harpers Ferry, West Virginia, on July 23-24. The first workshop addressed general issues involved in developing safety goals. The second workshop focused on a discussion paper which presented proposed safety goals. Both workshops featured discussions among knowledgeable persons drawn from industry, public interest groups, universities, and elsewhere, and representing a broad range of perspectives and disciplines.

The Commission also received and considered a Discussion Paper on Safety Goals for Nuclear Power Plants submitted in November 1981 and a revised safety goal report submitted in July 1982, by its Office of Policy Evaluation.

In arriving at a final decision on a statement of its nuclear power plant safety policy and goals, the Commission has taken into consideration the comments and suggestions received from the public in response to the Proposed Policy Statement on "Safety Goals for Nuclear Power Plants."

II. QUALITATIVE SAFETY GOALS

The Commission has decided to adopt qualitative safety goals supported by design objectives for use during a 2-year evaluation period. The Commission's first qualitative safety goal is that the risk from nuclear power plant operation should not be a significant contributor to a person's risk of accidental death or injury. The intent is to require a level of safety such that individuals living or working near nuclear power plants should be able to go about their daily lives without special concern by virtue of their proximity to such plants. Thus, the Commission's first safety goal is:

> Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.

Even though protection of individual members of the public inherently provides substantial societal protection, the Commission also decided that a limit be placed on the societal risks posed by nuclear power plant operation. The Commission believes that the risks of nuclear power plant operation should be comparable to or less than the risks from other viable means of generating the same quantity of electrical energy. Thus, the Commission's second safety goal is:

> Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

The comparative part of this goal is to be interpreted as requiring that the risks from nuclear power plant operation are comparable to or less than the risks of the operation of competing electricity generating plants, particularly coal-fired plants.

III. QUANTITATIVE DESIGN OBJECTIVES

A. General Considerations

As used here, a design objective is an aiming point for public risk reduction which nuclear plant designers and operators should meet where feasible. Since the design objectives are aiming points and not firm requirements, there may be instances where a given nuclear plant may not achieve all of the objectives. A key element in formulating a safety policy which establishes design objectives is to understand both the strengths and limitations of the techniques by which one judges whether these objectives have been met.

A major step forward in the development and refinement of accident risk quantification was taken in the Reactor Safety Study completed in 1975. The objective of the Study was "to try to reach some meaningful conclusions about the risk of nuclear accidents." The Study did not directly address the question of what level of risk from nuclear accidents was acceptable.

Since the completion of the Reactor Safety Study, further progress in developing probabilistic risk assessment and in accumulating relevant data has led to recognition that it is feasible to begin to use quantitative reactor safety design objectives for limited purposes. However, because of the sizable uncertainties still present in the methods and the gaps in the data base--essential elements needed to gauge whether the objectives have been achieved--the design objectives should be viewed as aiming points or numerical benchmarks which are subject to revision. In particular, because of the present limitations in the state of the art of quantitatively estimating risks, the design objectives are not substitutes for existing regulations.

B. Quantitative Design Objectives

We want to make clear at the beginning of this section that no death attributable to nuclear power plant operation will ever be "acceptable" in the sense that the Commission would regard it as a routine or permissible event. We are discussing acceptable risks, not acceptable deaths. In any fatal accident, a course of conduct posing an acceptable risk at one moment results in an unacceptable death moments later. This is true whether one speaks of driving, swimming, flying or generating electricity from coal. Each of these activities poses a calculable risk to society and to individuals. Some of those who accept the risk (or are part of a society that accepts risk) do not survive it. We intend that no such accident(s) will occur, but the possibility cannot be entirely eliminated. Furthermore, individual and societal risks are less than the risk that society is now exposed to from each of the other activities mentioned above.

1. Individual and Societal Mortality Risks

The Commission has decided to adopt the following two design objectives:

- The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of one percent (0.1%) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.

- The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of one percent (0.1%) of the sum of cancer fatality risks resulting from all other causes.

The Commission adopts this 0.1% ratio of the risks of nuclear power plant operation to the risks of mortality from non-nuclear plant origin to reflect the first qualitative goal, which would provide that individuals bear no significant additional risk. However, this does not necessarily mean that an additional risk that exceeds 0.1% would by itself constitute a significant additional risk. The 0.1 percent ratio to other risks is low enough to support an expectation that people living or working near nuclear power plants would have no special concern due to the plant's proximity.

The average individual in the vicinity of the plant is defined as the average individual biologically (in terms of age and other risk factors) and locationally who resides within a mile from the plant site boundary. This means that the average individual is found by accumulating the estimated individual risks and dividing by the number of individuals residing in the vicinity of the plant.

In applying the design objective for individual risk of prompt fatality, the Commission proposes to define the vicinity as the area within 1 mile of the nuclear power plant site boundary since calculations of the consequences of major reactor accidents suggest that individuals within a mile of the plant site boundary would generally be subject to the greatest risk of prompt death attributable to radiological causes. If there are no individuals residing within a mile of the plant boundary, then the vicinity should be taken as a one-mile wide annulus measured outward from the location of the first individual.

In applying the design objective for cancer fatalities, as a population guideline, the Commission proposes that the population generally considered subject to significant risk be taken as the population within 50 miles of the plant site. A substantial fraction of exposures of the population to radiation would be concentrated within this distance. This design objective would ensure that the estimated increase in the risk of delayed cancer fatalities from all potential radiation releases at a typical plant would be no more than a small fraction of the year-to-year normal variation in the expected cancer deaths from non-nuclear causes. Moreover, the prompt fatality limit protecting individuals generally provides even greater protection to the population as a whole. That is, if the design objective for prompt fatality is met for individuals in the immediate vicinity of the plant, the estimated risk of delayed cancer fatality to persons within 50 miles of the plant would generally be much lower than the limit set by the design objective for cancer fatality. Thus, compliance with the design objective applied to individuals close to the plant would generally mean that the aggregated estimated societal risk for a 50-mile radius area would be a number of times lower than it would be if compliance with just the design objective applied to the population as a whole were involved.

2. Benefit-Cost Guideline

The Commission has adopted a benefit-cost guideline for use as one consideration in decisions on safety improvements. It has decided that a guideline of $1,000 per person-rem averted be adopted for trial use. The value is to be in 1983 dollars. This value should be modified to reflect general inflation in the future.

- The benefit of an incremental reduction of societal mortality risks should be compared with the associated costs on the basis of $1,000 per person-rem averted.

This guideline is intended to encourage the efficient allocation of resources in safety-related activities by providing that the expected reduction in public risk that would be achieved should be commensurate with the costs of the proposed safety improvements. The benefit as measured by an incremental reduction of societal mortality risks in terms of person-rem averted should be compared with the reasonably quantifiable costs of achieving that benefit (e.g., design and construction of plant modifications, incremental cost of replacement power during mandated or extended outages, changes in operating procedures and manpower requirements). Application of the benefit-cost guideline should be focused principally on situations where one of the quantified safety goals is not met. No further benefit-cost analysis should be made when it is judged that all of the design objectives have been met. This guideline does not replace the Commission's backfitting regulation (10 CFR 50.109).

The NRC staff has some experience in the use of benefit-cost analysis and criteria in evaluating improvements to reduce the risks from normal operations. In the past the Commission discussed a benefit-cost value of $1,000/person-rem reduction in the evaluation of improvements proposed to reduce releases of radioactive material during normal reactor operations including expected operational occurrences. However, the use of a benefit-cost guideline in evaluating the means for reducing population risks from power reactor accidents would be new.

3. Plant Performance Design Objective

An important objective of efforts to reduce the public risk associated with nuclear power plant operation is to minimize the chance of serious reactor core damage since a major release of radioactivity may result from accidents involving severe core damage. Therefore, to assure emphasis on accident prevention, the Commission has decided to adopt a limitation on the probability of a large-scale core melt as an objective for NRC staff use in the course of reviewing and evaluating probabilistic risk assessments of nuclear power plants. The design objective for large-scale core melt is subordinate to the principal design objectives limiting individual and societal risks. This design objective may need to be revised as new knowledge and understanding of core performance under degraded cooling conditions are acquired. Thus, the Commission has selected the following design objective:

- The likelihood of a nuclear reactor accident that results in a large-scale core melt should normally be less than one in 10,000 per year of reactor operation.

The Commission also recognizes the importance of mitigating the consequences of a core melt accident and continues to emphasize features such as containment, siting in less populated areas, and emergency planning as integral parts of the defense-in-depth concept.

IV. IMPLEMENTATION

The qualitative safety goals supported by the quantitative design objectives are being adopted for use during a 2-year evaluation period. The Commission believes that an evaluation period is necessary in order to judge effectiveness of the goals and design objectives. At the end of the evaluation period the Commission will consider what changes in the regulations and regulatory practices appear necessary in light of experience during the 2 years. Proposed changes in the regulations will be addressed in rulemakeing proceedings.

To provide adequate protection of the public health and safety, current NRC regulations require conservatism in design, construction, testing, operation and maintenance of nuclear power plants. A defense-in-depth approach is mandated in order to prevent accidents from happening and to mitigate their consequences. Siting in less populated areas is emphasized. Emergency response capabilities are mandated to protect the surrounding population. It is not clear how the Commission's essentially deterministic regulations would be supplemented if the qualitative safety goals and quantitative design objectives--which are based on considerations of probable risk--were incorporated into the regulatory framework.

The basic impediment to adoption of regulations requiring risks to the public to be below certain quantitative limits, as exemplified by the quantitative design objective for large-scale core melt, is that the techniques for developing quantitative risk estimates are complex and, in the cases of interest here, have substantial associated uncertainties. This raises a serious question whether, for a specific nuclear power plant, the achievement of a regulatory-imposed quantitative risk goal can be verified with a sufficient degree of confidence. For this reason, the Commission has decided that, during the evaluation period, implementation of the Policy statement should be limited to uses such as examining proposed and existing regulatory requirements, establishing research priorities, resolving generic issues, and defining the relative importance of issues as they arise. The evaluation period should be used to develop information and understanding as to how to further define and use the design objectives and the cost-benefit guideline.

The qualitative safety goals and quantitative design objectives contained in the Commission's Policy Statement will not be used in the licensing process or be interpreted as requiring the performance of probabilistic risk assessments by applicants or licensees during the evaluation period. The goals and objectives are also not to be litigated in the Commission's hearings. The staff should continue to use conformance to regulatory requirements as the exclusive licensing basis for plants.

The detailed Staff Evaluation Plan addresses ways to use the Safety Goals during this trial period so as to gain the experience necessary for later application in the regulatory process. The Evaluation Plan outlines a process for obtaining this experience in developing new regulatory requirements as well as examining existing requirements to determine whether the regulatory basis needs to be revised.

It is expected that during the evaluation period familiarization may be gained with the techniques of risk estimation and sufficient data may be collected and analyzed so that the Commission can decide whether to expand the use of the Policy Statement or to propose rulemaking that would incorporate quantitative risk limits as design objectives in the regulations. The qualitative safety goals and quantitative design objectives may be changed as a result of the experience gained during the two-year evaluation period.

SEPARATE VIEWS OF COMMISSIONER GILINSKY ON THE COMMISSION'S POLICY STATEMENT ON SAFETY GOALS

I do not support the Commission's Policy Statement on Safety Goals. As the Commission's Advisory Committee on Reactor Safeguards points out, the particular safety goals chosen by the Commission are poorly conceived. In addition, the Commission appears to be headed toward an over-reliance, in its regulatory decisions, on estimates of the overall nuclear power plant risks which are based on uncertain and unreliable calculational techniques. These techniques cannot bear the weight the Commission intends them to support. We are unlikely ever to know with much confidence whether any plant meets the safety goal. I am concerned that, in spite of this, overly optimistic calculations will be used to rationalize a weakening of the regulatory system of public protection.

Safety Doctrine

My view remains that the only reliable guides to reactor safety are the time-tested engineering principles of careful construction and operation, redundant and diverse means of protection against core damage, sound containment, sufficient distance from populated areas, and effective emergency planning. The Commission should distill its experience, and the results of calculations, including probabilistic calculations, and state clearly and succinctly how each of these principles must be satisfied separately. Such limited engineering goals may not be as grand as all-encompassing ones, but they are much more practical.

The Commission is unfortunately on an opposite course: toward allowing the several layers of protection to be traded off one against the other without limit, presumably on the assumption that probabilistic risk assessment will prove to be sufficiently workable and accurate to permit confident tradeoffs in specific reactor cases among the various elements of "defense in depth".

The Commission seems also to be counting heavily on a sharp reduction in the "source term", the estimated amount of volatile radioactive material that could be released in an accident. However much we may all hope that these estimates can be reduced, it is premature to count on this. Yet the statement that "siting in less populated areas is emphasized", which reflects longstanding Commission policy, was retained in the document by only one vote, over the opposition of the Chairman and one other Commissioner, both of whom apparently want to retain the option of siting in more populated areas, and it was not reflected in any of the safety goals.

Safety Goals Poorly Conceived

So far as the safety goals themselves are concerned, my views are generally in accord with those expressed by the ACRS, the Commission's statutory advisory group, in a brief but highly critical January 10, 1983, letter to the Commissioners. It is unfortunate that the Commission decided not to discuss this letter with the Committee before adopting the safety goals statement, especially because the goals depart from the traditional approach of this regulatory agency and its predecessors: to protect the most exposed individual, and to put a ceiling on the overall impact of an accident. The Commission has also dropped the principle that the risk should continue to be reduced to a level that is "as low as reasonably achievable." As the ACRS points out, dropping this element removes the incentive for the industry to continue to improve its performance in the future.

Individual Risk Too Narrowly Defined: No Real "Societal" Goal

In setting a goal for individual risk near a nuclear plant, the Commission has included the prompt radiation fatalities from a nuclear accident, but not the delayed deaths from cancer, although in most instances the number of delayed deaths are likely to be greater. The cancer deaths are included in a second goal, which is improperly labeled a "societal" goal. This sets a limit on the number of cancer deaths caused by nuclear accidents at a plant at a fraction -- one thousandth -- of the cancer deaths in a fifty mile circle around the plant. Choosing such a large circle has the effect of averaging the higher additional risk of cancer to a relatively small population near the plant with the negligible risk to a much larger population distant from the plant. More importantly, it sets no ceiling on the overall impact of an accident -- as a real societal goal would. This means that the larger the population around the plant, the larger the allowed impact, even though the benefit -- power produced by the plant -- is the same in both cases.

What the Commission should have done -- and what the ACRS urged it to do -- was to include both prompt deaths and those caused by subsequent cancers in defining the individual most at risk, and set a limit on this risk. In addition, it should have set a societal goal which put a ceiling on the impact from any single accident. This would have encouraged siting in less populated areas.

Core Melt Probabilities Downplayed

The one part of the safety goal which comes closest to being potentially useful and workable is the guideline limiting core melt probabilities to less than one in ten thousand per year of reactor operation. (Calculations on the reactor hardware systems are on somewhat firmer ground, though even here the uncertainties are very large.) At the strong urging of the staff, however, the Commission has downplayed this portion of the goal, labeling it "subordinate". The difficulty seems to be that a substantial fraction of the operating plants may not meet this goal. At any rate, out of a compendium of about fifteen probabilistic risk assessments for operating reactors, roughly a third fail to meet this goal. Ironically, these results, which were given to the Commission and subsequently released only after I asked about them at a meeting on January 5, were immediately branded by the agency as highly uncertain. (Which, of course, they are. But I do not remember such emphatic warnings being attached to assessments which gave favorable results.)

ADDITIONAL VIEWS OF COMMISSIONER AHEARNE

Commissioner Gilinsky raises several objections to the Safety Goal Policy Statement on which comments are necessary:

(1) The fundamental purpose of attempting to develop safety goals is to bring a more rational approach to regulating nuclear safety. It is not, as Commissioner Gilinsky implies, to allow "overly optimistic calculations [to] be used to rationalize a weakening of the regulatory system of public protection."

(2) Commissioner Gilinsky states that "My view remains that the only reliable guides to reactor safety are the time-tested engineering principles of careful construction and operation, redundant and diverse means of protection against core damage, sound containment, sufficient distance from populated areas, and effective emergency planning." I have but two disagreements with this position: (a) The possible inference that the other Commissioners do not support those aspects. That, of course, would not be correct. I believe all support these factors as being vital to providing adequate protection to the public. (b) The use of the word "only." There are other items I would include (they might not be "time-tested engineering principles," but neither is emergency planning), such as use of human factors techniques to analyze control rooms and operating procedures and use of qualified and well-trained operating personnel.

Each of the factors, and many others, underlie our regulations, which will remain controlling.

(3) Commissioner Gilinsky charges that the Commission is on a course "toward allowing the several layers of protection to be traded off one against the other without limit." This is plainly wrong. I know I am not, and as far as I can tell, neither is the Commission.

(4) Commissioner Gilinsky states "The Commissioner seems also to be counting heavily on a sharp reduction in the 'source term.'" As proof of this he mentions that a statement on siting "was retained in the document by only one vote." First, the Commission did adopt the statement. Second, Commissioner Gilinsky did not propose to include the siting statement--I did. I certainly am not counting heavily on a sharp reduction in the "source term," and have been critical of some in the NRC who have very high expectations for the new source term (the "Holy Grail"). Nevertheless, I do support the safety goal.

(5) ACRS ALARA--Commissioner Gilinsky's comment regarding the ACRS and the "as low as reasonably achievable" (ALARA) concept could be read as though the Commission rejected the ACRS advice on ALARA. However, the ACRS advised us not to apply that standard to plants currently operating or under construction. We accepted that advice. They did

recommend that standard for future plants, advice we rejected. Frankly, I do not believe there will be any new plants proposed during the two-year trial period. Thus, I do not believe the current omission is significant.

(6) The question of a societal goal was debated heavily over the last two years. The NRC staff and participants in several workshops and public meetings struggled to establish individual and societal goals that were separately useful. The principle difficulty is to avoid having one be swallowed by the other. The proposed goals are not entirely satisfactory --but the purpose of a trial or pilot period is to test such ideas, see how they work, and to try to improve them.

(7) Commissioner Gilinsky describes core melt probability as being "downplayed." The safety goal philosophy does make it secondary --secondary to public health and safety. As the staff pointed out to the Commission, the NRC's mission is to protect the public, not the licensee. Consequently, our fundamental responsibility must be to prevent harmful radiation from reaching the public. It is the licensee's responsibility to ratepayers and owners to prevent plant damage. Certainly the NRC is concerned about core melt--greatly concerned. Preventing core melt prevents large offsite releases. However, we must go beyond that point and ask the "What if" questions. What if the core melts despite our best effort to prevent it? (Accidents do happen.) We have to be concerned about the systems that provide protection in the event the core melts (Commissioner Gilinsky has been the staunchest supporter of this, for example in his push for strong containments). Consequently we have, I believe correctly, treated core melt as subordinate.

ADDITIONAL VIEWS OF COMMISSIONER ASSELSTINE

I support the issuance, for the purpose of further evaluation, of the Commission's safety goals policy statement. I believe that the careful evaluation of the safety goals policy statement as well as alternative safety approaches, as provided for in the proposed evaluation plan, represents a significant first step toward determining the feasibility of defining a set of safety goals that can serve as part of the basis for the Commission's regulatory and licensing decisions for nuclear power plants.

Although I support this first step, I believe that several aspects of the Commission's safety goals policy statement and the proposed evaluation plan deserve further comment.

Qualitative Safety Goals

With one exception, I support the elements of the qualitative safety goals contained in the policy statement. That exception provides that societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies. For several years, the Commission has routinely performed a general comparision of the costs and benefits of alternative electric generating means in individual nuclear power plant licensing proceedings in fulfilling the agency's responsibilities under the National Environmental Policy Act of 1969. However, the Commission has acknowledged that the comparative element of the qualitative safety goals will require a more detailed, quantitative evaluation of the relative risks of nuclear and other competing electric generating methods. In adopting this element of the policy statement, the Commission has committed to undertake such a study unless some other organization is prepared to do so.

I do not support the Commission's decision to undertake such a study for several reasons. First, such a study will be very complex, time consuming and expensive. To appropriately make comparisions of the risks of competing electric energy technologies, all phases of fuel cycles should be addressed for the different technologies. To do otherwise would unfairly bias the evaluation of comparative risks, subjecting our safety goal to the charge on promotionalism.

Second, the uncertainties involved in quantifying the relevant risks, including calculations of the long-term risk for the disposal of high-level radioactive waste and uranium mill tailings and for global build-up of carbon dioxide, acid rain and the health effects of coal emissions, call into serious question our ability to make accurate risk comparisions. Given these factors, I do not believe that the conduct of a comparative risk study is a wise use of this agency's resources. In fact, I believe that similar considerations influenced the decision by the National Academy of Sciences to terminate a similar effort -- the

CONAES Risk/Impact Study. For these reasons, it does not appear to me that a comparative technology safety goal would provide a useful, reliable and accurate basis on which to regulate nuclear power plants.

Quantitative Design Objectives

Most of the disagreement over the safety goals policy statement, both in the Commission's discussions and in the comments submitted on the draft safety goals policy statement, has centered on the quantitative design objectives -- a set of numerical expressions for individual risk, societal risk, large-scale core melt frequency, and cost-benefit comparisons that is included as part of the safety goals. As Commissioner Gilinsky indicates in his separate views, our Advisory Committee on Reactor Safeguards has proposed a number of alternative formulations of the quantitative design objectives. These alternative formulations include: retention of the as-low-as-reasonably-achievable (ALARA) concept for all future nuclear power plants; a separate design objective for the individual risk of fatal cancer due to nuclear power plant operation or accidents; the use of a smaller radius than 50 miles in calculating the societal risk of cancer from nuclear power plant operation and accidents as well as from other causes; and a cost-benefit design objective that includes consideration of the off-site economic costs of a nuclear power plant accident. I supported unsuccessful efforts to include some of these alternative approaches in the safety goals policy statement, and I proposed other elements, such as a cost-benefit design objective for the averted person-rems that would be associated with the cleanup of a nuclear power plant accident. However, a majority of the Commission did not favor these changes.

I do not believe that we now have the information to say with any real certainty that the alternative numerical design objectives proposed by the ACRS and others are inappropriate, or that the design objectives in the policy statement constitute a fair and complete reflection of the qualitative safety goals. Indeed, it appears clear that at least one other country proposes to use numerical design objectives (allowable frequency for large-scale core melt accidents) that are considerably more stringent than those contained in the safety goals policy statement.[1] Statements have also been made by officials of the Tennessee Valley Authority that the design objectives used by the TVA nuclear program (use of the as-low-as-reasonably-achievable concept) are more appropriate than those contained in the policy statement.[2]

Moreover, there may be an even more fundamental concern with respect to the numerical design objectives contained in the safety goals policy statement. That concern relates to use of the probabilistic risk assessment (PRA) methodology as a basis for determining whether the numerical design objectives are met in a particular case.

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[1] "Britain's Approach to the PWR Stresses Safety and Reliability," by B.V. George and D.E. Hilsley, Nuclear Engineering International, December 1982.

[2] The Knoxville News Sentinel, January 12, 1983.

There appears to be a strong basis for believing that PRA can:

(1) serve as a useful tool for better understanding of the dominant sequences and for taking advantage of plant operating experience;

(2) provide a systematic way for examining the appropriateness of operating procedures, maintenance and testing practices, technical specifications and emergency procedures;

(3) help identify weak areas in a specific plant that may constitute significant contributors to risk; and

(4) provide information on generic and plant-specific risks that can be used to assess the adequacy and appropriateness of existing NRC requirements as well as the need for modifications to existing requirements or for new requirements.

However, our Advisory Committee on Reactor Safeguards and others have warned that present uncertainties associated with the PRA methodology and with the existing PRA assessments for specific plants make PRA an unreliable basis for making judgments on the overall risk posed by specific plants or by nuclear power plants in general. Thus, to the extent that they depend on such "bottom line" risk assessments, the quantitative design objectives contained in the safety goals policy statement may represent an unreliable and inappropriate basis for making regulatory decisions.

In order to address these concerns, the Commission has agreed to a two-year evaluation period to assess the effects that would result from applying the safety goals and numerical design objectives as well as the alternative design objectives that have been proposed by the ACRS and others. I believe that such an evaluation process is essential to our informed judgment on the appropriateness of both the numerical design objectives contained in the policy statement and the alternative design objectives that have been proposed. I also believe that the evaluation period will provide useful insights on the uncertainties associated with PRA methodology as it would be used in conjunction with the safety goals and design objectives -- insights that are needed to reach a decision on the feasibility of the safety goals approach and its elements.

Until the evaluation process has been completed and understood, the Commission has determined that neither the qualitative safety goals nor the numerical design objectives will be used as a basis for any regulatory decision. Thus, the Commission's present regulatory program, including such elements as the as-low-as-reasonably-achievable (ALARA) concept, remains the exclusive basis for reaching safety decisions for nuclear power plants. Given these factors, I believe the Commission's decision on the safety goals policy statement and evaluation plan represents a careful and deliberate step toward exploring the potential benefits and pitfalls of the use of quantitative safety goals in the NRC's regulatory decision-making for nuclear power plants.

V. SAFETY GOALS

A. General Considerations

The approach selected by the Commission for setting forth safety goals in the FOR COMMENT version of NUREG-0880 was to adopt qualitative goals with quantitative design objectives. This approach achieves the benefits of qualitative goals while retaining the ability to measure the performance of the goals with quantitative design objectives. The Commission has decided to continue using this approach during the two-year evaluation period.

In response to the comments received during the public comment period and the recommendations from the NRC staff, the Commission made some changes to the safety goals that were proposed in the FOR COMMENT version of NUREG-0880. One of the changes in the safety goal policy statement, which was made in response to numerous public comments, was to change the scope of the safety goals. Previously, the focus of the policy statement in the FOR COMMENT version of NUREG-0880 was on reactor accidents. Now the policy statement includes the risks from all potential radioactive releases from nuclear power plant operation. However, the risks from the nuclear fuel cycle and risks stemming from sabotage and diversion of nuclear material continue to be excluded. A discussion of the modified safety goals is provided in the following sections of this report.

B. Qualitative Safety Goals

1. Individual Risk

- Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.

Because persons are inevitably exposed to various risks of accidents in the course of everyday life, each individual has an annual probability of dying as the result of an accident. An individual's risk of accidental fatality varies with the person's age, occupation, habits, leisure activities, and many other factors. This safety goal proposes that the risk of a nuclear accident not be a significant contributor to a person's risk of accidental death or injury. The incremental risk should be sufficiently low that individuals should be able to go about their daily lives without special concern because of their proximity in residence or work to a nuclear power plant.

In deciding upon the qualitative goal for individual risk, the Commission also considered the comments received during the public comment period. Many of the comments from industry representatives agreed with the first qualitative safety goal as proposed. Several other commenters advocated a "zero risk" goal. Additional comments suggested modifications to this qualitative goal such as more precise definition of the risk, distinguishing between voluntary and involuntary risks and including risks from all fuel cycle activities.

The ACRS stated in its letter of June 9, 1982 that, "the proposed qualitative goals are a useful statement of the position of the Commission on the risk to which it believes it would be acceptable for the public to be exposed by accidents in nuclear power plants."

A review of the public comments on the individual risk safety goal by the Commission does not reveal a choice which would be a clear improvement over that proposed by the Commission in NUREG-0880. For this reason, the Commission proposes to retain this qualitative safety goal as stated during the two-year evaluation period.

2. Societal Risk

- Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

Even though protection of individual members of the public inherently provides substantial societal protection, the Commission also decided that a limit be placed on the societal risks posed by nuclear power plant operation. The Commission believes that, societal risks are to be compared with those of viable competing means of generating the same quantity of electricity. We see coal as ordinarily the only important viable competing technology at this time. In most situations, hydro-generation is not a viable alternative means of central-station generation because there are too few potential hydro sites in many sections of the country. Natural gas or oil-fired generation is not considered a viable alternative because of the uncertain long-term supply and high cost. There may be other means of generating the same quantity of electricity with advanced technologies (e.g., solar), but we do not believe that these technologies can be considered viable alternatives today.

Public comments on the risk comparison element of the societal risk goal were generally favorable. Some felt that the risk comparison should be made against all energy alternatives, including renewable technologies and conversation. Others suggested the comparison should be with "other beneficial technologies." These comments seem to reflect dissatisfaction with the limitation to "viable" and "competing" alternatives, not with the concept of technology comparisons. The Commission has not accepted the argument that the comparison should include other technologies. The limitation to comparison with viable and competing technologies for generating electricity is consistent with the NEPA requirement to consider "alternatives to the proposed action."

A number of commenters objected to the fact that the comparison seemed to be inappropriate since the risks of nuclear power plant accidents were being compared with the total risks of competing technologies. This appears to be a valid objection. The goal has been revised so that the comparison is now between the risks of nuclear power plant operation (normal operation and accidents) and the risks of operation of viable competing electricity generators.

In the long run, the risks of viable competing technologies may decrease (e.g., through improvements in control of effluents from coal-fired power plants) thus changing the comparative basis of the societal risk. A commenter, referring to the possibility of technological change remarked that a goal based on comparison of technologies could lead to a ratcheting process if each technology adopted safety goals that required its risks to be less than the risks of the other technologies. While this possibility cannot be ruled out, its occurrence would not invalidate the basic principle expressed by the goal. Clearly, if the risks of viable competing electric generating technologies are reduced below the level of risks of nuclear power plant operation, the Commission's safety goal would only be achieved by further improvement of nuclear power plant safety. This would not be an unreasonable consequence.

Public comments on the ALARA element of the societal risk goal were mixed. Some felt the concept was too vague and open-ended and should be eliminated. Some suggested that its relationship to the cost-benefit guidance should be made explicit. Still others believed that the ALARA standard was fundamental to an achievable goal. The Commission decided not to seek further risk reduction when it is judged that all of the design objectives have been met. Therefore, the ALARA portion of the proposed societal risk goal has been deleted.

VI. DESIGN OBJECTIVES

A. General Considerations

A key element in formulating goals or guidance which contain numerical safety objectives is to understand both the strengths and limitations of the techniques by which one judges whether these objectives have been met. The extent to which present methods are capable of verifying that safety objectives are met thus becomes an issue in the process of deciding whether available data and methods permit establishing quantified safety goals. At the heart of the issue is a question about the reliability of probabilistic risk assessment as a basis for confidence that safety goals have been met. The design objectives discussed in this paper rely on probabilistic risk assessment to indicate whether they are met. Hence, it is appropriate to review briefly the development of probabilistic analysis as a means of quantifying risks from reactor accidents.

A major step forward in the development and refinement of accident risk quantification was taken by the Reactor Safety Study during the period 1972-1974. The objectives of the Study was "to try to reach some meaningful conclusions about the risk of nuclear accidents." The study did not address the question of what level of risk from nuclear accidents were acceptable. Despite its substantial methodological advances in the state of the art of quantifying the probabilities and consequences of reactor accidents, the final report of the study (WASH-1400) and particularly its Executive Summary were subject to strong criticism. The summary findings and conclusions did not properly emphasize the data gaps and uncertainties in underlying assumptions as well as the subjective manner of accounting for human errors.

In July 1977, the NRC chartered a Risk Assessment Review Group to provide advice and information to the Commission on the final report of the Reactor Safety Study, WASH-1400. In January, 1979, after consideration of the Review Group's report (NUREG/CR-0400), the Commission issued a policy statement on risk assessment disavowing the Executive Summary. With respect to reactor accident probabilities, the Commission accepted the Review Group's conclusion that absolute values of the risks presented by WASH-1400 should not be used uncritically either in the regulatory process or for public policy purposes. Nonetheless, taking due account of the reservations expressed in the Review Group Report, the Commission supported the extended use of probabilistic risk assessment in regulatory decisionmaking where warranted by the quality of the data base.

With encouragement from the Commission to extend the use of probabilistic risk assessment methods, the NRC staff has continued to develop and refine the technique and its application. Progress has been made in recent years. As an example, electrical and other reactor safety systems component failure rates are tabulated by component and operating environment properties. Efforts are now under way to improve the capability of quantifying the effects of operator errors on plant safety performance. Estimates of the radioactivity released in the event of a major reactor accident are being reviewed for possible revision and refinement on the basis of new experimental and analytical work.

Despite the progress in applying probabilistic risk assessment to many reactor safety problems as well as in improving the methodology and acquiring greater understanding of its value and limitations, overall risk estimates remain and will undoubtedly continue to remain subject to significant uncertainty. Overall risk as the "bottom line" in evaluating the adequacy of protection of the public health and safety depends on many safety analysis decisions that will continue to involve substantial elements of engineering judgment which are now necessarily based on a less well-developed foundation than one might wish. Accordingly, NRC has a substantial research program to refine the probabilistic risk methods and a major analytical program to evaluate the rapidly accumulating operating experience and to feed back the lessons learned from this experience into the reactor operating and design groups. Primary research areas include the phenomenology of core melt and containment behavior, fission-product transport, modeling of emergency protective actions, analysis of the effects of operator error on plant safety performance, and evaluation of the reliability of reactor components and systems.

In summary, we believe that progress in the development of probabilistic risk assessment and the accumulation of the relevant data base are sufficient to make it feasible to use quantitative reactor safety design objectives for limited purposes. However, because of the sizable uncertainties still present in the methodology and the gaps in the data base--essential elements needed to gauge whether the objectives have been achieved, the quantitative objectives should be viewed as aiming points or numerical benchmarks which are subject to uncertainties in interpretation, which may perhaps be reduced as further improvements are made in the state of the art of probabilistic risk assessment. In particular, because of the present limitations, the Commission believes that numerical safety objectives should serve as guidelines to provide a safety perspective only, and not as a substitute for existing regulations. Application of the present deterministic regulatory requirements should be continued, at least until the residual uncertainties in estimates of overall risks of the reactor accidents can be greatly reduced.

The design objectives presented in this section are stated as limits on increased individual and societal mortality risks as a consequence of nuclear power plant operation in relation to other risks of prompt and delayed fatalities faced by the public.

The Commission has decided to test these design objectives during a 2-year evaluation period. These design objectives would be subject to revision at the end of that period on the basis of the experience and degree of success in application. During this period, we expect that additional refinements would be made in probabilistic risk assessment methods.

B. Statement and Rationale

1. Individual and Societal Mortality Risks

> The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of one percent (0.1%) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.
>
> The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of one percent (0.1%) of the sum of cancer fatality risks resulting from all other causes.

Individual Risk. The Commission decided on the 0.1% ratio of the risk to an individual from nuclear power plant accidents to the risk of accidents of non-nuclear-plant origin in the belief that it reflects a reasonable interpretation of the first qualitative goal, which would provide that individuals bear no significant additional risk. However, this does not necessarily mean that an additional risk that exceeds 0.1% would by itself constitute a significant additional risk. The 0.1 percent ratio to other accident risks is low enough to support an expectation that individuals living or working near nuclear power plants would have no special concern due to the plant's proximity. The individual risk limit is applied to the biological average individual (in terms of age and other factors) who resides at a location within 1 mile from the plant site boundary. This means that the average individual is found by accumulating the estimated individual risks and dividing by the number of individuals residing in the vicinity of the plant.

Estimates of prompt fatalities due to a major reactor accident indicate that individuals most at risk live or work within a few miles of a reactor. We propose to define the vicinity as the annular area within one mile of the nuclear power plant site boundary since calculations of the consequences of major reactor accidents suggest that individuals in the population within a mile of the plant site would generally be subject to the greatest estimated risk of prompt death attributable to radiological causes. Beyond this distance, atmospheric dispersion of the airborne radioactive materials sharply reduces the radiation exposure levels and the corresponding risk of prompt fatality.* If there are no individuals residing within a mile of the plant boundary, then the vicinity should be taken as a one-mile wide annulus measured outward from the location of the first individual.

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*One set of calculations (Ref. 8, at p. I-38) indicates that, in the absence of protective measures, the conditional probability of exceeding a 200-rem whole-body dose given a core-melt accident would be reduced from the probabilities at 1 mile from the reactor by a factor of 1.5 at 5 miles, 3 at 10 miles, and 100 at 14 miles; and that 3000-rem lung-dose probabilities would be reduced by a factor of 4 at 5 miles and 15 at 7 miles.

The individual mortality risk of prompt fatality in the United States is about $5x10^{-4}$ per year for all accidental causes of death (Ref. 9). Thus, on the average, approximately 5 persons out of 10,000 die annually as a result of accidents in the United States. The prompt mortality risk design objective would limit the increase in an individual's annual risk of accidental death (5 in 10,000) by an increment of no more than 5 in 10,000,000 per year.*

Population data for 111 reactor sites in 1979 are reported in Reference 10. The population within 1 mile of a site** ranges from 0 to approximately 1,400 persons. The average (mean) for all sites is 168. Ninety percent of all sites have populations less than 560 persons; half the sites (median) have less than 41 persons within a mile of the plant; some have no persons within that distance. Thus, for an average site (i.e., one with a population of 168 within a mile), there would be, on the average, one-tenth of a fatality per year due to all accidental causes (i.e., motor vehicles, falls, drownings, etc.) for the general population within 1 mile.*** According to the design objective, the increased risk due to major reactor accidents should not exceed 0.0001 of an estimated fatality per year for this average site. For a more densely populated location, one with a population of about 500 persons within 1 mile of the site (a population exceeded by less than a dozen nuclear power plant sites), the estimated prompt fatalities in the event of a major reactor accident would increase by 0.0003 per year. (The increase would be 0.002 per year for a 2-mile circle.)

Comments on the individual mortality risk design objective were received during the public comment period. Many of the industry commenters stated that 1% is a more appropriate value than the proposed 0.1%. They believed that the 0.1% value was excessively stringent and unrealistic. The ACRS agreed with that view, stating in its letter of June 9, 1982:

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*The additional prompt mortality risk from a nuclear power reactor accident is far below the risk of death from nonnuclear accidents. For example, each year about 3 of out of every 100,000 persons in the United States dies as a result of fires or burns, widely dreaded causes of death. The proposed numerical design objectives would limit the risk of a prompt fatality from a nuclear power reactor accident to less than one-sixtieth of this risk for those within 1 mile of a reactor site.

**The population data cited are for circular areas of 1-mile radius from the reactor. Demographic statistics are not available for the somewhat larger, irregularly shaped areas extending to 1 mile from the site boundaries. For the still larger circular areas extending to 2 miles from the reactor the population ranges from 0 to slightly over 9,000; the mean population is 1089, the median 280. Ninety percent of the sites have fewer than 3,900 inhabitants within 2 miles from the reactor.

***Accident statistics show that the average annual accident rate to farm residents is about 66 per 100,000; the national average accident rate is 48 per 100,000. Thus, using the national average accident rate as a reference should be conservative since the population in the vicinity of power reactors is probably more characteristic of farming populations.

The use of a quantitative guideline for individual risk for early death of 0.1% of the risk of accidental death from all causes (with a similar guideline for latent cancer) provides a useful way of placing the risk in perspective; however, it may lead to risk limits which are more stringent than necessary if they are to be met with a reasonable degree of assurance.

It should be noted, however, that the ACRS has qualified their characterization of the 0.1% criteria with the statement "if they are to be met with a reasonable degree of assurance."

Other commenters thought that the mortality risk design objectives of 0.1% was too high and yielded too high a mortality risk, especially when risks from the nuclear fuel cycle, sabotage, diversion of nuclear material, etc., are excluded from the design objectives. Additional commenters suggested that the proposed numerical guidelines should identify total, rather than incremental risk; that individual and societal risks should not be combined in the same numerical guideline; and that nuclear risks could not be compared with the risks of other accidents. Some other commenters suggested that the applicability of the individual risk limit be extended from one to ten miles. The ACRS in particular believed it important that explicit usable quantitative goals be provided for the industry and the NRC staff as a guide for meeting the qualitative goals expressed to the public, including guidance on how to deal with issues involving large uncertainties.

In view of the number of critical comments, the Commission decided to retain the 0.1% value for the individual risk design objective on a provisional basis and investigate the appropriateness of this value during the 2-year evaluation period.

<u>Societal Risk.</u> The delayed mortality risk design objective for societal risk would limit the increased risk of a delayed fatality as a result of nuclear power plant operation to one-tenth of one percent (1 in 1,000) of the cancer risk not related to nuclear power to which these individuals in society are already exposed. One the average, roughly 19 persons per 10,000 population die annually in the United States as a result of cancer (Ref. 11). The risk of developing a fatal cancer is subject to large variation depending on geographic and demographic factors. The variations among states range from an annual rate of about 7 deaths per 10,000 population in Alaska, to roughly 16 in Virginia, to about 25 deaths in Rhode Island. The variation in annual rate of cancer death is even greater when age is taken into account, from 3 deaths per 10,000 in the 25-to-44-year age group to 133 per 10,000 in the over-75-year age group. (The long latency period for many cancers, up to 30 years in some cases, is a factor in increased mortality at older ages.)

The delayed mortality risk design objective would limit the increase in an individual's annual risk of a cancer death (19 in 10,000) by an increment of no more than 19 in 10,000,000 per year. Normally, in the event of a release of radioactivity, the degree of an individual's exposure to the risk of cancer (or more prompt serious radiation illness) varies according to his or her location (distance and direction from a plant) with respect to the meteorological pattern prevailing at the time of the accident. The individual risk of developing a latent cancer decreases substantially as distance from the plant increases.

In applying the design objective for delayed cancers, as a population guideline, we propose that the population generally considered subject to significant risk be taken as the population within 50 miles of the plant site. We choose a 50-mile distance because a substantial fraction of the exposures of the population to radiation would be concentrated within this distance. The NRC already uses a 50-mile cutoff distance in implementing the ALARA principle for routine reactor releases. By limiting to 0.1 percent the risk to the population living within 50 miles of a nuclear power plant, this design objective would provide that the estimated potential increase in cancer fatalities from any nuclear power plant would be no more than a small fraction of the normal variation in the expected cancer deaths from other (non-nuclear) causes. Moreover, the limit to individual risk generally provides even greater protection to the population as a whole. That is, if the design objective for prompt fatality is met for individuals in the immediate vicinity of the plant, persons much further away would generally have a risk much lower than the limit set by the design objective for cancer fatality. Thus, compliance with the design objective applied to individuals close to the plant would generally mean that the aggregated estimated risk for a 50-mile-radius area would be a number of times lower than the societal design objective alone would permit.

The 1979 population within 50 miles of a plant ranges from 7,700 to 17.5 million (Ref. 10). The average (mean) is 1.7 million. Ninety percent of the plant sites have populations less than 4.1 million within 50 miles; half the sites (median) have populations less than 950,000 within 50 miles. From the mean population figure of 1.7 million, the average number of cancer fatalities per year from non-nuclear causes is predicted to be approximately 3,200. For the average plant, the design objective permitting a 0.1 percent increase in delayed fatalities would allow no more than an additional 3.2 estimated cancer fatalities per year. This value is not only small with respect to the average number of predicted cancer fatalities per year for a population of 1.7 million; it is also small with respect to the geographic variation in cancer death rates. When applied to the mean population within a 50-mile radius of a power plant site, the annual cancer rate for Rhode Island (2.5 per 1000) would correspond to 4,300 cancer deaths per year, and the annual cancer rate for Virginia (1.6 per 1000) would correspond to 2,700 cancer deaths. Thus, the average number of 3.2 additional estimated deaths per year is small in comparison to a regional variation of 1,600 (i.e., 4,300 - 2,700) cancer deaths per year. (We draw attention again to our previous observation that operation of the design objective for individual risk would normally be controlling, which would necessarily limit the aggregated societal risk to a fraction of the delayed cancer deaths estimated by using the societal design objective alone.)

Where the design objectives are used for assessing existing or proposed generic regulatory requirements, we believe that the national health and accident statistics should be used as the comparison basis. [In plant-specific applications, state or regional health and accident statistics may be appropriate.]

The public comments on the societal risk design objective ranged from objections to its "conservatism" to statements that the guideline should be "no risk of cancer fatality." Those citing excessive conservatism felt a risk of 1 percent of the sum of the risks of other U.S. technologies would be acceptable because it would make nuclear risks comparable to those of other technologies; moreover, they argued because society accepts much higher risks from other technologies, why should nuclear power be given special treatment. Those at the opposite end of the spectrum noted that the 0.1 percent guidelines meant some deaths were "acceptable", a consequence which they rejected. A few commenters pointed out that there was no logical basis for selecting 0.1 percent; higher values would have satsified the qualitative goals. It is not true that the figure chosen is entirely arbitrary. Its choice is based on the belief that the 0.1 percent value reflects the second portion of the societal risk goal which states that the risks should not be a significant addition to other societal risks.

Some commenters objected to the originally proposed individual and societal numerical guidelines because they were to be applied on a per-site basis. This would have resulted in tighter requirements being imposed on plants at multi-unit sites than at single-unit sites. The Commission decided not to impose a regulatory bias against multi-unit sites. Therefore, the quantitative design objectives were changed from risks per site to risks per plant.

Other comments were directed at the 50-mile radius which is assumed to define the population at risk. Some thought the limiting radius should be based on site-specific considerations. In principle, this suggestion has merit. However, the Commission is seeking to establish goals and design objectives applicable to all nuclear power plants. If in any specific case, it is found that the goals or design objectives do not assure adequate protection of the public, then revisions will be in order. One of the purposes of the evaluation period will be to confirm the generic applicability of the safety goals and quantitative design objectives. At this time the 50-mile radius will be retained.

2. Benefit-Cost Guidelines

The Commission chose a benefit-cost guideline for use as one consideration in arriving at decisions on safety improvements.

> The benefits of an incremental reduction of societal mortality risks should be compared with the associated costs on the basis of $1,000 per person-rem averted.

The Commission decided that a guideline of $1,000 per person-rem averted be adopted for trial use. The value is to be in 1983 dollars. This value should be modified to reflect general inflation in the future. During the evaluation period, the application of the benefit-cost guideline should be focused principally on situations where one of the quantified safety goals is not met. No further benefit-cost analysis should be made when it is judged that all of the design objectives have been met.

This guideline is intended to encourage efficient allocation of resources by providing that the reduction in public risk should be commensurate with the costs of proposed safety improvements. To take into account the fact that a safety improvement would reduce the public risk during the entire remaining lifetime of a nuclear power plant, both the benefit (risk reduction) and the estimated cost of the improvement should be compared on an annualized basis over the years during which the plant is expected to operate.

Safety improvements may reduce risks either by reducing the probability of an accident or by mitigating its consequences should it occur. The risk reduction, stated as person-rems averted per year, would be calculated by finding the difference between the product of the annual probability of occurrence of the accident and resulting consequences of population exposure, and the same product for the case in which the proposed safety improvement has been made.

For a given proposed safety improvement, the person-rems averted per year would be a constant. In contrast, the cost of a specific proposed safety improvement annualized over the lifetime of a plant would be less for a new plant than for an older plant. For this reason, the net effect of applying the benefit-cost guideline on an annualized basis is to justify a greater expenditure of resources to improve the safety of newer plants.

The benefit of an incremental reduction of societal mortality risks should be calculated for the population reasonably expected to be within 50 miles of the nuclear power plant. The associated costs should include all reasonably quantifiable costs (e.g., design and construction of plant modifications, incremental cost of replacement power during mandated or extended outages, changes in operating procedures and manpower requirements).

The NRC staff has some experience in applying benefit-cost analysis and criteria to the evaluation of reactor effluent treatment systems which would reduce radiation exposure of the off-site populations to routine radioactive releases. Since adoption of Appendix I to 10 CFR Part 50 in 1975, a value of $1,000/person-rem reduction has been in the literature for use in the evaluation of improvements in effluent control to reduce population exposures within 50 miles of a plant. However, the use of a benefit-cost guideline in reactor accident safety would be new. Moreover, the guidelines of Appendix I to 10 CFR Part 50 are applied to the reduction of the more or less continuous off-site low-level radiation exposure, whereas the guideline proposed here is intended to reduce off-site exposure to the occurrence of a highly unlikely but large consequence radiological hazard.

The guideline of $1,000 per person-rem would be equivalent to $10,000,000 per life saved, on the assumption that a 10,000 person-rem exposure results in one (statistical) fatality. This figure overstates the cost because, as calculations of accident consequences indicate, perhaps over half the delayed fatalities could occur outside the 50-mile radius (boundary of affected population) which we have assumed. If the exposed population outside the 50-mile zone is included, the guideline would typically be equivalent to a little less than $5,000,000 per life saved. This value is higher than values calculated for actual and proposed life-saving activities in other (nonnuclear) regulatory contexts (e.g., highway and automobile safety, air pollution, carcinogens in drinking water), where the estimated costs per life saved were found to range from zero to as much as a few hundred million dollars, with most of the values below $200,000 per life saved (Ref. 12) Studies of the costs of safety protective measures in nuclear power plants show a similar wide range in the net cost per life saved (Ref. 13.)

Comments on the benefit-cost guideline covered a wide range of issues. Many commenters believed that a benefit-cost guideline was inappropriate for nuclear accidents and should be deleted. A large number of the commenters stated that $1000 per man-rem averted was too high and some suggested that

$100 per man-rem averted would be more consistent with other activities. Other commenters thought that the $1000 value was too small. Many of the commenters stated that the guideline value should be discounted to account for the time-value of money.

The ACRS stated in its letter of June 9, 1982, that:

> The proposed benefit guideline of $1000 per man-rem averted out to fifty miles from nuclear plant accidents places a larger value on averting premature death than is generally used by the Department of Transportation or other federal agencies where this attribute is explicitly discussed. However, genetic effects are not included, nor are psychological effects on health, and these might be considerable. Also, the man-rem incurred at distances greater than fifty miles are likely to be comparable to or greater than the portion within 50 miles. Further studies should be made to provide better quantitative insight into the benefit to be attributed to a reduction in health effects.

In light of these comments, the Commission has decided to adopt, during the 2-year evaluation period, a benefit-cost guideline value of $1000 per man-rem averted in 1983 dollars. This value will be adjusted in future years to account for general inflation.

3. Plant Performance Design Objective

> The likelihood of a nuclear reactor accident that results in a large-scale core melt should normally be less than one in 10,000 per year of reactor operation.

An important aspect of the public risk associated with nuclear power plant operation is the chance of serious reactor core damage since a major release of radioactivity may result from accidents involving severe core damage. Therefore, to assure emphasis on accident prevention, the Commission has chosen a design objective to limit large-scale core melt probabilities for NRC staff use in the course of its review of probabilistic risk assessment studies. But this design objective is not intended to serve as a regulatory requirement which must be met for plant operation.

The limitation on large-scale core melt probability may need to be revised in the light of new knowledge and understanding of core performance under degraded cooling conditions. Although there are a number of intermediate damaged core conditions short of large-scale core melt, probabilistic risk assessment methods today cannot make a meaningful distinction among intermediate core failure states.

A great deal of relevant research work funded by NRC is now under way, and the Commission has in process a major policy development effort in which degraded core performance is addressed.*

Not all core-damage accidents will proceed to large-scale core melt, and, of those that do, only a fraction would be accompanied by failure of the containment to prevent substantial radioactive release offsite. The design objective is intended to be interpreted with some flexibility, to cover those cases where a somewhat higher probability of core melt might be considered acceptable because of other compensating factors, such as low power level, remote siting, or improved features to mitigate the consequences of a core-melt accident (e.g., an improved containment).

Any safety goal which depends on estimates of the probabilities of major reactor accidents is subject to substantial inherent uncertainties in its application.** There has only been one instance of a reactor accident resulting in serious core damage in a commercial light-water power reactor in the United States to date (i.e., TMI-2). Consequently, reactor core-damage probabilities cannot be based upon empirical, statistical evidence; nor, indeed, would major reactor accident frequencies high enough to permit statistical verification be tolerable.

As a result, the design objective for a larger-scale core melt must be viewed as subordinate to the design objectives limiting individual and societal risks. The history of reactor accidents may result from failure sequences not analyzed in advance. Indeed, a major purpose of NRC's ongoing light-water reactor reactor program is to increase our understanding of reactor systems and their behavior in accidents which may lead to core damage. Research results may add confidence in parts of the analyses involved in making estimates of core-damage probabilities, which would nevertheless retain a large measure of residual uncertainty.

We also recognize the importance of mitigating the consequences of a core melt accident and we advocate continuing emphasis on features such as containment, siting in less populated areas, and emergency planning as integral parts of the defense-in-depth concept.

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*This effort previously referred to as the Degraded Core Cooling Rulemaking, but now included in a broader research and policy-development effort encompassing severe accident rulemaking and related matters, may lead to revision of NRC's rules or conceivably new rules or policies which govern NRC's approach to hydrogen evolution and control, or equipment design to prevent or mitigate consequences in the event of a serious accident resulting in core degradation.

**One recent NRC study (reported in NUREG-0715) which has reviewed the results of a number of risk assessments performed by industry (Ref. 14) cites analyses of severe core damage probabilities, estimates of which range from 2 in 10,000 to 1 in 100,000 per reactor-year. These are plant-specific estimates for light-water reactors which include seven pressurized-water reactors and one boiling-water reactor. As the report stresses, these estimates are subject to considerable uncertainty. Considerable further work in core-melt probability assessment is in progress as part of the Interim Reliability Evaluation Program (IREP), under sponsorhsip of the NRC Office of Nuclear Regulatory Research.

A review of the public comments on the plant performance design objective indicates that many commenters believed that the risk of one in ten thousand of a large-scale core melt accident per year of reactor operation was too high. The ACRS adopted this position in its letter of September 15, 1982, stating that, "the proposal to use a median, best-estimate core-melt frequency of 10^{-4}/reactor-year as a principal test of overall societal protection is unsatisfactory." Some commenters believed that, in view of the other numerical guidelines, the plant performance objective was unnecessary.

Several of the industry commenters agreed with this design objective with the understanding that large-scale core melt is secondary to the goals on individual and societal risk and is not to be considered as a requirement. The Commission decided to maintain the plant performance design objective at 10^{-4} per reactor-year and to continue to use it as a subordinate objective.

VII. PLAN TO EVALUATE THE COMMISSION'S SAFETY GOAL POLICY STATEMENT

A. Purpose

This document provides the plan to evaluate the Commission's safety goal policy statement. The purpose of the plan is to outline (1) a description of how the safety goals will be evaluated as a factor in arriving at regulatory decisions, (2) the general approach to be used in developing the data and information needed to evaluate the usefulness of the safety goals in regulation and licensing, and (3) how the results of using the safety goals will be assessed at the end of the evaluation period.

One of the primary goals of this evaluation program is the development of an implementation plan at the conclusion of the evaluation period. That implementation plan would prescribe how final safety goals and numerical design objectives would be used in the regulatory process. The evaluation program will also include efforts to develop any revisions to the preliminary safety goals and design objectives that are shown to be necessary during the evaluation period.

The first phase of the evaluation period will begin with the publication of the proposed evaluation plan for public comment for a 90-day period. During this period, it is expected that preliminary information on new radiological source terms will become available and the staff will examine the effects that this information will have on comparison of risk estimates with the proposed design objectives for individual and societal mortality risks. At the end of the public comment period the staff will assess the comments received on the evaluation plan, as well as the impact of the new source term information, and will prepare a report to the Commission. The overall time for the first phase is expected to be about 6 months. During the second phase of the evaluation period expected to be about 18 months, the staff will conduct a limited evaluation of the safety goals and design objectives and their potential use in the regulatory process. It is anticipated that additional information on radiological source terms will become available during this second phase, and this new information will be factored into the staff's evaluations after review and approval by the Commission.

B. Scope

The qualitative safety goals and quantitative design objectives contained in the Commission's Policy Statement will not be used to make regulatory decisions during the evaluation period. However, the NRC has used and plans to continue using probabilistic risk assessments (PRA) to better understand the risks of various safety issues. The quantitative safety goals will be evaluated, where the PRA methodology is generally accepted, with regard to existing regulatory requirements, proposed new regulatory requirements, research priorities, prioritization and resolution of generic safety issues, and the relative safety importance of issues as they arise. These analyses will also provide information regarding the timing of implementation of any new requirements and the relative merits of alternative approaches. The safety goal will be evaluated using the results of PRA on selected plants where PRA information is already available. However, regulatory decisions on the need to backfit plants as the result of this evaluation are inappropriate.

The safety goal design objectives will also be evaluated using the following generic issues to gain hands-on experience; however, the safety goal will not be a factor in resolution of the issues during the evaluation period. These issues will include the following:

(1) ATWS rule (RES)

(2) Pressurized thermal shock of pressure vessels (USI A-49) (NRR)

(3) Siting policy or rulemaking, after new radiological source terms are available (RES)

(4) Severe accident policy or rulemaking (RES/NRR)

(5) Station Blackout (USI A-44) (NRR)

(6) Decay Heat Removal (USI A-45) (NRR)

(7) Reconsideration of Emergency Response (RES)

The safety goal design objectives will also be evaluated during the evaluation period by examining selected existing requirements. The purpose of this reexamination is to gain hands-on experience with the safety goal; however, regulatory decisions will not be based on this reexamination. Examples of such issues which may be reexamined are the reliability criteria for the auxiliary feedwater system of PWRs and the requirement to combine seismic and LOCA loads in the design of structural and mechanical components and their supports.

In order to address that aspect of the safety goal concerning a comparison of the operation of nuclear power plants to the risks of generating electricity by viable competing technologies, the staff, within 60 days of publication of the safety goal, will survey other organizations and government agencies to determine their interest in conducting such a comparative study. If no agencies commit to performing such a study, the staff, within 120 days of publication of the safety goal, will issue a request for proposal to complete such a study with the objective of contract issuance within 180 days of publication of the study goal. The staff will keep the Commission fully informed on the progress of the above efforts.

C. <u>General Approach to Be Used</u>

The design objectives in the policy statement include the risks from routine emissions, normally expected transients and low consequence accidents, design basis accidents, and accidents which might melt the core. Compliance with Appendix I to Part 50 assures that the risks from routine emissions are small; therefore, they need not be analyzed either generically or on a plant-specific basis to demonstrate conformance with the safety goals. Also, compliance with current regulations (principally Parts 20, 50, and 100) generally provides adequate protection against the risks from anticipated transients and low consequence accidents as well as design basis accidents; therefore, these need not be analyzed to demonstrate conformance with the safety goals. Thus, to evaluate the safety goal policy statement during the evaluation period, this action plan will focus on the risks from accidents involving potential core-melt.

An early step in evaluating the policy statement will be for the Office of Nuclear Regulatory Research (RES) to collect available information on PRA studies and prepare a reference document that describes the current status of knowledge concerning the risks of plants licensed in the U.S. It is essential that a reference document be prepared and receive peer review so that the staff, licensees, and public have a common base of information on the dominant contributors to the probability of core-melt and to the public risk due to radiation from serious nuclear accidents, the strengths and weaknesses of current plant designs and operations, and the usefulness of PRA and the safety goals in assessing such strengths and weaknesses.

This reference document will assess the uncertainties associated with estimates of core-melt probabilities and rediological consequences and will attempt to provide guidelines on how these uncertainties should be treated. It will also assess the uncertainties associated with making relative risk assessments compared to absolute risk assessments; and it will address the uncertainties in assessing the risks from external events (seismic and flood), and from fire, compared to the uncertainties of assessing risks from internal accident initiators (equipment failure and operator errors).

The reference document will include an assessment of procedures used for these PRA studies and their impact on the validity of the results, as well as a discussion of when it is appropriate to consider the risks from external events such as earthquakes and floods, the likely magnitude of such risks, and how one should evaluate such risks in light of the large uncertainties involved. It will also identify those areas of plant design that appear to be most amenable to possible improvement, including insights that have been gained with regard to the desired and achievable reliability of systems and components important to safety. Significant new information developed in the preparation of the reference document will be reported to the Commission, as well as the final reference document itself.

In parallel with the development of this reference document, the staff will begin evaluating the safety goal quantitative design objectives in some of the areas identified in Section B to begin developing a base of hands-on experience. In evaluating the benefit-cost guideline, the $1,000 per person-rem averted will be in 1983 dollars, and it will be modified to reflect general inflation in the future. Both the benefits (reduction in estimated public exposure) and the costs will be assessed for the remaining lifetime of the plants.

The staff will evaluate the safety goal in the area of reliability of systems and components important to safety.

Because of the present uncertainties in analyzing the risk from external events, care will have to be taken with regard to any apportionment of the design objectives between external and all other (internal) accident initiators. This subject will be addressed in the reference document. Substantial research is now underway to develop more effective techniques to analyze the probability of core-melt and the risk from external events. When this is completed, PRA will be used to determine generically whether the risk attributable to external hazards is large enough to warrant routine consideration in safety goal decisions.

PRAs will be performed using realistic assumptions, and the estimates normally will be based on median values after propagating uncertainty distributions. Also, the analyses will include as good an estimate as is feasible of the magnitude and nature of uncertainties, including differences between median and mean estmates, together with sensitivity analyses for certain parameters important to risk. It is the intention that conservatisms will be explicitly expressed in the decision rationale, rather than be buried in the risk analyses.

One way to improve the consistency of PRA results is to provide some reasonable assurance that analysts follow equivalent procedures, make similar assumptions, treat phenomena consistently, and utilize a common data base. NRC has developed reasonably prescriptive guidance on how to conduct a PRA, drawing upon the Integrated Reliability Evaluation Program (IREP) and the work of the ANS/IEEE. Such standardization is highly desirable for effective use of the safety goal design objectives.

D. Proposed Relation to Regulatory Decision Process

In evaluating proposed new regulatory requirements and assessing the need for regulatory action on safety issues that arise, the staff will evaluate the use of safety goals; however, during the evaluation period the safety goals will not be a factor in making regulatory decisions. The weight to be given the safety goal after the evaluation period will depend on many considerations. One important consideration will be the quality of the PRA information, including the source of the analysis, the methods and data used, and the extent of peer review it has received. Insofar as possible, the staff members most familiar with the PRA and its limitations will be consulted in the decision process. This staff input will provide an essential perspective to those who must consider the PRA information and weigh its importance in making a decision.

Other factors in making decisions after the evaluation period will include the uncertainties surrounding the PRA analyses, engineering judgment, the acceptability of safety tradeoffs implicit in the decision, and the applicable regulatory requirements. The staff believes that the above, coupled with the scrutiny given PRAs by the industry, the NRC staff, NRC management, the ACRS, and other experts will provide sufficient controls to avoid abuse of the use of PRAs and safety goals in regulation; but this judgment will have to be further evaluated during the evaluation period.

Because of the uncertainties inherent in PRAs one must be cautious in making absolute comparisons between a risk estimate for a plant and one of the safety goal design objectives. If, for example, such a comparison indicates that a design objective is not met, one would expect the next step would be to examine the underlying technical reasons. It could be that such an examination would reveal that an existing regulatory requirement is not met, in which case the appropriate regulatory action would be to focus on the improvements in the plant needed to meet the regulatory requirement. In other cases it may reveal a gap in our requirements, in which case appropriate actions may be needed to amend the regulations, depending on the safety benefits and the costs of the proposed actions. The timing of any corrective actions, if needed, would depend on factors such as the estimated magnitude of the risks involved, the need for power, the number of plants involved, the cost of replacement power, and the available industry and NRC resources.

It is expected that the initial focus in using the safety goal after the evaluation period will be on the design objective on core-melt frequency. Estimates of public risk will be performed if the core-melt design objective is exceeded, or a risk-important accident sequence is dominant. During the evaluation period, estimates of public risk will be performed even if the core-melt objective is not exceeded in order to gain hands-on experience. The importance of mitigating the consequences of a core-melt accident is fully recognized, and the staff will continue to emphasize features such as containment and emergency planning as integral parts of the defense-in-depth concept.

Where significant, occupational exposures would also be a consideration in any decision whether to make safety improvements. Such considerations would include any increased exposures accrued during plant modifications and any incremental increases (or decreases) subsequently required to maintain the plant. However, it is not clear whether occupational exposures would be given the same weight in decisions as would public exposures. One consideration that is important is that the occupational exposure incurred as a result of any imposed new requirement is a real impact with a small uncertainty band, whereas averted public exposures are calculated probabilistic numbers with large uncertainty bands. In at least one case the staff will include averted occupational exposure as one of the benefits in the cost-benefit evaluation. These factors will be assessed during the evaluation period.

A paramount consideration in evaluating the use of PRAs and the safety goals is that one must be sensitive to the "bottom-line risk" syndrome. The principal benefit of PRA, considering the present state-of-the-art, is to identify strengths and weaknesses in plant design and operation, not to calculate accurate, absolute risk numbers. Therefore, the primary application of PRA information during the evaluation period will be to compare the results and evaluate insights gained from the spectrum of PRA analyses done to date, which will be summarized in the reference document.

E. Assessment of Results at End of Evaluation Period

At the end of the evaluation period the staff will assess the information gathered on PRAs contained in the reference document, together with the hands-on experience gained in evaluating the safety goals to make recommendations to the Commission regarding the use of safety goals in regulation or licensing and any changes in the safety goals. This assessment will include:

1. A comparison of existing plant-specific PRAs with the design objectives.

2. A discussion of situations where PRAs and the design objectives might have provided a useful perspective for decisions, and where their use would not have been very beneficial.

3. The impact of any changes in source term assumptions on the safety goals, including whether the design objectives should be changed.

4. An evaluation of the need for proposed guidelines as to actions to be taken when one or more plants are estimated to exceed one or both of the public risk design objectives and/or the core-melt design objective. For example, should operating levels or limits be established; and, if so, what should they be?

5. Judgments regarding the methodology for containment performance assessment and whether a containment performance design objective would be useful. If so, what should be the recommended design objective(s)?

6. The influence of occupational exposures or other factors on decisions after the evaluation period.

7. Judgments regarding the methodology that should be used to perform PRAs to enhance their use in the regulatory process.

8. For any future plant-specific applications, an evaluation of alternatives as to how conformance with the individual risk guideline should be assessed for situations where no one lives within one mile of the site boundary.

9. Whether a single monetary value of averted person-rem is an appropriate and useful way to implement the benefit-cost guideline. If not, what might be more appropriate?

10. An assessment of whether the design objectives for societal cancer risk should consider the population within 50 miles, as proposed in the policy statement, or some other distance from the plant.

Careful attention will be paid to management of the various activities during the evaluation period. Toward this end the staff will do the following:

- Establish appropriate tasks and milestones (Ref. Section F) in the FY83-85 EDO and Commission Program Planning and Guidance documents and in office Operating Plans.

- Establish a Steering Group which will include, as a minimum, management level representatives from the EDO, NRR, RES, IE, ELD, and OPE. The staff will maintain close involvement with the ACRS during the evaluation period.

- Provide appropriate reports to the Commission including the reference document, an assessment of substantive public comments received, and recommendations on any mid-course corrections that appear warranted.

F. Highlights of Future Staff Actions

The following summarizes the action items required to evaluate the safety goals and develop improved technical implementation guidance during the evaluation period. Information gathered during the evaluation period will be evaluated by the staff to assist in any subsequent recommendations to the Commission regarding the future role of PRA or the safety goals in regulation or licensing.

1.	Prepare a report to the Commission that summarizes and evaluates the public comments received on the proposed evaluation plan. (EDO)	Mid-1983
2.	The staff, within 60 days of publication of the safety goal, will survey other organizations and government agencies to determine their interests in conducting a study of the comparison of the operation of nuclear power plants to the risk of generating electricity by viable competing technologies. If no agencies commit to performing such a study, the staff within 120 days of publication of the safety goal will issue a request for proposal to complete such a study with the objective of contract issuance within 180 days of publication of the safety goal. The staff will keep the Commission fully informed of the progress of the above efforts. (EDO)	60 days 120 days 180 days
3.	Prepare a reference document that evaluates existing PRAs to: assess the dominant accident sequences; identify and rank safety systems and components as to their risk importance; evaluate how the risks from external events should be weighed in the decision process; estimate the magnitude, direction, and risk significance of uncertainties; and assess lessons learned with regard to strengths and weaknesses of various methodologies and procedures. (RES)	Early 1984
4.	Provide appropriate reports to the Commission regarding evaluation of the safety goal, such as the reference document, evaluation of public comments, and any recommended mid-course corrections that might appear to be warranted. (EDO)	1983-85
5.	Improve the quality and review of PRAs by developing a review plan for PRAs, consensus on the methodology for assessing the performance of all types of containments, and guidance on the assessment of the risks of external events. (NPR/RES)	1983-85

6. Evaluate the safety goals:

a.	Prioritize generic safety issues (NRR)	Early 1983
b.	Evaluate proposed new requirements that are amenable to assessment by PRA (RES/NRR)	1983-85
c.	Prioritize research in areas amenable to assessment by PRA (RES)	1983-85
d.	Develop and begin to implement a plan to assess existing requirements to determine whether some aspects need changing (RES)	1983-85
e.	Begin to develop risk-based reliability criteria for systems and components most important to safety (NRR/RES)	1983-85
f.	Begin to develop a methodology to prioritize selected reactor inspection procedures and to assist decision-making on the issuance of circulars, bulletins, and orders related to generic issues (IE)	1983-85

7. Make recommendations at the end of the evaluation period for the future use of safety goals in regulation and licensing, including: policy changes based on the experience gained; further guidance regarding implementation; any action guidelines felt to be warranted to assist decision-making as to whether new requirements should be implemented or existing requirements waived, and the timing of implementation of new requirements; application of the safety goals to operating reactors and licensing, e.g., the use of operating limits; and the effect of new developments, such as revised radiological source terms, on the implementation of the safety goals. (EDO) — Early 1985

VIII. ABSTRACT OF COMMENTS

This section consists of abstracts of the public comments which were submitted on the Commission's proposed policy statement on safety goals for nuclear power plants published in February, 1982. The purpose of this section is to provide a convenient means for discerning the overall nature of the public comments. The abstracts were prepared from the 285 comments, representing eleven categories of public participants, as shown in Section II. c of this report.

The "Abstract of Comments" is organized into groupings of comments as they address the various goals, guidelines, and Commission questions set forth in the FOR COMMENT version of NUREG-0880. Comments on the overall reaction to the proposed safety goals are provided in Section A while comments on the implementation of the goals is given in Section B. The subsequent Sections contain comments on each of the proposed goals, guidelines and Commission questions identified at the heading of each Section. The commenter reference number is placed in parenthesis following the abstract of each comment. Comments given at the public meetings are identified by a letter and a number (i.e., A-6 for the sixth speaker at ATLANTA). A list of the commenters, with their reference number, is provided at the end of this Section.

Although the abstracts are intended to be accurate representations of the oral and written comments that were received prior to July, 1982, it may not faithfully reflect the respondents' views. Moreover, the abstractors, in the interest of brevity, have included few details of the commenters' discussions of the reasons for their views. The reader who finds the abstract unclear and wishes to know exactly what the commenter said should consult the original responses themselves; these are available for inspection at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C. 20555.

A. OVERALL REACTION TO PROPOSED SAFETY GOALS

Reactions to the proposed safety goals range from enthusiastic praise and endorsement to vigorous rejection accompanied by derogatory remarks. The extreme reactions at both ends of the range are of limited value in terms of preparing a revised policy statement. The many intermediate reactions - endorsements with rationalized rejections and suggested changes - are valuable in revealing what many respondents expected of the safety goals and how they would wish to modify the goals to satisfy their expectations. These reactions provide a useful basis for considering revisions to the draft to enhance its acceptability by a broader segment of the interested public.

As the following summary indicates, the reactions of respondents within certain categories (such as the utilities and the nuclear industry and professional groups) are more consistent and easier to categorize than the reactions of individual members of the public.

The Utilities

The utilities' responses are almost unanimously supportive of the proposed safety goals. Many repeat the purposes included in the proposed policy statement, i.e., the safety goals

- will clarify NRC's position on "how safe is safe enough?"
- will lead to more coherent, consistent regulation and a more predictable regulatory process
- will aid public understanding of and confidence in the safety of nuclear power plants
- will help utilities evaluate safety-cost tradeoffs to achieve an optimum balance

The utilities note the following additional reasons for adopting the safety goals:

- will ultimately allow for a better focusing on the issues of true safety significance, rather than the present practice of treating all issues alike (120, C10)
- is a necessary first step toward the resolution of such matters as the severe accident rule, many unresolved safety issues, and the conduct and objectives of the NREP program (114)
- represents a first step in removing the subjectivity that many feel is characteristic of the current licensing process (127)
- will rationalize the regulatory process and maximize the safety benefits obtained from expenditure of available resources (98)

A number of the utilities express misgivings about the value and practicality of the goals until more is known about the standards to be used for demonstrating compliance and the plan that is developed for implementation. Many express reservations about the wisdom of publishing safety goals for nuclear power to the exclusion of comparable goals for other activities.

Some responses are less than endorsements and include reservations, such as:

- hoping that the adoption of the safety goal will lead to a backfitting policy based on consideration of overall safety rather than the current practice of focusing on systems or components (126)
- hoping that the safety goals will lead to a rational differentiation between regulatory requirements for new plant designs and operating plants (126)

- noting that the development of safety goals will require concurrent development and identification of an acceptable methodology such as probabilistic risk assessment that provides a safety "yardstick" suitable for determining whether safety improvements are required (98)

- believing that the use of goals in the regulatory process must be subject to right-of-challenge by industry (122)

- noting that, unless there are clear-cut criteria by which compliance can be shown, a derogatory implication would be added to an already conspicuously berated industry without just cause (69)

- suggesting that the public welfare might better be served by a comprehensive comparison of risks and benefits of the various alternatives (140)

The Nuclear Industry and Related Professional and Industry Organizations and Individuals

The various architect-engineer firms, major vendors, and professional societies almost all endorse the safety goals. Many of the responses advance the same supportive arguments as the utilities. For example, Chauncey Starr, EPRI, believes that "The NRC's endeavor is the only way to provide an explicit means for constructive exchange between the nuclear industry and the NRC and to disclose all the factors involved in decision-making." (32)

In addition, the following points are made:

- several aspects of the policy statement lead to the belief that issuance as a final policy statement is premature at this time (128)

- adoption of the statement should not precede an assessment of how it can be implemented and what positive and negative benefits will result (94)

- the instant policy is overly stringent and is based on reducing a remote hypothetical risk to essentially zero (94)

- safety goals for nuclear power plants should be set up in accordance with other technical regulation of our society, i.e., a minimum of risk is only achieved if the same goals is established for all technical equipment (132)

- the goals should reflect the actual, not perceived, risk to the public (B10, B17)

Academics and professionals

Relatively few academics and professionals testified at the hearings or responded to the draft policy statement. The respondents divided into two groups: On the one hand, there were those who believed that the safety goals were a "timely effort" (90) and a "large step in the right direction" (133) that would produce a workable set of goals that might serve as a "model for other technological activities that are regulated." (89) On the other hand, the second group believed that the formulation of safety goals by NRC was an "illusion to create public confidence" and that the goals were too vague and abstract and too devoid of an implementation plan to be useful. (31) Several in the latter group also believed that the safety goals should include risks from routine emissions, the nuclear power plant cycle, waste management, sabotage, diversion of nuclear materials, transportation, etc. (77) One commenter believed that the goals omitted the alternative of moderating population growth around nuclear plants and contained a potential data problem involving individual site area population. (11)

The reactions of this group in general reflected the comments expressed by the Committee on Nuclear Technology and Law, American Bar Association of New York (109), which stated in part "Before numerical guidelines can play a significant role in reactor safety activities... it will be necessary for the Commission to agree upon a more uniform and predictable method of application of probabilistic risk assessment concepts." They also reflected the views of Alvin Weinberg, Oak Ridge Associated Universities (47), who considered the quantitative safety goals to be "valuable design criteria" but believed that the goal statement was deficient in at least three important respects: (1) "the quantitative goals do not form a consistent set potentially useful for design or licensing," (2) "the objective of the policy statement is too vague," and (3) "there is no implementation plan."

State Legislators

Only a few state representatives responded. The comments ranged from positive ones, such as "excellent and acceptable starting point" (115) to negative ones including:

- illusion to give public confidence (B3)
- fails to deal with major safety issues attached to operation of nuclear power plants; hence the title is misleading (B12)
- comparing deaths from nuclear accidents to other means of death is totally incomprehensible. (B2)

Private Citizens

The vast majority of commenters were private citizens who were representing their own positions. Although some of them were associated with groups of various persuasions (e.g., environmental, anti-nuclear, pro-nuclear, etc.) their comments reflected their individual - rather than the group - point of view.

The most popular themes expressed by the individuals, most of them having an anti-nuclear bias, concerned the following points (listed in general order of frequency of articulation):

- the "limited" scope of the "omissions" inherent in the proposed safety goals. Many individuals believed that it was both improper and unwise to consider nuclear safety without looking at such issues as worker safety, waste problems, fuel cycle effects, routine radioactive releases, nuclear material diversion, earthquakes, sabotage, and intergenerational transfers of risks. One commenter noted that risk of psychological damage should be included. Another commented that risks to forms of life other than human beings are ignored.

- the "general, vague" quality of the goals. Many individuals agreed with Commissioner Gilinsky that "the proposed guidelines were too remote from the nitty gritty hardware decisions that have to be made every day... to be of much use." They pointed out that the goals were too abstract to be meaningful, bore "no demonstrable connection to practical reality" and did not provide a realistic way to assure health and safety of the public.

- Too little emphasis on enforcing quality, or improving engineering principles and practices and on improving safety. It was suggested that "real safety comes from good design of facilities, good construction (and) good fabrication."

- Substantial variations exist in individual perceptions regarding the "acceptable" level of risk. Commenters questioned the acceptability of risk limits as high as those specified in the report and stated that greater emphasis should be placed on zero population risk - on the prevention of deaths from public safety accidents. These commenters objected to goals that "would permit 13,000 deaths over the lifetime of 150 reactors" or the likelihood of "murder" of large numbers of people. One commented that "acceptable risks means acceptable deaths since nuclear plants will always be operated up to their maximum capacity."

- Objection to qualitative goals. Closely tied to the notion of zero risk was the oft-stated belief that the use of numerical guidelines might be a source of misinformation - to connote standards or levels of acceptability in the public mind. One commenter asked, "Does proposing a limit on core meltdown probability make it less likely?"

- The purpose for which the guidelines were to be used. Commenters foresaw problems with using probabilistic risk assessment (PRA) to define safety aspects of nuclear power plants on the basis that it would be impossible to factor in or calculate human error, poorly trained operators, inadequate maintenance, multiple failures, etc. These individuals saw no assurance of safe operation until "human behavior" problems were resolved. Further problems with the use of PRA concerned the belief that information on goals would become inaccessible to independent review by the public. As one commenter stated: "Complex and unverifiable computer programs inaccessible to the independent reviewer will substitute for basic judgment in safety regulation." And again "any reliance on PRA to provide a good basis for a safety goal must be counterproductive or so undisciplined as to be worthless." Some noted the inconsistency between use of PRA and NRC repudiation of WASH-1400.

Many individuals stated that comparisons are misleading; that "nuclear power poses a unique kind of risk." And that their risks cannot be compared with other types of energy plants. These commenters believe that the societal risk of nuclear power, with its more hazardous technology, could not be compared with other electricity-generating techniques. Many commenters pointed out that the draft safety goals ignored alternatives to electricity for supplying our needs, particularly "conservation which makes any expansion in generating ability unnecessary." These individuals questioned the taking of chances when "safer alternatives exist." Some individuals believed it would be desirable to have a historical backup of recorded deaths and injuries (or lack thereof) from nuclear energy production as compared to other forms of electricity production. Others thought that the safety goals should take into account the "plausible level of individual exposures as determined by realistic calculations."

- Many individuals perceived the draft safety goals as "window dressing, an effort to assuage public fears, daily increasing, concerning accidents at nuclear power plants." Some saw it as a "statement in defense of the indefensible; a transparent fraud;" and/or "play designed to mask specific issues related to nuclear power safety with a smoke screen based on PRA." Others saw it as an "exercise in futility", and a "cover-up of deadly nuclear hoax," and "an attempt to improve public perception of nuclear safety instead of preventing risks." One suggested that NRC should not waste its time trying to convince the public that nuclear power is safe.

- Many individuals advocated that we should cease building plants to achieve ALARA risks; that the reliability of nuclear plants remains so uncertain that there is no way to assure safety.

- Some individuals thought the safety goal statement should include risk factors for the "non-biologically average" members of the public, such as infants, children, and pregnant women.

- Finally, individual comments covered the following points:

  -- NRC should look at its siting practices and identify risks at each specific site

  -- NRC should examine "unexpected" malfunctions; PRA doesn't take them into account

-- safety goal statement is an "elitist" statement and "will not reach a broad spectrum of people"; it is "premature and overly specific," and would be better if it were limited to clear understandable qualitative considerations

-- the statement "widens the gap between theoretical work in probabilistic risk assessment and experience in the field."

-- Risks addressed by safety goals are not as extensive as actual risks nor are they based on realistic accident scenarios; they should include risks of evacuation as well as the risks of ingesting contaminated food, milk, water as these may contribute more man-rem than exposure to the plume.

-- Authors of safety goals have a risk-benefit mindset that is philosophically bankrupt

-- An honest and clear description of all costs involved in generating electricity by various means and their related health and safety risks should be presented to the public, and the people that would be receiving nuclear power should determine if the risks are acceptable.

-- NRC's function is not to determine acceptable risk but to make certain that accidents do not occur; if it's impossible to avoid accidents, NRC should see that the plants are closed down and decommissioned safely

-- There is no place for nuclear power plants in a free society; they should be shut down as they will surely kill us and poison the land

-- Detonation of a nuclear weapon on a nuclear power plant, whether intentional or unintentional (e.g., intended for a nearby military installation such as the Vandenberg Air Force Base near Diablo Canyon), would create an enormous catastrophe; nuclear plants should be shut down.

-- Nuclear power should have no subsidies and no regulations and be required to compete with other forms of power generation

-- As long as private corporations run nuclear plants while looking for profit the plants are going to be unsafe

-- Nuclear plants should be built into a mountain or located underground to reduce risk

-- Fatalities already caused by release of low-level radiation are not taken into account

-- Waste problem should be solved before building nuclear plants

-- PRA-based safety standards may thwart nuclear power developments; failure to build nuclear power plants have already cost millions of lives

B. IMPLEMENTATION OF GOALS

Nineteen commenters stated they would need to review the implementation plan before they could fully comment on the Safety Goals. (121, 122, 112, 92, 117, 116, 58, 68, 128, 100, 110, 56, 70, 47, 142, C21, C16, 32, L20). The following comment by the American Nuclear Society is representative of the views of this group:

> Judgments on the value of a safety goal approach cannot be made by consideration of the goals themselves apart from consideration of the implementation process. Certainly the safety goals are devoid of much meaning without a clear specification of how it will be established that the goals are met. It is clear that implementation of the safety goals approach must be made in a cautious and enlightened manner.
>
> For the above reasons, the endorsement of the ANS to the safety goal approach, while unqualified in principle, must remain with some reservations until the value of the approach, as actually implemented, is validated. (117)

Five commenters believe that the goals should not be used in licensing, but only to assess regulations. (101, 114, 70, 72, 81). Detroit Edison's comment summarizes this group's views:

> The safety goal should be the standard against which both existing and future rules and guidelines are measured. To ensure consistency and order of the regulatory process, these rules and guidelines, and not the safety goal itself, should be applied in individual licensing activities. (101)

Five commenters agreed that the safety goals should be used on a trial basis. (127, 120 + C10, 104, 136, 139). The comment of Alabama Power provides an example of this position:

> Alabama Power Company concurs with the plan to provisionally adopt the proposed, or amended, safety goals. Since the concept of safety goals and the methodology for determining compliance has not been used in the past, provisional adoption will allow the ideas to be tested and developed without impacting the licensing of nuclear power plants if problem areas are identified. Provisional use would only be for the purpose of determining viability of the safety goal concept and would not be the basis for actual licensing or backfit decisions. After provisional use of these goals and guidelines, this subject should be reopened for public comment. (127)

Four commenters thought that the safety goal should only be a tool to supplement current requirements. (130, C10 + 120, 126, 136). The comment by Portland General Electric reflects the views of this group:

> It is important to realize that any numerical guidelines adopted now cannot be "hard and fast," since the risk assessment methodology and supportive data base are as yet not fully refined. The uncertainties associated with any analysis must be taken into consideration, and thus, it is best to rely on risk assessment techniques to provide supplementary information for consideration in the regulatory process. (130)

Three commenters believe there needs to be a better consensus on the usefulness of PRA before it can be used in the implementation of the safety goals. (98, 133, 47). The following comment by Baltimore Gas and Electric provides examples of the reasoning behind this position:

> It may be premature to insist on the application of PRA to the determination of compliance with the safety goals suggested, or even compliance with the suggested risk guidelines. Because these are expressed as a relationship of risk to risk, they provide a reasonable basis for expressing and clarifying NRC regulatory policy in absolute terms, independent of assessment methodology. Without a broader technical consensus on the precision of PRA results, the question of whether existing plants meet these goals will not be directly resolved by PRA. (198)

Three commenters believe that the implementation plan must be considered with great care. (107, B17, 85). Miro M. Todorovich's (Scientists and Engineers for Secure Energy) comment is representative of the group's views:

> It is premature for NRC to adopt the particular guide, or even revised guides, at this time. Any guides promulgated should be tested in principle before being published. The use of safety goals and numerical benchmarks as tools for evaluation must be distinguished from attempts to cement them into regulations. The first application can be extremely beneficial; the second would spawn a continual regulatory and litigatory problem. Safety goals and guidelines should not be used explicitly other than in the regulatory process. Because the proposed draft does not specify how the guidelines should be employed, it may merely add to an already impossible regulatory load; guidelines would be of value only if they could subtract from the load by replacing existent regulations. (85)

Three commenters believe that the present state of PRA will make the implementation of the safety goals very difficult, if not impossible (B5, 49, 70). The following comment by Professor Gilbert Brown of University of Lowell is typical of this group:

> I'm afraid the safety goals won't be workable. This is especially true of the numerical guidelines. Without a yardstick, it would be impossible to measure how the given reactor measures up the proposed guidelines. Furthermore, given the state of the yardstick, it is not clear that we understand the physical phenomena that may occur in an accident well enough to even know what we are measuring. (B5)

Other comments include:

- Wait for the conclusion of the current source term investigation (109, 23)
- The implementation plan should provide a uniform approach to PRAs. (89, 96)
- Operators should be given flexibility to meet goals (L40)

- Numerical compliance is impossible, use consensus approach (32)
- How will plants just out of compliance be treated (72)
- Safety goals should be useful in design (57)
- Goals too vague to be practical (69)
- Narrow scope of goals to equipment reliability (140)
- Set trial period of one year (135)
- It is important to determine the effect that use of safety goals will have on regulatory efficiency (70)
- PRA should not be used to implement goals (12)
- Acceptable risk should be determined by a vote of citizens living near the plant (61)
- Make explicit the fact that the proposed risk levels are absolute, not balanced against other considerations (118)
- Include the risks of genetic defects (L35)
- Explicitly acknowledge the limitations of quantitative methods (31)
- Use greatest risk individual instead of average individual (31)
- QA should be used to assure compliance (3)
- The implementation plan should emphasize reducing uncertainty in calculations (96)
- Explicitly include unquantifiable risks (96)
- Include in all results uncertainty (96)
- The implementation plan should distinguish between old and new plants (96)

C. QUALITATIVE GOAL ON INDIVIDUAL RISK

The proposed qualitative goal on the individual risk is stated as follows: "Individual members of the public should be provided a level of protection from the consequences of nuclear power plant accidents such that no individual bears a significant additional risk to life and health."

Eleven commenters agreed with the goal as proposed. (101, 69, 117, 58, 68, 54, 139, 93, 142, 34, 129). The following comment by Detroit Edison is representative of the group's views:

> Edison agrees that an appropriate and reasonable safety goal should include protection of individuals living near nuclear power plants. (101)

A number of commenters proposed restatements of the goal. Six commenters thought that the first and second qualitative goals should be combined or comparing nuclear risks against the risks of other activities should be included in the individual goal. The comment of the Department of Energy provides an example of these restatements:

> Individual members of the public should be provided with a level of protection from the consequences of nuclear powerplant accidents such that they do not bear a significant additional risk to life and health compared to other potentially severe man-made risks. (92)

Three commenters' statements were intended to clarify the meaning of the goal. The Atomic Industrial Forum (116) suggested defining individual as "individual in the vicinity of the nuclear power plant." John C. Fanta of Harvard Law School (31) believes that the goal should "express the fact that not all of the total risks of nuclear power plant operations are addressed." Edith Chase of the League of Women Voters of Ohio (64) suggests that the goal state that there should be "no adverse effects, prompt or delayed, on the life or health of the individual."

Seven commenters stated that NRC's goal should be that there be no risk of a serious accident or risk to an individual. (12, A11, A18, C29 +102, 27, 111, L13). The comments of Witan Consultants, Inc., and Robert L. Anthony of Friends of the Earth in the Delaware Valley summarize the views of this group:

> Expand the qualitative goals to include the intent of the NRC that no public deaths occur that are attributable to nuclear plant accidents. (12)

> We do not consider any risk of death from a nuclear plant <u>acceptable</u>! No individual should bear <u>any</u> additional risk; we do not know what "significant" means and do not accept it. (27)

Four commenters thought that the goal needed to be better defined to be implemented. (C30, 61, 91, 133). The comment of Deborah L. Norton of Action for a Non-Nuclear Future was typical of this group: "The word significant makes this goal vague and unenforceable."

Two commenters believe that only involuntary risks should be compared (C4, L7). The following comment by Joanna Hoelscher of Citizens for a Better Environment is representative of this viewpoint:

> CBE believes that it is inappropriate to compare voluntary with involuntary risks, i.e., the risks of nuclear power with other accident risks such as "driving, swimming, and flying." There is an element of personal choice in each of the latter which simply does not exist in the process which leads to the construction of a nuclear power plant. I can decide if I want to drive, or swim, or fly; but the selection of fuel and even the more basic decision about whether or not to even build a new electric generating plant are, by and large, out of my control. (C4)

Mary Basch (L13) thought the goal should "include the risks from routine emission, from the nuclear fuel cycle, from sabotage or from diversion of nuclear material."

Mark P. Oncavage of Floridans United for Safe Energy (129) stated that the "other proposed goals hopelessly undermine the attainment of this goal. Thus all proposed guidelines should be reconstructed to enhance the attainment of the first safety goal."

D. QUALITATIVE GOAL ON SOCIETAL RISK

The proposed guideline is the following:

"Societal risks of life and health from nuclear power plant accidents should be as low as reasonably achievable and should be comparable to or less than the risks of generating electricity by viable competing technologies."

Nine commenters thought that comparing the risk of nuclear power with other viable electrical generating technologies was too narrow. (130, 120, +C10, 122, 114, 69, 45, 116, 23, 38). This group believes that the risk comparison should be made against all other technologies. The following comment by Portland General Electric is representative of this group's views

> The societal risk evaluation from a comparative standpoint should be weighed against other beneficial technologies, and not just against operation of competing electrical generating plants. (130)

Eight commenters believe that ALARA should be eliminated from this goal or is vague or meaningless. (92, 68, 54, C17, 27, 113, 52, 74). The comments of IEEE Power Engineering Society and Connie Kline summarize the views of this group:

> The "as low as reasonably achievable" concept creates an open-ended specification of safety sufficiency that defeats the objective of improved regulatory stability and predictability. (68)

> Stating that risks should be "as low as reasonably achievable (ALARA)" is meaningless. To whom is this standard reasonable--the populace near a nuclear power plant or the utility? (113)

Seven commenters thought that the risks of nuclear power should be compared with all energy alternatives including renewable technologies and conservation. (A14, A18, C4, C29 + 102, 27, 97, 64). Tom B. Younkers' comment is typical of this group:

> I realize the Commission's narrow scope of consideration, but the question which compares different methods of generating electricity according to some theoretical risk factor does not allow room for consideration of displacing that electricity altogether with insulation or efficiency. These are two methods that have a much broader base to risk assessment. (A4)

Five commenters believe that the relationship between ALARA and the cost/benefit guideline should be made explicit. (114, 116, 100, 110, 142). The comment of the Atomic Industrial Forum is representative of the views of this group:

> The policy statement also notes that the use of a cost-benefit test for safety improvements is implicit in the goal through the use of the phrase "as low as reasonably achievable." However, this interpretation is often not well understood in practice, and we would recommend explicitly recognizing the appropriateness of cost-benefit balancing in the statement of the qualitative goal. (116)

Five commenters agreed with the proposal to compare the risks of nuclear power with the risks of other viable electrical generation technologies. (92, 58, 54, 83, A5). The comment by Texas Utilities Generating Co. summarizes the views of this group:

> The goal that societal risks from nuclear power plants should be comparable to or less than the risks of generating electricity by viable competing technologies is a useful and appropriate safety goal. (54)

Five commenters believe that risk comparisons are not appropriate in a safety goal. (117, A16, 34, 36, 111) The following comment by the American Nuclear Society is an example of the reasoning behind this position:

> The final thought relates to the comparison of societal risk for viable competing technologies. Although such comparison provides useful insights and may be a decisive factor in decision making, we doubt that it properly belongs in the safety goal framework. Such comparison studies should be performed, and we have no doubt that nuclear power will come out favorably in them. But we recommend that favorable comparison be deleted as a safety goal for the following reasons. If comparison is to be made with competing technologies, the comparison must logically be made on total impact, i.e., in the nuclear plant case on the total fuel cycle. We do not recommend this approach, however, since it carries us too far afield, and, more importantly, we do not believe that comparison of competing technologies is necessarily relevant.
>
> Compared technologies could, in principle, all present risks far below acceptable values with comparative risks therefore not a decisive factor. A further criticism of this part of the second qualitative goal is that it may lead to all competing technologies (assuming they all in time establish safety goals) specifying they must present comparable or less risks than the others, thus leading to a racheting process. (117)

Five commenters suggested that a risk comparison should include the risks from the total nuclear fuel cycle in order to place all risks on an equal basis. (31, A16, 38, 111, 52). The comment of John C. Fanta of Harvard Law School is representative of this group's views:

> The comparison made is not between the total risk of nuclear power plant operations and the total risks of competing technologies, but rather between only the risks of nuclear power plant accidents and the total risks of competing technologies. This second proposed goal should be amended to state that the total risks of competing technologies should be compared to the total risks of nuclear power. (31)

Three commenters thought that ALARA is an important part of the goal and should be emphasized. (101, 122, 117). The comment of Yankee Atomic Electric is typical of this group:

The As-Low-As-Reasonably-Achievable (ALARA) standard is fundamental to an achievable safety goal. There is a limit on how much this country can afford to spend to reduce risk from all its technological activities. Current societal perspectives are causing more spending for light water rector safety. (122)

Other comments include:

- Unqualified agreement with proposed goal (58, 34).
- Supply and political risks to other energy sources such as oil should be considered (71).
- The risk comparison needs to be clarified (68).
- A societal risk goal is redundant to the individual risk goal (90).
- Remove "or less than" from goal (142).
- Include psychological stress in risk calculations (74).

E. NUMERICAL GUIDELINES ON MORTALITY RISKS

The proposed numerical guideline on mortality risks is as follows:

"The risk to an individual or to the population in the vicinity of a nuclear power plant site of prompt fatalities that might result from reactor accidents should not exceed one-tenth of one percent (0.1%) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed."

Eight commenters believe that 1% is a more appropriate value than the proposed 0.1%. (B10, 117, 116, 58, 68, 128, 55, 142). The following comment by the Atomic Industrial Forum is representative of the views of this group:

> The proposed value of 0.1% of existing accident risk as a guideline for prompt fatality risk is excessively stringent and conflicts with the qualitative safety goals. This value should be increased to 1% or replaced with a formulation that effectively provides a more realistic and reasonable value for individual risk. (116)

Seven commenters thought that the guideline was too conservative. (112, 71, B10, 96, 62 +C21, 85, 126) The comment by Stone and Webster Corp. summarizes this group's views:

> The goals as defined by the NRC are too conservative. Even though these calculations of risk are mathematical exercises, they may end up in excessive costs for the generation of power. (B10)

Six commenters thought that the guideline was set too high. (2, 9 +141, 86, L13, 52, 61). The comment by Mary B. Davis of the Sorghum Alliance is typical of this group:

> The 0.1% yields too high a mortality risk, especially considering mortality risks of other aspects of nuclear industry (routine emissions, the nuclear fuel cycle, sabotage, and diversion of nuclear material, etc.) (52)

Five commenters thought that the individual, prompt fatality limit would, but should not, dominate the other numerical risk limits. (120+C10, 122, 114, 69, 38). The following comment by the Yankee Atomic Electric provides an example of this viewpoint:

> The NRC's proposed goals separated individual risk/prompt fatalities from population risk/latent fatalities, but established a common numerical guideline of 0.1% for the acceptable risk increment for either category. Thus, individual prompt fatality risk considerations will predominate in most scenarios. We believe the prompt fatality risk-goal of 0.1% of accidental deaths normally occurring may be too low. It translates roughly into a risk-goal of $5(10)^{-}$_ per year. Compared to the average mortality risk for accidents [$5(10)^{-4}$ per year] or for cancer [$2(10)^{-3}$ per year], it is extremely small. A more reasonable value must be chosen. (122)

Five commenters suggested extending the distance criteria from 1 to 10 miles. (45, 96, 117, 133, 24). The comment by Pennsylvania Power and Light Co. summarizes the views of this group:

> The risk of early (prompt) fatalities that might result from a nuclear power plant accident should be based on the population that can potentially receive life threatening doses. The NRC has stated that such exposure should not occur beyond 10 miles from the plant site. This led to the development of the 10-mile plume exposure emergency planning zone (EPZ). (45)

Four commenters thought that the NRC should set a value for prompt risk from nuclear power plants. (101, 135, 118, 64) Two suggested a value of 10^{-6} fatalities per year (118, 64). The comment by General Atomic Co. is representative of this group:

> The proposed numerical guidelines specify an incremental risk (0.1%) but do not identify within the guideline the total risk. These are specified in later sections of NUREG-0880. Since members of the general public may not read all of NUREG-0880, it is recommended that the numerical guidelines incorporate the total risk due to nuclear power plant accidents as well as the incremental risk. On pages 22 and 23 of NUREG-0880, these are no more than 5 in 10,000,000 per year for prompt fatality and 19 in 10,000,000 per year for delayed mortality. It is better to know one's total risk rather than an increment of an unknown base. (135)

Four commenters thought that nuclear risks cannot and should not be compared with other risks. (A8, 27, 113, 84) The following comment by Mrs. H. T. Reed of the Sierra Club of North Carolina summarizes the views of this group:

> Total risks from all causes are not comparable to the risk of meltdown effects. Personal risks are a matter of individual choice and action, such as taking refuge from lightning or going over the Niagara in a barrel, driving fast or slow, or not driving at all. Risk in other technologies is limited in area and self-limiting in time. To the extent that it increases in the age of chemistry, we should be trying to reduce other risks, not enlarge them by allowing given percentages for them. So that as social risks increase, then the risk of nuclear death becomes increasing wide and acceptable. (A8)

Three commenters thought that it was not wise to include both individual and societal risk in the same numerical guideline (130, 69, 92). The comment by Virginia Electric and Power Co. provides an example of the reasoning behind this position:

> The quantitative goals lump the risk to individual and population together for comparison where the qualitative goals address them separately. It is not credible that the individual risk and population risk will even be the same order of magnitude for many reasons, not the least of which are individual age and location with respect to reactor. (69)

Three commenters thought that the guidelines were confusing and its implementation plan unclear. (34, 111, 116) The comment by Robert English is representative of this group's views:

> The discussion is mixed up, is confusing and, therefore, does not provide unambiguous guidance for future decisions. (34)

Three commenters believe that the prompt fatality risks of nuclear power should be compared with the risks of other competing electrical generating technologies. (127, 126, 62 + C21). The following comment by Florida Power and Light Co. summarizes the views of this group:

> The quantitative risk guidelines and cost-benefit guideline appear inconsistent with the qualitative guideline requiring that the "total risks of nuclear power plants resulting from normal operation and accidents are comparable to or less than the total risks of the operation of competing electricity generating plants." The individual total accident risk guideline, which applies to the most exposed individual is about 2.5×10^{-6}. Others in the vicinity of the plant would be exposed to a much lower risk. A coal plant, the competing form of generating electricity, would routinely expose large numbers of individuals to a risk of about 2×10^{-4}. These figures would indicate that the nuclear plant guideline is excessively restrictive. (126)

Other comments include:

- consider involuntary risks only (34, 64)
- support AIF proposal of individual risk 10^{-5} per year and societal 1 fatality per 1000 MWe per year (122, 114)
- disagree with use of biologically average individual (34, 86)
- delete societal risk limits
- distinction between prompt and delayed fatalities is unnecessary (89, 34)
- delete distance criteria (34, L13)
- compare with total mortality, not just accidents and cancer (38)
- guideline does not address what is reasonably achievable (38)
- actual experience shows that guidelines would relax safety, why change? (A10)
- guideline should not include multiple reactor site restrictions (120 +C10)
- agrees with prompt vs delayed distinction (112)

- use per MWe instead of per plant (112)
- define source term levels (69)
- apply guideline only to population exposed to risk (45)
- guideline should compare nuclear risks with the risks of other low probability events. (92)
- agrees with the use of biologically average individual (92)
- unqualified approval of proposed guideine (54)
- one mile criteria unclear (128)
- it is not prudent to use numerical guidelines (31)
- do not increase risk limit by increasing distance criteria (96)
- if all dangerous industries adopted this guideline, public risk would increase substantially (49)
- to concentrate on individual risk makes large societal risk appear acceptable (49)
- state range of total deaths from all nuclear risks (49)
- there is disagreement within the UK about whether safety guidelines should connect probabilities of releases with their consequences. (57)
- use only national fatality statistics (142)
- .1% nuclear risk limit when compared with numerous hazards could lead to nuclear being the largest hazard (124)
- estimating risk is not possible (124)
- guideline should include consideration of organ doses (67)
- guideline should consider injury risks of evacuation (67)
- distance criteria is too small (86)
- it is not possible to control risk this precisely (L36)
- risks of nuclear power should be compared with those of other energy alternatives (64)

F. NUMERICAL GUIDELINES ON CANCER RISKS

The proposed numerical guideline on cancer risks is as follows: "The risk to an individual or to the population in the area near a nuclear power plant site of cancer fatalities that might result from reactor accidents should not exceed one-tenth of one percent (0.1%) of the sum of cancer fatality risks resulting from all other causes."

Six commenters believe that 1% would be more appropriate than the proposed 0.1% (112, 45, 117, 68, 100 +131, 110). The following comment by Pennsylvania Power and Light Co. summarizes the views of this group:

> We believe the numerical guidelines have been developed too conservatively. We recommend that they be revised to reflect that risks from nuclear power plant accidents should be comparable to the risks from other technologies. Specifically, we recommend that the risk to an individual or the local population should not exceed one percent (1%) of the sum of other risks from technologies in the U.S. The 1% ratio is not too conservative and does assure an insignificant impact from nuclear power. Since the NRC intends to introduce the guidelines on a trial basis, the 1% ratio could be used and modified if determined to be unacceptable. If a 0.1% ratio is used, we believe it is highly unlikely to be increased even if operating history provides suitable justification. (45)

Five commenters believe that it is not possible to determine whether a cancer resulted from the operation of nuclear power plants. (65, 59, 50, 52, 63). The comment of Chester Maliszewski is representative of this group's views:

> I don't see how you come up with your projected numbers for the cancer rate associated with nuclear power plants. You are implying a level of knowledge that is not present in the technology you're using. Causation of cancer has not been sufficiently pin-pointed to allow you to claim much accuracy for your projections. (65)

Four commenters felt that this level of risk is unacceptable. (27, A1, A8, 65) The comment by Robert L. Anthony of the Friends of the Earth in the Delaware Valley is typical of this group's position:

> No risk of cancer fatality from nuclear should be added to other causes; neither are acceptable. (27)

Three commenters thought that the 50-mile radius defining the population at risk should be flexible depending on site-specific conditions. (120 + C10, 128, 57). Commonwealth Edison's comment is representative of the views of this group:

> The numerical guidelines have set forth a 50-mile radius for defining the population at risk. We suggest that this may be overly conservative in many cases. A better approach would be to let the individual plant assessments establish the radius of significant risk considering the site specific and area specific factors of interest. In addition to being more realistic, such an approach might avoid some basic philosophical (and possibly legal) difficulties if two sites, owned by two utilities, in two states, exist less than 100 miles apart. (120 + C10)

Three commenters thought that the NRC should determine a value for non-nuclear risks or set an arbitrary value for nuclear risks. (C10 + 120, 126, 118). The following comment by Professor Richard Wilson of Harvard University provides an example of this position:

I would personally prefer that NRC explicitly state a risk level of 1 in 10^{-6} as the accepted risk level, and not 0.1% of a cancer rate. This is because 1 in 10^{-6} has already been widely discussed. Yet the numbers are not dissimilar. The cancer risk is about 2×10^{-3}/year and 0.1% of this is 2×10^{-6} per year. I have, therefore, no great quarrel with 0.1% of cancer rate provided it is agreed to as a de minimis risk to be acceptable without argument. (118)

Three commenters believe that the 0.1% value is too small. (121, 114, 126). The comment by Middle South Services, Inc. summarized the views of this group:

> There is also no logical basis for selecting 0.1%, nor is one cited anywhere in the document. This number could just as well have been 0.1%, 1%, or even 5% and would have still met the qualitative goals.
>
> Our society willingly accepts much higher percentages from other technologies. Why should nuclear power be afforded such special treatment? (114)

Other comments include:

- include risk of genetic defects (L13, 52)
- 0.1% should be tied to existing cancer rates not to the current cancer rate (101, 64)
- meeting the individual guideline ensures compliance with the societal goal (96, 57)
- unqualified agreement with guideline as proposed (83)
- guideline ignores cumulative risk of those living within 50 miles of two different plant sites (49)
- guideline cast solely in terms of "expected value,"
- supplement with "limit lines" and/or "CCDF." (120 + C10)
- this guideline will be difficult to implement. (69)
- instead of 0.1% of cancer mortality, compare with cancer risk of other technologies (92)
- consider only societal risk (116)
- consider only individual risk (58)

- divide guidelines in terms of individual and societal risk instead of in terms of prompt and delayed fatalities. (100 + 131)
- consider environmental effects (26)
- explicitly state that the risk to the population within 50 miles envelopes the total population. (70)
- use a 1000 person-rem limit (47)
- inconsistent with goal to compare with risks of competing technologies (137)
- individual and societal risk should not have the same value (57)
- use of PRA is not acceptable. (C4)
- it is not possible to annualize delayed cancer fatalities (24)
- NRC's cancer mortality model is not conservative (111)
- does not believe in concept of "acceptable deaths" (103)
- no rationale for 13,000 deaths (59)
- contamination of food and water not considered (67)
- consider synegistic effects of radiation and pollution (86)
- use 100 mrem limit (L7)

G. BENEFIT-COST GUIDELINE

The proposed benefit-cost guideline is as follows:

> "The benefit of an incremental reduction of risk below the numerical guidelines for societal mortality risks should be compared with the associated costs on the basis of $1,000 per man-rem averted."

Sixteen commenters thought that the guideline needs to be better defined or there must be a clear implementation plan in order for them to tell whether the $1,000 per man-rem averted is reasonable. Many wanted the NRC to explain the rationale for choosing $1,000. (127, 130, 120 + C10, 121, 69, 94, 2, 12, C1, 113, 103, 65, 59, 50, 91, 64). The following comment by Virginia Electric and Power Co. is typical of this group:

> The cost/benefit guideline is linked to the quantitative guidelines already discussed as too vague to be of practical value. Determination of the man-rems averted is subject to the same variables as population risk and with the cost of determining the value achieved added to the cost, $1000 may well be inappropriate. (69)

Fourteen commenters suggested that $100 be used instead of $1000. (122, 112, 100, 117, 116, 128, 137, 110, 136, 139, 142, C21, 4, 126). The Westinghouse comment provides an example of the reasoning behind this position:

> With these other guidelines already satisfied, efficient allocation of resources should result in the dollar expenditures to avert exposure consistent with those expended to save lives or reduce health risks in other activities and technologies. As pointed out in the 1981 AIF White Paper, a figure of $100/man-rem (equivalent to about $1 million/life using the linear relation between dose and cancer) would be more consistent with other activities. (110)

Eleven commenters felt that the $1000 value was too large. (114, 112, B10, 116, 92, 70, 55, 57, 77, C26, 85). The following comment by Duke Power Co. is representative of this group's views:

> The cost-benefit criterion of $1000/man-rem seems somewhat high. Although that particular value has a precedent in nuclear applications, it was originally chosen as being "conservative." (112)

Eleven commenters believe that the cost/benefit guideline should be deleted. Five felt it should only be used as a tool (92, 68, 54, C4, 89,) and six felt that no risk is acceptable (A18. 27. C17, 9 + 141, 123, 52). The Department of Energy's comment summarizes the views of the first group:

> We recommend that the benefit/cost guideline be deleted. The numerical guidelines of individual and societal mortality risks are sufficient for public protection. The proposed numerical benefit/cost guideline works against the objective of having clear predictable requirements. (92)

The comment of Dennis Hoffarth is representative of the views of the second group:

> The mere concept of using a mathematical calculation to compare dollars to human life deserves extreme caution. We can't afford this approach with nuclear plants. We must face the mistakes of the past and be willing to force shutdowns or major repairs regardless of costs if there is significant danger of a major nuclear accident. (A18)

Eight commenters believe that the $1000 value is too small. (A5, 38, 111, 103, 65, 59, 86, L13). The comment by Russ Lacewell is typical for this group:

> Your proposal to spend $1,000 dollars per man hour rem of exposure prevented puts no thought at all toward the effect of those rem exposures. Who pays for the cancer treatments, the loss of job time? How much is a life worth? I don't know, but it is a lot more than $1,000 a rem. (103)

Eight commenters believe that the guideline should be discounted to account for the time-value of money (122, 2, 133, 96, 77, 34, 10, 129). The comment of Yankee Atomic Electric Co. is representative of the views of these groups:

> We believe the issue of discounting should be somewhere addressed in the Safety Goals. Discounting addresses how future costs and benefits are discounted to present worth for decision-making. What is a reasonable difference in value for averting a prompt fatality now versus a cancer fatality twenty years later? It may be argued that by investing money not spent today to reduce present risk, a large increase in resources would be available in the future to achieve life saving then. (122)

Four commenters thought that plant damage losses should be excluded from the cost/benefit calculation (*122, 114, 58, 128). The following comment by Bechtel Power Corp., summarizes the views of this group:

> The factors to be included in this evaluation must be clearly defined. Factors which have large economic impact to the utility with little or no risk to the public should not be considered as part of the NRC's regulatory charter nor part of the safety goals. Therefore, reduced risk of economic loss of the plant itself should not be included in these evaluations. (128)

Three commenters believe that only the direct costs of an improvement and direct safety benefits should be considered in the cost/benefit calculation (117, 116, 100). The comment of the Atomic Industrial Forum provides the reasoning behind this position:

> In implementing this guideline, consideration of benefits should be limited to public risk reduction and consideration of costs should be limited to the immediate costs of proposed safety improvements. Economic factors relating to potential future plant or offsite property damage are not related to safety and thus, are inappropriate for inclusion in this benefit-cost balancing process. (116)

Other comments include:

- unqualified support for the proposed guideline (101, 98, 118)
- liability loss or offsite economic damage should be excluded (112, 114)
- benefit cost guideline is not consistent with de minimus prompt and delayed risk guidelines (57, A18)
- use of 50 mile limit is not practical (96, 10)
- people living near the plant should be compensated for extra risk they assume (133, 24)
- NRC should state a value for man-rem equivalent for statistical death (C16, 34)
- include economic losses in cost/benefit calculation (96, 34)
- do not annualize (A8, 124)
- include the cost of replacement power (58)
- consider all sources of exposure (67)
- use variable value depending on the size of man-rem reduction (68)
- consider total population (34)
- use 50 miles cut off (135)
- there are site specific problems with attempting to implement 50 mile limit (109)
- use of cost/benefit analysis should be limited to a few cases (110)
- instead of $1000 per man-rem averted criteria use relative contribution to core melt probability (10)
- this guideline would eliminate spending money to reduce uncertainty which sometimes is more valuable than reducing risk (70)
- suggests $1000 for large accidents and $100-200 for small releases (23)
- suggests that NRC use cut off value of 500 mrems in calculating health risks (55)
- use guideline in designing new plants (96)
- use guideline in reviewing NRC requirements (139)

H. PLANT PERFORMANCE GUIDELINE - LARGE SCALE CORE MELT

The numerical guideline for the plant performance is as follows:

"The likelihood of a nuclear reactor accident that results in a large-scale core melt should normally be less than one in 10,000 per year of reactor operation."

Fourteen individuals and public interest group commenters believe that the risk of one in ten thousand of a large-scale core melt per year of reactor operation is too high. (A1, A20, A22, 34, 27, 113, 111, 97, 54, 65, 52, 61, 63, 64). The following comment by Lavinia B. George is representative of the views of this group:

> The proposed goals that the risks of a core-melt at one reactor during one year of operation should be one in 10,000 calculates to a 45 percent chance of melt in a 200 reactor industry over a 30-year operating cycle. Certainly, this is too great a risk. (A1)

Nine utility, vendor and nuclear industry group commenters agreed with the characterization of this guideline in NUREG-0880 as subordinate to the other numerical guidelines; that it provided an interim limitation to be used by the staff in reviewing PRAs; and that it should not be a requirement. (120, 114, 112, 58, 54, 110, 128, 142). The comment by Commonwealth Edison summarizes this group's views:

> Although we are in agreement with this guideline, it is important that the policy statement emphasize that this large scale core melt goal is secondary to the goals on individual and societal risk, as well as, the benefit-cost ratio; and is not to be considered a requirement. Furthermore, we believe that core melt frequency is a good indicator of the financial risk to a utility from an accident which causes core damage, even though the scenarios which contribute most to core melt frequency are not necessarily the major contributors to plant risk. (120)

Eight commenters thought that the plant performance guideline was incomplete because it failed to relate accident risks, through containment reliability and radioactive releases, to the consequences of core melts to the public. Some felt that the plant performance guideline could and should be derived from the guidelines on prompt and delayed mortality risks. (69, 118, 90, 96, 109, 72 + C12, 38, 67). The following comment by Sherwood Davis is an example of this position:

> This plant performance guideline does not relate to offsite releases but to probabilities of a core melt and releases within containment. It would be more meaningful in light of the proposed prompt and delayed mortality risk guidelines to relate the probability and source term of an environmental release following a large-scale core melt accident. (67)

Four commenters thought that, in light of the other three numerical guidelines, the plant performance guideline was redundant and unnecessary. (127, 122, 116, 68). The comment by Alabama Power Co. reflects the views of this group:

> The proposed guideline on the likelihood of a large-scale core melt does not appear necessary. Since the dominant contributor to risk from a nuclear power plant accident is a large-scale core melt, the individual and societal mortality risks are dominated by this type of accident. Therefore, the guideline on mortality risk adequately addresses the concern about core melt accidents. Alabama Power Company opposes the numerical guideline for plant performance since it is redundant and unnecessary. (127)

Three commenters suggested using this guideline as a screening criteria. If utilities could prove compliance with this guideline, it would not be required to prove compliance with other numerical guidelines. (114, 98, 142). The following comment by Middle South Services, Inc. is representative of this group's views:

> Its use should be as a screening criterion - i.e., if one passes this test, it should not be necessary to check to see if the individual and societal criteria are met. (114)

Three commenters thought that the guideline was not practical because of the difficulties of performing and using PRAs. (49, 124, 129). The comment of Thomas and Hair (co-counsel for Limerick Ecology Action, Inc.) summarizes the views of this group:

> The plant performance guideline rests implicitly upon a purported ability to reliably make such absolute probability calculations, and this ability has <u>not</u> been demonstrated to exist. (49)

Other comments include:

- unqualified agreement with guideline as proposed (139, 101)
- proper implementation is essential to the usefulness of this guideline (100,104)
- The guideline should emphasize operational/basic engineering aspects of plant performance (92, 89)
- no basis given for 1/10,000 guideline (103, L8)
- the guideline essentially relates to economic aspects of nuclear power: NRC should consider economic aspects (23); NRC should not consider economic aspects (55)
- guideline is too restrictive (137)
- guideline should include external initiators and be more stringent (57)

I. <u>QUESTION 1 - ECONOMIC LOSS</u>

At the end of the proposed policy statement, the following background material and question are presented:

> "The proposed benefit-cost guideline provided in furtherance of the as low as reasonably achievable (ALARA) principle would set a numerical formula of $1000 per man-rem averted for consideration in tradeoffs of societal mortality risk reductions against the cost of achieving them. The discussion paper describes the basis of the trade-off calculations as follows: 'The benefit of an incremental reduction of risk below the numerical guidelines for societal mortality risks should be calculated for the population reasonably expected to be within 50 miles of the nuclear power plant site. The associated costs should include all reasonably quantifiable costs (e.g., design and construction of plant modifications, incremental cost of replacement power during mandated or extended outages, changes in operating procedures and manpower requirements).'

Question 1: Should the benefit side of the tradeoffs include, in addition to the mortality risk reduction benefits, the economic benefit of reducing the risk of economic loss due to plant damage and contamination outside the plant?"

Ten commenters were in favor of including the aversion of economic loss as a benefit in the benefit-cost guideline (24, 45, 57, 58, 96, 111, 115, 124, 132, 133). EPRI calculated the expected annual off-site property risk to range from $199 to $14,800 (1974 dollars). Pennsylvania Power and Light calculated a range of $1 million to $10 million per reactor year. The following comment of J. M. Griesmeyer (ACRS staff) is an example of the reasoning behind this position.

> Economic loss due to plant damage and contamination outside of plant would be as real a loss to society as direct health effects and may result in indirect health effects that are as large as direct effects. Many available risk studies suggest that the offsite economic costs of accidents would be larger than health effects cost at the nominal $1000/man-rem suggested in the proposal. Furthermore, some economic effects are omitted in the risk studies and others such as decontamination costs seem to be underestimated. Societal resources used to clean up and cope with a large release of radioactive material are not available to improve national productivity and general health care, or to reduce other specific societal risks for which relatively modest expenditures, compared to $1000/man-rem, are likely to defer a premature death.
>
> Experience and logic tell us that both offsite and onsite economic losses will usually be born by society, ultimately if not initially. Hence, the reduction in such losses should be considered as a benefit of an improvement to be balanced against its cost. (96)

Twenty-four commenters were opposed to inclusion of the economic benefit of reducing the risk of economic loss. The following comment by Duke Power Company summarizes the views of this group (23, 55, 68, 69, 90, 92, 98, 100, 101, 104, 110, 112, 114, 116, 117, 120 & C10, 122, 126, 127, 130, 136, 139, 142, C16):

> The benefit side of the benefit-cost analysis should represent a measure of the potential reduction in risk only in terms of public health and safety. The NRC is not charged with, and should not concern itself with, protecting the financial investment of a utility and its shareholders in a nuclear plant. Likewise, neither the economic benefits of electricity produced by nuclear power plants, nor the potential economic losses associated with their operation come within the purview of the NRC. As a practical matter, the calculation of economic consequences of reactor accidents is much more difficult and subject to larger uncertainties than the evaluation of radiological consequences, and would thereafter unduly complicate the cost-benefit analyses. (112)

J. QUESTION 2 - CONTAINMENT AVAILABILITY

At the end of the proposed policy statement, the following background material and question are presented:

> "The primary numerical guidelines address the permissible net residual health risks after application of all elements of a defense-in-depth safety philosophy. Safety against core melt and integrity of containment are two of the chief elements of that defense in depth. A further guideline sets a proposed numerical limit on core-melt probability. However, for reasons stated in the paper (NUREG-0880), no numerical guideline for containment failure risk is included. Instead, qualitative guidance and the operation of the other numerical guidelines are relied on to guide regulation of containment effectiveness.
>
> Question 2: Should there be added a numerical guideline on availability of containment function, given a large-scale core melt?"

Four commenters (24, 69, 101, 147) felt that a numerical guideline on the availability of containment function should be added to the safety goals. The view of Virginia Electric and Power Company (69) follows:

> The final analysis of the safety goal will compare the plant capacity to contain harmful radiation against guidelines of what maximum amount might be released without regard to type of accident. Any guidelines must therefore include a measure of containment effectiveness under worst case, i.e. core melt conditions.
>
> VEPCO feels that the guidelines call for evaluation of the entire plant as a system to keep radiation from the public and, therefore, a numerical analysis of containment should be part of the guideline.

Twenty-six commenters were opposed to a numerical guideline on containment availability. (23, 45, 55, 57, 58, 68, 81, 92, 98, 100, 104, 110, 112, 114, 115, 116, 117, 120 & C10, 122, 126, 127, 129, 133, 136, 139, 142). The following comment by the Atomic Industrial Forum (116) is representative of the group's views:

> The individual and societal mortality risk guidelines inherently serve the objective of ensuring low probability of large release accidents. The addition of a containment guideline to the proposed set of guidelines would overspecify the framework and complicate implementation and could lead to imposition of requirements that conflict with the benefit-cost guidelines.

Three commenters (A1, 111, 124) were not responsive to the question.

K. QUESTION 3a - UNCERTAINTY

At the end of the proposed policy statement, the following background and question are presented:

> "The last paragraph of the proposed policy statement calls on the NRC staff to develop, for Commission review, an action plan for implementation of the goals and numerical guidelines. The policy statement as well as the discussion paper (NUREG-0880) provide guidance on the implementation approach to be employed, but only in rather general terms. Comments and suggestions are solicited for consideration in development of a detailed approach to implementing the safety policy. Responses to the following specific questions would be welcome.
>
> Question 3a: What further guidance, if any, should be given for decisions under uncertainty?"

Four commenters (45, 104, 120, 139) recommended that very little or no guidance should be provided for treating uncertainties.

Nine commenters (23, 68, 77, 92, 98, 110, 117, 126, 133) stated that the NRC should prescribe how to perform PRA calculations and then the impact of the uncertainties would be minimized. A typical comment by the Department of Energy (92) was:

> We view the entire process of using quantitative guidelines that require probability risk calculations to be a process that applies to decisions made under uncertainty. We think the correct approach is to specify the decision rules that require PRA calculations including specification of uncertainties and to reach agreement on the way the PRA calculations are to be done.

Eight commenters (57, 58, 100, 112, 114, 116, 127, 142) stated that PRA results should be calculated using best estimate values and judgment should be relied upon if the PRA results, with uncertainties quantified, overlap the numerical guidelines. The Atomic Industrial Forum (116) provided a representative comment for this group:

> In using quantitative risk assessment methodology and safety goals in regulatory decision-making, it is important to use best estimate values of risk and to estimate the range of uncertainty in any risk estimate. The weight given any quantitative risk estimate must be dependent on its relationship to the appropriate numerical guideline being used in the decision process. In many cases, the estimated risk value, even with uncertainty, may fall well above or below the relevant numerical guideline. In such cases, regulatory decisions may be based on the PRA studies and numerical guidelines with greater confidence. However, where the best estimate results of PRA studies are near the numerical guideline value, additional sound engineering judgment must support the regulatory decision process.

Other comments (69, 90, 111, 115) were not responsive to the question.

L. QUESTION 3b - CONFLICTS

As part of Question 3, the following was asked:

> Question 3b. "What further guidance, if any, should be given on resolution of possible conflicts among quantitative aspects of some issue?"

Seven commenters (68, 100, 101, 104, 110, 117, 139) apparently did not understand the question because their comments were not responsive. Three commenters (69, 112, 115) stated that further guidance is not needed and two commenters stated that no conflicts are expected (98, 127). Some of these commenters, such as the following comment by Duke Power Co. (112), recommended a trial period of use:

> Further guidance is probably not advisable until the guidelines have been subjected to a trial period of use, after which problems in applying them can be more readily resolved.

Three commenters (45, 92, 142) recommended that further guidance be given to resolve conflicts and a fourth commenter Florida Power & Light Co. (126) suggested some guidance:

> Engineering judgment cannot be eliminated through implementation of PRA techniques. Guidance to the staff will be required to handle a situation where a safety goal quantitative guideline is not met, but is within the bounds of uncertainty (say < 10), and all backfits to bring the plant into compliance are not cost-beneficial. For situations of this type it would seem that:
>
> - an evaluation of the conservatism in the PRA methodology may be sufficient to allay any undue risk concern generated by the PRA, or
>
> - additional inspection, or test or surveillance requirements may be appropriate in lieu of a backfit that is not cost-beneficial.

Three commenters (58, 114, 116) proposed changing the individual numerical risk guideline to resolve possible conflicts. The following comment by the Atomic Industrial Forum (116) is representative of this group:

The best way to avoid possible conflicts among quantitative aspects of an issue is to ensure that the goals or numerical guidelines to be used in the decision-making process are well balanced; that is, no one consideration relating to individual risk, societal risk, benefit-cost or large scale core melt should dominate all decisions to the extent that the other factors become meaningless. Our comments on the proposed numerical guidelines of 0.1% on prompt fatality risk reflect our concern on the need to avoid such conflicts. The prompt fatality guideline, as proposed, would tend to dominate resolution of many issues in a manner which would conflict with benefit-cost considerations in that changes to design or operating procedure may be required which are far more costly than $100 or even $1,000/man-rem.

M. QUESTION 3c - ACCIDENT INITIATORS

As part of Question 3, the following was asked:

Question 3c: "What approach should be used with respect to accident initiators which are difficult to quantify, such as seismic events, sabotage, multiple human errors, and design errors?"

Six commenters (98, 101, 126, 127, 130, 142) recommended that the staff continue to use a deterministic approach for initiators which are difficult to quantify. Portland General Electric (130) provided a representative comment:

> In dealing with those accident initiators that are difficult to quantify, such as seismic events, the methodology at the present must follow the currently-used deterministic approach. It is possible to include such events in risk assessments. However, they primarily contribute to calculational uncertainties. It may be that in the future advanced risk assessment methods may be developed that are capable of dealing with these uncertainties, but not at the present time.

Thirteen commenters (23, 58, 68, 92, 100, 104, 110, 112, 114, 116, 117, 120 & C10, 139) recommended a dual-pronged approach. They felt that most of the accident initiators could be quantified for a probabilistic analysis; however, sabotage should be handled deterministically. The following comment by the Electric Power Research Institute (58) is representative of this group:

> We do not believe that the NUREG-0880 report need provide additional guidance on the quantification of seismic events, multiple human errors, and design errors. A comprehensive and well-executed probabilistic risk assessment should address these issues, and guidance is being provided in the pending PRA Procedures Guide, NUREG/CR-2300. In our opinion, the risk from sabotage cannot be meaningfully quantified and should be excluded from probabilistic risk assessments and safety goals. We believe that the existing engineered safety features and the required security measures limit this risk to a small fraction of the quantified accidental risk, but we know of no analytical procedure which can demonstrate this.

Five commenters (45, 57, 69, 90, 115) proposed alternative approaches:

- Recognize that such events have a different level of realism and evaluate using a set of goals for conservative analysis (45)

- Four examples should be dealt with in different ways: multiple human errors by improved operator training, improved display of relevant information, etc.; design errors by properly organized system of cross-checks and review; seismic events possibly by application of the 0.1% increase in casualty rate; sabotage - no comment at this stage (57)

- Address according to order of magnitude of risk and state of the art of relevant technology (69)

- Seismic events and sabotage - "use of general terms"; human errors control by following U.S. Navy training system for operators; PRA would identify design errors (115)

- To account for uncertainties, plant design should include robust line of defense, e.g., design to withstand much larger accelerations that the design acceleration; emphasis should be on robustness and mitigation procedures (90)

N. QUESTION 3d - MEAN, MEDIAN, CONFIDENCE

As part of Question 3, the following was asked:

> Question 3d: "Should there be definition of the numerical guidelines in terms of median, mean, 90 percent confidence, etc.? If so, what should be the terms?"

Eleven commenters (23, 57, 58, 70, 100, 104, 110, 112, 116, 117, 130) advocated use of best-estimate calculations. Nine commenters (45, 58, 68, 100, 110, 112, 114, 126, 130) recommended the use of mean values as stated in the following comment by Portland General Electric (130):

> Probabilistic risk assessment studies should be used to provide best-estimate probabilities and consequences. Mean values associated with calculated uncertainties are most appropriate for such application. These specifications should be made in the finalized procedures guide.

Whereas three others (98, 104, 120 & C10) wanted to use median. The following comment by SNUPPS (104) is representative:

> The numerical guidelines should be based on best estimate, i.e., median calculations. When many factors are combined it is not always apparent which assumptions are 'conservative' and which are 'non-conservative.'

Six commenters (90, 92, 115, 133, 139, 142) advocated further specification of the numerical guidelines and three commenters (69, 101, 127) opposed it at this time.

O. QUESTION 3e - METHODOLOGY

As part of Question 3, the following was asked:

Question 3e. "Should the staff action plan include further specification of a process which will lend credibility to the use of quantitative guidelines and methodology? If so, what should be the principal bases and elements of such guidance?"

Four commenters (58, 127, 139, 142) stated that no further specification should be provided at this time. However, sixteen commenters (23, 45, 68, 69, 92, 98, 100, 101, 104, 110, 112, 114, 115, 116, 120 + C10, 126) were in favor of further specifications and seven of them recommended the PRA Procedures Guide (NUREG/CR-2300).

P. QUESTION 3f - APPLICATION TO INDIVIDUALS

As part of Question 3, the following was asked:

> Question 3f. "On what basis should the numerical guidelines be applied to protection of individuals? Should they be applied to the individual at greatest risk, or should they be used in terms of an average risk limit over a region near the plant? Any comments or suggestions pertaining to the present discussion of this topic (or other specifics) would be welcome."

Comments were about evenly divided between those who would apply the numerical guidelines to the individuals at average risk and those who would apply the guidelines to the individuals at greatest risk. However, most of the comments included caveats, such as assumptions of different guidelines or specific definitions of maximum risk. Some comments were ambiguous (45). The average risk comments included those who supported:

- average risk over region (98, 101, 120 + C10, 133) usually in reference to biologically average individual (100)

- average risk but limiting region to 1 mile from plant (110, 112, 92) or 2 miles (23), or at 1 mile using a directional average with realistic meteorological assumptions and referring to a 1% limit of prompt fatality risk (58)

- average risk, in view of belief that "proper" numerical guideline would assure adequate protection of individual at greatest risk (112)

- average risk, generic and mathematically derived, to a person exposed in "a defined area" (69)

Some of those supporting the average risk concept cautioned against assuming a maximum risk individual (23, 120 + C10); it was noted that even defining this individual would serve as a focus of dispute (122) and would put the utility (in a site-specific application) in the position of having to meet a standard that changed as individuals near plant moved to new locations (69). It was further noted that numerical guidelines for individual risk should be more "tolerant" (i.e., >0.1%) because individuals are mobile and can take protective actions. (69)

Comments supporting the maximum individual risk concept noted that the guideline would apply to

- biologically average, maximum exposed individual (126, 127, 139)

- individual at greatest risk, assuming the level of the guideline takes this into account (57)

- maximum exposed individual which must be defined in prescriptive rules (68)

- maximum exposed indvidual based on best-estimate or average factors, not worst case (116)
- individual at midpoint of closest population segment in downwind sector (122)
- no selected population group but assuming guideline different from NRC's (114)
- group of individuals which as a whole have maximum exposure (142)

Q. QUESTION 4 - RISK AVERSION

At the end of the proposed policy statement, the following background material and question are presented:

> "The Advisory Committee on Reactor Safeguards has proposed, as part of a safety-goal approach 'intended to serve as one focus for discussion,' that greater weight should be given to a single very severe accident than to a number of smaller accidents with the same total consequences. (NUREG-0739). The ACRS proposal includes a specific quantitative formula for reflecting such 'risk aversion.' The risk aversion concept and the ACRS formula were discussed in the NRC-sponsored safety-goal workshops, with controversial results. As pointed out in the discussion paper (NUREG-0880), some elements of the defense-in-depth approach (containment, remote siting, emergency plans) aim at mitigation of severe accidents. However, the proposed guidelines include no specific risk-aversion formula.
>
> Question 4. "Should there be specific provision for 'risk aversion'? If so, what quantitative or other specific provision should be made?"

Very few responses (57, 72, 118, 133, C-12) favored inclusion of a specific risk-aversion factor. Those who advised against such a factor cited the following reasons:

- The proposed guidelines are conservative and essentially take into account public aversion to multiple-fatality accidents. (23, 45, 98, 101, 120 + C10, 126)
- A risk-aversion factor would overemphasize high-consequence low-probability accidents and cause unwarranted attention to accidents that contribute little to overall plant risk. (100, 114, 116, 142)
- Because formulation of such a factor would require consideration of social perceptions which are not easily understood, are dynamic and dependent on unpredictable circumstances, involve many variables, etc., it is not practical nor objective to include it in the safety guidelines. (100, 122, 139, 142)
- Adopting a subjective criterion might further inflame issue of nuclear power plant safety and increase difficulty in obtaining public understanding. (116, 127)
- A preferred alternative would be to reference nuclear risk estimates against other multiple-fatality risks, as in WASH-1400. (58)
- Inclusion of risk-aversion factors unwarranted in light of very large uncertainties associated with low-probability, high-consequence accidents. (112)
- Effort to develop factor would involve inefficient use of resources. (58, 136)

- Steps taken to prevent and mitigate severe accidents provide for risk aversion. (69)

- Only a small minority of population, those who cannot accept the finite probability of a Class 9 accident, want a risk-aversion factor. (115)

- No need in principle, since as a matter of equity, isolated victims and victims of large accidents should be equally protected. (90)

Those who favored inclusion of a risk-aversion factor advanced the following reasons:

- Unless risk aversion is taken into account, the proposed safety goals will deviate significantly from popular values. (133)

- Some allowance for risk aversion should be made, the form to be discussed by experts (57); the ACRS proposal would be reasonable for trial use. (72, C12)

- Risk aversion could be taken into account by calculating the total societal impact in some conservative way, e.g., equivalent to the 95th percentile of risk distribution. (118)

LIST OF COMMENTERS

Reference Number	Name	Affiliation
1	Alfred Nat Mantell	
2	Allan Mazur	Department of Sociology, Syracuse University
3	Frederick Forscher	Division of Facility Operations, Office of Nuclear Regulatory Research, NRC
4	E. Koffman	
5	Thomas J. Ballen	
6	Alan L. Hausman	
7	John Northrop	Conservation Committee Birmingham Audubon Society
8	William P. Dornsife	Supervising Nuclear Engineer, Bureau of Radiation Protection, Commonwealth of Pennsylvania
9	Marvin I. Lewis	
10	Steven E. Mays	
11	Dr. William Metz	Energy and Economic Analysis Division, Brookhaven National Laboratory
12	Stephen L. Derby	WITAN Consultants, Inc.
13	Cindy Klinksiek	
14	Joanna Shea	
15	Linden P. Martineau	
16	Tom Galazen	
17	Kenneth Nemire	
18	Bill Hafner	
19	Ellena P. Kohler	

Reference Number	Name	Affiliation
20	J. J. MacNulty	
21	Kenneth E. Joel	
22	Albert Bates	Natural Rights Center
23	Jussi K. Vaurio	Fast Reactor Safety, Technology Management Center, Argonne National Lab.
24	Robert S. Stone	
25	F. E. "Bud" Murphy	
26	Bruce Blanchard	Environmental Project Review U. S. Department of the Interior
27	Robert L. Anthony	Friends of the Earth - Delaware Valley
28	Judith C. Friedman	
29	Darrel G. Wells	
30	Suzanne Breiseth	Exeter-Hampton League of Women Voters
31	John C. Fanta	Environmental Law Society
32	Chauncey Starr	Electric Power Research Institute
33	Maude Skillman	
34	Robert E. English	
35	Diana J. Mendelsohn	
36	Frank R. Beyer	
37	Mary Sinclair	
38	Abraham S. Goldin	
39	Dr. Henry Hurwitz, Jr.	
40	Dr. Robert D. Young	
41	Michael Appling	

Reference Number	Name	Affiliation
42	H. G. McNeill	
43	Paul R. Beswick	
44	Ray Miller	
45	N. W. Curtis	Pennsylvania Power & Light Company
46	Theodore Arthur Mahr	
47	Alvin M. Weinberg	Institute for Energy Analysis, Oak Ridge Associated Universities
48 (B2)	Roberta C. Pevear	New Hampshire House of Representatives, Rockingham District #12 and Civil Defense Director for Hampton Falls
49	Charles W. Elliott	Thomas & Hair, Attorneys at Law
50	Bruce Johnson	
51	Mark & Eleanor Worthen	Stop Uranium Mining, INc. (SUM)
52	Mary B. Davis	Sorghum Alliance
53	Gretchen Van Lente	
54	Michael D. Spence	Texas Utilities Generating Company
55	Joyce P. Davis	General Physics Corporation
56 (C15)	Kenneth E. Jesse	Department of Physics, Illinois State University
57	J. Gaunt	Atomic Energy Attache, British Embassy
58	Staff Comments	Electric Power Research Institute
59	Jeannie Kreder	
60	Dennis R. Nelson	
61	Deborah L. Norton	Action for a Non-Nuclear Future
62 (C21)	R. J. Hammersley	Council on Energy Independence
63	Janet Denison	Nebraskans for Peace, A Chapter of Clergy and Laity Concerned

Reference Number	Name	Affiliation
64	Edith Chase	League of Women Voters of Ohio
65	Chester P. Maliszewski	
66	Barbee Thomas	
67	Sherwood Davies	
68	Mark I. Temme	Working Group SC-5.4, Institute of Electrical & Electronics Engineers
69	R. H. Leasburg	Virginia Electric & Power Company
70	Robert J. Budnitz	Future Resources Associates, Inc.
71	L. Bernath	Nuclear Department, San Diego Gas & Electric
72	George Ray Hudson	Illinois Commission on Atomic Energy
73	John J. Vetalice	
74	P. Blubaugh	
75 (B1)	Jane Doughty	Seacoast Anti-Pollution League
76	Kathy Bond	Paddlewheel Alliance in Kentucky & Indiana
77	William A. Buehring & James P. Peerenboom	Energy and Environmental Systems Division, Argonne National Laboratory
78	Flora Friedman	
79 (A4)	Tom B. Younker	
80	Anne Moore	
81	Diane Hughes & Helen Hubbard	Citizens for Total Energy (CITE)
82	Margaret W. Bangs	
83	Alfred A. Hageman	Local Union No. 204, International Brotherhood of Electrical Workers

Reference Number	Name	Affiliation
84	Bill Evans	
85	Miro M. Todorovich	Scientists and Engineers for Secure Energy, Inc.
86	Susan L. Hiatt	
87	Mr. & Mrs. Charles L. Hocker	
88	Mr. & Mrs. G. E. Ashbum	
89	Dennis F. Miller (2 letters)	National Research Council
90	M. E. Pate-Cornell	Assistant Professor of Industrial Engineering & Engineering Management, Stanford University
91	Leslie W. Davis	
92	Shelby T. Brewer	Assistant Secretary for Nuclear Energy Department of Energy
93	William L. Baldawicz	
94	William J. Shelley	Kerr-McGee Corporation
95	Dr. Trenkler	Vereinigung Deutscher Elektrizitätswerke
96	J. Michael Griesmeyer	Staff Engineer, Advisory Committee on Reactor Safeguards, NRC
97	Jeanne Fudala	
98	Chris H. Poindexter	Baltimore Gas and Electric
99	Diana P. Sidebotham	New England Coalition on Nuclear Pollution, Inc.
100	A. E. Scherer	Combustion Engineering, Inc.
101	Wayne H. Jens	Detroit Edison
102 (C29)	Bridget Little Rorem	Illinois Friends of the Earth
103	Russ Lacewell	
104	Nicholas A. Petrick	Standard Nuclear Unit Power Plant System

Reference Number	Name	Affiliation
105 (B8)	Lucius Gilman	
106	Cornelia W. Iselin	New England Coalition on Nuclear Pollution, Inc.
107	John J. Kearney	Edison Electric Institute
108	Joanne Doroshow	Three Mile Island Alert, Inc.
109	Peter D. Lederer	Committee on Nuclear Technology & Law, The Association of the Bar of the City of New York
110	E. P. Rahe, Jr.	Westinghouse Electric Corporation
111	Wells Eddleman	
112	William O. Parker, Jr.	Duke Power Company
113	Connie Kline	
114	D. Clark Gibbs	Middle South Services, Inc.
115	M. Arnold Wight, Jr.	Committee on Science & Technology New Hampshire House of Representatives
116	D. C. Gibbs	Committee on Reactor Licensing and Safety, Atomic Industrial Forum, Inc.
117	Corwin L. Rickard	American Nuclear Society
118	Richard Wilson	Department of Physics, Harvard University
119	L. G.	
120 (C10)	L. O. DelGeorge	Commonwealth Edison
121	Norris L. Stampley	Mississippi Power & Light Company
122	D. W. Edwards	Yankee Atomic Electric Company
123	Paul F. Burmeister	
124	Russell M. Bimber	
125	Mary J. McClurkin	

Reference Number	Name	Affiliation
126	Robert E. Uhrig	Advanced Systems & Technology, Florida Power & Light
127	F. L. Clayton, Jr.	Alabama Power
128	A. L. Cahn	Bechtel Power Corporation
129	Mark P. Oncavage	Floridians United for Safe Energy
130	Bart D. Withers	Portland General Electric Company
131 (100)	A. E. Scherer	Combustion Engineering, Inc.
132	A. Oberle	Brown, Boveri & Company, Ltd.
133	Michael W. Golay Manuel Castillo	Department of Nuclear Engineering Massachusetts Institute of Technology
134 (105, B8)	Lucius Gilman	Duplicate of 105
135	C. R. Fisher	General Atomic Company
136	R. L. Mittl	Public Service Electric & Gas Company
137	Karl Cohen	
138	Gorden R. Corey	
139	R. B. Bradbury	Stone & Webster Engineering Corp.
140	T. C. Nichols, Jr.	South Carolina Electric & Gas Company
141 (9)	M. I. Lewis	
142	Glenn G. Sherwood	General Electric Company
143	Robert W. Barber	Department of Energy
144	P. Shewmon	Advisory Committee on Reactor Safeguards, NRC
145	Jerry D. Griffith	Department of Energy
146 (L4)	Joel Jaffer	
147	Leo P. Mariani	American Nuclear Insurers
148	Mr. & Mrs. Earl Chowning	

Reference Number	Name	Affiliation
149	L. Manning Muntzing	American Nuclear Society
150	S. W. Shields	Nuclear Division Public Service Indiana
151	John McDonald	Senior Resident Inspector, NRC
152	William H. Hannum	Organisation for Economic Cooperation and Development
153	Dr. Trenkler	Association of German Electric Utilities
154	R. Bradbury	Stone & Webster Engineering Corp.
155	W. A. Widner	Georgia Power Corporation
156	Mark & Plesset	Advisory Committee on Reactor Safeguards, NRC
157	William J. Dircks	Executive Director for Operations, NRC
158	Robert W. Davies	Department of Energy
159	Robert Wilson	
160	Kimberly Rusinow	Milwaukee Audubon Society, Inc.
161	Carl Walske	Atomic Industrial Forum, Inc.

ATLANTA PUBLIC MEETING

April 26, 1982

Reference Number	Name	Affiliation	Transcript Page
A1	Lavinia B. George		11
A2	Stuart D. Strand		13
A3	Forrest Ridenhour		15
A4	Tom B. Younker		20 + 84
A5	Ivan Winsett	Citizens Advisory Council on Energy	24
A6	Steven Johnson		26
A7	J. J. Kelly		35
A8	Mrs. H. T. Reed	Sierra Club of North Carolina and Kudzu Alliance	47
A9	Igal Roodenko		56
A10	S. S. Howze		61
A11	Pam Beardsley		65 + 129 + 138
A12	Dwayne Hardy		77
A13	Gary Washington		80
A14	Emily Calhoun Graham		82
A15	Embry F. Cobb	George Power Company	93
A16	John O. Roach	Georgians Against Nuclear Energy (GANE)	94 + 149
A17	Mrs. A. Bovee	GANE	98
A18	Dennis Hoffarth		101 + 120 + 152
A19	Danny Feig		111
A20	Steve Farrell		114

Reference Number	Name	Affiliation	Transcript Page
A21	Jeanne James		123
A22	Barbara Harvey		137
A23	Dan Moore		140 + 144
A24	Mrs. Cushner		142

BOSTON PUBLIC MEETING

April 29, 1982

Reference Number	Name	Affiliation	Transcript Page
B1	Jane Doughty	Seacoast Anti-Pollution League	10
B2	Roberta Pevear	New Hampshire House of Representatives Civil Defense Director for Hampton Falls	15 + Attachment
B3	Beverly Hollingworth	New Hampshire House of Representatives	18
B4	Wells Hotchkiss	Massachusetts Voice of Energy	24
B5	Gilbert Brown	University of Lowell	26
B6	Elizabeth Mudge	Woman for Energy	30 + Attachment
B7	Charlie Donaldson	Massachusetts Public Interest Research Group	35
B8	Lucius Gilman	Americans for More Power Sources	41 + 108
B9	Chris Nord	Greater Newburyport Clamshell	47 + 61
B10	John Coombe	Stone & Webster Engineering Corp.	54
B11	Barry Feldman		58 + 70
B12	Jonathan Healey	Massachusetts House of Representatives First Franklin District	64
B13	Grafton Burke, Jr.		69
B14	Suzanne Breiseth	League of Women Voters Exeter, New Hampshire	75
B15	Joel Rubin		78
B16	Nicholas J. Costello	Massachusetts House of Representatives First Essex District	81

Reference Number	Name	Affiliation	Transcript Page
B17	David Moelling	American Nuclear Society - Connecticut	87
B18	Herb Moyer		89 + 107
B19	David Creighton	Massachusetts Nuclear Referendum Campaign	96
B20	Lynn Hodges		99
B21	Janet Kenney		104
B22	Rina Petit		113
B23	Harold Lynde		120 + 141
B24	Charles Park	Fusion Energy Foundation	128
B25	Jack Blais		132
B26	Judy Spear	New England Coalition on Nuclear Pollution	135
B27	John Lanford		147

CHICAGO PUBLIC MEETING

May 5, 1982

Reference Number	Name	Affiliation	Transcript Page
C1	Jan Kodner	Attorney for Prairie Alliance	15
C2	Betty Johnson	League of Women Voters Rockford, Illinois	20
C3	Wesley Uemura	Clergy & Laity Concerned in Chicago	25
C4	Joanna Hoelscher	Citizens for a Better Environment	30
C5	Bill Steyert		37
C6	Ed Gogol	Citizens Against Nuclear Power	43
C7	Harriet Parker		48
C8	Miriam Targ	Citizens Opposed to Radioactive Pollution	51
C9	Wendy Allen		56 + 194
C10	Louis Del George	Commonwealth Edison	66
C11	Dorothy Ragland		72
C12	Jan B. Van Erp	Illinois Commission on Atomic Energy	79
C13	Marcel Wilkins		85
C14	Catherine Quigg	Pollution & Environmental Problems	91 + 113
C15	Ken Jesse	Department of Physics Illinois State Univ.	98
C16	Robert Young		99
C17	Fern Gayden for Louise Roth	Women's International League for Peace & Freedom - American Section	103

Reference Number	Name	Affiliation	Transcript Page
C18	Stanley Campbell	Sinnissippi Alliance for the Environment - Rockford, Illinois	106 + 189
C19	George Stanford		116
C20	Evelyn Lewert		120
C21	Bob Hammersley	Council on Energy Independence	135
C22	Evelyn Tyner		140
C23	Sheila Schnoff	League of Women Voters - Chicago	147
C24	Evelyn Cheslow		152
C25	Dave Kraft	Nuclear Energy Information Service	157
C26	Eugene Voiland		161
C27	Ernest Cheslow		168
C28	Richard Mandel		172
C29	Bridgette Rorem	Illinois Friends of the Earth	176 + 192
C30	Bill Garfield	Sierra Club	183 + 197

LOS ANGELES PUBLIC MEETING

May 3, 1982

Reference Number	Name	Affiliation	Transcript Page
L1	Carol Dunovan	Positive Energy and Clean Environment - Santa Barbara	11 + 151
L2	Garrett Connelly		14 + 170 + 165
L3	Ivan Hoffman		17
L4	Joel Jafer		21
L5	Alfred E. Hollander		24
L6	Judith Evered		28 + 166
L7	Eugene Cramer		31
L8	Tom Hitchcock		36 + 170
L9	Valery Sklarevsky	Humans for a Liveable World and Outrage	41 + 158
L10	Elizabeth Burk		44
L11	Speaker for Diana Hull		46
L12	Tim Carpenter	Southern California Alliance for Survival	50
L13	Mary L. Basch		55
L14	Macy Morse	New Hampshire Energy Coalition New Hampshire Clamshell Alliance Vermont Yankee Decommissioning Alliance	58 + 180
L15	Dorothy Boberg	Guard	62
L16	Lynn Harris Hicks	Chairman, Emergency & Evaluation Planning Committee San Onofre State Park Planning Advisory Committee	64 + 146

Reference Number	Name	Affiliation	Transcript Page
L17	Lee Steelman	Guard	68
L18	Jerry Rubin	Alliance for Survival Santa Monica/Venice Chapter	71
L19	Joe Byelick		75
L20	Bruce Campbell		77
L21	Jeffrey Quenton Johnson		82
L22	Tanya Luna Mount		85
L23	Moni Plank & Lucy		87
L24	Rod Crother		90
L25	Jennie Garcia		93
L26	Sarah Caldwell		95
L27	Deborah Taigel	Alliance for Survival San Fernando Valley	97
L28	Martin Simon on behalf of William Wertz		98
L29	Cynthia Raymaker		101
L30	George Mount	Alliance for Survival East Los Angeles	103
L31	Julia Luna Mount		107
L32	Don May	Friends of the Earth	116
L33	Dick Eagleson		119 + 191
L34	Barry Schier	Alliance for Survival	125
L35	Alexander Andrasi		128 + 160
L36	David Kaftell	World Survival Network	132
L37	Cash Sutton		135

Reference Number	Name	Affiliation	Transcript Page
L38	Craig Frei	Alliance for Survival Diablo Canyon Task Force	136 + 177
L39	James Odling	Labor Committee for Safe Energy and Full Employment	139
L40	Bill Hannaman	San Diego Voice of Energy	142
L41	Mick Harrigan		149
L42	Jeffrey Johnson		156 + 195
L43	David Kefalight		176

IX. DISCUSSION ON THE COMMISSION'S ADDITIONAL QUESTIONS

When the "Proposed Policy Statement on Safety Goals for Nuclear Power Plants" was published, the Commission requested comments on a number of basic issues that had been raised during the development of the proposed statement. The issues were posed in a series of questions. The comments received were considered by the Commission in preparing the final Policy Statement. In the following we provide the rationale for the Commission's response (as reflected in the Policy Statement) to the comments.

Economic Losses. The first question was whether reduction in the risks of economic losses due to plant damage and contamination outside the plant should be considered as a "benefit" in addition to the monetary risk reduction benefit. The Commission decided that the aversion of economic losses should not be considered a benefit in the implementation of the Commission's Safety Policy. Instead, the focus of the Commission's cost-benefit guidance should be on protection of the public health and safety. The Commission believes that although aversion of economic losses may be considered (and should be encouraged since it leads to greater conservatism) by nuclear power plant operators in their evaluations of the need for specific safety-related actions, it is not appropriate for the Commission's Safety Goal Policy Statement to include specific requirements for such considerations.

Containment Performance. The second question was whether a numerical guideline on the availability of containment function, given a large-scale core melt, should be added. Most of the responses did not favor such inclusion, and the Commission agreed. However, as the Commission's Advisory committee on Reactor Safeguards commented, a specific effort to formulate and ultimately establish containment performance criteria should be made during the period of trial use of the safe goals. The NRC will investigate during the evaluation period, whether a containment performance design objective will be useful.

Implementation - The third question, which concerned implementation of the safety goals and numerical guidelines, was posed as six subsidiary questions. Many responses addressed the overall issue of implementation without the suggested subdivisions.

The first subsidiary question asked what further guidance should be given for decisions under uncertainty. This relates to how much Commission guidance should be provided for the use of probabilistic risk assessment (PRA). Most responses recommended that the Commission prescribe the way PRA calculations should be done. The Evaluation Plan to be used during the two-year evaluation period includes specific provisions for such prescription.

The second subsidiary question was whether further guidance on resolution of conflicts among qualitative guidelines should be provided. Comments included specific suggestions which have been considered in devloping the Evaluation Plan. The Commission does not wish to provide additional guidance; the extent of conflicts and ways to eliminate or reduce them will be determined during the evaluation period.

The third subsidiary question asked what approaches should be used with respect to accident initiators which are difficult to quantify, such as sabotage, seismic events, etc. Many commenters felt that probabilistic analyses were appropriate for all except sabotage. Some felt the deterministic approach should be taken. The Commission has decided to exclude consideration of sabotage and nuclear material diversion. The Evaluation Plan calls for assessing the risks, resulting from natural phenomena (earthquakes, floods, tornados, etc.) relative to internal accident initiators. The Commission will continue to require consideration of sabotage protection and mitigation in licensing the construction and operation of nuclear power plants.

The fourth subsidiary question concerned a technical issue, namely, how the numerical guidelines should be defined. Most comments advocated use of best-estimate calculations; a comparable number recommended use of mean values. Others recommended use of median values. The Commission's Advisory Committee on Reactor Safeguards recommended risk estimates during the trial period include both the median and the mean "plus an explicit attempt to quantify confidence limits, say 10% and 90%." The evaluation plan states that PRA estimates will be based on median values after propagating uncertainty distributions.

The fifth subsidiary question concerned guidance on risk assessment methodology to be provided by the Commission. Most of the comments recommended further guidance be provided. The Commission has provided general guidance in the "Implementation" section of the Policy Statement and this has been amplified in the NRC staff's Evaluation Plan.

The final subsidiary question was whether the guidelines should apply to individuals at greatest risk or individuals at average risk. The comments were divided. However, it was apparent from the comments that the individual mortality risk guideline needed clarification. The Commission has revised the design objective for individual risk in the Policy Statement to clarify its intent. The approach adopted is to protect the "average" individual in the vicinity of a nuclear power plant. The average individual in the vicinity of the plant is defined as the average individual biologically (in terms of age and other risk factors) and locationally who resides within a mile from the plant site boundary. This means that the average individual risk is found by accumulating the estimated individual risks and dividing by the number of individuals residing in the vicinity of the plant. The Commission believes this is sufficiently conservative to satisfy the qualitative safety goals.

<u>Risk Aversion</u>. The fourth question asked if there should be a specific provision for risk aversion. Very few commenters favored inclusion of a specific risk aversion factor. The formulation of a risk aversion factor would involve arbitrary and subjective presumptions of public preceptions of risk. Moreover, it would over-emphasize the importance of preventing the very rare, severe accident which contributes less to the overall public risk than contributed by the more frequent, less severe accidents.

The Commission decided not to include a provision for risk aversion. The safety goals should be focused on individual and societal risks and not be arbitrarily altered to provide for risk aversion.

X. REFERENCES

1. The District Court decision in Nader v. Ray recognizes some kind of balancing process:

   Absolute certainty or "complete," "entire," or "perfect" safety is not required by the Atomic Energy Act, nor does nuclear safety technology admit of such a standard. Power Reactor Development Co. v International Union, Electrical Workers, supra; cf., Crowther v. seaborg, 312 F. Supp. 1205, 1235 (D. Colo. 1970).

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XI. GLOSSARY

ACRS - Advisory Committee on Reactor Safeguards

Annualized - applied to a data basis in which both benefits (risk-reduction) costs are taken into account for each of the remaining years of plant operational lifetime

Anticipated Operational Occurrences - Those conditions of normal operation which are expected to occur one or more times during the life of a nuclear power plant and include, but are not limited to, loss of power to all recirculation pumps, tripping of the turbine-generator set, isolation of the main condenser, and loss of all offsite power. (Appendix A of 10 CFR Part 50). In the present context, design-basis accidents are included.

Benefit-cost analysis - comparative analysis of benefits and costs that may serve as as basis of decisionmaking. A common measure, usually dollars, is employed. The method calls for employment of quantitative equivalence standards between benefits and costs. Rigorously applied, benefit-cost analysis quantifies all effects, even though some are more easily quantified than others.

Backfit - to apply new requirements to previously approved reactors to bring them up to the same degree of compliance with the new regulations and new interpretations and guidance as new reactors.

Containment - an enclosure around a reactor to confine radioactive materials that otherwise might be released to the atmosphere in the event of an accident.

Core - the central portion of a nuclear reactor containing the fuel elements, moderator, neutron poisons and support structures.

Core melt (also fuel melt) - the term applied to the overheating of a reactor core as a result of the failure of reactor shutdown or cooling systems, leading to substantial melting of the radioactive fuel and the structures which hold the fuel in place. The probability of extensive but lesser core damage cannot now be calculated accurately enough to use the concept of intermediate states of core melt in a safety goal.

Defense in depth - in engineering practice as applied to nuclear power plants, involves careful quality assurance and control in plant design, construction, and operation to reduce the likelihood of accidents; installation of backup systems to nullify the consequences of malfunctions in important plants systems and to prevent individual malfunctions from escalating into major accidents; and installation of engineered safety features to confine the consequences of certain postulated major "design basis accidents" to minimize effects on the public health and safety. It also involves siting of nuclear plants in areas of low population density and in locations that are not near natural or manmade hazards, and calls for responsible assurance that adequate protective measures can and will be taken by the licensee and the state and local authorities in the event of serious accidents.

Delayed (or latent) fatalities - fatal cancers that may occur a long time (typically 20 or 30 years) after a person's exposure to radiation. These exposures increase a person's statistical likelihood of being stricken by cancer. The higher the dose, the greater that likelihood.

Design-basis accident - a postulated accident that a nuclear facility must be designed and built to withstand without exceeding the offsite exposure limits provided in the siting regulation (10 CFR Part 100).

Event-tree analysis - as applied to nuclear reactor safety, an event tree defines an initial failure within the plant and examines the sequence of events which follow, depending upon the subsequent operation or failure of various systems that are designed to mitigate the adverse consequences of the initial failure.

Fault-tree analysis - a fault tree examines an event such as a system or subsystem failure and traces the various possible event paths to that failure. Using fault trees along with component failure data, it is possible to estimate the likelihood of system failure. While an event tree proceeds from assumed causal event to inferred consequent events, the fault tree proceeds from assumed consequence to inferred potential causes. Fault trees are used to derive the function or system success/failure probabilities that are then used in the event tree modeling.

Individual risk - the estimated probability of fatality from a nuclear power plant accident for an individual in the vicinity of the plant, including prompt deaths and delayed deaths. Incapacitating illness or morbidity is not included here explicitly, because protection against death also provides added protection against illness. (In similar fashion, the risk of death stands as a surrogate for genetic effects; i.e., prevention of one results in prevention of the other.) The individual risk limit is applied to the biologically average individual (in terms of age and other risk factors) who resides at a location within 1 mile from the plant.

Nuclear fuel cycle - the risks from the nuclear fuel cycle are a result of potential radioactive releases from mining, milling, waste disposal, etc., but not from nuclear power plant operation.

Nuclear Power Plant Operation - the risks from nuclear power plant operation are a result of potential radioactive releases from normal operation, normally expected transients and low consequence accidents, design basis accidents, and severe accidents but not from the nuclear fuel cycle.

Probabilitistic risk assessment or probabilistic risk analysis (PRA) - the art of mathematically quantifying an expected average risk based on observed and calculated component and human failure rates and the anticipated consequences associated with these failures, which may occur either singly or in combination. Probabilistic risk assessment typically involve the use of event trees and fault trees, although these are not the only tools available for such assessments.

Prompt (or early) fatalities - those fatalities that could occur shortly after an accident (generally within sixty days) as a result of a lethal dose of radiation.

Regulatory Guide - an NRC publication which is used to describe and make available to the public methods acceptable to the NRC staff of implementing specific parts of the Commission's regulations, delineate techniques used by the staff in evaluating specific problems or postulated accidents, and otherwise provide guidance to applicants. Regulatory Guides are not NRC requirements in a strictly legal sense.

Rem - acronym for "roentgen equivalent man" it is a unit of dose of any ionizing radiation that produces the same biological effect as a unit of absorbed dose of ordinary X-rays.

Risk - the product of the probability of occurrence of an accident and the magnitude of the consequences given that occurrence.

Risk aversion - the view, held by some, that a single large-scale accident with severe consequences is more undesirable than the sum total of many smaller accidents each of which involves lesser consequences, even when the total consequences associated with the single large accident are comparable to the aggregated consequences of the many smaller accidents.

Societal risk - the risk to the aggregate population near nuclear power plant sites. It is the product of the number of fatalities that could result from an accident and probability of occurrence of the accident. In estimating societal risk, we propose that the calculations assume a distance out to 50 miles from the plant site since a substantial fraction of the total exposure of the population to radiation would be concentrated within this distance.

Vicinity - as applied to nuclear power plant sites, "vicinity" refers to the area immediately adjacent to the site. It is the annular area within one mile of the site boundary, where the risk of prompt fatalities in the event of a radioactive release resulting from a major nuclear accident would be greatest.

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16. ABSTRACT *(200 words or less)*
This report presents and discusses the Nuclear Regulatory Commission's, "Policy Statement on Safety Goals for the Operation of Nuclear Power Plant." The safety goals have been formulated in terms of qualitative goals and quantitative design objectives. The qualitative goals state that the risk to any individual member of the public from nuclear power plant operation should not be a significant contributor to that individual's risk of accidental death or injury and that the societal risks should be comparable to or less than those of viable competing technologies. The quantitative design objectives state that the individual and societal risks of nuclear power plant operation should not exceed 0.1% of certain other risks to which members of the U.S. population are exposed. A subsidiary quantitative design objective is established for the frequency of large-scale core melt. The significance of the goals and objectives, their bases and rationale, and the plan to evaluate the goals are provided. In addition, public comments on the 1982 proposed policy statement and responses to a series of questions that accompanied the 1982 statement are summarized.

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