

POLICY STATEMENTS

51 FR 28044
Published 8/4/86

51 FR 30028
Published 8/21/86
Effective 8/4/86

10 CFR Part 50

**Safety Goals for the Operations of
Nuclear Power Plants; Policy
Statement; Republication**

[Editorial Note.—The following document was originally published at page 28044 in the issue of Monday, August 4, 1986. It is being republished in its entirety, with corrections, at the request of the agency.]

AGENCY: Nuclear Regulatory
Commission.

ACTION: Policy statement.

SUMMARY: This policy statement focuses on the risks to the public from nuclear power plant operation. Its objective is to establish goals that broadly define an acceptable level of radiological risk. In developing the policy statement, the NRC sponsored two public workshops during 1981, obtained public comments and held four public meetings during 1982, conducted a 2-year evaluation during 1983 to 1985, and received the views of its Advisory Committee on Reactor Safeguards.

The Commission has established two qualitative safety goals which are supported by two quantitative objectives. These two supporting objectives are based on the principle that nuclear risks should not be a significant addition to other societal risks. The Commission wants to make clear 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. The Commission is discussing acceptable risks, not acceptable deaths.

- The *qualitative safety goals* are as follows:

- Individual members of the public should be provided a level of

POLICY STATEMENTS

protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.

—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 following *quantitative objectives* are to be used in determining achievement of the above safety goals:

—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 percent) 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 percent) of the sum of cancer fatality risks resulting from all other causes.

EFFECTIVE DATE: August 4, 1986.

FOR FURTHER INFORMATION CONTACT: Merrill Taylor, Regional Operations and Generic Requirements Staff, Office of the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, DC 20555. Telephone (301/492-4356).

SUPPLEMENTARY INFORMATION: The following presents the Commission's Final 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 the result.

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 level of risks to public health and safety that the industry should strive for in its nuclear power plants.

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 goals.

These fuel cycle risks 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 goals. 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 will be done to keep these types of risks at their present very low level; and it is the Commission's expectation that efforts on this point will continue to be successful. With these exceptions, it is the Commission's intent that the risks from all the 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, the staff considers several types of releases. Current NRC practice addresses the risks to the public resulting from operating nuclear power plants. 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 undergoes 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 that broadly define an acceptable level of radiological risk that 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 because of compliance with Federal Radiation Council (FRC) guidance, (40 CFR Part 190), and NRC's regulations (10 CFR Part 20 and Appendix I to Part 50), the risks from routine emissions are small compared to the safety goals. Therefore, the Commission believes that these risks need not 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 the policy statement, the Commission solicited and benefited from the information and suggestions provided by workshop discussions. NRC-sponsored workshops were held in Palo Alto, California, on April 1-3, 1981 and in Harpers Ferry, West Virginia, on July 23-24, 1981. 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, who represented a broad range of perspectives and disciplines.

The NRC Office of Policy Evaluation submitted to the Commission for its consideration a Discussion Paper on Safety Goals for Nuclear Power Plants in November 1981 and a revised safety goal report in July 1982.

The Commission also took into consideration the comments and suggestions received from the public in response to the proposed Policy Statement on "Safety Goals for Nuclear Power Plants," published on February 17, 1982 (47 FR 7023). Following public comment, a revised Policy Statement was issued on March 14, 1983 (48 FR 10772) and a 2-year evaluation period began.

The Commission used the staff report and its recommendations that resulted from the 2-year evaluation of safety goals in developing this final Policy Statement. Additionally, the Commission had benefit of further comments from its Advisory Committee on Reactor Safeguards (ACRS) and by senior NRC management.

Based on the results of this information, the Commission has determined that the qualitative safety goals will remain unchanged from its March 1983 revised policy statement, and the Commission adopts these as its safety goals for the operation of nuclear power plants.

POLICY STATEMENTS

II. Qualitative Safety Goals

The Commission has decided to adopt qualitative safety goals that are supported by quantitative health effects objectives for use in the regulatory decisionmaking process. 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 such a level of safety 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 these 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 should be placed on the societal risks posed by nuclear power plant operation. The Commission also 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 broad spectrum of expert opinion on the risks posed by electrical generation by coal and the absence of authoritative data make it impractical to calibrate nuclear safety goals by comparing them with coal risks based on what we know today. However, the Commission has established the quantitative health effects objectives in such a way that nuclear risks are not a significant addition to other societal risks.

Severe core damage accidents can lead to more serious accidents with the potential for life-threatening offsite release of radiation, for evacuation of members of the public, and for contamination of public property. Apart from their health and safety consequences, severe core damage accidents can erode public confidence in the safety of nuclear power and can lead to further instability and unpredictability for the industry. In order to avoid these adverse consequences, the Commission intends

to continue to pursue a regulatory program that has as its objective providing reasonable assurance, while giving appropriate consideration to the uncertainties involved, that a severe core damage accident will not occur at a U.S. nuclear power plant.

III. Quantitative Objectives Used To Gauge Achievement of The Safety Goals

A. General Considerations

The quantitative health effects objectives establish NRC guidance for public protection which nuclear plant designers and operators should strive to achieve. A key element in formulating a qualitative safety goal whose achievement is measured by quantitative health effects objectives is to understand both the strengths and limitations of the techniques by which one judges whether the qualitative safety goal has been met.

A major step forward in the development and refinement of accident risk quantification was taken in the Reactor Safety Study (WASH-1400) 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 a recognition that it is feasible to begin to use quantitative safety 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 quantitative objectives should be viewed as aiming points or numerical benchmarks of performance. In particular, because of the present limitations in the state of the art of quantitatively estimating risks, the quantitative health effects objectives are not a substitute for existing regulations.

The Commission 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 associated with its accident prevention and mitigation philosophy.

B. Quantitative Risk Objectives

The Commission wants 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 accidents will occur, but the possibility cannot be entirely eliminated. Furthermore, individual and societal risks from nuclear power plants are generally estimated to be considerably less than the risk that society is now exposed to from each of the other activities mentioned above.

C. Health Effects—Prompt and Latent Cancer Mortality Risks

The Commission has decided to adopt the following two health effects as the quantitative objectives concerning mortality risks to be used in determining achievement of the qualitative safety goals—

- *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 percent) 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 percent) of the sum of cancer fatality risks resulting from all other causes.*

The Commission believes that this ratio of 0.1 percent appropriately reflects both of the qualitative goals—to provide that individuals and society bear no significant additional risk. However, this does not necessarily mean that an additional risk that exceeds 0.1 percent 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

POLICY STATEMENTS

risks and dividing by the number of individuals residing in the vicinity of the plant.

In applying the objective for individual risk of prompt fatality, the Commission has defined 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, an individual should, for evaluation purposes, be assumed to reside 1 mile from the site boundary.

In applying the objective for cancer fatalities as a population guideline for individuals in the area near the plant, the Commission has defined the population generally considered subject to significant risk as the population within 10 miles of the plant site. The bulk of significant exposures of the population to radiation would be concentrated within this distance, and thus this is the appropriate population for comparison with cancer fatality risks from all other causes. This 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 nonnuclear causes. Moreover, the prompt fatality objective for protecting individuals generally provides even greater protection to the population as a whole. That is, if the quantitative 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 10 miles of the plant and beyond would generally be much lower than the quantitative objective for cancer fatality. Thus, compliance with the prompt fatality objective applied to individuals close to the plant would generally mean that the aggregate estimated societal risk would be a number of times lower than it would be if compliance with just the objective applied to the population as a whole were involved. The distance for averaging the cancer fatality risk was taken as 50 miles in the 1983 policy statement. The change to 10 miles could be viewed to provide additional protection to individuals in the vicinity of the plant, although analyses indicate that this objective for cancer fatality will not be the controlling one. It also provides more representative societal

protection, since the risk to the people beyond 10 miles will be less than the risk to the people within 10 miles.

IV. Treatment of Uncertainties

The Commission is aware that uncertainties are not caused by use of quantitative methodology in decisionmaking but are merely highlighted through use of the quantification process. Confidence in the use of probabilistic and risk assessment techniques has steadily improved since the time these were used in the Reactor Safety Study. In fact, through use of quantitative techniques, important uncertainties have been and continue to be brought into better focus and may even be reduced compared to those that would remain with sole reliance on deterministic decisionmaking. To the extent practicable, the Commission intends to ensure that the quantitative techniques used for regulatory decisionmaking take into account the potential uncertainties that exist so that an estimate can be made on the confidence level to be ascribed to the quantitative results.

The Commission has adopted the use of mean estimates for purposes of implementing the quantitative objectives of this safety goal policy (i.e., the mortality risk objectives). Use of the mean estimates comports with the customary practices for cost-benefit analyses and it is the correct usage for purposes of the mortality risk comparisons. Use of mean estimates does not however resolve the need to quantify (to the extent reasonable) and understand those important uncertainties involved in the reactor accident risk predictions. A number of uncertainties (e.g., thermal-hydraulic assumptions and the phenomenology of core-melt progression, fission product release and transport, and containment loads and performance) arise because of a direct lack of severe accident experience or knowledge of accident phenomenology along with data related to probability distributions.

In such a situation, it is necessary that proper attention be given not only to the range of uncertainty surrounding probabilistic estimates, but also to the phenomenology that most influences the uncertainties. For this reason, sensitivity studies should be performed to determine those uncertainties most important to the probabilistic estimates. The results of sensitivity of studies should be displayed showing, for example, the range of variation together with the underlying science or engineering assumptions that dominate this variation. Depending on the decision needs, the probabilistic results

should also be reasonably balanced and supported through use of deterministic arguments. In this way, judgements can be made by the decisionmaker about the degree of confidence to be given to these estimates and assumptions. This is a key part of the process of determining the degree of regulatory conservatism that may be warranted for particular decisions. This defense-in-depth approach is expected to continue to ensure the protection of public health and safety.

V. Guidelines For Regulatory Implementation

The Commission approves use of the qualitative safety goals, including use of the quantitative health effects objectives in the regulatory decisionmaking process. The Commission recognizes that the safety goal can provide a useful tool by which the adequacy of regulations or regulatory decisions regarding changes to the regulations can be judged. Likewise, the safety goals could be of benefit in the much more difficult task of assessing whether existing plants, designed, constructed and operated to comply with past and current regulations, conform adequately with the intent of the safety goal policy.

However, in order to do this, the staff will require specific guidelines to use as a basis for determining whether a level of safety ascribed to a plant is consistent with the safety goal policy. As a separate matter, the Commission intends to review and approve guidance to the staff regarding such determinations. It is currently envisioned that this guidance would address matters such as plant performance guidelines, indicators for operational performance, and guidelines for conduct of cost-benefit analyses. This guidance would be derived from additional studies conducted by the staff and resulting in recommendations to the Commission. The guidance would be based on the following general performance guideline which is proposed by the Commission for further staff examination—

Consistent with the traditional defense-in-depth approach and the accident mitigation philosophy requiring reliable performance of containment systems, the overall mean frequency of a large release of radioactive materials to the environment from a reactor accident should be less than 1 in 1,000,000 per year of reactor operation.

To provide adequate protection of the public health and safety, current NRC regulations require conservatism in design, construction, testing, operation

POLICY STATEMENTS

and maintenance of nuclear power plants. A defense-in-depth approach has been mandated in order to prevent accidents from happening and to mitigate their consequences. Siting in less populated areas is emphasized. Furthermore, emergency response capabilities are mandated to provide additional defense-in-depth protection to the surrounding population.

These safety goals and these implementation guidelines are not meant as a substitute for NRC's regulations and do not relieve nuclear power plant permittees and licensees from complying with regulations. Nor are the safety goals and these implementation guidelines in and of themselves meant to serve as a sole basis for licensing decisions. However, if pursuant to these guidelines, information is developed that is applicable to a particular licensing decision, it may be considered as one factor in the licensing decision.

The additional views of Commissioner Asselstine and the separate views of Commissioner Bernthal are attached.

Dated at Washington, DC, this 30th day of July 1986.

For the Nuclear Regulatory Commission,
Lando W. Zech, Jr.,
Chairman.

Additional Views by Commissioner Asselstine on the Safety Goal Policy Statement

The commercial nuclear power industry started rather slowly and cautiously in the early 1960's. By the late 1960's and early 1970's the growth of the industry reached a feverish pace. New orders were coming in for regulatory review on almost a weekly basis. The result was the designs of the plants outpaced operational experience and the development of safety standards. As experience was gained in operational characteristics and in safety reviews, safety standards were developed or modified with a general trend toward stricter requirements. Thus, in the early 1970's, the industry demanded to know "how safe is safe enough." In this Safety Goal Policy Statement, the Commission is reaching a first attempt at answering the question. Much credit should go to Chairman Palladino's efforts over the past 5 years to develop this policy statement. I approve this policy statement but believe it needs to go further. There are four additional aspects which should have been addressed by the policy statement.

Containment Performance

First, I believe the Commission should have developed a policy on the relative

emphasis to be given to accident prevention and accident mitigation. Such guidance is necessary to ensure that the principle of defense-in-depth is maintained. The Commission's Advisory Committee on Reactor Safeguards has repeatedly urged the Commission to do so. As a step in that direction, I offered for Commission consideration the following containment performance criterion:

In order to assure a proper balance between accident prevention and accident mitigation, the mean frequency of containment failure in the event of a severe core damage accident should be less than 1 in 100 severe core damage accidents.

Since the Chernobyl accident, the nuclear industry has been trying to distance itself from the Chernobyl accident on the basis of the expected performance of the containments around the U.S. power reactors. Unfortunately, the industry and the Commission are unwilling to commit to a level of performance for the containments.

The argument has been made that we do not know how to develop containment performance criteria (accident mitigation) because core meltdown phenomena and containment response thereto are very complex and involve substantial uncertainties. On the other hand, to measure how close a plant comes to the quantitative guidelines contained in this policy statement and to perform analyses required by the Commission's backfit rule, one must perform just those kinds of analyses. I find these positions inconsistent.

The other argument against a containment performance criterion is that such a standard would overspecify the safety goal. However, a containment performance objective is an element of ensuring that the principle of defense-in-depth is maintained. Since we cannot rule out core meltdown accidents in the foreseeable future, given the current level of safety, I believe it unwise not to establish an expectation on the performance of the final barrier to a substantial release of radioactive materials to the environment, given a core meltdown.

General Performance Guideline

While I have previously supported an objective of reducing the risks to an as low as reasonably achievable level, the general performance guideline articulated in this policy (i.e., ". . . the overall mean frequency of a large release of radioactive materials to the environment from a reactor accident should be less than 1 in 1,000,000 per year of reactor operation.") is a suitable

compromise. I believe it is an objective that is consistent with the recommendations of the Commission's chief safety officer and our Director of Research, and past urgings of the Advisory Committee on Reactor Safeguards. Unfortunately, the Commission stopped short of adopting this guideline as a performance objective in the policy statement, but I am encouraged that the Commission is willing at least to examine the possibility of adopting it. Achieving such a standard coupled with the containment performance objective given above would go a long way toward ensuring that the operating reactors successfully complete their useful lives and that the nuclear option remains a viable component of the nation's energy mix.

In addition to preferring adoption of this standard now, I also believe the Commission needs to define a "large release" of radioactive materials. I would have defined it as "a release that would result in a whole body dose of 5 rem to an individual located at the site boundary." This would be consistent with the EPA's emergency planning Protective Action Guidelines and with the level proposed by the NRC staff for defining an Extraordinary Nuclear Occurrence under the Price-Anderson Act. In adopting such a definition, the Commission would be saying that its objective is to ensure that there is no more than a 1 in 1,000,000 chance per year that the public would have to be evacuated from the vicinity of a nuclear reactor and that the waiver of defenses provisions of the Price-Anderson Act would be invoked. I believe this to be an appropriate objective in ensuring that there is no undue risk to the public health and safety associated with nuclear power.

Cost-Benefit Analyses

I believe it is long overdue for the Commission to decide the appropriate way to conduct cost-benefit analyses. The Commission's own regulations require these analyses, which play a substantial role in the decisionmaking on whether to improve safety. Yet, the Commission continues to postpone addressing this fundamental issue.

Future Reactors

In my view, this safety goal policy statement has been developed with a steady eye on the apparent level of safety already achieved by most of operating reactors. That level has been arrived at by a piecemeal approach to designing, constructing and upgrading of the plants over the years as experience

POLICY STATEMENTS

was gained with the plants and as the results of required research became available. Given the performance of the current generation of plants, I believe a safety goal for these plants is not good enough for the future. This policy statement should have had a separate goal that would require substantially better plants for the next generation. To argue that the level of safety achieved by plant designs that are over 10 years old is good enough for the next generation is to have little faith in the ingenuity of engineers and in the potential for nuclear technology. I would have required the next generation of plants to be substantially safer than the currently operating plants.

Separate Views of Commissioner Bernthal on Safety Goals Policy

I do not disapprove of what has been said in this policy statement, but too much remains unsaid. The public is understandably desirous of reassurance since Chernobyl; the NRC staff needs clear guidance to carry out its responsibilities to assure public health and safety; the nuclear industry needs to plan for the future. All want and deserve to see clear, unambiguous, practical safety objectives that provide the Commission's answer to the question, "How safe is safe enough?" at U.S. nuclear power plants. The question remains unanswered.

It is unrealistic for the Commission to expect that society, for the foreseeable future, will judge nuclear power by the same standard as it does all other risks. The issue today is not so much calculated risk; the issue is public acceptance and, consistent with the intent of Congress, preservation of the nuclear option.

In these early decades of nuclear power, TMI-style incidents must be rendered so rare that we would expect to recount such an event only to our grandchildren. For today's population of reactors, that implies a probability for severe core damage of 10^{-4} per reactor year; for the longer term, it implies something better. I see this as a straightforward policy conclusion that every newspaper editor in the country understands only too well. If the Commission fails to set (and realize) this objective, then the nuclear option will cease to be credible before the end of the century. In other words, if TMI-style events were to occur with 10-15 year regularity, public acceptance of nuclear power would almost certainly fail.

And while the Commission's primary charge is to protect public health and safety, it is also the clear intent of Congress that the Commission, if possible, regulate in a way that preserves rather than jeopardizes the nuclear option. So, for example, if the

Commission were to find 100 percent confidence in some impervious containment design, but ignored what was inside the containment, the primary mandate would be satisfied, but in all likelihood, the second would not. Consistent with the Commission's long-standing defense-in-depth philosophy, both core-melt and containment performance criteria should therefore be clearly stated parts of the Commission's safety goals.

In short, this pudding lacks a theme. Meaningful assurance to the public; substantive guidance to the NRC staff; the regulatory path to the future for the industry—all these should be provided by plainly stating that, consistent with the Commission's "defense-in-depth" philosophy:

(1) Severe core-damage accidents should not be expected, on average, to occur in the U.S. more than once in 100 years;

(2) Containment performance at nuclear power plants should be such that severe accidents with substantial offsite damages are not expected, on average, to occur in the U.S. more than once in 1,000 years;

(3) The goal for offsite consequences should be expected to be met after conservative consideration of the uncertainties associated with the estimated frequency of severe core-damage and the estimated mitigation thereof by containment.¹

The term "substantial offsite damages" would correspond to the Commission's legal definition of "extraordinary nuclear occurrence." "Conservative consideration of associated uncertainties" should offer at least 90 percent confidence (typical good engineering judgment, I would hope) that the offsite release goal is met.

The broad core-melt and offsite-release goals should be met "for the average power plant"; i.e., for the aggregate of U.S. power plants. The decision to fix or not to fix a specific plant would then depend on achieving "the goal for offsite consequences." As a practical matter, this offsite societal risk objective would (and should) be significantly dependent on site-specific population density.

The absence of such explicit population density considerations in the Commission's 0.1 percent goals for

¹ Interestingly enough, the Commission has adopted proposed goals similar to the above core-melt and containment performance objectives—without clearly saying so. Taken together, the Commission's: (1) 0.1 percent offsite prompt fatality goals; (2) proposed 10^{-4} per-reactor-year "large offsite release" criterion; (3) commitment "to provide reasonable assurance . . . that a severe core-damage accident will not occur at a U.S. nuclear power plant," though they may be ill-defined, can be read to be more stringent than the plainly stated criteria suggested above.

offsite consequences deserves careful thought. Is it reasonable that Zion and Palo Verde, for example, be assigned the same theoretical "standard person" risk, even though they pose considerably different risks for the U.S. population as a whole? As they stand, these 0.1 percent goals do not explicitly include population density considerations; a power plant could be located in Central Park and still meet the Commission's quantitative offsite release standard.

I believe the Commission's standards should preserve the important principle that site-specific population density be quantitatively considered in formulating the Commission's societal risk objective; e.g., by requiring that for the entire U.S. population, the risk of fatal injury as a consequence of U.S. nuclear power plant operations should not exceed some appropriate specified fraction of the sum of the expected risk of fatality from all other hazards to which members of the U.S. population are generally exposed.

I am further concerned by the arbitrary nature of the 0.1 percent incremental "societal" health risk standard adopted by the Commission, a concept grounded in a purely subjective assessment of what the public might accept. The Commission should seriously consider a more rational standard, tied statistically to the average variations in natural exposure to radiation from all other sources.

Finally, as noted in its introductory comments, the Commission long ago committed to "move forward with an explicit policy statement on safety philosophy and the role of safety-cost tradeoffs in NRC safety decisions." While this policy statement may not be very "explicit", as discussed above, it contains nothing at all on the subject of "safety-cost" tradeoffs in NRC safety decisions." For example, is \$1,000 per person-rem an appropriate cost-benefit standard for NRC regulatory action? While I have long argued that such fundamental decisions are more rightly the responsibility of Congress, the NRC staff continues to use its own ad-hoc judgment in lieu of either the Commission or the Congress speaking to the issue.

In summary, while the Commission has produced a document which is not in conflict with my broad philosophy in such matters, I doubt that the public expected a philosophical dissertation, however erudite. It is a tribute to Chairman Palladino's efforts that the Commission has come this far. But the task remains unfinished.



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

ATTACHMENT 2

June 15, 1990

OFFICE OF THE
SECRETARY

MEMORANDUM FOR: James M. Taylor, Executive Director
for Operations

FROM: *U. B. Chilk* Samuel J. Chilk, Secretary

SUBJECT: SECY-89-102 - IMPLEMENTATION OF THE
SAFETY GOALS

The Commission's objective in publishing the Safety Goal Policy Statement was to define an acceptable level of radiological risk from nuclear power plant operation. The Commission also believed that by establishing a level of safety considered to be safe enough, public understanding of regulatory criteria and public confidence in the safety of operating plants would be enhanced. In formulating the policy, the Commission indicated that it believed that current regulatory practice ensured compliance with the basic statutory standard of adequate protection; but the Commission also believed that current practices could be improved to provide a better means for testing the adequacy of current requirements and the possible need for additional requirements. In establishing this policy, the Commission adopted two qualitative safety goals that are supported by two quantitative health effects objectives for use in the regulatory decision making process. The Commission reaffirms its endorsement of these earlier initiatives. The Commission has approved the following actions relating to the Safety Goal Policy Statement:

- 1) Probabilistic risk assessment (PRA) is used as a tool to provide measures of plant performance and overall risk to the public. Insights can be drawn from this information to evaluate the consistency of regulations with the safety goals and, to identify possible changes in the regulations that make them more consistent with the safety goals. The result of the several PRA level calculations (i.e., core damage probability, source terms, consequence estimates), as well as the results of the various internal steps within each level, can be compared with certain specific regulatory requirements. This has resulted in the suggestion that the Safety Goals and health objectives be partitioned into further subsidiary objectives. While the Commission believes

NOTE: THIS SRM AND THE SUBJECT SECY PAPER WILL BE MADE PUBLICLY
AVAILABLE 10 WORKING DAYS AFTER ISSUANCE OF THE SRM.

that such "partitioned" objectives can be useful in making regulatory decisions and improving regulatory practices, it does not believe it is necessary to specifically incorporate the partitioned objectives into the Safety Goal Policy Statement.

- 2) In the Safety Goal Policy Statement, the Commission proposed for further staff examination a guideline for general plant performance that the overall mean frequency of a large release of radioactive materials to the environment from a reactor accident should be less than 1 in 1,000,000 per year of reactor operation. The examination of this proposed guideline by the staff has resulted in a conclusion that specifying this frequency as an overall mean value is inherently more conservative than either of the quantitative health effects objectives. However, this more conservative result is within an order of magnitude of the Commission's health objectives and provides a simple goal which has generally been accepted. The Commission believes that the basic concept of a plant performance objective that focuses on accidental releases from the plant and eliminates site characteristics, as suggested by the ACRS, is appropriate. The staff should evaluate and advise the Commission whether such an objective can be developed and how it would be useful. In conducting this evaluation, the staff should formulate a new definition for large release and supporting rationale consistent with this approach.

~~(EDO)~~ (RES/NRR)

(SECY Suspense: 9/28/90)

Wits
9000136

- 3) The staff, in developing and reviewing regulations and regulatory practices, should routinely consider the safety goals. To achieve this objective, the staff should establish a formal mechanism including documentation for ensuring that future regulatory initiatives are evaluated for conformity with the safety goal. (Recognizing that the state of knowledge is such that the degree to which regulatory issues can be related to the safety goals will vary considerably, the staff's consideration of the safety goals could range anywhere from quantitative risk comparisons involving the safety goals themselves to a deterministic judgment that, in light of the safety goals and available knowledge (or lack thereof), a given issue does or does not warrant a change to the regulations or regulatory practices.)

~~(EDO)~~ (RES/NRR)

(SECY Suspense: 11/30/90)

Wits
9000137

- 4) Implementation of the safety goal may require development and use of "partitioned" objectives. In

general, the additional objectives should not introduce additional conservatisms. The staff should bring its recommendations on the use of each such subsidiary objective to the Commission in the context of the specific issue for which it would be useful and appropriate, and explain its compatibility with the safety goals. Based upon the NRC's review of a sample of plant PRAs, it appears that these plants not only meet the quantitative health effects objectives but exceed them. This may or may not reflect excessive conservatism in regulations. While there have been improvements in PRA techniques, uncertainties in the summary results are still such that quantitative PRA objectives should not be used as licensing standards or requirements.

The Commission believes that the safety goal objectives should be applied to all designs, independent of the size of containment or character of a particular design approach to the release mitigation function. Accordingly, for the purpose of implementation, the staff may establish subsidiary quantitative core damage frequency and containment performance objectives through partitioning of the Large Release Guideline. These subsidiary objectives should anchor, or provide guidance on "minimum" acceptance criteria for prevention (e.g. core damage frequency) and mitigation (e.g. containment or confinement performance) and thus assure an appropriate multi-barrier defense-in-depth balance in design. Such subsidiary objectives should be consistent with the large release guideline, and not introduce additional conservatism so as to create a de facto new Large Release Guideline.

A core damage probability of less than 1 in 10,000 per year of reactor operation appears to be a very useful subsidiary benchmark in making judgements about that portion of our regulations which are directed toward accident prevention.

Containment performance objectives for evolutionary and advanced designs should be submitted to the Commission for approval, together with a justification for the recommended approach. In developing recommendations the staff should assure that: (NRR/RES)

- a) The CCFP objective is not so conservative as to constitute a de facto new "Large Release Guideline."
- b) Establishment of a CCFP should be approached in such a manner that additional emphasis on prevention is not discouraged. In this regard, staff should develop appropriate

guidance for establishing CCFPs to address this concern and provide a uniform methodology for implementing such an approach.

- c) Recognizing that it is entirely possible that a deterministically-established containment performance objective could achieve the same overall objective as a CCFP, staff should be prepared to review the merits of such an approach (if proposed) and, if workable, accept such an approach as an alternative to a CCFP.

The Commission has no objection to the use of a 10^{-1} CCFP objective for the evolutionary design, as applied in the manner described above.

Within a particular design class (e.g., LWRs, LMRS, HTGRs) the same subsidiary objectives should apply to both current as well as future designs. A specific subsidiary objective might differ from one design class to another design class to account for different mitigating concepts (e.g. confinement instead of containment). However, the Large Release Guideline relates to all current as well as future designs.

These partitioned objectives are not to be imposed as requirements themselves but may be useful as a basis for regulatory guidance.

- 5) It is important to note that the Commission has made it clear in the advanced plant and severe accident policy statements that it expects that advanced designs will reflect the benefits of significant research and development work and experience gained in operating the many power and development reactors, and that vendors will achieve a higher standard of severe accident safety performance than their prior designs. The industry's goal of designing future reactors to a core damage probability of less than 1 in 100,000 per year of reactor operation (EPRI for ALWRs and GE for the ABWR) is evidence of industry's commitment to NRC's severe accident policy. The Commission applauds such a commitment. However, the NRC will not use industry's design objectives as the basis to establish new requirements.
- 6) In order to enhance our regulatory process for the current generations of plants, the Commission believes the staff should strive for a risk level consistent with the safety goals in developing or revising regulations. In developing and applying such new requirements to existing plants, the Backfit Rule should apply.

- 7) The Commission supports the use of averted on-site costs as an offset against other licensee costs (and not as a benefit) in cost-benefit analyses.
- 8) Both the staff and ACRS agree that the safety goal objectives and other relevant objectives should be used to identify possible changes in the regulations applicable to nuclear power plants; however, the task of undertaking a total review of the whole body of applicable regulations and regulatory practices appears to be a massive, resource intensive effort. The staff should describe a plan, with specific detail, for assessing the consistency of our regulations with the safety goals and for identifying and possibly eliminating unnecessary requirements, and modifying requirements that may be inadequate. This may fold in current work to review regulations and eliminate unnecessary requirements, and plans to use IPE-PRA information to make comparisons of current regulations with safety goal objectives. The staff should consider whether a trial case of limited scope may be a useful way to proceed with this request.

(EDG) (RES, coordinate (SECY SUSPENSE: 12/91) Wits 9000138
w/NRR)

- 9) In stating that quantitative objectives can be useful in making regulatory decisions to address safety issues, the Commission recognizes the uncertainties associated with the numerical results of PRA. Some issues (e.g., human performance) also do not readily lend themselves to quantitative comparisons.

Therefore, the staff in applying the criteria provided in 10 CFR Part 52 may conclude that additional requirements are needed based on experience with prior designs in order to provide substantial assurance that future designs will meet the level of safety provided in the Safety Goal Policy Statement. The staff should elevate such safety issues to the Commission for consideration and should not be constrained from proposing new requirements where benefits cannot be quantified in terms of risk.

- 10) The Commission believes that "adequate protection" is a case by case finding based on evaluating a plant and site combination and considering the body of our regulations. Safety goals are to be used in a more generic sense and not to make specific licensing decisions. It is not necessary to create a generic definition of adequate protection, nor is it necessary to amend the Safety Goal Policy Statement in order to provide a direct relationship between the safety goals and the concept of adequate protection.

- 11) The Commission agrees that it must not depart from or be seen as obscuring the arguments made in court defending the Backfit Rule.

These arguments clearly established that there is a level of safety that is referred to as "adequate protection". This is the level that must be assured without regard to cost and, thus, without invoking the procedures required by the Backfit Rule. ^{1/} Beyond adequate protection, if the NRC decides to consider enhancements to safety, costs must be considered, and the cost-benefit analysis required by the Backfit Rule must be performed. The Safety Goals, on the other hand, are silent on the issue of cost but do provide a definition of "how safe is safe enough" that should be seen as guidance on how far to go when proposing safety enhancements, including those to be considered under the Backfit Rule.

- 12) The term "credible" is used in Part 100 and has in some instances been given a probabilistic interpretation or definition by the staff which is more stringent than the Large Release Guideline. This lack of uniformity should be addressed by the staff in conjunction with the staff's efforts on siting. (RES/NRR/OGC) Wits 900139
- 13) All Commissioners agree that how well a plant is operated is a vital component of plant safety. In order to improve communication to the public, ACRS has recommended that this fact be given more prominence in the Safety Goal Policy Statement as a major element

^{1/} On a related point, the presumption is that compliance with our regulations provides adequate protection. The converse, however, is not true, i.e. adequate protection does not necessarily require compliance with the body of our regulations. The Commission can and does grant exemptions to specific requirements in our regulations as long as we assure adequate protection is achieved by other means. Moreover, we also have regulations which go beyond adequate protection and have been issued to enhance safety e.g. the Station Blackout Rule. Thus, if an "enhancement" passes the tests of the Backfit Rule, there is nothing to prohibit its imposition other than the guidance provided by the Safety Goals policy.

of uncertainty, recognizing that it is not quantifiable in a fashion similar to the other objectives. The current wording of the policy statement contains such a message implicitly; therefore, the Commission does not believe a change is necessary. The staff should, however, recognize this as a major element of uncertainty when referring to the safety goals in making regulatory decisions.

cc: Chairman Carr
Commissioner Roberts
Commissioner Rogers
Commissioner Curtiss
Commissioner Remick
OGC
GPA
IG
ACRS
ASLAP
ASLBP

August 15, 1996

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: RISK-INFORMED, PERFORMANCE-BASED REGULATION AND RELATED
MATTERS

During the 433rd meeting of the Advisory Committee on Reactor Safeguards, August 8-10, 1996, we discussed the issues identified in the Staff Requirements Memorandum dated May 15, 1996. We also discussed the pilot applications for risk-informed, performance-based regulation. Our Subcommittee on Probabilistic Risk Assessment (PRA) met with representatives of the NRC staff and the nuclear industry on July 18 and August 7, 1996. We also had the benefit of the documents referenced.

The staff presentations dealt only with the development of guidelines from the Commission's safety goals to be used as an element of the evaluation of licensee-initiated changes to licensing commitments. All of our comments address the application of risk-informed regulation in that context. At a later time, we will discuss the larger question of the application of the safety goals on a plant-specific basis.

CONCLUSIONS

Issue 1: Should the Commission's safety goals and subsidiary objectives be referenced or used to derive guidelines for plant-specific applications and, if so, how?

We believe the safety goals and subsidiary objectives can and should be used to derive guidelines for plant-specific applications. It is, however, impractical to rely exclusively on the Quantitative Health Objectives (QHOs) for routine use on an individual plant basis. Criteria based on core damage frequency (CDF) and large, early release frequency (LERF) focus more sharply on safety issues and can provide assurance that the QHOs are met. They should be used in developing detailed guidelines.

Issue 2: How are uncertainties to be accounted for?

This is a difficult issue. There are models and formal methods to account explicitly for a large number of uncertainties. However, other uncertainties are unquantifiable. The staff proposes to explore a number of options, such as establishing margins in the acceptance guidelines, placing more importance on defense-in-depth, and others, to deal with such uncertainties. Such approaches seem appropriate, although much work remains to be done.

Issue 3: Should requested changes to the current licensing basis be risk-neutral or should increases be permitted?

We agree with the staff and industry that increases in risk should be permitted in some situations. Acceptance guidelines expressed in terms of the proposed change in risk and the current risk estimates should have three regions: a region in which some increase in risk is acceptable, one in which it is unacceptable, and one in which further analysis and evaluation would be required.

Issue 4: How should performance-based regulation be implemented in the context of risk-informed regulation?

We agree with the staff that, where practical, performance-based strategies should be included in the implementation and monitoring step of the risk-informed decision-making process. The pilot programs may provide an opportunity for a more concrete definition and development of performance-based strategies.

DISCUSSION

Issue 1

Even though a CDF could be derived from the QHOs that could be greater than 10^{-3} per reactor-year, the current subsidiary goal of 10^{-4} per reactor-year should be maintained and should be stated as a fundamental safety goal, along with the QHO. Accident sequences that have a high probability of leading to severe consequences could be controlled by the QHOs, but a more workable measure would be a subsidiary goal on the LERF. The definition of the latter needs to be improved. Whether the LERF should be a fixed value or derived from the QHOs, which would allow the LERF goal to include site-specific characteristics, needs to be investigated.

We recommend that the staff develop guidance for handling situations in which high values of the CDF occur for short periods of time (for example, 10^{-2} per reactor-year for a day).

Issue 2

In accounting for uncertainties, it is important to distinguish between those plant characteristics or phenomena that are modeled in the PRA and those that are not modeled (e.g., the actual layout of components and organizational factors). For those that are modeled, parameter and model uncertainties should be explicitly quantified and propagated through the PRA. The resulting distributions should be an input to the decision-making process along with other qualitative input.

Mean values of distributions should, in general, be used for comparison with goals or criteria, although the sensitivity of the mean value to the high tail of a distribution should not be overlooked. For very broad distributions, such as those that typically result when significant model uncertainty is present, reliance on the mean values may not be appropriate and a more detailed investigation of the reasons for this large uncertainty should be undertaken. This could possibly lead to decisions to conduct additional research or to take other measures.

Accounting for uncertainty in the case of plant characteristics or phenomena that are not currently modeled at all is much more difficult. The staff proposes to explore a number of options, such as establishing margins in the acceptance guidelines, placing more importance on defense-in-depth, and others. We agree and encourage the staff to actively pursue the resolution of this issue.

Issue 3

The concept of a "three-region" approach is consistent with the Electric Power Research Institute's PSA Applications Guide (PSAAG), although the boundaries of the regions used in the PSAAG are not necessarily the ones that the staff will adopt.

The staff has raised the issue of how "packaged" requests are to be handled. Packaging is the process by which risk trade-offs can be accomplished. It is a significant benefit of risk-informed regulation. We believe that it is the overall impact on plant risk that is important, and related changes should be handled as a package. Such changes should be consistent with the current philosophy of risk management; i.e., that the "bottom-line" numbers should not be the only input to the decision-making process, and other concepts such as defense-in-depth must be maintained.

We will continue to monitor the progress of the staff on these issues.

Sincerely,

/s/

T. S. Kress
Chairman

References:

1. Staff Requirements Memorandum dated May 15, 1996, from John C. Hoyle, Secretary, NRC, to James M. Taylor, Executive Director for Operations, NRC, regarding Briefing on PRA Implementation Plan on April 4, 1996
2. Memorandum dated June 20, 1996, from James M. Taylor, Executive Director for Operations, NRC, to the Commission, Subject: Status Update of the Agency-Wide Implementation Plan for Probabilistic Risk Assessment (PRA) (from March 1, 1996 to May 31, 1996)
3. Electric Power Research Institute, EPRI TR-105396, Final Report dated August 1995, "PSA Applications Guide"