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Report of the Siting Policy Task Force

Office of Nuclear
Reactor Regulation

U.S. Nuclear Regulatory
Commission

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ABSTRACT

In August 1978, the Nuclear Regulatory Commission directed the staff to develop a general policy statement on nuclear power reactor siting. A Task Force was formed for that purpose and has prepared a statement of current NRC policy and practice and has recommended a number of changes to current policy. The recommendations were made to accomplish the following goals:

1. To strengthen siting as a factor in defense in depth by establishing requirements for site approval that are independent of plant design consideration. The present policy of permitting plant design features to compensate for unfavorable site characteristics has resulted in improved designs but has tended to deemphasize site isolation.

2. To take into consideration in siting the risk associated with accidents beyond the design basis (Class 9) by establishing population density and distribution criteria. Plant design improvements have reduced the probability and consequences of design basis accidents, but there remains the residual risk from accidents not considered in the design basis. Although this risk cannot be completely reduced to zero, it can be significantly reduced by selective siting.

3. To require that sites selected will minimize the risk from energy generation. The selected sites should be among the best available in the region where new generating capacity is needed. Siting requirements should be stringent enough to limit the residual risk of reactor operation but not so stringent as to eliminate the nuclear option from large regions of the country. This is because energy generation from any source has its associated risk, with risks from some energy sources being greater than that of the nuclear option.

This report of the Siting Policy Task Force was prepared in response to the Commission's request for a comprehensive staff effort to develop a general policy statement on nuclear power plant siting. A Task Force comprised of senior staff members directly involved in nuclear power plant siting was formed to consider not only current NRC siting policy, but also the staff practice which reflects siting experience over the past 25 years. The Task Force endeavored to extract from this experience lessons which could be applied in the future to improve and strengthen the siting of nuclear power plants.

This report was prepared under the direction of the Siting Policy Task Force and represents either the Task Force consensus; or where a different view is held, that view is also included in the report and identified.

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

REPORT OF THE SITING POLICY TASK FORCE

1. INTRODUCTION

The essential elements of nuclear power plant siting policy are derived from the Atomic Energy Act of 1954 and are contained in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and in 10 CFR Part 100, "Reactor Site Criteria." These regulations were promulgated by the Atomic Energy Commission in 1962 and have remained essentially unchanged since that time. The authors of Part 100 recognized that experience with siting nuclear power plants was at that time limited and, in anticipation of subsequent changes as experience was gained, included in Paragraph 100.1 the statement that:

> (b) Insufficient experience has been accumulated to permit the writing of detailed standards that would provide a quantitative correlation of all factors significant to the question of acceptability of reactor sites. This part is intended as an interim guide to identify a number of factors considered by the Commission in the evaluation of reactor sites and the general criteria used at this time as guides in approving or disapproving proposed sites.

In the time since Part 100 was promulgated, the NRC has issued additional siting-related pronouncements in the form of siting decisions on specific cases, General Design Criteria, Regulatory Guides, Standard Review Plans, Licensing and Appeals Board decisions, and advice from the Advisory Committee on Reactor Safeguards (ACRS). All of these sources have contributed to formulation of the Commission's current siting policy and practice. During this evolutionary period, the nuclear industry experienced a rapid expansion, the use of nuclear power plants became commonplace, and the size of such plants increased significantly. As a consequence of this expansion, some inconsistencies in staff practice and implementation of the siting regulations have evolved. In addition, the Commission's implementation of the National Environmental Policy Act of 1969 (NEPA) has added new dimensions to siting policy.

Recognizing that the staff has dealt with a broad spectrum of siting issues since the time that 10 CFR Part 100 and NEPA were promulgated, the Commission requested in June 1975 that the staff draw together this information into a single statement of siting policy and practice. An ongoing effort has continued since that time. Most recently, a Siting Policy Task Force composed of senior staff members of NRR, OSD and OELD was formed to meet this request.

The Task Force reviewed the diverse sources of existing siting policy and practice. During the study process, a number of areas were identified in which siting policy is incomplete, unclearly stated, or in need of change. This report identifies these areas and the related Task Force recommendations.

Although it is recognized that implementation of these recommendations will require reallocation of priorities and staff resources, the Task Force has not quantified the resources needed to implement the recommendations.

1.1 Objective of Siting Policy Statement

The objective of this study is to obtain an overview of the siting policy and practice that has evolved over the years as a result of implementation in the licensing program, and to determine whether elements of current siting policy and practice need to be more clearly stated or changed. The ultimate objectives of this effort as viewed by the Task Force are to:

1. Improve siting for nuclear power plants,
2. Improve predictability of siting policy decisions, and
3. Improve efficiency of regulatory process with regard to siting.

1.2 Scope of Siting Policy Statement

This staff study is an examination of the manner in which NRC discharges its duties originating from the Atomic Energy Act, the Energy Reorganization Act and the National Environmental Policy Act with regard to the review of sites for nuclear power reactors.

This study includes a review of staff practice as provided in such documents as Regulatory Guides and Standard Review Plans in addition to specifically enunciated policy as provided in the Regulations. The major elements of this study are divided as follows:

Section 2
Section 2 includes present policy and practice on siting. The NRC siting policy and practice is expressed in terms of areas of review responsibility in the licensing process.

Section 3
In Section 3, the Task Force discusses areas in which the policy is not clear or warrants change based on the current perception of siting requirements. In each area, the merits of various general approach options leading to the recommendations are included.

Section 4
The Task Force Report was distributed to the Commission Offices for comment. This section includes copies of the Offices' comments. This section also includes additional comments on the study by members of the Task Force and Working Group who have elected to present other viewpoints.

The Commission requested that the Task Force assure that the study address various elements of the Public Interest Research Group (PIRG) Petition on Population Density Criteria. In this regard, the Task Force concludes that the recommendations concerning population distribution, transient population, exclusion distance, and low population zone address the essential elements of the PIRG petition. A detailed analysis of the manner in which this study considers the elements of the PIRG petition is included in Appendix A.

The Commission requested that the Task Force ascertain the experience of other Federal agencies in the use of risk assessment in the development of safety criteria. The results of a survey of select Federal agencies are presented in Appendix B.

The analysis in this report has been prepared based on experience with the siting of light water nuclear power plants. For this reason, the Task Force believes that the siting principles stated in this study are not directly applicable to other types or applications of reactors (for example, gas-cooled plant and fast reactor plant), and that such applications must be examined on a case-by-case basis.

Since siting considerations of nuclear fuel cycle facilities differ from that of nuclear power plants, this report does not consider the siting of such facilities.

1.3 Legal Basis for Siting

1.3.1 The Atomic Energy Act of 1954, as Amended

The Atomic Energy Act subjects the construction and operation of nuclear power reactors to the licensing and regulatory control of the Commission. Under this Act it is unlawful to construct or operate nuclear power reactors except under a license issued by the Commission. The Commission is enjoined by the Act to exercise its licensing and regulatory authority to protect the public health and safety and promote the common defense and security. The Commission's jurisdiction under the Atomic Energy Act has been interpreted as confined to matters of radiological health and safety and common defense and security.[1]

Under this Atomic Energy Act, "no license may be issued. . . if, in the opinion of the Commission, the issuance of a license. . . would be inimical to the common defense and security or to the health and safety of the public." The Act authorizes the Commission to "prescribe such regulations or orders as it may deem necessary. . . to govern any activity authorized pursuant to this Act, including standards and restrictions governing the design, location, and operation of facilities used in the conduct of such activity, in order to protect health and to minimize danger to life or property."

This language is free of close prescription as to how the Commission shall proceed to carry out its statutory responsibilities. Thus, the Commission has considerable flexibility in this regard. Power Reactor Development Co. v. International Union, 367 U.S. 396 (1961) and Siegel v. Atomic Energy Commission, 400 F.2d 778, 783 (C.A.D.C. 1968).

[1]The Commission also has prelicensing antitrust review responsibility.

To carry out its broad statutory responsibilities under the Act, the Commission has issued regulations one of which is "Reactor Site Criteria" in 10 CFR Part 100. The purpose of Part 100 is "to describe criteria which guide the Commission in its evaluation of the suitability of proposed sites..." [10 CFR 100.1(a)]. The criteria, which are to be flexibly applied [10 CFR 100.2(b)], list a number of factors that are considered by the Commission in evaluating the radiological safety of proposed reactor sites. These factors include the design and type of proposed operation of the particular reactor that is proposed for the site, the population density and use characteristics of the area, and the physical characteristics of the site, including its seismology, meteorology, geology, and hydrology. (10 CFR 100.10).

The Supreme Court has held that the Commission's interpretation of its regulations is controlling so long as it is reasonable and consistently applied. Northern Indiana Public Service Co. v. Porter County Chapter of the Izaak Walton League of America, Inc., 423 U.S. 12, 15 (1975).

1.3.2 National Environmental Policy Act of 1969

The National Environmental Policy Act of 1969 (NEPA), which became effective on January 1, 1970, and its subsequent interpretation by the Federal courts have resulted in a significant enlargement of the jurisdiction of the Commission and a profound change in its facility licensing processes. This regulatory regime underwent major changes on September 9, 1971, as a consequence of the landmark Calvert Cliffs judicial decision interpreting NEPA as applied to the Commission's reactor licensing functions.

The Commission is now directly responsible under NEPA for evaluating the total environmental impact of nuclear power plants, and for assessing this impact in terms of the available alternatives and the need for electric power. NEPA requirements must be satisfied in reactor siting.

Courts have held that the "requirement for a thorough study and a detailed description of alternatives... is the linchpin of the entire impact statement" process. Monroe County Conservatism Counse' Inc. v. Volpe, 472 F.2d 693, 697-98 (2d Cir. 1972). The ultimate decision is left to the discretion of the agency which must take a "hard look" at the environmental consequences of its ultimate decision. Kleppe v. Sierra Club, 427 U.S. 390, 410 n21(1976). The mandate of NEPA is designed "...to insure a fully informed and well-considered decision..." Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519 (1978). NEPA "does not require that a plant be built on the single best site for environmental purposes. All that NEPA requires is that alternative sites be considered and that the effects on the environment of building the plant at the alternative sites be carefully studied and factored into the ultimate decision." New England Coalition on Nuclear Pollution v. NRC, 582 F2d 87, (1st. Cir.) (August 22, 1978).

1.3.3 Energy Reorganization Act of 1974

The Energy Reorganization Act of 1974 does not, by its terms, amend any of the substantive public health and safety and common defense and security standards set forth in the Atomic Energy Act of 1954, as amended. The House Committee Report specifically stated that "the Commission will continue to carry out those [regulatory] functions under pertinent provisions of the Atomic Energy Act of 1954, as amended....."[2]

A major purpose of the Energy Reorganization Act of 1974, was to separate the "developers" from the "regulators."[3] The legislative history of the Energy Reorganization Act of 1974 suggests that Congress sought to enhance the regulation of nuclear energy by establishing a separate agency with separate people to perform a purely regulatory mission, and did not seek to impose different statutory standards or specify different factors for consideration in making public health and safety and common defense and security judgments.

1.4 Premises

In preparing this siting analysis, the Task Force identified the following premises:

1. Siting policy and practice has as its foundation the basic responsibility of the NRC as provided by the three acts under which it operates. These basic responsibilities are protection of the public from a radiological health and safety point of view and protection of the environment.

2. In nuclear plant siting, the applicants select the sites to be reviewed, and the NRC reviews the sites and makes a decision to approve or disapprove. The NRC neither recommends specific sites to applicants, nor does it participate in an applicant's site selection process.

3. It is the applicant's responsibility to provide information concerning all significant characteristics of a proposed site and of alternative sites in support of its application before the NRC.

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[2]H.R. Rep. No. 93-707, 93rd Cong., 1st Sess. (1973) at 22, I Leg. Hist. 413. There is no indication of any contrary intent in the legislative history.

[3]Section 2(c) of the Energy Reorganization Act of 1974, as amended. See also, S. Rep. No. 93-980, 93rd Cong. 2d Sess. (1974) at 2, 19, 27, II Leg. Hist. 965, 982, 990; H.R. Rep. No. 93-707, 93rd Cong., 1st Sess. (1973) at 4, I Leg. Hist at 395.

4. A number of site features, although addressed in this siting analysis, normally do not prove to be important in the siting of light water reactors; however, such features would be important in the evaluation of plant design to match the site features. Where such features achieve specific importance and warrant consideration, they are included in the analysis.

5. Antitrust and Indemnity considerations in no way affect site acceptability per se and therefore are not included in this siting analysis.

6. Although site acceptability is established during the construction permit review, substantive new information could require reopening the issue of site acceptability any time during the plant life.

7. Existing licensed sites would be exempt from the changes to siting requirements proposed in this study.

8. Siting decisions are made considering, collectively, the impact of normal plant operation on the public and the environment and the impact of accidents on the public and the environment.

1.5 Staff Participation

The following NRC staff members participated in the preparation of this report:

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2. CURRENT SITING POLICY AND PRACTICE

2.1 Safety

2.1.1 Site Selection

Introduction

As contrasted with the environmental site selection process conducted by the applicant and the subsequent reviews of that process performed by the NRC staff, the regulations are silent in reference to the process of site selection from a radiological health and safety point-of-view.

Policy

The applicant selects a single proposed site and submits for NRC staff review "a description and safety assessment of the site on which the facility is to be located" [10 CFR Part 50, §50.34(a)(1)]. 10 CFR Part 100, §100.10 contains factors to be considered when evaluating sites.

Practice

The staff reviews the characteristics of the proposed site against various acceptance criteria included in the Standard Review Plans. Should the applicant's proposed site have unfavorable characteristics, they are permitted to be compensated for by plant design, or the applicant is encouraged to withdraw the application.

Recently, if the applicant's proposed site has unfavorable characteristics from a safety point of view, the staff practice has been to use the NEPA site selection and alternative site review process as a convenient mechanism to demonstrate that the site is unacceptable in lieu of an outright rejection on safety grounds. For example, in the Newbold Island case, the staff concluded that a more desirable alternative site existed from an environmental standpoint.[4] Subsequent to the Newbold Island review, the staff published population density threshold criteria for use in NEPA review of alternative sites.[5]

In the case of Perryman, the presence of both the external hazards and the high population density led the staff to reject the proposed site in the environmental review based on the existence of an obviously superior alternate site.[6]

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[4]Letter from L. Manning Muntzing, Director of Regulation, to Robert L. Smith, President, Public Service Electric and Gas of New Jersey, October 5, 1973.

[5]Memo from John F. O'Leary to A. Giambusso and J. M. Hendrie, "Population Density Consideration in Acceptance Review of Nuclear Power Plant Applications," November 28, 1973, and Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," Revision 1, November 1975.

[6]Letter from H. R. Denton, NRC, to J. W. Gore, Jr., Baltimore Gas and Electric Company, December 1, 1977.

2.1.2 Review of the Proposed Site

Introduction

This section deals with the policy and practice of the NRC staff concerned with the review of a proposed nuclear power plant site. As contrasted with Section 2.1.1, Site Selection, the review and decisional process used by the NRC staff is extensively documented. The principal elements of this section are keyed to the requirements of 10 CFR Part 100, "Reactor Site Criteria."

The discussion in the following paragraphs summarizes both the evolution of 10 CFR Part 100 and the inclusion of engineered safety features and other design features in the plant to compensate for various accidents and severe natural phenomena. This discussion is provided to aid the reader in understanding siting policy and practice by placing it in historic perspective.

Prior to the preparation of 10 CFR Part 100 in the early 1960s, the general policy of the Atomic Energy Commission regarding power plant siting was to provide both site isolation and plant design (primarily containment) as elements of defense in depth to assure no undue hazard to the health and safety of the public. An early statement of this defense-in-depth policy is contained in a letter from W. F. Libby to B. B. Hickenlooper dated March 14, 1956. "It is expected that power reactors, such as that now under construction at Shippingport, Pennsylvania, will rely more upon the philosophy of containment than isolation as a means of protecting the public against the consequences of an improbable accident, but in each case there will be a reasonable distance between the reactor and major centers of population." The maximum credible accident concept was developed during that time period to test whether the degree of site isolation and plant design would be sufficient.

The maximum credible accident concept was carried into Part 100 in which an analysis of the consequences of the accident was used as a test of suitability of a proposed site and plant design. In Part 100, the maximum credible accident is defined as "...a major accident, hypothesized for purposes of site analysis or postulated from considerations of possible accidental events, that would result in potential hazards not exceeded by those from any accident considered credible" [10 CFR §100.11(a), footnote 1]. Although more severe accidents (now generally referred to as Class 9 accidents) are conceivable, the consequences of such accidents were normally not analyzed for assessing the suitability of a proposed site and plant design.

At the time Part 100 was prepared, the maximum credible accident was assumed to be a loss-of-coolant accident (LOCA) that would result in a substantial meltdown of the core with subsequent release of appreciable quantities of fission products. At that time, reactors were relatively small and the assumed substantial meltdown of the core was believed to be capable of being accommodated without loss of containment integrity. This provided an effective upper bound on offsite radiological consequences as

long as the containment remained intact. Subsequently, the size of reactors has increased by about an order of magnitude, and emergency core cooling systems have become a requirement for all reactors. Performance of the emergency core cooling system in conformance with Appendix K of 10 CFR Part 50 would result in a fission product release from the core that is significantly smaller than that resulting from the previously assumed substantial meltdown. On the other hand, should the emergency core cooling system not function properly, a substantial meltdown might then occur, and the significantly greater size of present reactors could lead to the core melting through the containment. However, the principal concerns with regard to loss of containment integrity are from steam or hydrogen explosions and containment overpressure, not melt-through. The accidents considered in Part 50 are used for the purpose of designing the plant to prevent those accidents from occurring (such as loss-of-coolant accident with no core melt because of proper functioning of the emergency core cooling system). The fission product source term used in Part 100 for siting purposes, on the other hand, could only result from substantial core melt.

During the same period that Part 100 was prepared and in recognition of a relatively large fission product source term, the applicants proposed and the staff accepted various engineered safety features that tended to mitigate the radiological consequences of the loss-of-coolant accident.

Current designs that use engineered safety features such as dual containments and iodine removal systems (e.g., sprays and filters) have the capability for controlling virtually all of the radioactive material assumed to be released in the postulated LOCA. By using such designs, it is possible for present nuclear power plants to be located at sites with a very small exclusion area and a small low population zone (LPZ) distance and still meet the dose criteria of Part 100. Thus, the distance factor contemplated in the regulations has been reduced. For example, the Bailly site has a minimum exclusion area distance of 188 meters (0.12 mile). A distance of 1 mile would be required if one were to use the TID-14844 approach referenced in a footnote to Part 100. The Midland site has a low population zone distance of 1600 meters (1 mile). The TID-14844 distance would be 19 miles for the proposed power level.

Within current practice, diminishing the distance factor is limited only by the degree of effectiveness attributable to the engineered safety features (ESFs) and by the consideration of proximity to very large cities. This has resulted in plants being located closer to "population centers" than would have been approved by the techniques in use at the time Part 100 was published.

Part 100 has built-in flexibility that permits unfavorable site characteristics to be compensated by design. This provision has encouraged improved plant designs and it has succeeded in that regard. However, an unbounded reduction of the distance factor as a tradeoff for added safety features can lead to an erosion of the protection provided by distance that was originally contemplated in Part 100. The Statement of Considerations that accompanied publication of the effective Part 100 on April 12, 1962, stated that the underlying objectives were to assure that "...the cumulative

exposure dose to large numbers of people as a consequence of any nuclear accident should be low..." and, "...since accidents of greater potential hazard than those commonly postulated as representing an upper limit (i.e., the 'maximum credible accident') are conceivable, although highly improbable, it was considered desirable to provide for protection against excessive exposure doses to people in large centers" (37 FR 3509).[7] The Statement of Considerations then addresses how these objectives are met. "Neither of these objectives were readily achievable by a single criterion. Hence, the population center distance was added as a site requirement when it was found for several projects evaluated that the specification of such a distance requirement would approximately fulfill the desired objectives...."[8] The manifestations of the foregoing discussion are considered in following sections.

2.1.2.1 Role of Plant Design

Policy

The use of plant design features to compensate for unfavorable site characteristics is provided for in the regulations. Part 100 states "...where unfavorable physical characteristics of the site exist, the proposed site may nevertheless be found to be acceptable if the design of the facility includes appropriate and adequate compensating engineering safeguards" [10 CFR Part 100.10(d)].

Practice

1. The assumed fission product release from a loss-of-coolant accident[9] and the exposure criteria (dose guidelines)[10] provided in Part 100 are used.

2. The effectiveness of each of the various engineered safety features of the plant provided to mitigate the consequences of the postulated accident is evaluated.

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[7]As the Statement of Considerations for the proposed version (1961) stated, based on calculations in use at that time, the consequences of core melt with containment failure were not likely to result in acute fatalities at population center distances one and one-third times the LPZ distance (as determined from the same event with containment intact).

[8]The proposed rule (10 CFR Part 100) first published on May 23, 1959 (24 FT 4184), contained one criterion dealing with the population in the vicinity of the plant. As noted in the Statement of Consideration for the final version, such a simple criterion was not adequate. The rule therefore contains the criteria for both the LPZ and population center distance.

[9]Fission products available for release include 100 percent of the noble gases and 25 percent of halogens.

[10]Dose guidelines are 25 rem whole body and 300 rem thyroid during specified time periods.

2.1.2.2 Design Basis Accidents

Policy

The guideline dose limits stated in 10 CFR Part 100 (see footnote 10 of this report) resulting from an assumed major accident are to be used in determining the exclusion area, low population zone, and population center distance. The Part 100 dose levels are not intended to imply acceptable limits for emergency doses to the public under accident conditions, but serve as reference values only to be used in evaluating the reactor sites with respect to potential accidents [10 CFR §100.11(a)(1), footnote 2].

Practice

1. Staff practice relating to dose calculations is now documented in numerous Regulatory Guides and Standard Review Plans. This current practice supersedes procedural method and sample calculations contained in TID-14844 (March 23, 1962). TID-14844 reflects siting practices used in 1962, although Part 100 presently refers to TID-14844 as "current siting practices of the Commission."

2. Throughout this evolution in staff practice, the source term of TID-14844 (100 percent of the noble gases and 50 percent of the iodine fission products) and the dose limits of Part 100 have not been unchanged. Staff practices dealing with performance of engineered safety features and meteorological assumptions have continuously evolved.

3. Dose calculation is based on inhalation of and immersion in airborne radioactivity. The calculation is performed for a "standard man." Doses to other segments of the population (e.g., infant) are not calculated. Calculations of possible doses from other pathways, such as ingestion of contaminated milk following deposition of iodine on land, are not normally performed. This practice arises from viewing the purpose of the dose calculation in the site suitability evaluation as a reference value rather than a calculation of precise doses that might be realized by members of the public under accident conditions.

4. The staff regards the dose values of Part 100 to be absolute upper limits rather than treating these as guidelines subject to a degree of staff judgment. Furthermore, at the construction permit (CP) stage, allowable doses somewhat lower than the values of Part 100 (about 150 rem thyroid and 20 rem whole body) are used to compensate for uncertainties in final design details and meteorology or new data and calculational techniques that are expected to arise during the time between issuance of the CP and the operating license (OL) review.

5. The design basis accident dose calculation is used to verify that the performance of the engineered safety features is acceptable, or to determine whether improvements are needed. If the doses are calculated to be in excess of the values given in Part 100, staff practice requires additional measures, such as reducing the containment leak rate, adding engineered safety features or (rarely) acquiring additional site property for the exclusion area, to bring the consequences into conformance. In principle, the result of the design basis accident dose calculations could be used to find a site unsuitable if sufficient improvements could not be added to make the consequences acceptable. In practice, this has not occurred because sufficient improvements, particularly the purchase of more property, are always available.

6. In evaluating the suitability of a proposed site, the staff confirms that the radiological dose consequence of the postulated loss-of-coolant accident (LOCA) is limiting, that there is not some other limiting accident (such as a steam line break for a pressurized water reactor) that would have greater consequences, and that none have consequences exceeding the guideline values of Part 100.

2.1.2.3 Class 9 Accidents

Policy

The regulatory history of Part 100 suggests that a purpose of the population center distance was to provide some additional measure of protection for large numbers of people from accidents greater than those considered credible. Such accidents, which are not compensated for by plant design, are generally referred to as Class 9 accidents. In addition, Part 100 identifies special circumstances in which such an accident must be considered in site reviews.

1. Part 100 provides for "a population center distance of at least one and one-third times the distance from the reactor to the outer boundary of the low population zone" [10 CFR §100.11(a)(3)].

2. Section 100.11(a)(3) states that "where very large cities are involved, a greater distance (than the population center distance) may be necessary because of total integrated population dose consideration."

3. Section 100.10(a)(3) states that "the extent to which the reactor incorporates unique or unusual features having a significant bearing on the probability or consequences of accidental release of radioactive materials" should be considered.

4. Section 100.10(b)(3) provides that "special precautions should be planned if a reactor is to be located at a site where a significant quantity of radioactive effluent might accidentally" be released into the hydrosphere.

5. Section 100.2(b) provides that "for reactors that are novel in design and unproven as prototypes...these basic (site) criteria will be applied in a manner that takes into account the lack of experience."

Practice

1. In routine reviews, the staff determines the acceptability of the LPZ (as discussed in Section 2.1.2.5) and whether the population center distance meets the one and one-third requirement.

2. During reviews of unique or advanced reactor designs, such as liquid metal fast breeder reactors (LMFBRs), the staff has considered risks associated with core-melt/containment-failure accidents.

3. The staff's concern about siting nuclear power reactors in densely populated areas has led to the development of population guidelines.[11,12,13]

   After publication of the population guidelines, the only site submitted for NRC review that exceeded these guideline values was the Perryman site of the Baltimore Gas and Electric Company. The staff concluded that "alternative sites are available which are obviously superior to the Perryman site, particularly from the standpoint of population density, proximity of potentially hazardous activities, and overall project costs" and that "the application should be denied."[13]

4. Unique site features of the application by Offshore Power Systems (OPS) for a manufacturing license to construct eight floating nuclear power plants (FNP) presented a significant departure from land-based siting. In this case, the staff evaluated the risk associated with Class 9 accidents through the liquid pathway compared to that of land-based plants.

[11]For a more detailed perspective of AEC (NRC) actions taken in cases of sites proposed for high population areas, see NUREG-0478, "Metropolitan Siting - A Historical Perspective," October 1978.

[12]Letter from L. Manning Muntzing, Director of Regulation, to Robert L. Smith, President, Public Service Electric and Gas of New Jersey, October 5, 1973.

[13]Memorandum from John F. O'Leary to A. Giambusso and J. M. Hendrie,"Population Density Considerations in Acceptance Review of Nuclear Power Plant Applications," November 28, 1973, and Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," Rev. 1, November 1975.

These results were factored into an overall balancing of risks (including air pathway) and the cost-benefit analysis in the Final Environmental Statement (FES).[14]

2.1.2.4 Exclusion Area

Policy

An exclusion area as defined in Part 100 shall be determined for every power reactor (10 CFR §100.3 and §100.11). Certain plant unrelated activities shall be allowed within the area. Although residences are normally prohibited, traversal of the area by transportation routes such as highways or waterways is allowed provided that these are not so close as to interfere with normal operations of the plant, and provided that arrangements have been made to control traffic on these routes in the event of an emergency. Other "activities unrelated to operation of the reactor may be permitted... under appropriate limitations, provided that no significant hazard to the public health and safety will result" (10 CFR §100.3).

Practice

1. The primary objectives perceived by the staff for the exclusion area include:

   a. Control of land use close to the plant;

   b. Protection of the public in the event of an accident; and

   c. Protection of the plant from offsite man-made events.

2. Outright ownership (of mineral rights as well as surface rights) of the exclusion area or a long-term lease arrangement is considered to be sufficient to demonstrate the requisite authority. However, under special circumstances, control over the exclusion area need not be total. For example, lack of control over a strip of publicly owned beach between high and low tides is judged to be "de minimis" and is therefore of no concern (ALAB-432).

3. A variety of plant unrelated activities such as visitor centers, camps, and industrial facilities are present within the exclusion areas of many sites. Staff practice is to determine whether such activities are a potential hazard to the plant, and whether individuals involved in such activities can be evacuated before receiving a dose in excess of the values given in Part 100. Staff practice has been neither to discourage nor to encourage unrelated activities within the exclusion area.

[14] NUREG-0502, "Final Environmental Statement Related to the Manufacture of Floating Nuclear Power Plants by Offshore Power Systems," December 1978.

4. If a body of water is included in the exclusion area, the staff requires the applicants to show the appropriate arrangements to control water traffic in the event of emergency.

5. The staff requires the doses from the postulated design basis accident to be less than the values given in Part 100 for an individual located at the outer boundary of an exclusion area for a period of two hours following the accident.

6. Exclusion areas may or may not be circular in shape, and the minimum distance to the exclusion area boundary ranges from 0.1 mile to 0.6 mile, with a distance of about 0.4 mile being fairly typical.

2.1.2.5 Low Population Zone

Policy

A low population zone (LPZ), which is usually circular with a typical outer boundary of 2 to 3 miles, should be determined for every power reactor. It is a zone immediately surrounding the exclusion area (10 CFR §100.3, §100.11).

The area need not be under the control of the applicant and may contain "residents, the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of a serious accident." A limit on permissible number and density of persons in this zone is not specified because "the situation may vary from case to case." Appropriate protective actions, such as evacuation or taking shelter, "will depend on many factors such as location, number and size of highways, scope and extent of advance planning, and actual distribution of residents within the area" [10 CFR §100.3(b)].

Practice

1. The primary objectives perceived by the staff for the LPZ in siting include:

   a. A zone where evacuation is feasible, and

   b. A buffer zone between the exclusion area and large population concentrations to control or minimize societal consequences in the event of an accident.

2. The staff requires that the doses from the postulated design basis accident be less than the values given in Part 100 [10 CFR §100.11(a)(2)] for an individual at the outer boundary "during the entire period" of the radioactive cloud passage (interpreted by the staff to be 30 days).

3. In evaluating the suitability of the LPZ, the staff, after reviewing population distribution, transportation networks, and dose projections for the design basis accident, determines whether the LPZ can be evacuated in a timely fashion so that no individual within it is likely to receive a dose in excess of the values given in Part 100. Although the regulations permit the use of shelter, the staff in its siting practice relies only on evacuation as a means of protective action.

2.1.2.6 Population Center

Policy

The nearest densely populated center containing more than about 25,000 residents must be identified. The population center distance must be at least one and one-third times the LPZ outer boundary, but "where very large cities are involved, a greater distance may be necessary because of total integrated population dose consideration" [10 CFR §100.11(a)(3)].

The population center distance is defined as the distance from the reactor to the nearest boundary of a densely populated center; however, "political boundaries are not controlling" and the "boundary...shall be determined upon consideration of population distribution" [10 CFR §100.11(a)(3)].

Practice

1. The staff verifies whether the nearest population center of 25,000 or more residents has the following characteristics:

   a. The center is located at a distance at least one and one-third times the LPZ outer boundary, and

   b. There is a cluster of population closer to the site that should be indicated as the nearest population center. If the population center distance does not meet this test (as a result of actual or projected residential growth closer to the plant), staff practice is to request the applicant to propose plant modifications so that a reduced LPZ will meet the test.

2. The staff has identified communities having populations in the range of 12,000 to 15,000 persons as the nearest population center on the basis of projected growth.

3. Contiguous communities are combined for the purpose of identifying the population center.

4. When a new reactor is proposed at a site where an operating reactor already exists, the population center distance for the proposed reactor is evaluated independently of that for the existing reactor.

2.1.2.7 Population Density

Policy

There is no specific guidance in the regulations regarding population density in the vicinity of a power reactor site, other than in the definitions of the exclusion area, LPZ, and nearest population center as given in 10 CFR §100.3.

Practice

1. Criteria published in Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," state:

> Areas of low population density are preferred for nuclear power station sites. High population densities projected for any time during the lifetime of a station are considered during both the NRC staff review and the public hearing phases of the licensing process. If the population density at the proposed site is not acceptably low, then the applicant will be required to give special attention to alternative sites with lower population densities.
>
> If the population density, including weighted transient population, projected at the time of initial operation of a nuclear power station exceeds 500 persons per square mile averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), or the projected population density over the lifetime of the facility exceeds 1,000 persons per square mile averaged over any radial distance out to 30 miles, special attention should be given to the consideration of alternative sites with lower population densities.
>
> Transient population should be included for those sites where a significant number of people (other than those just passing through the area) work, reside part time, or engage in recreational activities and are not permanent residents of the area. The transient population should be taken into account by weighting the transient population according to the fraction of time the transients are in the area.

2. The above criteria are levels that trigger an additional depth of review in the consideration of alternative sites in the environmental review rather than representing upper limits of acceptability. A site exceeding these population density guidelines could nevertheless be selected and approved if no obviously superior alternative sites were identified.

2.1.2.8 Hazardous Activities in Plant Vicinity

Policy

Part 100.10 requires that the factors used in evaluating sites include "characteristics peculiar to the site," the "use characteristics of the site environs," and the "physical characteristics of the site." Plant design criteria reflect consideration of site-related factors. General Design Criterion 4 (GDC 4) requires that portions of the plant be "appropriately protected against dynamic effects...that may result... from events and conditions outside the nuclear unit."

Practice

1. Staff practice expressed in Regulatory Guides and the Standard Review Plan further defines site characteristics to include man-made activities such as transportation, industrial, and military activities near the site.[15]

2. The staff requires that nuclear facilities be designed and located so that there is reasonable assurance that external events will not trigger an accident that would result in radiological consequences in excess of 10 CFR 100 guideline doses. This requirement can be met if the plant design can be shown to withstand the effects of the external event.

3. If the probability of the hazardous activity is below the acceptance criteria of SRP Section 2.2.3 (10^{-7} per reactor year determined realistically), no design accommodation is required.

4. Where multiple external hazards may exist, the hazards are grouped in categories according to their effect on the plant (missiles, fire, etc.). The probability of occurrence of each category from all potential hazard sources (greater than 10^{-7} per reactor year determined realistically) is considered to determine whether or not a particular category of accident need be considered in the design.

2.1.2.9 Site Aspects of Emergency Planning

Policy

NRC policy relating to elements of emergency planning is included in the definitions of exclusion area and low population zone (LPZ) (10 CFR §100.3). The definition of the LPZ calls for "a reasonable probability that appropriate protective measures could be taken" on behalf of persons within an LPZ "in the event of a serious accident." Specific reference is made to evacuation or taking shelter as potential protective measures. Additional policy on aspects of emergency planning not related to siting policy are contained in 10 CFR Part 50, Appendix E.

[15] Regulatory Guides 1.70.8 and 1.91 and SRP Sections 2.2.3, 3.5.1.5 and 3.5.1.6 are the most explicit examples.

Practice

The staff evaluates the physical characteristics of the low population zone to determine whether there is a reasonable probability that protective measures could be taken. The potential for entrapment is an essential consideration.

Although not reviewed in the context of site suitability, emergency planning within the LPZ and beyond is reviewed in the licensing process.

2.1.2.10 Changes in Offsite Activities and Population

Policy

The NRC policy is to consider the safety significance of population density and distribution, and other activities in the vicinity of the plant (10 CFR §100.10 and §100.11). Although the regulations do not clearly require consideration of offsite activities projected beyond the time at which the license would be granted, the Statement of Consideration for Part 100 states that "AEC review of land use surrounding a proposed site includes considerations of potential residential growth" (27 FR 3509). Both the regulations and the Statement of Consideration are silent concerning changes in land use following issuance of a CP or OL.

Practice

1. Between issuance of the CP and the OL review, significant changes in offsite activities may trigger reconsideration.

2. During OL review, the current and projected population distribution is reevaluated. The site and facility combination must meet the criteria of 10 CFR Part 100.11 for the population projected over the lifetime of the plant. Projections of other offsite activities (such as a major industrial facility) cannot normally be made.

3. Following issuance of an operating license, changes in population and land use having potential safety implications in the vicinity of operating reactors are managed by the NRC by exercising its control over the reactor licensee and by seeking the cooperation of other government agencies.

4. The NRC Office of Inspection and Enforcement reviews the population and land use changes in the site vicinity on a 3-year cycle to determine if significant changes have occurred.[16]

[16] Inspection Procedure No. 30702, July 1, 1977, includes eight subject categories including population, recreational facilities, transportation routes, industrial and military facilities, routing of pipelines, erection of dams, and naturally occurring changes in the site features.

5. Administrative actions have been taken in several cases to monitor the development of potentially hazardous situations in the vicinity of nuclear sites. Examples include significant changes in airport activity near Three Mile Island and developments regarding liquid natural gas (LNG) traffic near the Hope Creek Plant.

6. The NRC reviews the draft environmental impact statements submitted by Federal agencies with a view toward commenting on any proposed activities having the potential to affect the safety of the facilities licensed by the Commission.[17]

7. The staff has become involved with other governmental agencies in dealing with developments in the vicinity of the site.[18]

8. The NRC cannot exercise control over non-nuclear activities that take place in the vicinity of a plant but it can and does exercise control over the design and continued operation of the nuclear facility in light of changes in these activities.

2.1.2.11 Natural Phenomena and Physical Characteristics

Policy

The 10 CFR Part 100 states that the physical characteristics of the site (including seismology, meteorology, geology, and hydrology) shall be considered in determining the acceptability of a site. The regulation also provides that, where unfavorable physical characteristics of the site exist, the proposed site may nevertheless be found to be acceptable if the design of the facility includes appropriate and adequate compensating engineered safety features.

General Design Criterion 2 of Appendix A to Part 50 states:

> Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena... [and]....The design bases for these structures, systems, and components shall reflect: (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area with sufficient margin for the limited accuracy, quantity, and period of time in which

[17]Such a review is the means by which the NRC learned of the Cove Point LNG facility near Calvert Cliffs.

[18]The staff obtained the cooperation of the Coast Guard and the Captain of the Port of Baltimore in establishing shipping restrictions to limit the hazard to the Calvert Cliffs plant from transport of LNG. As a result of this and other incidents, the staff suggested to the Coast Guard that we work toward a memorandum of understanding regarding the potential hazard associated with the close proximity of LNG vessel movements to nuclear facilities. The Coast Guard agreed and preliminary meetings have taken place.

the historical data have been accumulated, (2) appropriate combinations of the effects of the natural phenomena, and (3) the importance of the safety functions to be performend.

Appendix A to Part 100 provides seismic and geologic siting criteria for nuclear power plants and describes the nature of investigations required to obtain the geologic and seismic data necessary to determine site suitability. Appendix A was developed to provide guidance in the form of regulations on geology and seismic issues that would reduce repetitive and exhaustive considerations in individual licensing proceedings and would focus attention on the relevant issues.[19] Appendix A criteria, procedures, and methods are directed toward the following major objectives:

1. The estimation of the severity of ground shaking at a site due to potential earthquakes for use in nuclear power plant design;

2. The assessment of the potential for ground rupture that could affect plant structures due to fault movement;

3. The evaluation of the effect on the site of phenomena associated with earthquakes such as seismically generated sea waves (tsunamis) and ground failure (for example, liquefaction); and

4. The assessment of the potential for other geologic hazards such as landslides, subsidence, or volcanic activity.

Practice

1. The quantification of the physical characteristics (such as seismology, meteorology, geology, and hydrology) and extremes of the severe environmental hazards (such as tornados, floods, and faulting) at the proposed site provide bases for the staff to make site suitability judgments required for issuance of Construction Permits (CPs) under Parts 50 and 100, Limited Work Authorizations (LWAs) under Part 50.10, and Early Site Reviews (ESRs) under Part 2, Subpart F, and Part 51, Appendix Q. The Standard Review Plans and Regulatory Guides provide review procedures, information guidelines, and criteria that the staff finds acceptable for implementing the regulations with respect to natural phenomena. (Specific references are provided in Table 1.)

[19] These elements are discussed in detail in the Commission Information Report, "Geologic and Seismic Siting Policy and Practice for Nuclear Power Plants," SECY-77-288A (August 18, 1977), and in "Identification of Issues Pertaining to Seismic and Geologic Siting Regulation, Policy, and Practice for Nuclear Power Plants," SECY-79-300 (April 27, 1979).

2. The staff bounds the severity of some natural phenomena on a regional basis to facilitate the licensing process and standardize design requirements (for example, tornado wind speeds). Each natural phenomenon is considered separately as indicated in Table 1.

3. The staff permits unfavorable physical characteristics of the site to be compensated by engineering design. The staff practice is to identify and evaluate the unfavorable physical characteristics or severe natural phenomena associated with the site. When the staff concludes that the uncertainties associated with identifying the severity of natural phenomena are great or that the feasibility of engineering solutions is doubtful or questionable, the staff has not permitted the unfavorable physical characteristics of the site to be compensated by engineering design. Based on staff experience, three natural phenomena are judged to be possible reasons for site rejection. These phenomena are (a) surface faulting caused by earthquakes,[20] (b) extensive ground failure caused by liquefaction,[21] and (c) floods caused by nearby dam failures.[22] Under special circumstances (such as vulcanism), other natural phenomena could also be bases for site rejection. Table 1 gives information requirements, criteria, and review procedures developed by the staff to detect such circumstances.

4. Some natural phenomena relate only to the acceptability of the site and plant design combinations and do not serve as bases for site rejection because the severity can be bounded and appropriate design provisions can be made (for example, atmospheric transport and diffusion). Table 1 identifies phenomena that are related to the site and plant design combination.

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[20] Surface faulting considerations can lead to possible site rejection because there is a high level of uncertainty associated with predicting the amount of differential displacement that could occur beneath plant structures (Regulatory Guide 4.7; SRP Section 2.5.3). Without such specific information, design solutions cannot be established.

[21] Although liquefaction problems can be overcome in some cases by ground modification, such as soil densification, engineering solutions become prohibitive when liquefaction could result in extensive ground failure (Regulatory Guides 1.70, 1.132 and 1.138; SRP Section 2.5.4.8).

[22] The bases for rejecting a site because of potential severe dam failures are related to the (a) engineering feasibility of incorporating design provisions for very large impact forces, and (b) submergence consequences (SRP Section 2.4; Regulatory Guides 1.59 and 1.102).

5. The staff uses two levels of severity for earthquakes and winds during the review of site and plant design (Appendix A to Part 100 and Sections 2.3, 2.5, and 3 of the SRP). The higher level of severity is related to site suitability and plant design. The lower level is related solely to plant design.

6. Because the level of understanding and data available vary for each natural phenomenon, it is staff practice to use either probabilistic or deterministic quantification methods, depending on the phenomenon. Probabilistic methods are based on statistical treatment of a set of data and are used in the staff's meteorology analyses. Deterministic methods rely on an understanding of the physical causes of an event, consider the combination of circumstances leading to the occurrence of the phenomenon, and are used in the staff's hydrology, geology, and seismology analysis. In its deterministic analysis, the staff goal is to establish levels of severe phenomena that have little chance of being exceeded at the site. The staff considers its practices to be conservative, but the probabilities of exceedance and the margins of safety provided in plant design and operation have not been quantified.

   For example, different methodologies are used by the staff in the assessment of tornados, floods, and earthquakes. In assessing tornadoes, the method used is to determine a Design Basis Tornado by statistically analyzing a historical data based and extrapolating to a likelihood level of 10^{-7} per year. For earthquakes and floods, deterministic approaches based on an understanding of the causes of the phenomena are used. The approach for earthquakes was developed by the staff and the USGS and is codified in Appendix A to Part 100. Although the approach is deterministic in the sense that the distribution and severity of earthquakes are limited to areas containing consistent geologic features, members of the staff have concluded that it also has inherent probabilistic concepts because consideration of the frequency of earthquakes in such a region over a period of time infers probability.

7. Because of the benefits of having expert advice on detailed local conditions, the infrequent need for extremely specialized technology, and peak workload conditions, the staff practice is to augment its personnel resources by the use of consultants and advisors in evaluating site physical characteristics. Our consultants and advisors include representatives from NOAA on meteorology, the Corps of Engineers on geotechnical engineering and coastal engineering, and the USGS on geology and seismology.

   Differences of opinion between the staff and its consultants and scheduling difficulties frequently occur in the geoscience areas (see NUREG-0270, "Guideline for the Development of a Methodology for Measuring Level of Effectiveness of Physical Protection Facilities at Fixed-Site Facilities," May 1977).

8. Staff practice with respect to assessments of accident risks via the liquid pathway has been to consider only the consequences of a conservatively postulated failure of radwaste tanks. In land-based light water reactors considered to date, the postulated event has not been controlling for either site suitability or plant design. The potential for the liquid pathway to play a role in the suitability of a site for a Floating Nuclear Plant was evaluated in the Liquid Pathway Generic Study.

Table 1. Phenomena Considered by the Staff in the Review of Site and Plant Design

Discipline	Phenomena	Site and Design Related	Site Suitability Related	Siting Guidance and Criteria Available
Meteorology	Tornadoes	X		R.G. 1.70, 1.76; WASH-1300; SRP 2.3
	Waterspouts	X		R.G. 1.70, SRP 2.3
	Lightning	X		R.G. 1.70; SRP 2.3
	Thunderstorm/hail	X		R.G. 1.70; SRP 2.3
	Ice/snow/freezing rain accumulations on the plant	X		R.G. 1.70; SRP 2.3
	Dust/sandstorms	X		
	Atmospheric dispersion and transport	X	X	R.G. 1.70, 1.3, 1.4 1.23, 1.111, 1.145; SRP 2.3; 10 CFR 100.10(c)(2); TID-14844
	Wind (not tornado)	X		SRP 2.3
	General climate	X		R.G. 1.70; SRP 2.3
	Air pollution	X		R.G. 1.70; SRP 2.3
	Cooling system effects	X		R.G. 1.70; SRP 2.3
Hydrology (hydrology, oceanography)	Precipitation flooding on streams	X		R.G. 1.70, 1.59, 1.102; SRP 2.4

Table 1 (continued)

Discipline	Phenomena	Site and Design Related	Site Suitability Related	Siting Guidance and Criteria Available
Hydrology (continued)	Surge and seiche flooding (e.g., hurricane)	X		R.G. 1.70, 1.59, 1.102; SRP 2.4
	Tsunamis	X		R.G. 1.70, 1.59, 1.102; SRP 2.4; 10 CFR 100 Ap. A
	Dam failures	X	X*	R.G. 1.70, 1.59, 1.102, 1.27; SRP 2.4; 10 CFR 100 Ap. A
	Ice effects	X		R.G. 1.70, 1.27; SRP 2.4
	Groundwater	X		R.G. 1.70; SRP 2.4; 10 CFR 100.10(c)(3); Branch Tech. Position HMB-1
	Local flooding	X		R.G. 1.70, 1.59, 1.102; GDC 2 10 CFR 50; SRP 2.4
	Water supply availability	X		R.G. 1.70, 1.27; SRP 2.4; 10 CFR 100 Ap. A
	Hydrospheric transport and diffusion	X		R.G. 1.70, 1.113; SRP 2.4; 10 CFR 100.10(c)(3)
Geosciences (geology, seismology, & geotech. engr.)	Surface faulting	X	X*	R.G. 1.70, 1.113; 10 CFR 100 Ap. A; SRP 2.5.3
	Seismicity	X		R.G. 1.70, 10 CFR 100 Ap. A; SRP 2.5.2
	Vibratory ground motion	X		R.G. 1.70, 1.60; 10 CFR 100 Ap. A; SRP 2.5.2

*Identified as current basis for rejection of sites.

Table 1 (continued)

Discipline	Phenomena	Site and Design Related	Site Suitability Related	Siting Guidance and Criteria Available
Geoscience (continued)	Liquefaction	X	X	R.G. 1.70, 1.132, 1.138; 10 CFR 100 Ap. A; SRP 2.5.4.8
	Landslide	X	X	R.G. 1.70, 1.132, 1.138; 10 CFR 100 Ap. A; SRP 2.5.5
	Settlement	X		R.G. 1.70, 1.132, 1.138; 10 CFR 100 Ap. A; SRP 2.5.4
	Subsidence	X	X	R.G. 1.70, 10 CFR 100 Ap. A; SRP 2.5
	Dam stability	X	X*	R.G. 1.70, 1.127, 1.132, 1.138; 10 CFR 100 Ap. A; SRP 2.5.2, 2.5.3, 2.5.4, 2.5.5
	Bearing failure	X		R.G. 1.70, 1.132, 1.38
	Cavity collapse	X		R.G. 1.70, 1.132; 10 CFR 100 Ap. A; SRP 2.5
	Vulcanism	X	X	R.G. 1.70; 10 CFR 100 Ap. A; SRP 2.5
	Uplift	X		R.G. 1.70; 10 CFR 100 Ap. A; SRP 2.5

*Identified as current basis for possible rejection of sites.

2.1.2.12 Multiple Siting

Policy

The Part 100.11(b) addresses multiple units on a site for accident conditions and distinguishes between reactors that are independent of one another and those for which there may be a degree of coupling. It prescribes the manner in which the site criteria of exclusion areas, low population zones, and population center distances should be determined in such cases. It also prescribes that the total radioactive effluent releases from the simultaneous operation of multiple reactors at a site should not exceed the allowable limits of applicable regulations. In addition, General Design Criterion 5 (Part 50, Appendix A) generally prohibits the sharing of structures, systems, and components among nuclear power units unless the applicant can show that such sharing cannot significantly impair items important to the safe shutdown of the remaining units in the event of an accident in one of them. The regulations regarding routine effluent releases (Part 20 and Appendix I to Part 50) do not limit the number or reactors on a single site.[23]

Practice

1. Multiple sites are considered on a case-by-case basis. The staff has not been faced with a need to establish a generic upper limit on the number of reactors that can be placed on a single site. The maximum number of units on a site for which construction permits have been requested is five units (Palo Verde). Construction permits have been issued for four units at each of three sites: Shearon Harris, North Anna, and Hartsville.

2. Staff practice is neutral concerning placing additional units on previously approved sites. When an additional unit is proposed, the staff evaluates updated site information. The site criteria are applied to each additional unit independently. This practice has resulted in different sizes for low population zones and population center distances for different units at the same site (in the cases of Arkansas 2 and Pilgrim 2, this was a result of changes in the population).

[23]The EPA has issued the Uranium Fuel Cycle Standard (40 CFR 190) that becomes effective for uranium fuel cycle facilities including light water reactors on December 1, 1979. This standard will limit the releases from LWR sites and supporting facilities to 25 mrem/year to the total body or any organ except the thyroid and 75 mrem/year to the thyroid. For reactor sites, there will be an upper limit of about six reactors on a site if each reactor operates within the Appendix I design objectives.

The staff is presently developing an implementation scheme for 40 CFR Part 190. Currently, routine releases are evaluated for individual reactors using Appendix I criteria and for sites using 10 CFR Part 20. The technical specifications issued for implementing ALARA reflect the same evaluation.

3. Staff practice does not specifically limit the number of nuclear power plants that can be located within any region of the United States; e.g., within 50 or 100 miles of one another. However, implementation of 40 CFR Part 190 will require that the normal operation radioactive effluent contribution to public exposure of each new plant to be licensed does not violate the dose limit of 25 mrem per year to any member of the public from all nuclear fuel cycle facilities in the vicinity. (See Footnote 23 of this paper.)

2.2 Environmental

Introduction

There are four distinct and different areas of decision-making in the NRC review process. One decision that must be made is whether additional generating capacity need be provided; i.e., the "no action" alternative. The second decision is whether nuclear is an acceptable choice (e.g., coal versus nuclear). The third decision is whether the proposed site is acceptable. This third decision involves the consideration of alternative sites, which includes the consideration of mitigation measures that might be used to reduce significant adverse environmental impacts to acceptable levels at the candidate sites and the consideration of the costs of such mitigation measures, as well as any costs required to make the site acceptable from a safety standpoint. The fourth decision is whether other mitigation measures are warranted that normally would be of little importance to site selection, but may still be important from the standpoint of decreasing to the extent reasonable any residual adverse environmental or social impacts that likely might be incurred during the construction or operation of the plant.

Until the past year, the NRC review of the alternative sites has been to focus on the qualities of the proposed site and to not conduct an extensive review of the applicant's site selection process and alternative sites unless substantial inferior qualities were indentified at the proposed site. Because of decisions in recent cases, including the Pilgrim and Seabrook proceedings, the NRC now routinely conducts detailed reviews of alternative sites in situations where no substantial inferior qualities are identified at the proposed site. Also, the NRC comprehensively reviews the process used by the applicant to select the proposed nuclear power plant site and its alternatives. This review process is reflected in the following sections.[24]

[24]New review procedures are currently being established by the proposed rulemaking for alternative sites. Refer to NUREG-0499, Supp. 1, "General Consicerations and Issues of Significance on the Evaluation of Alternative Sites for Nuclear Generating Stations Under NEPA," December 1978.

2.2.1 Site Selection

Policy

Section 102(2)(E) of NEPA states "Study, develop, and describe appropriate alternatives to recommend courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources...." NRC rules also inherently require the evaluation of alternative sites in that 10 CFR Part 51.20(a) states:

> (3) Alternatives to the proposed action; ...
>
> (5) The discussion of alternatives to the proposed action required by paragraph (a)(3) shall be sufficiently complete to aid the Commission in developing and exploring, pursuant to section 102(2) of NEPA, "appropriate alternatives... in any proposal which involves unresolved conflicts concerning alternative uses of available resources."

Current environmental review procedures on the siting of nuclear power plants is shaped by these requirements as well as court interpretations and Commission and ASLAB decisions. Further guidance is provided by the CEQ, Executive Orders, and case-related decisions by the ASLB.

Practice

1. Role of NRC and Other Agencies in Site Selection

   a. The NRC has the statutory responsibility for reviewing applications for the construction and operation of nuclear facilities and for early site reviews and has the responsibility for assuring the accuracy and relevance of information, for performing the analysis, and for making the decision to accept or reject a site.[25] In carrying out its responsibilities, the NRC does not select sites or participate with the applicant in selecting a proposed site. The NRC does, however, validate the information, analyses, and forecasts supplied by the applicant. Such validation may include the analysis of information that is independently obtained by the NRC and is pertinent to important issues related to the application.

   b. The staff may defer to other Federal agency expertise in the assessment of certain impacts; e.g., EPA expertise in evaluating aquatic impacts.[26] The Commission has also

[25] Under NEPA, decisions cannot be delegated by the NRC. Greene County Planning Board v. EPC, 445 F.2d 412 (2d Cir.), cert. denied, 409 U.S., 849 (1972); Steubing v. Brinegar, 511 F.2d 489 (2d Cir. 1975).

[26] Seabrook (CLI-78-1).

stated that "the fact that competent and responsible state authority has approved the environmental acceptability of a site or project after extensive and thorough environmentally sensitive hearings is properly entitled to substantial weight in the conduct of our own NEPA analysis."[27] In addition, consideration is given to other information developed by State, regional and/or local agencies (such land or water use plans), but the weight to be given to such information varies from case to case.

2. Required Level of Information and Analyses

The analysis of alternative sites is normally based upon "reconnaissance" level information such as scientific literature, reports of government or private resource agencies, consultation with experts, or brief field investigations.[28] The amount of data required and the extent of analyses is matched to the importance of possible impacts and the degree of certainty regarding their magnitude. In some cases, detailed investigations related to specific issues may be important to the site decision. However, normally detailed site-specific baseline information serves only to confirm judgments on likely adverse environmental impacts that are made using reconnaissance level data, and as a basis for decision-making regarding mitigative measures to reduce any residual adverse environmental impacts.

Region of Interest

The geographical area to which the applicant's search for sites is limited is identified as the region of interest (ROI). Typically, the staff has accepted the applicant's proposed region of interest, which commonly is the applicant's service area.[29]

4. Candidate Sites

The staff makes a determination whether the candidate sites identified by the applicant are "among the best which reasonably could have been found."[30] There are no specific criteria to

[27]Seabrook (CLI-77-8, 5 NRC at 527).

[28]CLI-77-8 and NECNP v. NRC (August 22, 1978) at 13 of slip opinion.

[29]The lead applicant's service area has been found reasonable in cases where no special circumstances exist (Bailly, ALAB-224). While narrower boundaries have been adequate (e.g., TVA), broader approaches have also been necessary (e.g., Seabrook - CLI-77-8, June 30, 1978).

[30]Refer to Environmental Standard Review Plan Section 9.2.

assist the staff in applying the "among the best" standard. Accordingly, the staff's review focus is primarily on the applicant's procedure for selection of candidate sites. There is no clearly "best" procedure for identifying candidate sites. Because of this, there is no easily demonstrated proof that a method used by an applicant would indeed yield sites that are among the best.

5. Comparison of Proposed Site with Alternative Sites

After the determination that the alternative sites are "among the best that reasonably could have been found," the staff compares the alternative sites with the proposed site to determine whether one of the alternatives is "obviously superior" to the proposed site. The staff will recommend rejection of the proposed site, if this comparison results in a determination that an "obviously superior" site exists. A two-phase test to determine obvious superiority among the candidate sites has recently evolved. The first phase considers water supply, water quality, aquatic biological resources, terrestrial resources, water and land use, socioeconomics, and population to determine whether there is an "environmentally preferred" site. The second phase overlays consideration of project economies, technology, and institutional factors to determine whether, if such an environmentally preferred site exists, such a site is, in fact, an "obviously superior" site.[31]

The following factors are considered in this second phase of the test:

a. Construction and operating costs of project

b. Technological considerations

c. Forward costs including costs of delay

[31] In applying both parts of the test, the NRC will give consideration to the inherent uncertainties affecting confidence due to imprecisions in measuring and balancing environmental impacts and, where applicable, to the uncertainties affecting confidence due to the disparate information base that might exist at the applicant's proposed site compared to the information available at the alternate sites, considering the fact that detailed baseline studies and analyses of possible impacts usually have been performed at the proposed site. Such detailed analysis could have identified more of the environmental impacts at the proposed site than could have been found by the reconnaissance level review at an alternative site, thus making the proposed site appear to be inferior to the alternative site.

d. Other considerations, such as possible institutional barriers.

The applicant's proposed site will be rejected if it is found that, considering both phases of the test, there is an environmentally preferable alternative site that is obviously superior to the proposed site.

2.2.2 Review of the Proposed Site

Policy

There are a number of Federal laws that are influential on siting decisions that the NRC must consider, and these laws, in many instances, could preclude the siting of a nuclear power plant. Such laws include: Endangered Species Act; Coastal Zone Management Act; Wild and Scenic Rivers Act; Wilderness Act; Fish and Wildlife Coordination Act; and National Historic Preservation Act. There are also laws at the State level that affect siting decisions, as well as Executive Orders that provide direction on the use of floodplains, wetlands, and prime farm land. Staff policy is to consult and cooperate with agencies at the Federal and State levels that are responsible for administering these laws.

Practice

This portion of the environmental review, which is based on detailed site-specific information, serves primarily to (a) verify the assessments of impacts that were made using reconnaissance level information in the review of alternative sites, (b) assess impacts that could not be assessed using reconnaissance level information, and (c) review measures proposed by the applicant to reduce the unavoidable impacts resulting from the project. The determination of the unavoidable impacts and the benefits of various mitigation measures normally are based on the results of detailed studies performed at the proposed site. Staff practice in deciding whether mitigative measures should be imposed, and the choice of measures, is based upon an analysis of economic and technical considerations. In making these analyses, the staff often consults with the Federal or State agencies having administrative responsibilities regarding these areas.

2.3 Procedural Considerations

2.3.1 Separation of Site Approval from Design Approval

Policy

1. In an Early Site Review, one or more siting issues of a proposed site can be reviewed and decisions reached with an absence of detailed plant design information [10 CFR Part 2.101(A-1)(1)].

2. Under the Standardization Policy, a proposed plant design or a major part thereof can be reviewed and approved in the absence of specific site information (10 CFR Part 50, Appendices M, N and O).

3. A site may be reviewed and approved and a Limited Work Authorization issued prior to completion of all aspects of the safety review of the plant design [10 CFR Part 50.10(e)].

Practice

1. Experience in Early Site Reviews is limited since most reviews to date have been the result of a deferred CP review. The only "true" Early Site Review has been Perryman and, most recently, Carroll County.

2. The staff has issued a number of LWAs since the LWA rule change in 1974.

2.3.2 Roles of Other Federal Agencies in Siting

Policy

The NRC policy is to cooperate with other Federal agencies that have statutory responsibility related to siting nuclear power plants.

Practice

1. Environmental Protection Agency has regulatory authority for water quality. Under Memorandum of Understanding,[32] it assists NRC (lead agency) in evaluation of impacts on water quality and biota, and participates in joint hearings where feasible. EPA also comments on Environmental Impact Statements (EISs).

2. Corps of Engineers (U.S. Army), under Memorandum of Understanding,[33] assists NRC (lead agency) in evaluation of impacts on navigable waterways and other areas of Corps jurisdiction, advises NRC in safety reviews regarding foundation engineering and coastal engineering, and comments on EISs.

[32]Second Memorandum of Understanding Regarding Implementation of Certain NRC and EPA Responsibilities, December 17, 1975.

[33]Memorandum of Understanding Between the Corps of Engineers, United States Army, and the United States Nuclear Regulatory Commission for Regulation of Nuclear Power Plants, July 2, 1975, and Interagency Agreement No. NRC-03-77-006, October 29, 1976.

3. National Oceanic and Atmospheric Administration, under Memorandum of Understanding,[34] advises NRC on atmospheric dispersion for radiological effluents.

4. Department of Energy comments on EISs and assists in evaluations of transmission costs and electric power system reliability and stability.

5. Department of Interior comments on EISs, assists in evaluations of impacts related to endangered species, wilderness areas, wildlife refuges, water supplies, public lands, wild and scenic rivers, Indian lands and water rights, outdoor recreation, and historical and archeological values.

6. U.S. Geological Survey assists on geologic and seismic evaluations of nuclear power plant sites.

7. Department of Commerce comments on EISs and assists in reviews related to marine sanctuaries, endangered species, and coastal zones.

8. Department of Agriculture comments on EISs and assists in reviews of impacts on national forest, wilderness and primitive areas and on wild and scenic rivers.

9. Department of Housing and Urban Development comments on EISs and contributes to land use planning by state and local agencies which may affect selection of site by an applicant.

10. Advisory Council on Historic Preservation comments on EISs, judges adequacy of NRC findings on impacts on cultural resources and mitigation measures, and assists in NRC assessments in these areas.

11. Department of Transportation comments on EISs. The Coast Guard, under a Memorandum of Understanding, assists in reviews of floating nuclear power plants. The Coast Guard also assists in evaluations of LNG transportation and terminals in the vicinity of a proposed site. The Federal Aviation Agency assists in reviews where air traffic considerations are involved.

12. River Basin Commissions and Great Lakes Basin Commission comment on EISs and assist in NRC reviews of relevant considerations of water quality and water consumption.

13. Council on Environmental Quality assists in coordination with other Federal agencies on NEPA matters.

[34] Interagency Agreement NRC-03-79-132 Between NRC and NOAA regarding Meteorological Consulting Services, February 5, 1979.

14. Department of Defense assists in reviews where specific interactions with military installations or activities may be involved.

2.3.3 Roles of States

Policy

It is NRC policy to encourage cooperation with States and to provide for State and local government participation in the nuclear power plant siting. It should be noted that present siting policy does not provide guidance in the event a state opposes a site on grounds other than those reserved for the Federal government under legislation such as The Atomic Energy Act of 1954, as amended.

Practice

1. Staff notifies State officials or impending licensing actions.

2. The NRC Office of State Programs acts as liaison with States.

3. There is involvement of State and local governments in the NRC staff's early site suitability reviews.

4. There are Memoranda of Understanding for the review of water quality and aquatic impact matters between the NRC and certain States having authority delegated by EPA to issue National Pollutant Discharge Elimination System permits.[35]

5. There are Memoranda of Understanding with the State of New York whereby the State will undertake the review of environmental matters for the NRC in areas other than water quality and aquatic impacts.

6. There is protocol for the conduct of joint hearings with States on specific projects.[36]

7. There is consultation with State and local agencies having special expertise to obtain specific site-related information and assessments.

8. There is solicitation of State comments in environmental reviews under the National Environmental Policy Act.

[35]Memoranda of Understanding have been established with Virginia, New York, South Carolina, Washington, and Indiana.

[36]Joint hearing protocols have been developed for specific cases in Maryland, New York, and Massachusetts.

2.3.4 Roles of Public in Siting

Policy

The NRC policy is to keep the public informed of its considerations of siting issues and to obtain and use all relevant input.

Practice

1. The NRC issues public notices and drafts of regulations, environmental impact statements, regulatory guides, and other documents for public comment.

2. A public document room is maintained at NRC headquarters and local public document rooms are established near the sites of power reactors to make case-related documents available to interested persons.

3. Persons who have an interest in a proceeding before the Commission are invited to participate in the public hearing.

4. The public hearings on power reactors are usually held in the vicinity of the proposed sites to facilitate attendance and participation by interested members of the local public.

5. NRC staff meets with local officials during the environmental reviews for proposed power reactors.

6. NRC staff meets with interventors to discuss both safety and environmental matters.

7. Informal public meetings near power reactor sites are also often held to inform local citizens and organizations about the project and the NRC review and to receive their comments and answer questions.

8. ACRS meetings and ACRS subcommittee meetings are open to the public and are often held in the vicinity of the site.

9. Conferences and workshops with public participation are held on rulemaking and other generic issues relating to power plant siting to elicit broad input from the public, industry, and other governmental agencies.

10. Meetings with applicants concerning siting are open to the public, often with opportunity for members of the public who are invited to observe to comment briefly on the matters under consideration.

3. SITING POLICY CHANGES

3.1 Introduction

As a consequence of reviewing the Commission reactor siting policy and practice leading to preparation of Section 2 of this report, the Task Force has identified a number of areas in which changes or clarification to current siting policy and practice are recommended. Supporting each recommendation is a brief discussion of the basis for the recommendation, the merits of the recommended course of action, and other main courses of action considered by the Task Force. For those cases in which there was not complete agreement with a specific recommendation, the other opinions are identified and discussed. More general disagreements with the recommendations as well as Office comments are included in Section 4.

No recommendations were made in one significant area considered by the Task Force, because action is presently being taken that is supported by the Task Force. Certain issues related to alternative sites have been a major source of controversy in a number of cases involving construction permits (and LWAs) for nuclear generating facilites.[37] To resolve this problem, on December 13, 1978, the Commission directed the staff to prepare a proposed rule to define the regulatory requirements for alternative site review procedures.

Most of the Task Force deliberations leading to this report were completed prior to the accident at the Three Mile Island Plant, but the report was completed after the accident. In preparing the report, the Task Force attempted to assure that the various recommendations made in this section are consistent with any new concepts developed as a result of the accident.

A prevailing opinion throughout the deliberations of the Task Force was that the framers of Part 100 had prepared a document that withstood the test of time and had substantially accomplished the intended objectives relative to plant design and siting requirements. The objectives at that time were to encourage the industry to locate plants at favorable sites and to encourage improvements in plant design that would mitigate the consequences of credible accidents. As improvements in plant design evolved, the site exclusion areas and low population distances, which were based on meeting the guideline doses stated in Part 100, were allowed to decrease. In some cases, although meeting the letter of the regulations, the distances are probably smaller than envisioned by the framers of Part 100. In addition, even though Part 100 contains only a general requirement that relates population in the vicinity of the site to emergency preparedness, some plants have been located in relatively densely populated areas.

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[37] See also "Nuclear Power Plant Licensing: Opportunities for Improvement," NUREG-0292, June 1977; "Preliminary Statement on General Policy for Rulemaking to Improve Nuclear Power Plant Licensing," NUREG-0499, December 1978, and "General Considerations and Issues of Significance on the Evaluation of Alternative Sites for Nuclear Generating Stations Under NEPA," NUREG-0499, Supplement 1, December 1978.

A number of Standard Review Plans and Regulatory Guides implement Part 100. These plans and guides were based on siting experience at the time the plans and guides were prepared. The problem with this staff practice as seen by the Task Force is that it has allowed some erosion of the original intent of Part 100 regarding the use of both population distribution and distance as elements of defense in depth to provide an unquantified additional protection against the consequences of accidents beyond those for which the plant is designed.

The Task Force believes that these basic objectives can be met by modifying Part 100 to limit the flexibility currently allowed in siting and thus reaffirm the use of population density and distance as elements of siting as originally envisioned. With our current knowledge of, and experience with, light water reactors (LWRs) of contemporary design, this can be accomplished by isolating the plant design decisions regarding accident mitigation from siting decisions, by requiring fixed limits on population density and distances, and by implicitly including in Part 100 consideration of the risk associated with accidents beyond those for which the plant is designed.

As a result of the various changes proposed for Part 100, certain design provisions presently contained in Part 100 will be eliminated. The Task Force believes that these provisions should, upon appropriate review and possible modification, be transferred to Part 50. It should be pointed out that current practice calls for evaluation of the effectiveness of accident-limiting engineered safety features (such as containment sprays, filters, and double containments) for conformance with the dose guideline values presently contained in Part 100. With the proposed removal of those dose guidelines from Part 100, means for assessing the efficacy of engineered safety features will have to provided in Part 50.

At the present, however, Part 100 clearly envisions the consideration of plant design characteristics im making siting decisions. For example, paragraph 100.10 lists the following as factors to be considered when evaluating a site:

1. Intended use of the reactor including the maximum power level and the nature and inventory of radioactive materials;

2. The extent to which generally accepted engineering standards are applied to the design of the reactor;

3. The extent to which the reactor has unique and unusual features; and

4. The safety features that are to be engineered into the facility and those barriers that must be breached as a result of an accident before a release of radioactive material to the environment can occur.

Paragraph 100.10 also lists meteorological, geological, and hydrological factors to be considered but states that, "Where unfavorable physical

characteristics of the site exist, the proposed site may nevertheless be found acceptable if the design of the facility includes appropriate and adequate compensating engineered safeguards."

Furthermore, paragraph 100.11 requires calculations of radiation doses for establishing the exclusion area, low population zone, and population center distance. Inherent in these calculations are assumptions regarding plant design features such as containment and other engineered safety features characteristics. The approach of establishing the exclusion area, low population zone, and population center distance based on calculations that take into account the efficacy of engineered safety features is no longer needed as a basis for establishing site acceptability. This is because of the experience gained by the staff in evaluating a large number of LWR plant and site combinations, the LWR standardization, and the knowledge of the ranges of site characteristics in different parts of the country that are important in plant design. Collectively, this experience would allow the staff to consider sites in the absence of specific plant design information. The staff has found that it is able to envelope the impact of LWRs of current design on the site environs (e.g., releases of radioactivity from both normal operation and under accident conditions) and the ability of plant designs to accommodate site characteristics (e.g., seismicity, floods, and winds).

This knowledge of site and LWR plant characteristics has already permitted the staff to evaluate plant designs in the absence of specific site information under the standardization regulations and to evaluate sites in the absence of specific plant design information under the Early Site Review regulations. Based on this experience, the Task Force concludes that the experience of the staff can be used in developing criteria for siting LWRs of current design and size that are independent of specific plant design. Siting criteria that are independent of reactor design will enhance siting as an independent element of defense in depth along with (a) design and quality assurance to prevent accidents, (b) design features to mitigate the consequence of accidents, and (c) emergency planning. A number of the recommendations made in the following section implement this objective.

Part 100 intended siting to provide protection against accidents beyond that for which the plant is designed (now called Class 9 accidents). This protection was to have been provided primarily by the population center distance. At the time Part 100 was written, the only engineered safety feature considered was containment. With the introduction of emergency core cooling systems and of engineered safety features designed to reduce doses (e.g., containment spray and filters), it became possible to reduce the low population distance and the population center distance to the point that the accident protection originally intended was no longer provided.

The accident risk information contained in WASH-1400 established that the risk to the public from a range of accidents including accidents beyond that for which the plant is designed is sufficiently high to be a consideration in siting. Based on this premise, the Task Force believes that proper siting should provide protection against the consequences of such

accidents to limit the residual risk[38] of reactor operation. The Task Force believes that this can best be accomplished by placing more emphasis on the site isolation intended in Part 100 as an important element of defense in depth. The Task Force recognizes that protection from the consequences of these accidents is not only related to site isolation but also to emergency planning.

Two possible approaches considered by the Task Force for implementing the role of Class 9 accident protection in siting were (a) to modify the regulations to require site-specific calculations of the consequences of Class 9 accidents, and (b) to modify the regulations to include specific requirements relating to site isolation and population density and distribution that are based on a generic consideration of the consequences of Class 9 accidents. For either approach, the calculational models available are similar and include large uncertainties. The Task Force believes that there is sufficient similarity of site characteristics that influence the consequences of Class 9 accidents to allow a generic analysis of Class 9 risks. This analysis can assist to establish bases for generic numerical limits on population density and distribution as a function of distance from the proposed plant site. This procedure has the advantage of avoiding stating site-specific results from a calculational model of consequences that contains large uncertainties. Although the uncertainties in the calculation models are also of concern in generically evaluating the effectiveness of criteria, the Task Force believes that risk calculations can be useful in developing population density and distribution criteria. The Task Force recognizes, however, that risk assessment calculations alone are not likely to provide a complete basis for the criteria. Other considerations, such as availability of viable sites and cost, may influence the recommended criteria.

The Task Force concluded that siting requirments based on generic considerations of Class 9 accidents would be the most effective and easily understood means of achieving the desired objective. The Task Force, therefore, has included in its recommendations that generic isolation and population criteria be developed.

The present policy and practice of accepting sites with unfavorable characteristics, provided they can be compensated for by plant design features, could arguably lead to greater (though still acceptable) residual risk than a site without such unfavorable characteristics. Inherent in the question of residual risk are the issues of how safe is safe enough, and how should the NRC establish criteria for measuring site acceptability. One basic conclusion of the Task Force is that, although in the past the Commission has licensed (i.e., found acceptably safe) sites with certain unfavorable site-specific factors, in the future it would be prudent to reestablish distance as an important factor of defense in depth.

[38] Residual risk is a term recognizing that absolute safety will never be achieved. It is the likelihood of occurrence of an accident whose consequences exceed the design basis accident, multipled by the consequences of that accident, realizing that there is and always will be a very small likelihood of having accidents with offsite consequences greater than those for which the plant was designed.

The question to be answered, then, is should siting criteria exist that would tend to reduce residual risk. This is basically a public policy question, and the Task Force believes that it would be prudent where practicable for the regulations to require the selection of sites with a minimum of unfavorable characteristics. Reducing residual risks through conservatism in siting criteria should result in increased confidence that the plant and site combination results in reasonable assurance of no undue risk to public health and safety. The problem of what constitutes adequate confidence is difficult, because the magnitude of the residual risk of a particular plant and site combination is uncertain, and, although small the risk certainly cannot be reduced to zero.

To gain perspective with regard to this question, the Task Force generally considered the consequences of reducing residual risk by establishing siting criteria so restrictive as to tend to restrict the supply of nuclear-generated electric power to large segments of the population. Such a policy would include, among others, a criterion of siting in areas very remote from population centers. In considering this extreme, the Task Force believes that if electric generating capacity is needed, it will be provided, either from nuclear fuel or from some other fuel source. Since at present the principal alternative fuel is coal, it is likely that a coal-fired plant would be provided if capacity were needed and the nuclear option were precluded.

Even considering the wide range of uncertainties involved in the analyses, comparisons of the health effects from the generation of electricity from coal and nuclear fuel indicate that the overall risks from coal-generated electricity might be greater than nuclear. Therefore, nuclear power plant siting criteria that would tend to limit the use of nuclear power by large segments of the population likely would not result in any decrease to the overall risk associated with electric power generation. Also, such a policy would be unnecessarily inequitable since most of the social, ecological, and health and safety costs of nuclear-generated electric power would be borne by the small portion of our society residing in remote areas, whereas the benefits of any nuclear power plants so sited would be received by the large portion of society in less remote areas that use the electricity. Therefore, the Task Force could see no technical or public policy merit in establishing siting criteria for nuclear power plants so stringent that large regions of the country would be eliminated for the siting of such plants.

To look at both excremes of possible siting policy options, the Task Force also considered the effect of allowing residual risks to rise by eliminating the Commission's long-standing policy against metropolitan siting. Although it could be argued that a siting policy permitting metropolitan siting would impose societal risks no greater than those from alternative electric power sources such as coal, the Task Force finds such arguments unconvincing. This is because of the uncertainties in such analyses, because allowing metropolitan siting would not significantly reduce the costs of generating electricity, and because it would not significantly increase the number of suitable reactor sites. Therefore, there does not appear to be any great benefit from such a change in policy. Consequently, the Task Force believes

that the current policy against metropolitan siting should be incorporated into the regulations.

The Task Force recognizes that changes in the regulatory system may be forthcoming as a result of activities associated with the investigation of the Three Mile Island Unit 2 (TMI-2) incident. The Task Force believes, however, that such changes will result in reduction of risk.

In summary, the Task Force concludes that siting criteria should be developed that reemphasize the contribution of favorable site characteristics to the overall achievement of a low level of residual risk resulting from the operation of light water reactors. However, the Task Force believes that siting criteria need not and should not be so stringent as to eliminate large regions of the nation from potential reactor siting. Such siting criteria should be numerical where possible and might be regionally based. In some cases, the numerical values may well be more conservative than the values that exist at some previously licensed facilities. This does not imply that the previous decisions were improperly made. It does mean that, in the future, when there are sites within a given region of the country that meet criteria placing more emphasis on favorable site characteristics (which provide additional protection to the public health and safety), sites within a region proposed by an applicant that do not meet those criteria would be rejected by the NRC as a matter of prudence, even though such proposed sites might well have been licensable based upon past licensing experience.

3.2 Recommendations

3.2.1 Recommendation 1

Revise Part 100 to change the way protection is provided for accidents by incorporating a fixed exclusion and protection action distance and population density and distribution criteria.

1. *Specify a fixed minimum exclusion distance based on limiting the individual risk from design basis accidents. Furthermore, the regulations should clarify the required control by the utility over activities taking place in land and water portions of the exclusion area.*

2. *Specify a fixed minimum emergency planning distance of 10 miles. The physical characteristics of the emergency planning zone should provide reasonable assurance that evacuation of persons, including transients, would be feasible if needed to mitigate the consequences of accidents.*

3. *Incorporate specific population density and distribution limits outside the exclusion area that are dependent on the average population of the region.*

4. *Remove the requirement to calculate radiation doses as a means of establishing minimum exlusion distances and low population zones.*

Discussion

Radiation Doses

Part 100 requires calculations of radiation doses for establishing the exclusion area, low population zone, and population center distance. Inherent in these calculations are assumptions regarding plant design features such as containment and other engineered safety features. It is the judgment of the Task Force that the approach of establishing the exclusion area, low population zone, and population center distance based on calculations that take into account the efficacy of engineered safety features does not provide enough emphasis on site isolation as an important contributor to defense in depth because engineered safety features such as iodine filters, containment sprays, and double containment structures can be designed to make almost any site acceptable from an accident dose calculation point of view.

Exclusion Area

The Task Force concludes that an exclusion area should continue to be an important requirement for nuclear reactor sites. The essential attributes of an exclusion area are:

1. Preventing activities in the immediate proximity of the plant that would pose potential hazards to its safe operation.

2. Controlling the access to and use of the area immediately surrounding the plant so that members of the public so admitted are not subject to undue risk, and

3. Assuring that land use factors not under the control of the licensee are maintained at a reasonable protective distance from the plant.

The Task Force concludes that the problems associated with establishing the exclusion area by dose calculations can be avoided, and the essential requirements of an exclusion area can be met by establishing a fixed minimum exclusion distance that would be applicable to all siting situations. Essentially, the differences in physical characteristics from site to site that would affect the size of the exclusion area are sufficiently small so that a single envelope would be adequate to handle all conceivable situations, assuming fixed design and performance criteria for engineered safety features.

Even though the Task Force did not establish a recommended single distance, a value of 0.5 mile would provide reasonable assurance, based on past staff review experience, that radiation doses beyond this distance would not result in consequences greater than the present guideline values given in Part 100.11, assuming that the engineered safety features function as designed. An exclusion distance in this range would provide reasonable assurance that no emergency action would be necessary beyond this distance for lifesaving purposes in the event of any design basis accident. Such a distance would also prevent many activities in immediate proximity to the plant that might pose hazards to its safe operation.

The Task Force considered the exclusion area predominantly as providing protection against design basis accidents and isolation from offsite hazards. However, in determining the minimum exclusion distance to be specified in the regulations, consideration should be given to whether increasing the exclusion distance up to about 1 mile would provide significant additional protection against Class 9 accidents. The Task Force believes that the exclusion area, in order to meet its stated objectives, should extend in all directions around the plant, including over-water directions, as applicable, and that Part 100 should be clarified to indicate this. Since these large water bodies are usually in the public domain, it is usually impossible for an applicant to obtain control over these areas. The staff has insisted that an applicant show that he has made arrangements with the appropriate authorities to warn as well as take other protective measures, such as evacuation. The Task Force believes that Part 100 should be clarified by stating that control over any over-water portions of an exclusion area is not required, but that applicants should be required to show that they have made appropriate arrangements to notify and take protective measures for members of the public in these areas in the event of accident.

Emergency Planning Zone

The Task Force concluded that, because the purpose of the low population zone and the emergency planning zone proposed by the NRC/EPA Task Force on emergency planning are the same, there would be less confusion if NRC adopts the term emergency planning zone (EPZ) to replace low population zone. The minimum distance to the outer boundary of the EPZ should be stated in Part 100 and be 10 miles as recommended by the NRC/EPA Task Force on emergency planning. The Task Force recommends that Part 100 require that the physical characteristics of the EPZ, including the population distribution in relation to transportation routes and other topographic features, be such to provide reasonable assurance that a relatively prompt evacuation of the EPZ, including transients, would be feasible in the event of an accident.

One Task Force member believes that a fixed value of 10 miles should not be placed in the regulations, since evacuation plans need to be flexible and pragmatic based on local topography, demography, transportation networks, meteorology, and jurisdictional boundaries. Language that states about 10 miles and that recognizes the influence of the above parameters would likely be more appropriate and operative than a circle of fixed radius.

Population Density and Distribution

The population center distance as presently established does not provide the protection originally intended against large accidents (Class 9). This has occurred because the credit given for engineering design has permitted a reduction in the population center distance and has tended to reduce the importance of siting as a factor in defense in depth. The Task Force concludes that the protection from Class 9 accidents originally intended to be provided by the population center distance should be restored; however, the Task Force recommends a different approach to accomplish this objective. The approach recommended by the Task Force is to replace the population center distance concept with limits on population density and distribution.

The Task Force considered the manner in which the risk to individuals as well as society from all classes of accidents should be handled from a siting viewpoint. The Task Force then considered the most effective means of avoiding undue risk to the public from these accidents.

The Task Force views the risk to an individual from Class 3 through 8 accidents as being effectively handled by the exclusion zone, by limiting the probability of accidents, by function of the dose limiting engineered safety features, and by protection action. The rationale for recommending population density and distribution limits both within and beyond the EPZ is to provide some additional assurance that the societal risk from Class 9 accidents for populations within about 20 miles of a nuclear plant is kept at reasonable levels. For this reason, the Task Force concludes that there should be limits on population characteristics in the vicinity of a nuclear plant.

The options considered by the Task Force to establish population criteria were (a) a single nation-wide limit, and (b) a limit based on the population in the region of the proposed site (a different limit in different parts of the country). A single population limit is more consistent with past regulatory practice than a limit that can vary from region to region. The Task Force concluded it would be difficult to set a limit that would result in the selection of sites that are among the best that could be found in the region where power generation is needed while not eliminating large areas of the country from consideration. For example, a fixed limit that would not preclude siting in northeast states would not provide incentive to select better sites in less densely populated western states.

In accepting the concept of different population limits for different parts of the country, one must accept that the societal risk of a reactor sited in the densely populated northeastern part of the country will be greater than that of a reactor sited in a less densely populated western or southern state. The societal risk is small in both instances, and the risks of other potentially hazardous activities and from natural phenomena are greater in more densely populated areas. People apparently either consider the benefits of living in densely populated areas (opportunity for employment, economic benefits, social and cultural amenities, and improved services) worth the increased risks or are unaware of the increased risks.

The Task Force concludes that Part 100 should be modified to eliminate the determination of the population center distance and the requirement that it be at least one and one-third times the LPZ outer boundary. This should be replaced by a combination of population density limits and limits on populations clustered in sectors. These limits should be established for annular rings extending out from the exclusion zone to a distance (perhaps 20 miles) beyond which there would be no population limitations. The population criteria should be more limiting closer to the site than for the more distant rings.

The Task Force has not completed a definitive study on the population densities or distribution, and distances given in the following paragraph are to illustrate the concept. If the Commission accepts this recommendation, the Task Force anticipates that a study would be made to establish whether a technical basis for the numbers chosen could be developed, or, alternatively, to establish the numbers on some other basis.

1. From the exclusion zone to 5 miles, the population density at the beginning of reactor operation in this annulus should not exceed one half of the average population density of the region where the reactor is to be located or 100 persons per square mile, whichever is greater. The population within this annulus should not be expected to increase to more than double the original population during the life of the plant, and no more than one half of the allowed number of persons in the zone should be permitted within any single 22-1/2° sector. Transients should be weighed according to their fractional occupancy within this annulus.

2. From 5 to 10 miles, the population density at the beginning of reactor operation in this annulus should not exceed three-quarters the average population density of the region where the reactor is to be located, or 150 persons per square mile, whichever is greater. No more than one-half of the allowed number of persons in this annular ring should be permitted in any single 22-1/2° sector.

3. From 10 to 20 miles, the population density at the beginning of reactor operation in this annulus should not exceed twice the average population density of the region where the reactor is to be located, or 400 persons per square mile, whichever is greater, but that no more than one-half of the allowed number of persons in this annular ring be permitted in any single 22-1/2° sector.

It is the judgment of the Task Force that beyond about 20 miles the societal risk is sufficiently low to warrant no specific limits on population.

3.2.2 *Recommendation 2*

Revise Part 100 to require consideration of the potential hazards posed by man-made activities and natural characteristics of sites by establishing minimum standoff distances for:

1. *Major or commerical airports,*
2. *LNG terminals,*
3. *Large propane pipelines,*
4. *Large natural gas pipelines,*
5. *Large quantities of explosive or toxic materials,*
6. *Major dams, and*
7. *Capable faults.*

Discussion

Certain human activities, natural phenomena, and characteristics of a site can present hazards to a nuclear power plant that could cause an accident. Currently, 10 CFR 100 provides no specific guidance on how to treat such external hazards in siting or plant design.

Staff practice has relied on a combination of (a) calculated probabilities of triggering events, which include site characteristics such as distance or topography; and (b) the ability of plant design to accommodate the hazard. There is no uniform staff practice regarding the relative importance to be given to these two evaluational components by which the overall adequacy of the combination is measured.

Over a period of time, there has been an increased reliance on design features with a corresponding decreased reliance on the inherent safety of the distance factor. Consequently, much staff time has been devoted to prolonged negotiations with the applicants as they demonstrate the adequacy of engineering to accommodate the hazard.

The Task Force believes that there is merit to maintaining the safety factor inherent in physical distance and that the distance factor should not be traded off for design features of the plant.

For those hazards for which practicable standoff distances can be set, the Task Force recommends that specific distances be established. Although the Task Force has not conducted a comprehensive study, the objective would be that an accident at a facility hosting a hazardous activity would not endanger the nuclear plant. In the opinion of the Task Force, such distance could be approximately the following:

1. Major or commercial airports, LNG terminals, and storage areas of large quantities of explosive or toxic material should be no closer than 5 miles.

2. Large propane pipelines should be no closer than 1.5 miles.

3. Large natural gas pipelines should be no closer than 0.5 miles.

4. No floodplain sites should be closer than 5 miles downstream of a major dam.

5. Capable faults should be no closer than 12.5 miles.[39]

[39]SECY-79-300, "Identification of Issues Pertaining to Seismic and Geologic Siting Regulations, Policy and Practice for Nuclear Power Plants," April 27, 1979.

3.2.3 *Recommendation 3*

Revise Part 100 by requiring a reasonable assurance that interdictive measures are possible to limit groundwater contamination resulting from Class 9 accidents within the immediate vicinity of the site.

Discussion

The staff studied the risk from the liquid pathway in the Liquid Pathway Generic Study (LPGS)[40] and in Floating Nuclear Power Plants Final Environmental Statement," Part III.[41] These two studies show that for land-based plants significant quantities of radioactivity could be introduced into the groundwater beneath the reactor following a core-melt accident with a simultaneous melting through the bottom of the containment. For typical site characteristics, slow groundwater movement and ion exchange of the radioactivity with the soil are expected to result in very slow transport of groundwater contamination. Sufficient time is expected to exist to assure that interdictive measures could be taken to isolate the contaminated groundwater in the immediate vicinity of the plant. Where these "typical" hydrologic characteristics do not exist, rapid groundwater transport of radioactivity could lead to uncontrolled contamination of groundwater and surface-water bodies.

The Task Force believes the current regulation regarding liquid pathway in 10 CFR 100.10 to be basically adequate as a siting tool. It should be supplemented, however, to reflect conclusions of the LPGS by requiring a reasonable assurance that interdictive measures can be taken to effectively isolate radioactive releases into the groundwater from any accident within the immediate vicinity of the site. Based on the licensing experience, the Task Force further believes that although, as a matter of prudence, sites should be avoided where offsite groundwater transport of radioactive materials would be so rapid as to preclude implementing reasonable interdiction measures to substantially reduce radiological impacts from the liquid pathway, such avoidance would not preclude reasonable siting options in any region of the country.

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[40] NUREG-0440, "Liquid Pathway Generic Study, Impacts of Accidental Radioactive Releases to the Hydrosphere from Floating and Land-Based Nuclear Power Plants," February 1978.

[41] NUREG-0502, "Final Environmental Statement, Floating Nuclear Power Plants by Offshore Power Systems," Part III, December 1978.

3.2.4 *Recommendation 4*

Revise Appendix A to 10 CFR 100 to better reflect the evolving technology in assessing seismic hazards.

Discussion

The issue reflected by this recommendation is one that has already been brought to the attention of the Commission as a result of earlier reviews of siting issues by the staff. Specifically, SECY 77-288A, "Geologic and Seismic Siting Policy and Practice for Nuclear Power Plants," and SECY 79-300, "Identification of Issues Pertaining to Seismic and Geologic Siting Regulations, Policy and Practice for Nuclear Power Plants," were prepared to inform the Commission of current power plant siting policy and practice as related to geology and seismology. SECY 77-288A states:

> The development of the staff views and positions, as well as the development of Appendix A to 10 CFR Part 100 has been an evolutionary process. Although this process has worked reasonably well for a majority of plants, a number of problems exist which have caused some licensing difficulties. We believe that there has been a consistent improvement in our siting procedures for nuclear power plants with respect to the disciplines of seismology and geology. However, problems have arisen which indicate that Appendix A could be modified to better reflect the current state-of-the-art and to clarify the intent and requirements of the regulation for the staff, applicants, and geological and seismological community.

The Task Force established that Appendix A contains concepts based on the state-of-the-art existing at the time the appendix was prepared that are not clearly defined and lack a clear statement of the intent of the regulation.

The Task Force recommends that Appendix A to 10 CFR 100 be revised to better reflect evolving technology in assessing seismic hazards and to be more specific with respect to the definition of the terms and concepts it contains. In addition, the Task Force recommends that specific guidance material be removed from Appendix A and be placed in Regulatory Guides.

3.2.5 Recommendations 5

Revise Part 100 to include consideration of post-licensing changes in offsite activities:

1. *The NRC staff shall inform local authorities (planning commission, county commissions, etc.) that control activities within the emergency planning zone (EPZ) of the basis for determining the acceptability of a site.*

2. *The NRC staff shall notify those federal agencies as in Item 1 above that may reasonably initiate a future federal action that may influence the nuclear power plant.*

3. *The NRC staff shall require applicants to monitor and report potentially adverse offsite developments.*

4. *If, in spite of the actions described in Items 1 through 3, there are offsite developments that have the potential for significantly increasing the risk to the public, the NRC staff will consider restrictions on a case-by-case basis.*

Discussion

In considering this issue, the Task Force recognized that a new hazardous activity or a significant change in population density in the vicinity of the plant could result in an increased risk to the public. However, specific occurrence of this nature has not yet occurred to the degree that changes in plant design or operation have been required. Nevertheless, there have been two instances that bear on this issue and that have influenced the Task Force toward making this recommendation:

1. Plans for a housing development in the immediate proximity of the proposed Newbold Island site influenced the staff toward recommending that the utility move the plant to a new site (Hope Creek). Although, fortuitously, these development plans were discovered during the CP review stage, the Task Force questioned what would have been the staff's options had the plans been discovered later.

2. The Cove Point LNG facility is in close proximity to the Calvert Cliffs plants. Fortuitously, again, administrative actions are possible such that the public risk is not significantly changed due to this new offsite activity.

Although in both of these instances the issue was readily resolved, it is the Task Force judgment that offsite activities in the vicinity of other nuclear plants will likely change so as to increase the public risk. In this case, some form of control or early notification would be useful.

The Task Force considered possible courses of action ranging from requesting legislation that would give NRC control over land use in the vicinity of nuclear plants, to considering land use changes on a case-by-case basis, in accordance with current practice.

The recommendation addresses some of the problems associated with changes in offsite activities, yet avoids potentially controversial legislation. Even though legislation would be time consuming and impinge upon such controversial issues as state and local jurisdiction, a member of the Task Force strongly recommends that the Commission pursue the legislative course for standoff distances but not for increases in population density. Increases in population represents marginal increases in risk, whereas violation of standoff distance could represent step function changes in risk. The member believes that such legislation would likely engender political support. Short of legislation, the Task Force recognizes that there is no absolute way to control land use. However, the action proposed in the recommendation is compromise directed toward assuring that those responsible for land use planning are informed of all implications of their decisions.

Items 1 and 2 of the recommendation are intended to notify those local and Federal authorities who make land-use decisions of those decisions that could influence risk to the public and the eventual operation of the nuclear plant. It suggests that decisions should be made in a balanced manner considering land use priorities and public risk, and in consultation with utility and government representatives.

Item 3 of the recommendation places the responsibility for knowledge of potential land use changes on the utility. It suggests that the utility should be in contact with land-use planners to assure that the planners can make decisions with full knowledge of the risk to the health and safety of the public and the possible operational problems with the plant.

Item 4 is consistent with present staff practice and should result in no change to the staff's current method of operation.

3.2.6 *Recommendation 6*

Continue the current approach relative to site selection from a safety viewpoint, but select sites so that there are no unfavorable characteristics requiring unique or unusual design to compensate for site inadequacies.

Discussion

Part 100.10 states that sites with unfavorable characteristics may be "found to be acceptable if the facility includes appropriate and adequate compensating engineering safeguards to accommodate the unfavorable characteristics." The Task Force believes that this statement in the regulations does not provide to the utilities an appropriate incentive to propose sites that have a minimum of unfavorable characteristics and constrains the staff to accept any site proposed by an applicant as long as the proposed plant design includes "appropriate and adequate compensating engineering safeguards..." It is the opinion of the Task Force that an unquantified but overall improvement in reactor safety can be achieved by selecting sites with minimum unfavorable safety-related characteristics, thus avoiding where possible the need to compensate by engineering design. The improvement in safety thus achieved relates primarily to avoiding the uncertainty associated with usually unique design features to compensate for a particular site characteristic.

The Task Force considered three possible approaches to require utilities to select sites with a minimum of unfavorable characteristics:

1. Provide in the regulations specific limits on certain site characteristics (e.g., population density and distribution and distance from hazardous activities and unfavorable natural features);

2. Require in the regulations an alternative site evaluation in the safety review similar to that in the environmental review; and

3. Provide in the regulations a requirement for the utility to avoid that unique or unusual compensating plant design features.

Recommendations 1, 2, and 3 provide limits concerning a number of site characteristics (standoff distances and population density and distribution). These recommended changes to the regulations go a long way toward requiring selection of sites without unfavorable characteristics. There is, however, a spectrum of site safety characteristics for which limiting regulations are not practicable; for example, threats to plant safety resulting from the transportation of hazardous materials, flooding from causes other than dam failure, the potential for subsidence areas of relatively high seismic activity, and unusual foundation characteristics.

In considering the possible siting improvements that could result from an evaluation of alternative sites in the safety review, we considered the level of information that might be obtainable by applicants on alternative sites. A requirement for information from core borings and trenching that cannot be obtained without detailed on-site data-gathering on a number of alternative sites would place a heavy cost burden on applicants and eventually on the rate

payers. Access to alternative sites for data-gathering purposes is frequently limited. The Task Force believes that the expense and difficulty of such data-gathering on alternative sites, even if feasible, would not be justified unless there were a significant problem with the proposed site. If there were such a problem with the proposed site, it could be evaluated without consideration of alternative sites in the safety review.

Where thresholds cannot be set, the likely reason is either uncertainty in verifying whether the threshold is exceeded, or inability to establish definitively where the threshold should be set. When this is added to the problem of uncertainty in establishing the magnitude of residual risk, the consideration of residual risk in the review of alternative sites likely would not be amenable to definitive decision-making and would not result in much improvement in safety.

Certain offsite man-made hazards, nearby transportation of hazardous materials, flooding from causes other than dam failure, and areas of high seismic activity are amenable to an alternative site review without onsite data gathering. In these areas of offsite man-made hazards and natural hazards, the Task Force would anticipate only minor improvement, if any, in siting that would result from considering alternative sites that is not available from the evaluation of only the proposed site. Furthermore, the Task Force was concerned that consideration of alternative sites in the safety review would result in a tendency in staff reviews and hearings to attempt to "fine tune" site safety characteristics with little actual improvement in safety. The Task Force, therefore, recommends that the site safety review continue to focus on the proposed site and not on alternative sites.

Two members of the Task Force have not been persuaded that the Task Force should have rejected including safety-related matters in the alternative site evaluation. It is their perception that the site-selection process as used in the environmental review has been successful in demonstrating that the optimum nuclear plant site has been selected from that viewpoint. They feel that it would be equally valuable to expand the site selection process to include safety aspects to also optimize the safety characteristics of the site. They are not persuaded that the fine-tuning argument is a serious detriment because it is a problem that could be handled successfully by careful management and guidance as it has been done in the environmental review. They are also not persuaded that detailed site-specific data is needed to make the type of decision that would help in the selection of optimum sites from a safety viewpoint. They feel that use of reconnaissance level data would go a long way toward achieving optimization even though ideally all of the information would not be available.

Another member of the Task Force believes that the reasons for not including safety matters in the alternative site analyses are understated. He believes that the limits proposed in Recommendation 2 should be extended, if possible, to include specifically all of those unique and unusual compensative features--perhaps on a regional basis. The basic arguments for taking this approach as opposed to including these matters in the comparative evaluation of alternative sites are:

1. The Task Force recommends that design considerations be removed from Part 100; therefore it would be difficult to address (in the review of a specific application) what a unique or unusual compensating plant design feature might be.

2. The uncertainties at present in trying to calculate residual risk are very large; thus, it would be almost impossible to make relative siting judgments unless all site characteristics (safety and environmental) of the candidate sites are virtually equivalent except for one of the safety characteristics.

3. The residual risk calculations would require detailed knowledge of the various designs, since clearly the designs would be different at sites having significantly different safety characteristics. Thus, not only would design be brought back in Part 100, but also the uncertainties regarding the relative magnitudes of residual risk would be even greater.

4. In view of the above, it would be very difficult to make credible technical decisions, which in turn would increase the vulnerability to successful legal challenge. More importantly, this very possible onset of decisional paralysis would not likely be accompanied by any actual increase in safety.

A concern remains, however, that the present regulations tend to encourage reliance on plant design features to compensate for unfavorable site characteristics. The Task Force concludes that Part 100 should be changed to state that it is desirable to select reactor sites that do not exhibit unfavorable physical and land use characteristics that require unique or unusual compensative design features. The Task Force believes that an admonition in the regulations on unique or unusual compensative features will encourage utilities to seek sites with favorable features. This will also make clear to the staff, public, and utilities that sites with unfavorable characteristics that are compensated by unique or unusual plant design features may be disapproved.

3.2.7 Recommendation 7

Revise Part 100 to specify that site approval be established at the earliest decision point in the review and to provide criteria that would have to be satisfied for this approach to be subsequently reopened in the licensing process.

Discussion

There is no general provision in siting regulations that clearly and comprehensively addresses the finality of site approvals. The early site review regulations provide for the finality of partial decisions on site suitability issues unless the Commission or its presiding boards "... finds that there exists significant new information that substantially affects the earlier conclusions and reopens the hearing record on site suitability issues" [10 CFR §2.606(b)(2)]. Site review and approval may be deferred until the construction permit (including limited work authorization) stage. There is no regulatory provision that is addressed to the finality of site approvals at this stage of the licensing process.

The lack of general regulatory guidance on this issue has resulted in some staff uncertainty regarding the status of siting approvals at various stages in the licensing process. This could result in unnecessary instability and unpredictability at subsequent stages in the licensing process when construction is under way on a previously approved site.

The Task Force has considered this issue and has concluded that the siting regulations should provide general and consistent guidance on the status of site approvals at the various stages of the licensing process. There is no perceived reason why the status and finality of a site approved under the Commission's early site review policy should differ from a site approved at the construction permit stage. In either situation, there is a need for predictability and stability to attach to the site approval process. On the other hand, the Task Force recognizes that the requisite finality of site approvals must be tempered with the effect of significant new information that relates to a previously approved site. In the opinion of the Task Force, the language previously quoted from the Commission's early site review regulations strikes a reasonable balance between the need for finality on the one hand and the need for the regulatory system to accommodate significant new information that could substantially affect the previously approved site on the other.

For these reasons, the Task Force recommends that the siting regulations provide explicit guidance regarding the finality of site approvals. Specifically, the approval at the early site review or at the construction permit stages would be final unless the Commission or one of its presiding boards (upon its own initiative or upon motion by a party) "...finds that there exists significant new information that substantially affects the earlier conclusions and reopens the hearing record on site suitability issues."

3.2.8 Recommendation 8

Revise Part 51 to provide that a final decision disapproving a proposed site by a state agency whose approval is fundamental to the project would be a sufficient basis for NRC to terminate review. Such termination of a review would then be reviewed by the Commission.

Discussion

Siting regulations do not deal with the effect of a cognizant state or local government's rejection of a proposed site on the continuing NRC review of that site. Under present practice, the staff, even under these circumstances, would process an application that is found to satisfy the requirements of applicable Federal law.

Cognizant state and local agencies have important responsibilities in the site approval process in areas other than those reserved for the Federal government and are involved in making decisions on questions of environmental impact and land-and water-use priorities. In recent years, there has been increasing emphasis at State government levels on early and thorough consideration of environmental impact, land use, and similar questions associated with energy facility siting, including nuclear facilities. Several states have enacted comprehensive new energy facility siting legislation.

NRC policy is to enhance NRC/State cooperation and to integrate the role played by State and local governments, as fully as possible, into the NRC site review and approval process. Where appropriate, the Commission undertakes active cooperative actions with the States for environmental impact assessments and determinations of site suitability. Siting regulations, however, provide no guidance on whether a proposed site, which has been properly rejected by a cognizant State agency, should be considered as a viable site for purposes of continued NRC review of a facility license application.

The Task Force believes that there is little useful purpose to be served by NRC's continuing to review a project if required State approval of the proposed site has been denied. Provisions in the siting regulations on this matter would be beneficial because (a) resources could be applied to viable alternatives and not wasted on a fait accompli, and (b) the regulations would recognize and enhance the role of State governments in the site selection and approval process.

On the other hand, the Task Force recognizes that there should be no premature termination of review. For example, what may appear to be a final rejection of the site to the staff may also appear to others to be simply an intermediate step in the machinery of State government operation. Furthermore, political factors may enter into such a decision. It should also be pointed out that rejecting an application on the grounds of states' opposition to the project may appear to conflict with the mandate to the Commission to issue licenses to persons applying therefor when the primary requirements relating to useful purpose, health and safety, and

common defense and security are met (Atomic Energy Act of 1954, Section 103). For these reasons, the Task Force believes that the decision to terminate review should be reviewed by the Commission after there is assurance that the proposed site has been officially and finally rejected by a state.

3.2.9 *Recommendation 9*

Develop common bases for comparing the risks for all external events.

Discussion

There are no quantitative bases for judging and managing the conservatism used to establish the severity of all natural phenomena and the resulting degree of safety afforded by associated design provisions. This is in part the result of the various earth science and engineering disciplines independently developing analytic techniques that result in a lack of common means to quantify and compare the risks from natural phenomena. Because of this, the staff management is hindered in its ability to control modifications to natural phenomena severity analyses and to control design requirements to accommodate these natural phenomena. The same situation exists for man-made external events. In the opinion of the Task Force, the overall risks from all external events need to be established to provide uniform quantitative bases for comparing the requirements in all disciplines dealing with natural phenomena and external events.

The Task Force believes that an interdisciplinary effort should be undertaken with the objective of developing quantitative risk comparisons of all external events and natural phenomena. The disciplines should include seismology, hydrology, meteorology, mechanical and structural design, and accident analysis as well as probabilistic risk analysis. The study should result in the development of a methodology that will permit the conservatism in these varied disciplines to be better managed.

4. DIFFERING TASK FORCE AND WORKING GROUP OPINIONS AND OFFICE COMMENTS

Rather than prepare a report that provides a consensus of Task Force beliefs but that does not provide the range of opinions held by the Task Force members on any given issue, the Task Force elected to debate to the point that the issues expressed in the recommendations were completely formulated, to prepare a summary of the "majority" viewpoint (Recommendations 1 through 9 in Section 3), and then to invite those members of the Task Force with differing points of view to present their opinions either in Section 4 or in the discussion of the recommendations.

4.1 Differing Task Force Opinions

4.1.1 Population Density and Distribution

One member of the Task Force agrees with the concept of placing reasonable limits on population density and distribution but disagrees with the proposed approach and suggested illustrative numbers. This member believes that the Task Force recommendation should be as follows:

Recommendation

Part 100 should be modified to eliminate the present LPZ and population center calculations and criteria and replace these with specific population density limits from 0 to 20 miles and a standoff distance of 20 miles to the nearest population center. The staff should study this problem promptly and propose a value of population density to be used in the definition of a population center (likely somewhere between 1,000 and 2,000 persons per square mile) based on typical population densities in towns of 25,000 to 50,000 inhabitants. The staff should also promptly recommend a value (or values) of population density [or, alternatively, site population factors (SPF)] that are regionally based and that, when applied, would permit a reasonable range of options for the siting of nuclear power plants within each region. In developing the proposed regionally based criteria, the staff should consider other environmental and engineering factors (such as water supply, land use, and seismicity) that are important to siting so as not to preclude unnecessarily (through over-restrictive population density criteria) the existence of siting options that might be superior. The staff should also promptly define the regional boundaries for purposes of this rule.

Discussion

This Task Force member has several significant problems with the proposed Task Force recommendations, as follows:

1. The proposed numbers, although stated to be illustrative, are likely to be more difficult to change once they are before the Commission; the illustrative numbers are not based on any regional study of siting options that would remain. Population density is only one of many important siting parameters. Since the underlying philosophy is to site prudently in less populated

areas while at the same time not preclude siting in any region of the country, the population density numbers must not be developed in a vacuum; i.e., developed independent of the consideration of other equally or even more important siting parameters.

2. It would seem that the SPF approach might be at least as easy to apply and might have a better technical justification than pure population density, since the population would be weighted by distance. This could avoid the perceived need for establishing different density numbers at different annuli.

3. The clear intent of the population center concept is to retain a standoff distance from areas of higher population. It would thus seem proper to have a set population density value (not regionally based) and an established standoff distance clearly expressed in the regulations. However, the proposed illustrative values would nominally permit "population centers" of over 25,000 people to be about 10 miles away from the site (they could be closer), whereas present siting policy has resulted in a mean population center distance of about 24 miles.

4. The proposed illustrative array of annuli and 22-1/2° sectors are somewhat complex, and the apparent accuracy of calculation implies an analytical importance that is not real. The overall level of risk is still small, and the uncertainties as to the actual magnitude of residual risk are far greater than the reduction of residual risk that would occur with more conservative limits. Also, the decrease in this small societal risk is not approximated by the percentage decrease in the close-in population. Much of the residual societal risk (man-rem) is assumed by the much larger total population that is more than 20 miles away. For these reasons, it would appear that a simpler calculation process that is more understandable to the general public would be better and would provide an equivalent improvement in the level of public safety.

5. Although this member agrees in principle with the necessity to consider population growth during plant lifetime (the proposed criterion is a doubling), the criterion should clearly state that it is established only as an analytical requirement to be imposed at the CP review stage to avoid sites that have a clear and presently planned potential for rapid growth. This type of criterion has no pragmatic usefulness after the CP stage, and other means should be sought to discourage future accelerated growth.

4.2 Differing Working Group Opinions

One member of the Working Group has suggested two additional recommendations the Task Force does not endorse. The Task Force position on these recommendations follows the discussions.

4.2.1 Site-Specific Consideration of Class 9 Accidents

Recommendation

The benefits and risks of siting at a specific location should be fully disclosed and used in site suitability determinations. Specifically, the benefits of siting at a specific location should be weighed against environmental impacts and radiological exposure risks (including Class 9 accidents) to individuals and population groups. The resulting findings should be fully disclosed to the public. With the response of the public fully considered in site suitability determinations.

Discussion

The staff presently weighs the nonradiological benefits and impacts of a plant site, and conservatively assesses the design basis accident radiological consequences to hypothetical individuals at exclusion area and low population zone boundaries in making site suitability judgments. The radiological risks from both normal operation and most accidents (including Class 9) are routinely judged to be acceptable by the staff. Specifically, the staff conservatively evaluates design basis accident consequences to a "standard man" as part of the site suitability criteria, but does not consider the consequences to be controlling in determining site suitability. In Appendix I of 10 CFR Part 50, disclosure of radiological consequences resulting from normal operation is not interpreted as being related to site suitability practice. Accident consequences are assessed in terms of doses to a hypothetical individual ("standard man"). No information is provided to the resident population of a proposed reactor site of their specific individual or collective risks. Furthermore, the uncertainties associated with such evaluations are not discussed. Lastly, the net effect of the Task Force's recommendations is to remove all public disclosure of accident consequences from site suitability considerations.

It is recommended that a full disclosure and discussion of siting benefits, risks, and the associated uncertainties be made on a case-by-case basis, giving the informed local public an opportunity to derive information from and provide input to NRC siting and licensing decisions. As a result of such a policy, the following factors would be explored: The benefits of tax revenue, jobs, and electricity generation versus the siting consequences of routine operation, accidents, health effects, population distributions, as well as radionuclide transport, dilution, and diffusion. Although generic evaluations of risk have been discussed, no evaluations at a specific site with associated uncertainties have been correlated to real people. Finally, the uncertainties, comparison of risks at other site locations, types and extent of various releases, characteristics of pathways to people, atmospheric and hydrospheric transport, accident likelihood, and alternatives should be disclosed to residents of a proposed reactor site.

Task Force Position

The Task Force does not disagree with, and in fact endorses, the concept of full public disclosure of information of all aspects of review and analyses. The Task Force does not endorse the narrow issue that site-specific Class 9 accidents should be analyzed and weighed in the decisional process.

The reasons for the Task Force's nonendorsement of this narrow issue are given as follows:

1. If the recommendations of Section 3 are implemented, the Task Force concludes, for the reasons expressed in Section 3, that site-specific Class 9 accident risk assessments will not contribute significantly to the selection of better sites.

2. Because of the uncertainties in site-specific Class 9 accident risk assessment public disclosure would not be enhanced by such assessments.

3. Decisions involving possible differences in plant design from one site to another (which would not be addressed in siting decisions) and the very large inherent uncertainties in the calculations of very small values of residual risk, could not likely be justified on cost-benefit balancing. Therefore, the effort would be of little value for decisional purpose.

4. The establishment of criteria, based on generic assessment of Class 9 accident risks, that are oriented toward acceptable population densities and various standoff distances would be easier to understand and demonstrate and would still achieve the basic goal of selecting sites that inherently have a lower level of residual risk.

4.2.2 Meteorologic Characteristics of Sites

Recommendation

Reactor sites should not possess meteorologic characteristics such that, given an accidental atmospheric release, the likelihood of radiological exposures at the locations of higher population concentrations should not be significantly greater than the likelihood of exposures to the general population. That is, reactor sites should not be selected so that local wind direction likelihood and related diffusion characteristics tend to "aim" releases at nearby population concentrations.

Discussion

The combination of meteorological characteristics and population distribution arount reactor sites can result in a difference in accident dose consequences of as much as an order to magnitude. Atmospheric transport and diffusion condition likelihood in different directions at a reactor site can vary by about an order of magnitude. Population density distributions by direction can also vary by more than an order of magnitude. Studies of the combination of meteorology and population distribution at selected existing reactor sites indicate about an order of magnitude difference in severe accident consequences between sites. To preclude the licensing of "bullseye" sites in the future, it is recommended that siting criteria be developed to limit the accident consequences due to the combination of meteorology and population distribution. The proposed population related criteria contained in the Task Force recommendations fail to acknowledge the large population risk differences resulting from the coupling of meteorology and population distributions. This recommendation is intended to specifically supplement, not substitute, item 3 of Recommendation 1.

Task Force Position

The Task Force does not endorse this recommendation for the following reasons:

1. The recommendation addresses a narrow issue of site-specific meteorology and is but a small slice of the same, much broader concern expressed in the previous recommendation (Section 4.2.1). The reasons for the Task Force's nonendorsement of recommendation 4.2.1 are applicable here as well.

2. By combining meteorologic and population distribution characteristics of the site, the recommendation is nondefinitive and noninterpretable. For example, a site having on the average a reasonably uniform wind rose (thus, seemingly meeting the recommendation) would still have the likelihood of areas of greater exposure if the population were nonuniformly distributed.

3. The recommendation re-introduces the concept of an exposure dose (thus involving consideration of plant design features) as a criterion for siting decisions. This runs directly counter to one of the major goals of this report that recommends separation of plant design decisions from siting decisions.

4.3 Office Comments

In accordance with the Commission's instructions to provide opinions and recommendations independent of Office position, the report was completed by the Siting Policy Task Force without the usual review and concurrence by the Program Offices. The Task Force, however, was of the opinion that comments on the completed report by the Program Offices would provide useful insight into the issues discussed in the report and would aid the Commission in its consideration of the contents of the report. Accordingly, the Program Offices were asked to comment on the report. These comments follow.

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

AUG 6 1979

MEMORANDUM FOR: Daniel R. Muller, Chairman
Siting Policy Task Force

FROM: Howard K. Shapar
Executive Legal Director

SUBJECT: REPORT OF SITING POLICY TASK FORCE

I have two significant comments on the report of the Siting Policy Task Force forwarded to me by your August 2, 1979 memorandum. First, the report adopts the premise that stringent nuclear power plant siting criteria are not warranted because, among other things, such criteria would tend to limit the use of nuclear power by large segments of the population, and this would not likely result in any decrease to the overall risk associated with electric power generation because nuclear power generation would be replaced by power generation from coal with equivalent or greater risk. The premise that nuclear power generation is no more damaging to health and the environment than coal-fired generation is highly controversial, and it seems to me that the Commission will prefer that new power reactor siting standards be based on some less controversial premise, if this is at all possible.

Second, the report indicates that there should be no site specific class 9 accident evaluations, or consideration of residual safety risks in considering alternative power plant sites. It seems to me that any refusal to look at class 9 accidents or residual risks on a site specific basis will provoke substantial controversy and give rise to the implication that the Commission is not interested in full disclosure of reactor accident risks to people who may be affected by them. I think that the report will need to be "beefed up" before a convincing case is made that class 9 accidents and residual risks should not be discussed on a site specific basis.

Howard K. Shapar
Executive legal Director

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

AUG 10 1979

MEMORANDUM FOR: Daniel R. Muller, Chairman, Siting Policy Task Force

FROM: James H. Sniezek, Director, Division of FFMSI, IE

SUBJECT: REPORT OF SITING POLICY TASK FORCE

We have reviewed the subject report and have no substantive comments.

J. H. Sniezek, Director
Division of Fuel Facility and
Materials Safety Inspection
Office of Inspection and Enforcement

CONTACT: E. D. Flack
49-28188

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

August 13, 1979

MEMORANDUM FOR: Daniel R. Muller, Chairman
Siting Policy Task Force

FROM: Robert G. Ryan, Director
Office of State Programs

SUBJECT: REPORT OF SITING POLICY TASK FORCE - NUREG 0625

Thank you for the opportunity to comment on the draft Siting Policy Report of the Task Force.

The report is, in our view, a model of clarity. It is extremely well written, logical and precise. Its conclusions are carefully drawn and its justifications are clearly shown. It is indeed one of the finest papers we have seen in many years. There are no major gaps or omissions. We fully support the conclusions and urge the early adoption of the report as NRC policy.

If the report can be adopted quickly, NRC would have an excellent siting policy and we would have the assurance that many of the problems which plague current sites would no longer exist. From the standpoint of off-site emergency planning, it is a major departure from previous practice and an enormous improvement.

We have several specific comments and amplifications:

Recommendation 1 - In the discussion of the population density at varying distances and of the elimination of radiation dose calculations, it may be well to also discuss the 50 mile radius for interdiction of food supplies recommended by the NRC/EPA Task Force report NUREG 0396/EPA-520/1-78-016. We believe the Siting Task Force recommendations cover the major elements that might affect a siting decision. Considering recommendation 8 on State actions, accepting an EPZ out to 50 miles for ingestion exposure pathway would be a desirable addition. It is not likely that such a zone would ever cause rejection of an obviously superior site, but would serve notice that such a planning zone is a part of the balancing of sites which may otherwise be relatively equal.

When talking about a 50 mile Emergency Planning Zone, we are talking about identifying, in advance, the major ingestion exposure pathways from contaminated agricultural products (in terms of types and location of products) and from potable water sources. We are also talking about identifying, in advance, the control or interdiction points whereby these food products or water supplies could be diverted from consumption by humans or domestic

animals in the food chain if necessary.

Recommendation 2 - The specific numbers for the stand-off distances appear to have uneven risk potential and need further justification. The stand-off distance below a major dam may be especially difficult to quantify on a generic basis, without relating the other parameters of dam type, head, reservoir size and flood plain configuration. In any event, we think five miles is somewhat optimistic.

Recommendation 5 - It may be that the discussion of tne proposed 50 mile EPZ for ingestion exposure pathways is involved in our informing local authorities because of the additional responsibilities they inherit as part of a siting decision. If so, the discussion should reflect it. We are particularly pleased, however, with the proposed requirement in Item 3.

Recommendation 6 - The application of recommendation 6 must be tempered by the universe of sites available to the applicant. We have always believed that a regional (multistate) area should be considered. This would tend to support the minority view that requires some consideration of unique and compensative features. If sites outside of an area of interest which is limited by service area concepts offer superior safety aspects, they should be considered out to the limits of practical benefit/cost comparison.

Recommendation 7 - We strongly support the concept of early and final site approval for those sites for which separate approval is sought. We have previously proposed that all sites be treated through an early and final site review process with regional scope on the basis that a system of pre-approved sites related to the regional electrical characteristics offers the most reasonable means of meeting NEPA alternatives. Even if a virgin site were proposed as part of a CP application, the system of approved sites would be an effective group of alternatives.

Recommendation 8 - We strongly support the concept of terminating a review upon formal action of a State to disapprove a site. We see, however, no purpose in a review by the Commission. Matters of economic regulation of power are clearly beyond the health and safety purview of the Commission and their rulings support this view. If national economic interests are vitally involved in the termination of a review, these interests should be addressed by Federal and State agencies with responsibility for these interests, or by the Congress.

I again thank you for the opportunity to comment on this excellent piece of work by the Task Force.

Robert G. Ryan, Director
Office of State Programs

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

AUG 14 1979

MEMORANDUM FOR: Daniel R. Muller, Chairman, Siting Policy Task Force

FROM: Norman M. Haller, Director, Office of Management and Program Analysis

SUBJECT: COMMENTS ON DRAFT REPORT OF THE SITING POLICY TASK FORCE

We recommend that a thorough value-impact analysis of these recommendations be prepared.

The Task Force recommends that numerical requirements for population density "be developed and published for public comment as soon as possible (Appendix A)." We believe that first a definitive value-impact analysis of all the Task Force's recommendations should be prepared before any recommendations are published for public comments. The "gross" costs of adopting the recommendations on minimum distances can be estimated by evaluating various numerical values of population densities. However, the net or true cost cannot be estimated unless the next best alternative (namely, allowing trade-offs between distance and unique design features to be made) is also analyzed.

The most controversial recommendation is for the site decision to be made separately from the safety-design decision. Thus, the applicant would no longer be able to choose the most cost-effective combination of site and design characteristics. This would appear to represent a reversal in Commission policy which has been moving toward performance standards that allow an applicant to select a method for satisfying the standards. (For example, the Commission has favored this approach in establishing safeguards standards.)

In general, adoption of the distance-related recommendations in this report would appear to undermine the philosophy that reactors can operate safely primarily because their designs satisfy NRC regulations. And, we believe that adoption of these recommendations would leave the Commission open to the charge that some existing reactors aren't safe enough (since they rely on design features).

Some readers might benefit from a more detailed discussion of the "base design" (i.e., what constitutes a "non-unique design"). The "base design" will have to be specified out before an acceptable value-impact analysis of the Task Force's recommendations can be prepared. In addition, a quantified, working definition of what the Task Force feels is "undue risk" will be required (it can be inferred

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(49-27721)

from the report that population beyond a 20-mile radius from the plant is not at undue risk). The same comment applies to the phrase "reasonable levels of societal risk."

The report recommends that Part 100 be revised so that NRC staff can consider "restrictions" in the event that the site became less acceptable due to post-licensing changes in offsite activities. In discussing this recommendation, the report appears to argue that NRC would have no authority to enforce such restrictions. The report then states that the recommendation is consistent with current practice. It would be helpful to the reader if some illustrative examples of restrictions recently imposed were included in the report (the two instances discussed refer to pre-licensing).

The Task Force's recommendation that site-specific Class 9 accidents not be analyzed and weighed in the decision process seems to be inconsistent with Recommendation 9, "Develop common bases for comparing the risks for all external events." That is, the ultimate risk is the risk to the health and safety of the population affected by an accident. Indeed, that's what the report seems to say in the last paragraph on p. 49. If so, development of a "common basis" would require analysis of Class 9 accidents.

The report does not address the issue of grandfathering. Do these recommendations apply to cases already docketed? If so, the value-impact study should include the two broad options (i.e., grandfather or no grandfather).

We would be happy to participate in the value-impact analysis recommended here.

for Norman M. Haller, Director
Office of Management and
Program Analysis

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

AUG 15 1979

MEMORANDUM FOR: Daniel R. Muller, Chairman
Siting Policy Task Force

FROM: Robert B. Minogue, Director
Office of Standards Development

SUBJECT: REPORT OF THE SITING POLICY TASK FORCE (NUREG-0625)

As requested by your August 2, 1979 memorandum, the subject report has been reviewed. The enclosed specific comments are the result of a preliminary SD staff review for accuracy and technical content. We were unable to complete the detailed review that the report deserves in the allotted time. The report contains many specific recommendations for numerical regulatory requirements which require a careful study by my staff as to their impact and meaning in siting policy and siting regulations. The report has identified the major problem areas in current siting policy and staff practices. However, we are concerned about the prospect that the report may be forced to be used as a basis for immediate rulemaking and is inadequate for that purpose.

We have the following general concerns with the recommendations of the Siting Policy Task Force:

1. Most of the criteria have absolute limits resulting in a go/no go judgment on site characteristics. However, the report does not recognize the need to address the subject of backfit at docketed (licensed and under review) sites. With no new applications expected in the near future, the review of docketed sites, especially with operating facilities, will be the major effort in NRC site review. We believe that the siting criteria will require a mix of threshold levels for alternative site evaluation and absolute levels for site specific evaluations as well as a recognition of the backfit consideration of docketed sites. Only four new sites have been docketed since 1975.

2. The report's recommendations fail to recognize the importance of localized degraded cooling in the evaluation of fission product release conditions to the containment and into the coolant systems and of the TID type of release fractions in the evaluation of equipment and system design and the unique siting considerations that these represent.

3. The implication in the discussion of past practices that the demographic features of population and distances have been getting progressively worse at licensed sites is not true. Indian Point, San Onofre, and Zion sites were reviewed and approved more than 10 years ago. Demographic features of current licensed sites have actually been improving somewhat since the above listed sites were approved.

4. The selected numerical limits for specific site characteristics have no basis or clear rationale and little consideration has been given to the application of these limits to previously approved sites and how the limits would be used in the review of specific site features. The many variables important to the establishment of such limits for specific site features have not been discussed or an explanation provided as to how these variables would be treated during an actual site review.

We are continuing our review of the specific recommendations and will provide additional comments on the subject report for consideration by the Commission.

Robert B. Minogue

Robert B. Minogue, Director
Office of Standards Development

Enclosure:
As stated

ENCLOSURE

Comments on the Report of the Siting Policy Task Force (NUREG-0625)

1. The conditions stated in Section 1.4 for Premise 7 do not reflect the real situation and are not consistent with Premise 6. Any recommendation for a change to the siting regulations worded in such absolute terms must address the impact on docketed (licensed and under review) sites for licensed facilities. The backfit application of any new siting requirements should be considered prior to the promulgation of a rule. The new information referred to in Premise 6 would almost certainly warrant the reopening of the site acceptability issue at docketed sites. New applications are not likely for a significant period so that the primary application of any new criteria would be on docketed sites.

2. In Section 2.1.1, the discussion of practice is not consistent with the proposed alternative site rule (SECY-79-481) or NEPA. NRC reviews do include safety considerations in terms of cost impact in the cost-benefit analysis of alternative site evaluations.

3. In Section 2.1.2, Introduction, the conditions in the core considered for evaluation are stated as either no core damage or core melt. The situation of localized degraded cooling with fuel damage and subsequent fission product release is not mentioned. A range of accident characterizations, including local fuel damage, needs to be discussed and requirements given for handling such accidental releases. Several staff papers have addressed some of these concerns as related to inerting containment (SECY-76-244 and SECY-78-290).

4. In Section 2.1.2.2, the conservatism included in the consequence model for evaluating doses to the public needs to be discussed as well as the significance of the reference dose guideline values. The use of the TID release fractions for equipment and system design purposes is not mentioned.

5. In Section 2.2.1, Item 5, the factors stated are inconsistent with the alternative sites paper (SECY-79-481) discussion and should be replaced by the following text:

a. The environmental and safety* considerations in terms of technology and costs of construction and operation of a nuclear power plant at the sites.

b. The forward costs ** at the proposed site compared to the alternative sites.

c. Other considerations, such as possible institutional barriers.

6. In Section 2.3.3, the policy statement does not address the situation where States with Federally approved Coastal Zone Management Programs find that a pending NRC License would be inconsistent with that program. Due to the Federal Consistency provision of the Federal Coastal Zone Management Act of 1972, the NRC would not be able to issue its permit or license.

7. In Section 3.1, an implication of continuous erosion or relaxation of requirements on distance and population density is indicated. In fact, since Indian Point and later the Newbold Island review, the requirements have become more stringent on population density and, on the average, greater distances have been required for the sites.

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* NOTE: There are some site safety issues for which a cost-effective means for successful mitigation is not state-of-the-art engineering. For the purposes of alternative site analysis, these site safety issues are considered in terms of site acceptability, i.e., where successful mitigation is considered outside the state-of-the-art, the site would be considered unacceptable. However, where the mitigation of the safety issue is considered within the state-of-the-art, the site would be considered acceptable, but still must undergo the comparative test, which includes impact of the mitigation on overall project cost, to determine whether there is an obviously superior alternative. Even though the proposed site successfully passes the early evaluation of alternative sites, it could still be found unacceptable in the later detailed safety review of that site.

** NOTE: For cases where the portion of the construction permit application containing facility design is filed after December 31, 1982, and an early site review application for the review of alternative sites had not been filed at least 2-1/2 years earlier, the costs of moving to another site, including costs of delay, will be given no weight in any consideration of alternative sites or in any decision whether to reopen a previous decision on this subject.

8. In Recommendation 1, the issues and concepts are identified but the specific requirements would be difficult, if not impossible, to defend in rulemaking. What is meant by "minimum" in the context of "fixed" when no evaluation criteria are given? Minimum implies that some situations may need more, implying an evaluation. How do you define "required control"? What is "feasible" evacuation out to 10 miles? The numerical requirements given in the Discussion are difficult to defend with no basis or rationale and would be difficult to apply on a site review. For example, the limit on population density growth to a factor of 2 taken absolutely would imply that, if indications were that a very sparsely populated area would increase its population density by more than a factor of two due to the availability of power, the site would be unacceptable even though the population density was still very low.

9. In Recommendation 2, all of the listed design basis events will require numerical levels which will require a basis. The values stated in the Discussion do not have the required basis or rationale for establishing them as appropriate regulatory requirements. The characteristics of these site features are variable and not conducive to fixed regulatory limits without a lot of careful staff analysis.

10. In Recommendation 3, what is meant by reasonable assurance and how long must the interdictive measure be expected to function? The Discussion might include a plan to discuss the type of interdiction measures proposed, the availability of equipment, materials and trained crews, and the detrimental effects of concurrent natural phenomena (floods, droughts, earthquakes, etc.,) on the interdiction effort.

    The question of protecting sole source aquifers as designated by EPA should be addressed. (This may have direct implication on the Jamesport and Shoreham Nuclear Power Plants).

11. We agree with Recommendation 4 but no new applications are expected in the near future to warrant staff effort in this area. Action plans have been cancelled and qualified staff have been reassigned or have left the program.

12. Recommendation 5 provides a realistic approach to a difficult issue which has been raised in the Senate amendment to the NRC Authorization Bill.

13. In Recommendation 6, the requirement of no unfavorable characteristics would severely restrict sites in cert in sections of the U.S. However, the Discussion indicates that minimum unfavorable characteristics would be used as the criterion for evaluating unique or unusual designs. These requirements are not the same and imply a significant difference in the review approach. The determination of unique or unusual design may be difficult and is ambiguous.

14. Recommendation 7 will be difficult to develop and provide a basis for rulemaking but has a good objective.

15. Recommendation 8 does not recognize the difference between a state agency with its mission but little authority and the State government which has the direct authority. This recommendation requires careful wording so that approval by the proper State authorities is reflected in the final NRC decision-making process.

16. Our concerns with the lack of consideration for the influence of meteorology on site suitability are expressed in Sections 4.2.1 and 4.2.2 of Differing Task Force Opinions. Meteorological characteristics of a site along with population distribution, not just population density, define the suitability of site from a consequence viewpoint, whether normal operations or accident conditions are evaluated.

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

AUG [illegible] 1979

MEMORANDUM FOR: Daniel R. Muller, Chairman
Siting Policy Task Force

FROM: William J. Dircks, Director
Office of Nuclear Material Safety and Safeguards

SUBJECT: REPORT OF SITING POLICY TASK FORCE

Your memorandum of August 2, 1979, requested Office comments on the Task Force report. NMSS was not able to make a detailed review of the report in the time made available. However, based on our limited review, this Office has no comments.

William J. Dircks, Director
Office of Nuclear Material Safety
and Safeguards

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

AUG 31 1979

MEMORANDUM FOR: Daniel R. Muller, Acting Director
Division of Site Safety and Environmental Analysis

FROM: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

SUBJECT: SITING POLICY TASK FORCE REPORT

NRR has reviewed the Report of the Siting Policy Task Force and finds it proposes innovative, balanced, and forward looking solutions to difficult and long standing siting problems. The limited success of past efforts to solve these problems over the years since Part 100 was adopted is evidence of the difficulty of the task. The meshing of many scientific and engineering disciplines in siting policy has contributed to the difficulty. The Task Force approach provides the views of knowledgeable staff members from NRR, OSD, and OELD, the principal organizations in NRC involved in the siting of nuclear power plants.

In our view, the Task Force has addressed in recommendations of Section 3 of the Report the important elements of siting that are in the need of updating or that have in our experience been the cause of inefficiencies in our decisional process. In particular we feel that the Task Force has shown good insight into the overall siting issues that are currently facing the Commission by including in the recommendations such basic issues as:

1. Making siting decisions independent of plant design, thus recognizing the problems inherent with using dose calculations as a siting decision criterion.

2. The role of Class 9 accidents in siting.

3. Minimizing the risk of energy generation.

In summary, we endorse the goals and the implementing recommendations submitted for consideration by the Commission.

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

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

SEP 4 1979

MEMORANDUM FOR: Daniel R. Muller, Deputy Director
Division of Site Safety &
Environmental Research
Office of Nuclear Reactor Regulation

FROM: Saul Levine, Director
Office of Nuclear Regulatory Research

SUBJECT: SITING POLICY TASK FORCE REPORT

We apologize for the lateness of our comments, but we hope that at least they will be in time for the Commission discussion of tne Siting Policy Task Force Report. Our review has been somewhat hurried and, therefore, may not have covered all of the ideas presented in the Task Force Report. Our comments are as follows:

1. RES agrees with the need to develop improved reactor siting criteria.

2. An important thread that runs through many of the suggested criteria appears to be the need for firming up the basis for the site review process to improve its efficiency, reduce the uncertainties involved in site approval and reduce the staff workload in this area. Apparently, one of the principles adopted to achieve this laudable objective is to decouple the design of engineered safety features (ESF) from site characteristics. While we have no quarrel with the principle, we can find no basis presented as to how design bases for ESFs will be established. To some extent, ESF design bases are now related to the DBA dose calculations involved in site approvals. Page 48 of the report states that the success of its approach rests on "assuming fixed design and performance criteria for engineered safety features." Clearly, adoption of the suggested approach will require the development of new bases for ensuring the adequacy of ESF designs; while this can be done, it is not a trivial task

3. It seems that the subject of criteria acceptable levels of risk may have been dismissed too lightly by the Task Force. The ACRS, at the request of Congressman Udall, plans to develop proposed criteria within the next year. Also, RES is doing work in this area and has been asked to cooperate with the ACRS in their effort. It would seem appropriate that the group reconsider its approach in view of this effort.

4. Some of the recommendations present suggested numerical values for various factors such as exclusion distance, emergency planning distance and stand off distances without presenting any technical analyses to support them. The report would be better without these values until the requisite studies are performed. We agree with the concept of preparing generic studies to try to establish appropriate values for these factors as well as for ESFs.

5. The discussion of residual risk appears illogical and should be deleted. The definition given is one of the standard definitions of risk, not residual risk. It should also be noted that WASH 1400 estimates that the risk (probability x consequences) appear to be larger for accidents that are lower in probability than DBAs.

6. In regard to recommendation 3, the report should note that RES has study underway at Sandia to determine, among other things, the groundwater interdiction potential of existing sites.

Saul Levine, Director
Office of Nuclear Regulatory Research

cc: L. V. Gossick
H. R. Denton
R. B. Minogue
V. Stello
R. J. Budnitz
T. E. Murley
F. J. Arsenault
F. Rowsome

APPENDIX A

REVIEW OF ISSUES IN PIRG PETITION ON POPULATION DENSITY CRITERIA

APPENDIX A
REVIEW OF ISSUES IN PIRG PETITION
ON POPULATION DENSITY CRITERIA

As requested by the Commission at the progress briefing on January 18, 1979 (memorandum) of February 15, 1979), the Task Force has reviewed the issues contained in a Public Interest Research Group (PIRG) petition regarding population density criteria around nuclear reactor sites. A comparative analysis has been performed to indicate how each issue raised by the petitioners has been addressed by the Task Force in its recommendations to the Commission for siting policy changes. A more complete discussion of each contention raised by the petitioners is contained in a recent staff Commissioner Paper, SECY-78-624, dated December 4, 1978.*

The following comparisons state the petitioners' proposal and the relevant Task Force recommendation:

1. The petitioners request that the outer boundary of the exclusion area shall be no less than 0.4 miles from the reactor [amend Section 100.11(a)(1 to Part 100].

   Task Force Recommendation. Specify a fixed minimum exclusion distance based on limiting the risk from design basis accidents. Furthermore, the regulations should clarify the required control by the utility over activities taking place in land and water portions of the exclusion area.

   Even though the Task Force does not establish a recommended single distance, it is noted that a value of 0.5 mile would provide reasonable assurance, based on past staff review experience, that radiation doses beyond this distance would not result in consequences greater than the present guideline values given in Part 100.11, assuming that the engineered safety features function as designed. It is further noted that an exclusion distance in this range would provide reasonable assurance that no emergency action would be necessary beyond this distance for lifesaving purposes in the event of any design basis accident. Finally, the Task Force states that such a distance would also prevent many activities in immediate proximity to the plant that might pose potential hazards to its safe operation.

2. The petitioners request that the outer boundary of the low population zone shall be no less than 3.0 miles from the reactor [amend Section 100.11(a)(2) Part 100].

*R. B. Minogue, Office of Standards Development, Requests approval of NRC response to PIRG petition for rulemaking to amend 10 CFR 100.

Task Force Recommendation. Specify a fixed minimum emergency planning distance of 10 miles. The physical characteristics of the emergency planning zone should provide reasonable assurance that evacuation of persons, including transients, would be feasible if needed to mitigate the consequences of accidents.

The Task Force concluded that, because the purpose of the low population zone and the emergency planning zone proposed by the NRC/EPA Task Force on Emergency Planning are the same, there would be less confusion if NRC adopts the term "emergency planning zone" (EPZ) to replace "low population zone". The minimum distance to the outer boundary of the EPZ should be stated in Part 100 and be 10 miles as recommended by the NRC/EPA Task Force on Emergency Planning. The Task Force recommends that Part 100 require that the physical characteristics of the EPZ, including the population distribution in relation to transportation routes and other topographic features, be such to provide reasonable assurance that a relatively prompt evacuation of the EPZ, including transients, would be feasible in the event of an accident.

3. The petitioner's request criteria that would either prohibit site location, require "state-of-the-art" engineered safety features, or require a finding that the proposed site offers significant advantages from the standpoint of environmental, economical, or other factors if the population density over any radial distance out to 40 miles could exceed 400 people per square mile at the time of initial plant operation or could exceed 800 people per square mile over the duration of the plant license.

   Task Force Recommendations.*

   a. Incorporate specific population density and distribution limits outside the exclusion area that are dependent on the average population of the region.

      The Task Force has not completed a definitive study on the population densities or distribution, and distances in the following paragraph are given to illustrate the concept. If the Commission accepts this recommendation, the Task Force anticipates that a careful study would be made to establish the basis for the number chosen.

      From the exclusion zone to 5 miles, the population density at the beginning of reactor operation in this annulus should not exceed one-half the average population density of the region where the reactor is to be located or 100

*See Section 4.1.2 the report for a differing opinion of one member of the Task Force.

persons per square mile, whichever is greater. The population within this annulus should not be expected to increase to more than double the original population during the life of the plant, and no more than one-half of the allowed number of persons in the zone should be permitted within any single 22-1/2° sector. Transients should be weighed according to their fractional occupany within this annulus.

From 5 to 10 miles, the population density at the beginning of reactor operation in this annulus should not exceed three-quarters the average population density of the region where the reactor is to be located, or 150 persons per square mile, whichever is greater. No more than one-half of the allowed number of persons in this annular ring should be permitted in any single 22-1/2° sector.

From 10 to 20 miles, the population density at the beginning of reactor operation in this annulus should not exceed twice the population density of the region where the reactor is to located, or 400 persons per square mile, whichever is greater, but that no more than one-half of the allowed number of persons in this annular ring be permitted in any single 22-1/2° sector.

It is the judgment of the Task Force that beyond about 20 miles the societal risk is sufficiently low to warrant no specific limits on population.

b. Continue the current approach relative to site selection from a safety viewpoint, but select sites so that there are no unfavorable characteristics requiring unique or unusual design to compensate for site inadequacies.

Provide in the regulations specific limits on certain site characteristics (e.g., population density and distribution and distance from hazardous activities and unfavorable natural features) and a requirement for the utility to avoid unique or unusual compensating plant design features.

4. The petitioners further propose that transient populations would be included in all population density evaluations and must be the transient population figure for the day of the year when it reaches its maximum size.

Task Force Recommendation. The recommendation involving the treatment of transient population is related to the evacuation of persons in the event of a serious accident as stated under item 2.

5. Other Task Force recommendations address the petitions contentions regarding the past performance of the Commission in the promulgation of siting policy in regulatory form, specifically population density. The following Task Force recommendations relate to this general siting policy issue raised by the petitioners:

   a. The siting criteria include consideration of the risk associated with accidents involving core-melt with resulting containment failure (Class 9 accidents) and liquid pathway by establishing fixed exclusion distance, fixed low population zone, and population density criteria.

   b. The siting regulations encourage the selection of sites with a minimum of unfavorable characteristics so that siting should make a significant contribution to the reduction (although not to zero) of the residual risks from the operation of power reactors.

   c. Part 100 should be revised to state that it is desirable to select reactor sites that do not exhibit unfavorable physical and land use characteristics. Where some unfavorable characteristics of the proposed site exist, it may nevertheless be found to be acceptable if the design of the facility includes appropriate and adequate compensating engineering safeguards. However, a site should not have unfavorable characteristics that would require unique or unusual design requirements to compensate for those characteristics.

Conclusion

Based on staff review of the issues in the PIRG petition on population density criteria, the alternative to deny the specific proposals in the petition but to proceed to develop numerical requirements on population density in 10 CFR Part 100 (Alternative 3 in SECY-78-624) appears to be consistent with the recommendations of the Task Force for siting policy changes. The alternative to deny the petition in part but grant in part by amending 10 CFR Part 51 to codify the present staff practice regarding use of numerical criteria on population density in alternative site analyses (Alternative 4 in SECY-78-624) does not agree with the recommendations of the Task Force for siting policy changes relating to Part 51 or Part 100.

We further recommend that the siting criteria and numerical requirements necessary to implement the siting policy changes be developed and published for public comment as soon as possible. We recommend that, in the interim period, the staff practice as stated in Regulatory Guide 4.7 for population density be continued without codification. Since we have not received any application for sites that exceed these population density criteria stated in the regulatory guide and do not expect any such sites in the near future, the staff effort to codify these criteria while changes to the current siting

policy are being developed is not justified. This recommendation is responsive to the petitioner's assertion that, "Let it be clear that we view our proposal as setting minimal interim standards and call upon the Commission to generate well-reasoned numerical standards on population density" (page 4 of the PIRG Petition for Rulemaking).

APPENDIX B

REGULATORY AGENCY USE
OF
RISK ASSESSMENT TO
DEVELOP SAFETY CRITERIA

Prepared by

Oliver D. T. Lynch, Jr.

and

Suzanne Keblusek

APPENDIX B

REGULATORY AGENCY USE OF RISK ASSESSMENT TO DEVELOP SAFETY CRITERIA

SUMMARY

Many regulatory agencies and the industry use risk assessment, but only a handful actually use it to develop safety criteria or otherwise use the technique in decision-making. There are many risk assessment techniques and no particular methodology appears to be applicable to all situations. The level of acceptable risk must be established before any real application of risk assessment can be made to the decision-making process. Only a few regulatory agencies have taken this step and formally set levels of acceptable risks.

1. FAA uses risk assessment to screen airports for the need of Air Traffic Control Towers by evaluating a benefit-cost ratio based on the values of accidents prevented divided by the costs of installation and operation of the tower.

2. HUD uses risk assessment to address safe separation distances from hazardous industrial complexes for HUD-assisted housing projects, although HUD leaves the establishment of the level of acceptable risk to the project sponsor, who may compare the risk to the project with a list of common risks ranging from 3×10^{-4} to 4×10^{-7} fatalities/person year exposure.

3. FDA has used risk assessment to support its proposed Federal guidelines for Protective Action Guides (PAGs) to be used in the event of radioactive contamination of foodstuffs. The risks are expressed in the form of man-rems of exposure to the population compared to that received from natural background. Somatic and genetic health effects were considered in the assessment. (FDA, for its food additives review, is required to enforce a "no risk" policy.)

4. EPA has proposed factors for consideration in risk assessment and for developing levels of acceptable risk for radioactive wastes, but it requires the affected agencies to perform the assessment (e.g., NRC and DOE). However, they have proposed applying a particular methodology and setting a formal acceptability level in a draft proposed regulation on high-level radioactive wastes.

5. Oregon Energy Facilities Siting Council requires the use of risk assessment for the treatment of residual risk for energy facility siting, but does not specify methodology nor acceptable risk levels.

6. Several agencies call their reviews "risk assessment" but really perform a judgmental analysis rather than a formal mathematical one to support their safety criteria.

INTRODUCTION

As a result of the progress briefing of the Commission by the Siting Policy Task Force on January 18, 1979, the Commission requested:

> that the Task Force include in their analysis practices of other regulatory agencies with respect to safety criteria, especially those using probabilistic approaches to evaluating risks;[1]

Recognizing that the broad interpretation of this task could encompass myriad possibilities, the task was limited to reviewing the practices of a few, specific regulatory agencies with respect to their use of risk analysis in developing safety criteria (especially those using probabilistic approaches to evaluating risk) and to providing the Commission with a "sample" review of practice of specific regulatory agencies.

In the investigative phase of this assessment, cross section of regulatory agencies and industry was consulted. It is believed that the "samples" of agency practices indicated here are, in fact, rather inclusive. Among those agencies and organizations contacted were the following:

Decision Science, Inc.

Department of Energy

Department of Housing and Urban Development

Department of Transportation
- U.S. Coast Guard Office of Research and Development
- Federal Highway Administration
- Federal Aviation Administration

Electrical Power Research Institute

Mitre Corporation

National Institutes of Health

U.S. Nuclear Regulatory Commission
- Probabilistic Analysis Staff

[1]Memorandum, from S. J. Chilk, NRC, to L. V. Gossick, February 15, 1979.

Occupational Safety and Health Administration

Office of Technology Assessment
Food and Drug Administration
Bureau of Biologics
Bureau of Drugs

Mr. Peter Barton Hutt, Covington and Burling

Planning Research, Inc.

Science Advisory Board

States of Oregon, California, Washington, Massachusetts, Connecticut and Maryland

USC Traffic Safety Center

In addition, the literature was searched for significant insight and information on the application of risk assessment to the development of safety criteria.

FINDINGS

In consulting the various Federal and State agencies and industry, it was quickly revealed that nearly every regulatory agency and many industry groups, notably insurance companies, use risk analysis, or at least are deeply involved in some form of risk assessment, including the use of probabilistic analysis. However, very few agencies have actually used risk assessment in setting or describing safety criteria. Some require, or propose to require, other agencies or licensees to use risk assessment in justifying their findings in their applications or regulations for facility siting, but specify neither the level of acceptable risk nor the methodology for the risk assessment. And some agencies use the term "risk assessment" somewhat loosely. In particular, "risk assessment" may be nothing more than an educated judgment of risk-benefit based solely on the assessor agency's perception of "state-of-the-science" and not at all on a rigorous application of mathematical theory. One agency is limited to a "zero risk" policy by law.

Of all the agencies consulted, the use of risk assessment to develop specific safety criteria was identified only for FAA, HUD, and FDA. FAA uses risk assessment to screen airports for control towers. HUD applies risk assessment for determining safe separation distances between HUD-assisted projects and hazardous facilities. FDA uses risk assessment to describe the effects associated with their proposed Protective Action Guides (PAG). Both EPA and the Oregon Energy Facility Siting Council require its use in regulatory actions: EPA, in its proposed Criteria for Radwaste Wastes and in its draft High-Level Radioactive Waste Standards, and Oregon in its site-acceptability criteria. EPA's pesticide tolerance-setting program uses a risk assessment

procedure, but it is presently under fire from Congress.[2] FDA has proposed (since rescinded by the courts for inadequate record) and is expected to repropose Criteria and Procedures for Evaluating Assays for Carcinogenic Residues in Edible Products of Animals, actually setting an acceptable level of risk of 10^{-6} cancers or deaths per lifetime (1.4×10^{-8} cancers or deaths per year). Each of these applications are discussed in detail in the annex to this review.

DISCUSSION

Regulatory agency use of risk assessment runs the gamut from actual utilization of formal mathematical risk assessment in order to set safety criteria (only a few agencies), to requiring others to use risk assessment (but failing to specify either methodology or acceptable risk), to a non-mathematical "informed risk assessment," or to no actual use of risk assessment in order to develop or support safety criteria.

Many regulatory agencies use or are investigating the use of risk assessment, but only a handful actually use it to develop safety criteria. Several studies have been initiated on the use of risk assessment in the decision-making process. Unfortunately, none of these studies were available for staff review. As an example of such interest the Office of Technology assessment proposed to conduct an all encompassing study of risk assessment, tentatively entitled "Risks to Humankind," and provided the staff with a copy of their work plan, developed in March, 1979. The sixteen tasks proposed for this study are provided here as Attachment 2 to this appendix. The proposal is ambitious, and its results would be of great interest to all regulatory agencies.

[2] "Cancer-Causing Chemicals in Food," Report by Subcommittee on Oversight and Investigations of the Committee on Interstate and Foreign Commerce, 95th Congress, December 1978, p. 9.

ANNEX

Examples of Regulatory Agency Use of Risk Assessment to Develop Safety Criteria

1. FAA - Establishment Criteria for Airport Traffic Control Towers (ATCT)

The Federal Aviation Administration performed a risk assessment to evaluate the need for installing equipment at airports that included a first-level screening process followed by a more detailed cost-benefit analysis. An example is presented in their Publication[3] that involves choosing the airports that should receive an air traffic control tower given a limited budget. FAA contacts stated that the risk assessments performed for airport equipment are more sophisticated than those performed for airplane equipment because the airport equipment is federally funded.

The FAA revised the criteria that determine which airports should be considered as candidates for an air traffic control tower (ATCT). This screening process uses a ratio approach which provides better results than the previous simple criteria of straight activity level. The actual cost-benefit analysis applied to the airports includes such factors as "collision and accident risk, mix of aircraft types, percentage of those persons aboard aircraft who may have been fatally or seriously injured in collisions or accidents, potential aircraft losses including accident investigation costs and cargo value, the impact of local operations, and time saved." This procedure screens and ranks those airports being considered for ATCT installation. Computing the benefits involves two situations. First, some benefit factors are determined from historical data, such as the probability of an accident occurring at tower locations versus non-tower locations, the average number of persons aboard an aircraft, and the fraction of those persons aboard an aircraft receiving fatal injuries in a collision. Second, other benefit factors are subject to judgment by persons experienced in the aviation field. These judgment factors include a factor that is used to adjust the preventable mid-air collision rate and preventable accident rate and a percentage factor to compute direct and indirect economic benefits to the community. Other benefits include reduction in delays. Statistical comparisons of historical data show that there were 0.6 mid-air collisions per million operations at airports without FAA towers and 0.03 collisions at airports with FAA towers. The "preventable" collision rate is expressed as a function that includes a factor used to account for statistical uncertainty and the greater weight that is generally attached to safety benefits than is justified. The FAA methodology for determining the benefits of airport traffic control towers is provided as Attachment 1.

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[3]Federal Aviation Administration, "Establishment Criteria for Airport Traffic Control Towers (ATCT)," Report ASP-75-4, October 1975.

2. HUD - Siting of Housing Projects in Proximity to Hazardous Industrial Complexes

The Department of Housing and Urban Development addresses the siting of housing projects at safe separation distances from industrial hazards using a probability of occurrence of abnormal events derived from historical data.[4] The methodology HUD provides is a guide for risk assessment for those chemicals having a safe separation distance that is greater than the distance from the housing project. This risk assessment takes into consideration any protective measures and attenuation factors. These attenuation factors are used to correct the annual probability of each industrial accident, as computed from historical data. The probabilities of all industrial accidents that could affect the project are then summed. The result is the probability that damage to the housing project or injury to the occupants may occur. At this point, the determination of the acceptable level of risk is left to the personal judgment of the authorities having jurisdiction over the proposed site. In this report, HUD compiled a table of individual risks of fatality by various causes that provides for comparison to the risk affecting the site. (It should be noted that the source of this table is WASH-1400.)

3. EPA - Criteria for Radioactive Wastes - Recommendations for Federal Radiation Guidance[5]

On November 15, 1978, the Environmental Protection Agency published for comment Criteria for Radioactive Wastes, with responses requested by January 15, 1979.[5] The recommended criteria establish the basic principles that should be applied in the formulation of policies, plans, programs, and decisions involving management and disposal of radioactive waste. These criteria also establish ground rules to be followed in the development of generally applicable standards for radioactive waste sources.

The EPA recommended criteria for radioactive wastes discuss the factors to be considered in assessing risk to the general public and the general environment and the factors that would result in unacceptable risk for different methods of disposa

This guidance, if approved by the President, will supersede any existing guidance concerning the disposal of radioactive wastes. Federal agencies (NRC and DOE) would be required to comply with this guidance in carrying out their responsibilitie

[4]U.S. Department of Housing and Urban Development, "Safety Considerations in Siting Housing Projects," December 1975.

[5]FR 43 No. 221, Wed. Nov. 15, 1978 (53262-53268).

The most significant aspect of the DPA recommendations is their statement that:

> ...radiation protection requirements for radioactive wastes should be based primarily on an assessment of risk to individuals and populations; such assessments should be based on predetermined models and should examine at least the following factors:
>
> a. The amount and concentration of radioactive waste in a location and its physical, chemical, and radiological properties;
>
> b. The projected effectiveness of alternative methods of control;
>
> c. The potential adverse health effects on individuals and populations for a reasonable range of future population sizes and distributions, and of uses of land, air, water, and mineral resources for 1,000 years, or any shorter period of hazard persistence;
>
> d. Estimates of environmental effects using general parameters or of health effects based on generalized assumptions for as long as the wastes pose a hazard to humans, when such estimates could influence the choice of a control option;
>
> e. The probabilities of releases of radioactive materials to the general environment due to failures of natural or engineered barriers, loss of institutional controls, or intrusion; and
>
> f. The uncertainties in the risk assessments and the models used for determining them.

Although the EPA criteria discuss the factors to be considered in assessing risk, they fall short in not specifying methodologies.

However, the proposed criteria do take a major step in discussing the factors that would result in unacceptable risk. The recommendations state:

> Any risks due to radioactive waste management or disposal activities should be deemed unacceptable unless it has been justified that the further reduction in risk that could be achieved by more complete isolation is impracticable on the basis of technical and social considerations; in addition, risks associated with any given method of control should be considered unacceptable if:
>
> a. Risks to a future generation are greater than those acceptable to the current generation;
>
> b. Probable events could result in adverse consequences greater than those of a comparable nature generally accepted by society; or

c. The probabilities of highly adverse consequences are more than a small fraction of the probabilities of high consequence events associated with productive technologies which are accepted by society.

EPA falls short of fully bridging the gap between risk assessment consideration and its use in setting safety criteria for the following reasons: first, the EPA criteria are presently only recommendations; and second, although risk assessment factors are discussed, the implementing agencies must formulate their own methodologies. However, EPA does take a formidable stab at the basics behind formally stating a level of acceptable risk by discussing the factors that must be considered in setting this level.

4. EPA - High-Level Radioactive Waste Management Standards

At the present time EPA is preparing proposed radiation protection standards for high-level radioactive waste management. These standards are in the draft stage, have only been provided to the affected agencies for comment, and have not been published in the Federal Register for public comment. If and when these standards are published, they may vary considerably from the present draft. And, if and when they are promulgated, they may vary considerably from their initial published comment form.

However, it is useful to review the supporting information for the draft standards because it does shed some light on current EPA thinking in the area of risk assessment utilization in developing safety criteria. For this reason, this information is reported here.

On December 6, 1976, EPA published an advance notice of its intent to develop an environmental radiation standard for high-level radioactive waste.[6] The proposed criteria have been developed subsequent to this announcement and were guided by the Criteria for Radioactive Wastes discussed above. EPA expects to forward the high-level waste standards to the President in 1979.

Existing Federal radiation guidance establishes the basic principles of radiation protection; i.e., that no radiation exposure be permitted without commensurate benefit, and that even then exposures are to be maintained as low as practicable.[7] EPA developed the draft criteria to expand these basic principles for radioactive wastes because they do not give guidance on limiting the long-term commitment of risk to future generations or on dealing with the probabilistic nature of exposures, nor do they provide the elements for determining when risks so presented may be unacceptable. The criteria address these issues in general terms only for all radioactive wastes; thus, standards for specific types of waste are still required to specify protection requirements for the risk each presents. The proposed standard carried out this requirement for high-level radioactive wastes and spent nuclear fuel.

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[6] 41 FR 53363

[7] 25 FR 4402

EPA indicates that radiation protection requirements for radioactive wastes, as well as other sources of radiation exposure, are generally derived from three interrelated concepts. First, there is a general, though not well defined, level of risk that is unacceptable, even if it means foregoing any beneficial aspects of an activity. Second, various levels of risk exist below the generally unacceptable level that may be argued to be also unacceptable depending on the circumstances involved. These include the benefits to be derived, the comparability of the risk associated with the activity to other risks assumed by society, equity in distribution of benefits and risks, and the existence of other alternative measures for achieving the same benefit. Third, within levels of risk that may be acceptable for a given set of circumstances, risks due to non-threshold pollutants are required to be maintained as low as reasonably achievable. This latter condition may include levels of zero risk or a continuum of risk levels between zero and some level of risk that has been determined to be unacceptable for the circumstances involved.

EPA believes the most reasonable approach is (a) to present information on levels of risk for circumstances that may be related to radioactive waste disposal and that appear to be reasonably acceptable to society; (b) to examine the expected risk from systems that might be used to dispose of radioactive waste; and (c) to use both sets of information, with allowance for uncertainty and perspective, to determine levels of protection that should be required.

In their discussion of comparative levels of risk, EPA states three considerations are involved: (a) the criterion that this generation should not impose risks on future generations it would not accept for itself; (b) the comparability of risks of other radiation-related circumstances such as environmental dose commitments from nuclear power generation and nuclear defense; and (c) the comparability of risks with long-lived naturally occurring circumstances such as natural background and undisturbed uranium ore deposits. It may be argued that similar comparisons ought to be made for non-radiation circumstances such as toxic chemicals, conventional air pollutants, other hazardous wastes, etc. Although this is reasonable, EPA believes these are more difficult to do, are more questionable as to comparability, and would not provide a sufficient basis for higher risks for radioactive wastes if these radiation-related situations are lower.

In searching for a basis for acceptable level of risk, EPA considered other currently accepted radiation-related risk levels. Currently acceptable radiation risks provided in Federal guides and risks due to nuclear weapons fallout were determined to be not applicable or justifiable for use as a basis for accepting risk from radioactive waste. Risks from naturally occurring radioactivity and from nuclear energy production were also considered, but of the risk perspectives considered by EPA the comparison with natural ore bodies was judged the most comparable. The rationale given is that it is similar to the long term of waste disposal and represents risk that would exist if these ore bodies were not disturbed.

EPA's next step was to examine reasonably achievable levels of risk. In order to gain understanding of the potential impact on individuals and populations that may be associated with the disposal of spent fuel and high-level radioactive waste to exposed members of the population, a disposal system based on geologic emplacement was examined. The disposal system modeled contained an inventory of about 100,000 metric tons of waste resulting from once-through use of nuclear fuel (the throw-away cycle). Some 60 events that could cause disruption of the system were postulated to occur at various periods of time after disposal was completed, and the specific release rate of radioactivity to the accessible environment and its associated probability of occurrence were calculated for several time periods ranging up to one million years. Geologic and environmental transport models were used to estimate the impact (as lethal cancers) on human populations due to each release of radioactivity into the accessible environment. More detailed discussions of these scenarios, the transport models used, and other assumptions are provided in the report entitled "Risk Assessment for High-Level Radioactive Waste Disposed in Geologic Media." EPA concluded that the projected impacts, including uncertainty, from at least one approach for disposing of high-level radioactive waste are well within the benchmarks that provide perspectives on reasonably comparable risk levels.

On the basis of the benchmarks and risk levels presented, EPA believes that the standard should state limitations to assure that achievable levels are realized, giving appropriate consideration to flexibility for uncertainty and reasonable and responsible implementation. Within this context, EPA indicates the derivation of the standard was guided by the following objectives:

a. To limit risks to future populations and reduce inequity of risk between generations,

b. To restrict acute or serious chronic exposure of individuals,

c. To minimize the probability of potentially high consequence events,

d. To ensure that the best disposal systems are used, and

e. To provide requirements that can be reasonably implemented.

Since the proposed standards are still in draft form and have not been released for public comment, it would be improper to state them in detail in this review. However, to provide the Commission with an idea of what is contemplated, the standards are discussed in general terms.

In order to limit the risks to populations, the proposed standard provides protection levels concluded to be required within the framework of a decision-making system incorporating acceptable risk perspectives and reasonable achievability in three areas: (a) disposal systems are not to have designed

release features, (b) estimated releases of major radionuclides due to incidents are to be less than prescribed limits, and (c) releases due to potentially catastrophic events are to be extremely unlikely.

In addition to limiting the total impact of disposal due to incidents, it is also important to assure that individuals do not incur excessive risks. This consideration also provides an extra measure of control for radionuclides not listed in Part 191.20(b). EPA's analysis of doses that could potentially occur to individuals due to releases in groundwater and surface water to the land surface, and the ocean are less than a few millirems per year in the accessible environment outside the area of the site. For this reason, the estimated annual exposure of any individual is proposed to be limited to less than a few millirems due to both reasonably foreseeable and highly unlikely natural events.

The proposed standards will be implemented by the U.S. Nuclear Regulatory Commission in accordance with the division of authorities prescribed by Reorganization Plan No. 3. The Department of Energy is required to obtain NRC licenses for certain specific sites and designs, and will be responsible for complying with regulations based on this environmental protection standard as well as other regulations NRC may provide.

In its implementation of the standards, EPA indicates the NRC will only need to provide models that show that release quantities are not exceeded; it need not address biospheric transport, dose determination, and dose/effect models to determine health effects.

EPA indicated that uncertainty in the models used is an important consideration with respect to implementation. Sensitivity analyses were performed in the various parameters of disposal systems in order to determine the most important ones for providing the required isolation. EPA believes that the following key parameters would be important to decisions on the use of disposal systems and should be established by appropriate study to establish their performance as fully as possible for specific sites:

a. The permeability and stability of the host medium and the surrounding media,

b. The retardation factors for specific geochemistry and waste forms, and

c. In-situ leaching characteristics of the waste forms.

EPA believes that such studies and implementation programs will provide reasonable assurance that public health and the environment are protected within the proposed standards.

5. FDA - Accidental Radioactive Contamination of Human Food and Animal Feeds - Recommendations for State and Local Agencies

On December 15, 1978, the Food and Drug Administration provided, for public comment, proposed guidelines and recommendations for action to be taken in the event of a radiological incident resulting in the contamination of human food or animal feeds.[8] These guidelines and recommendations are for use by State and local agencies responsible for constructing response plans in the event of a radiological incident. The proposal would establish a set of guidelines that can be used to determine whether or not levels of radiation encountered in food after a radiological incident warrant protective action and would suggest appropriate actions that may be taken if action is warranted. This proposal is made because the Food and Drug Administration (FDA) has a responsibility to issue guidance on appropriate planning actions necessary for evaluating and preventing contamination of foods and animal feeds and on the control and use of such products should they become contaminated.

The proposed guidelines define a Protective Action Guide (PAG) as the projected radiation dose equivalent or dose commitment to individuals in the general population that warrants protective action following a release of radioactive material. Protective action would be warranted if the expected individual dose reduction is not offset by negative social, economic, or health effects. A negative impact could occur, for example, if an adequate alternative food supply is not available. The PAG does not include the radiation dose that has occurred before the assessment, nor do these recommendations imply an acceptable radiation dose from food containing radioactivity during normal conditions.

Rather, their purpose is to prevent additional radioactivity from entering the human food chain and to reduce or avoid future radiation doses to the population after an accidental contaminating event. Such events include accidents at nuclear facilities, transportation accidents, and fallout from nuclear devices. The proposed protective actions are intended for implementation within hours or days from the time an emergency is recognized, and their duration should not be expected to exceed 1 or 2 months, based on previous experience with atmospheric fallout.

FDA indicates the process of determining numerical limits for setting radiation standards has traditionally been one of risk assessment. The process of risk assessment consists of two elements: determination of the probability that an event will occur, and determination of "acceptable risk." Because initiation of protective action assumes that an incident has occurred, the emphasis in this case is on the determination of acceptable risk or safety. FDA cites a recent discussion of acceptable risk defining risk as a measure of the probability and severity of adverse effects and safety as the degree to which risks are judged acceptable.[9] FDA agrees that safety involves a judgment as to the acceptability of the risks but recognizes that there may not be universal

[8]43 FR S8790, Dec. 15, 1978.

[9]Lowrance, W.W., "Of Acceptable Risk," William Kaufmann Inc., Los Altos, CA, 1976, p. 8-11.

agreement because various individuals may not all judge a given risk to be acceptable. Thus, the proposed PAGs represent the FDAs judgment as to that level of contamination resulting from radiation incidents at which protective actions should be taken to protect the public health.

To provide a basis for this judgment, the risk of radiation exposure was compared to the risk of prevalent hazards accepted by society and to the variability of the natural radiation environment. The numerical dose commitment values that were derived are comparable to the risk from natural disasters (approximately a one-in-a-million annual individual risk of death) and to the risk associated with two standard errors of the mean (the 95 percent confidence level) of the natural radiation environment in the United States (8.5 millirem per year). Both somatic risks (cancer deaths) based on an absolute risk model[10] and genetic effects have been assessed in this evaluation. An absolute risk approach (estimates of deaths per rem of dose) was used in preference to a relative risk model because a relative risk model is based on natural cancer rates. Natural cancer rates are highly variable and depend upon such diverse factors as age, location, socioeconomic class, race, genetic makeup, and environmental factors.

For the Preventive PAG, FDA indicates the most conservative estimates assume a dose commitment to the whole U.S. population that is associated with the somatic risk equivalent to two standard errors of the mean of the natural radiation environment. This statistic is a measure of the variability or scatter of the average doses of natural radioactivity among the states. These dose commitments are approximately 0.47 rem to the whole body, bone marrow, or other organs, and 1.4 rem to the thyroid. (FDA, in supporting documentation, provides equivalent health effects associated with exposure levels discussed here.)[11]

In the case of the Emergency PAG, it is reasonable to expect that a smaller population would be affected, and the value 15 million has been assumed, this being the estimated maximum population within 25 miles of present reactor sites. These assumptions yield values for the Emergency PAG of 7 rem whole body, bone marrow and other organs, and 21 rem thyroid.

The procedures for estimating genetic risks are less precise than those for somatic risks, and it is therefore necessary to give a range for the genetic dose that is considered equivalent to the risk of two standard errors of the mean for natural radiation. The range of genetic dose values is 0.07 to 1.73 rem for the Preventive PAG and 1 to 24 rem for the Emergency PAG.

[10] BEIR Report, 1972.

[11] Shleien, B, G.D. Schmidt and R. P. Chiacchierni, "Supporting Documentation for Proposed Recommendations in Case of the Accidental Radiation Contamination of Food and Animal Feeds," Food and Drug Administration, December 9, 1977 (corrected May 23, 1978).

Risks can be compared to the risks from natural disasters for the purpose of determining their acceptability. The radiation doses equivalent to the risk for natural disaster (taken as one in a million annual individual risk of death) are 1.01 rem to the whole body or bone marrow for the Preventive PAG and 15 rem for the Emergency PAG. These values are quite consistent with the dose of 0.47 rem for the Preventive PAG and 7 rem for the Emergency PAG that are equivalent to the risk of two standard errors of the mean natural radiation dose.

To obtain some perspective of the economic impact of the PAGs as a function of the numerical level recommended, FDA cites an NRC-performed cost-effectiveness analysis using existing data. The cost-effectiveness analysis was done for two models based on projected incidents with different magnitudes of the radioactive release from light-water nuclear power plants. Under the limited scenarios investigated, the rate of change in costs for condemnation of milk drops rapidly when interdiction criteria are between a 0.5 and 10 rem dose commitment to the infant thyroid. The rate of change drops more gradually when the criteria are between 10 and 20 rem, and the rate of change drops only moderately following an interdiction criterion of greater than 20 rem.

The FDA concludes that it is prudent to recommend proposed numerical limits for the Preventive PAGs equivalent to 0.5 rem dose commitment to the whole body, bone marrow, or other organs, and 1.5 rem dose commitment to the thyroid gland. Numerical limits for the Emergency PAG are recommended at 5 rem and 15 rem, respectively, representing a factor of 10 over the Preventive PAG.

In summary, the Preventive and Emergency PAGs refer to projected dose commitments to an individual in the exposed population. For the Preventive PAG the most critical segment of the population consists of newborn infants or children less than 1 year of age. For the Emergency PAG two critical segments are defined: (a) an infant group, and (b) an adult group (excluding young children). This definition permits a greater flexibility in cases where exposure can be limited to adults only because children are more easily removed from the area of contamination or their diet limited to canned or other stored food.

6. FDA - Criteria and Procedures for Evaluating Assays for Carcinogenic Residues in Edible Products of Animals[12] (21 CFR 1, A, E. 500.87)

On February 22, 1977, the FDA promulgated Criteria and Procedures for Evaluating Assays for Carcinogenic Residues in Edible Products of Animals. By these regulations, the FDA adopted a modification of the Mantel-Bryan Procedure for "Safety" Testing of Carcinogenic Agents.[13,14]

[12]42 FR 10412, Feb. 22, 1977.

[13]Mantel, N., and W. Ray Bryan, "Safety Testing of Carcinogenic Agents," Journal of the National Cancer Institute, Vol. 27, No. 2, August 1961, pp. 455-470.

[14]Mantel, Nathan, et al., "An Improved, Mantel-Bryan Procedure for Safety Testing of Carcinogens," Cancer Research, Vol. 35, April 1975, pp. 865-872.

The modified extrapolation procedure of Mantel and Bryan proposed for use in defining the no-residue standard for a sponsored compound is a statistical technique that allows estimation of the level, or dose, of a carcinogen that would lead to cancer incidence rates in test animals well below those rates that can be detected in practical experimentation. In the utilization of the modified Mantel-Bryan model, the FDA regulations establish the maximum risk to be used in the Mantel-Bryan calculation as 1 in 1 million (10^{-6} cancer or deaths per lifetime of an individual). This 1-in-1-million lifetime risk level assumes that an individual would consume maximum residue levels every day over a lifetime.

The use of this procedure for estimating the acceptable level is based on the assumption that the only risk to the human population is that from residues of the sponsored compound, not from such intervening causes as disease or accidents (e.g., the average risk of fatality by motor vehicle accident per year is approximately 1 in 4,000). Because the population is constantly at risk from a wide range of factors, however, any increment of increased risk associated with exposure to residues of multiple compounds is at most in the vanishingly small range.

In Animal Health Institute vs. FDA (D.D.C., February 8, 1978), the court concluded that the procedure used by FDA to promulgate the regulation was legally deficient (the record was deemed incomplete), and the regulation has therefore been withdrawn.[15] The matter is presently being reconsidered.

NRC staff contact with the FDA staff indicates that the regulation is scheduled to be repromulgated in April 1979, with an inhanced discussion for the completeness of the record. The FDA, apparently, still has concluded that a risk level of 1 in 1 million over a lifetime imposes no additional risk of cancer to the public. A lower risk would not significantly increase the public health protection, but would probably proscribe the use of most animal drugs or feed additives. A risk level significantly higher than 1 in 1 million (for example, 1 in 10,000) might present a significant additional risk of cancer to the public.

7. EPA - Pesticide Tolerance-Setting Program and FDA - Food Safety, Food Additives Program

The EPA Pesticide Tolerance Setting Program and FDA's Food Additives Program are examples of "zero risk" assessment. In other words, any risk assessment performed is to evaluate the levels to which no effects are observed in experimental animals. For the EPA, the No Observable Effect Level (NOEL) is defined as the "level of a substance administered to a group of experimental animals at which those (adverse) effects observed or measured at higher levels are absent."[16] A safety factor of 100 is tacked onto this value, and additional conservative manipulations are performed to obtain the maximum permissible intake that is compared with the theoretical maximum residue concentration to set the tolerable level.

[15] 43 FR 22675, May 26, 1978.

[16] "Cancer-Causing Chemicals in Food," Report by Subcommittee on Oversight and Investigations of the Committee on Interstate and Foreign Commerce, 95th Congress, December 1978, p. 9.

EPA's pesticide tolerance setting program is presently under fire by the Congress as a result of the report, Cancer Causing Chemicals in Food, by a subcommittee chaired by the former U.S. Senator John E. Moss (known as the "Moss Report").

FDA, on the other hand, is bound by the Delany clause, which prohibits the use of any food additives which have been shown to cause cancer in any test animals in any quantities, no matter how small. The Delany clause demands, essentially, that no risk be taken with food additives.

8. FDA - Unavoidable Contaminants in Food For Human Consumption and Food-Packaging Material (21 FR 109)

A tolerance for an added poisonous or deleterious substance in any food may be established by FDA when the following criteria are met:

a. The substance cannot be avoided by good manufacturing practice.

b. The tolerance established is sufficient for the protection of the public health, taking into account the extent to which the presence of the substance cannot be avoided and the other ways in which the consumer may be affected by the same or related poisonous or deleterious substances.

c. No technological or other changes are foreseeable in the near future that might affect the appropriateness of the tolerance established.

The procedure for establishing an action level or tolerance for an environmental food contaminant involves a decision-making process that follows the criteria of section 406 of the Federal Food, Drug and Cosmetic Act.[17] These criteria stipulate that:

a. The presence of added poisonous or deleterious substance (i.e., environmental contaminant) cannot be avoided by good manufacturing practice; and

b. The action or tolerance that is established be sufficient for the protection of the public health, taking into account both the extent to which the presence of the substance cannot be avoided and the other ways in which the consumer may be affected by the same or related poisonous or deleterious substances.

The decision-making process also addresses the following factors:

[17]Letter from Donald Kennedy, Commissioner of Food and Drugs, to J.B. Cordaro, Office of Technology Assessment, January 22, 1979.

a. Available acute and chronic toxicological data, including information on the biological half-life of the substance and its metabolic fate;

b. Available data on the levels and incidence of the contaminant in the overall food supply and specifically in the food commodity or commodities that are being considered for an action level or tolerance;

c. Normal serving sizes of the concerned food(s) and frequency of ingestion;

d. Susceptibility of certain population groups, such as infants and the aged, to adverse effects from anticipated dietary exposure to the contaminant;

e. The level at which available enforcement analytical methodologies can detect, measure, and confirm the identity of the contaminant;

f. Capability of manufacturers to monitor their food production to ensure that the products comply with the action level or tolerance; and,

g. Anticipated impact on the national food supply.

Each factor is assessed individually (assuming information on each is available) and then collectively brought into balance by a composite analysis in terms of the estimated risk to the public health versus both the extent to which the substance is unavoidable and the quantity of food that would be unlawful under levels being considered.

In using this analysis to develop an action level or tolerance for the contaminant, FDA has not fixed the weight to be given each of the above factors. Each factor will, to some degree influence their final decision; generally, the more information available about a particular factor, the greater its influence. This is one reason why FDA has not prescribed a predetermined quantifiable set of criteria for each factor. The unpredictable nature of the information available when FDA encounters an environmental food contamination problem is inherent in the system. Thus, because of this uncertainty, stating in advance the precise weight of each factor in the final determination is simply impractical.

Despite the uncertain weighting of these factors, FDA always follows the basic principle that dietary exposures to the contaminant must be minimized to provide an adequate margin of safety which will assure an acceptable level of risk to consumers. In other words, the public health factor outweighs all other considerations. Nevertheless in practice, this principle depends on a determination that relies on scientific judgment and opinion about the specific circumstances surrounding the food contamination problem at hand. Indeed, each instance of an environmental food contaminant must be viewed as a unique and dynamic situation; because of this, the procedure followed and the application of available data to the situation are also unique and must, as a result, be adjusted to suit the individual contaminant.

A similar procedure is utilized by the Bureau of Drugs to assess the utilization of new drugs. In this case, the formal mechanism for review includes studies and submissions to various committees set up for the review. However, in the long run, the ultimate consideration of risk appears to be a qualitative, but educated, judgment based on state-of-the-art, rather than a formal application of mathematical technique.

9. Oregon Energy Facility Siting Council

The Energy Facility Siting Council of The State of Oregon has established public health and safety standards for nuclear power plants. These standards limit the radioactive releases of the plants during both normal operation and as the result of abnormal occurrences. The state specifically requires that residual risk to the public arising from operation of the facility after compliance with the rules will not be undue. This must be proven through a risk analysis of plant safety which is related to the risk posed by coal-fired plants, tornadoes, hurricanes, meteor impacts, earthquakes, airline crashes, dam failures, and accidental release of chlorine.

Exerpt from "Establishment Criteria for Airport Traffic Control Towers (ATCT)"

SECTION V - METHODOLOGY FOR DETERMINING THE BENEFITS OF AIRPORT TRAFFIC CONTROL TOWERS

The generalized methodology for determining the annual benefits of control towers is a summation of the several benefit elements which relate prevented collision rates, accident rates, and time-loss rates to the costs of these occurrences if no control tower were established. Additional economic benefit elements are considered but are not as yet specifically quantified. The detailed methodology is as follows:

$$\text{Total Benefits } (B) = B_1 + B_2 + B_3 + B_4$$

Where:

B_1 = Benefits from prevented mid-air collisions.

B_2 = Benefits from prevented accidents. (Accidents shown to occur less frequently at tower airports. Included are collisions on the ground or with objects, overshoots, misaligned with runway, landing on wrong runway with respect to wind, and wheels-up landings.)

B_3 = Benefits from reduced flying time (the time saved by not having to overfly an airport to determine landing direction, airport and traffic conditions).

B_4 = Other benefits. (These include growth in activity levels over time, direct and indirect economic benefits to the community, and benefits due to the facility being part of a larger overall system. These benefits are currently considered nonquantifiable but are estimated as being about 20 percent of the other benefits.)

The remainder of this section describes in detail how each of the four benefit elements is computed. Reference is made to the source of the cost and probability factors which are used for the benefit computation.

1. Benefits from Prevented Mid-Air Collisions (B_1)

The benefits from prevented collisions (B_1) are estimated as follows:

$$B_1 = P \sum_{i=1}^{m} X_i \, C_i$$

Where:

P = "Preventable" collision rate (annual)

$$P = S\left(.0292642\right)\left(\frac{O_T}{80}\right)^{1.3}$$

And:

O_T = Annual total operations (000), e.g., 50,000 annual total operations = 50.0

P is based on the historical difference between mid-air collision rates at tower and non-tower airports in the 40,000 to 150,000 annual total operation range over an 8-year period. It is an adjusted "best fit" function describing the relationship between "tower preventable" collision rates and traffic volume. The function includes factor S which is used to account for statistical uncertainty in the mean value and, more importantly, to account for the historically greater weight FAA executives, Congress, and system users attach to safety benefits. In this case, the factor S is set at 2.0, which is probably low. The National Bureau of Standards determined that mid-air collision rates at tower and non-tower airports were statistically significaty different. On the basis of this determination, the difference in rates between tower and non-tower airports is assumed to be "tower preventable" collisions. The basic collision rate data and additional categorizations of the data are contained in "An Analysis of the Costs and Effectiveness of Airport Traffic Control Towers," Second Interim Report, FAA, Office of Aviation Economics, July 1970.

X_i = Ratio of operations of aircraft class i to total operations. Classes currently included are:

- Class 1 = certificated route air carrier operations
- Class 2 = air taxi operations
- Class 3 = military operations under 12,500 lbs. (light)
- Class 4 = military operations between 12,500 lbs. and 25,000 lbs. (medium)

- Class 5 = military operations 25,000 lbs. and over (heavy)

- Class 6 = general aviation itinerant operations

- Class 7 = general aviation local operations

C_i = Cost of collisions between two aircraft in class i

Also:

$$C_i = 2\left[R_i(k_i L_i + l_i I_i) + D_i A_i\right]$$

Where:

R_i = Average number of persons aboard an aircraft of class i

k_i = Fraction of those persons aboard an aircraft of class i receiving fatal injuries in a collision

l_i = Fraction of those persons aboard an aircraft of class i receiving severe injuries in a collision

L_i = Liability for a fatal injury received aboard an aircraft of class i

I_i = Liability for a serious injury received aboard an aircraft of class i

D_i = Average damage factor for aircraft of class i involved in collision--includes approximately 10 percent for accident investigation costs, baggage loss, etc.

A_i = Average value of aircraft of class i

Current values used for the above items are shown in Table 5-1.

2. Benefits from Prevented Accidents (B_2)

The benefits from prevented accidents (B_2) of the types shown to have less frequency of occurrence at tower airports are estimated as follows:

$$B_2 = \sum_{i=1}^{m} P_i X_i C_i$$

TABLE 5-1

Current Values of Collision Cost Elements ($000)

Class (i)	R_i	k_i	($000) L_i	l_i	($000) I_i	D_i	($000) A_i
1 - air carrier	40.0 1/	0.5 4/	300.0 6/	0.005 4/	61.8 6/	.75 5/	4500.0 8/
2 - air taxi	6.6 2/			0.1			150.0 2/
3 - military (light)	2.5	0.36					30.0 9/
4 - military (medium)	6.6	0.5					150.0
5 - military (heavy)	10.0			0.005			4500.0
6 - general aviation itinerant	2.5 3/	0.36 5/		0.1 5/		7/	30.0
7 - general aviation local	2.0 3/		300.0		61.8		20.0

1/ "Estimated Number of Persons to be Served by ILS's and ATCT's in FY 1970 Program," National Bureau of Standards for the FAA, June 1970.

2/ "Commuter Air Carrier Operations as of September 1969," Office of Management Systems, FAA. This report estimated average seat availability as 10 per aircraft. Average load factors estimated at 46 percent plus a crew of 2 for a total of 6.6 persons aboard.

3/ "Study of General Aviation Flying Occupant Load Factors," FAA, Office of Management Systems, May 1970.

4/ "Annual Review of U. S. Air Carrier Accidents, 1967-1968," NTSB.

5/ "Analysis of the Costs and Effectiveness of Air Traffic Control Towers," Second Interim Report, FAA, Office of Aviation Economics, September 1970.

6/ From CAB non-Warsaw Pact accident payments for period 1956 to 1970 - extrapolated to 1974 (modified for consistency with other analyses).

7/ "Annual Review of Aircraft Accident Data U. S. General Aviation 1967, 1968, 1969."

8/ Estimated on the basis of the average values of DC-9, B-727 aircraft.

9/ "An Analysis of ARTS III Terminal Area Automation System - Benefits and Costs," Office of Aviation Policy and Plans, FAA, November 1969.

Where:

P_i = annual "preventable" accident rate for aircraft class i

For all classes except air carrier and military (heavy) operations:

$$P_i = S\left[\frac{1}{1.66267 + O_T(-0.00318934)}\right]$$

For air carrier (ac) and military - heavy (mh) operations:

$$P_i \text{ (ac or mh)} = S\left[\frac{O_T(0.00665)}{25}\right]$$

And:

O_T = Annual total operations

S = Factor to account for statistical uncertainty in mean value--in this case factor S is set at 2

P_i was determined on the basis of the difference in accident rates at tower and non-tower airports over a 5-year period. It is a best fit function describing the relationship between average accident rates and traffic activity. Since the accident rates for air carriers were significantly lower than for other types of operations, these rates are shown separately.

Basic accident rates and additional categorizations are contained in "An Analysis of the Costs and Effectiveness of Air Traffic Control Towers," Second Interim Report, FAA, Office of Aviation Economics, July 1970.

X_i = Ratio of operations of aircraft class i to total operations

C_i = Average costs of accidents for aircraft of class i

And:

$$C_i = R_i(h_i L_i + I_i g_i) + d_i A_i$$

Where:

h_i = Fraction of those aboard an aircraft of class i receiving fatal injuries in an accident

g_i = Fraction of those aboard an aircraft of class i receiving serious injuries in an accident

d_i = Average damage factor for aircraft of class i involved in accidents

The remainder of the symbols are the same as those shown under C_i for the B_i computation.

Current values used for the above items are shown in Table 5-2.

3. Benefits from Reduced Flying Time (B_3)

Benefits from time saved (B_3) at control tower airports are estimated as follows:

$$B_3 = \sum_{i=1}^{m} F_i \, q_i \, x_i \, f_i$$

Where:

F_i = Average extra flying time (minutes) for an aircraft of class i to overfly an airport to determine landing direction, airport conditions, traffic conditions, etc.

x_i = Annual operations of aircraft class i

q_i = Fraction of operations of aircraft class i which overfly airport

f_i = Direct and indirect operating cost (per minute) for an aircraft of class i

Currently used values are estimated as shown in Table 5-3.

4. Other Benefits (B_4)

The other benefits (B_4) are estimated as follows:

$$B_4 = .2(B_1 + B_2 + B_3)$$

TABLE 5-2

Current Values of Accident Cost Elements ($000)

Class (i)	R_i	h_i	($000) z_i	g_i	I_i	d_i	($000) A_i
1 - air carrier	40.0	0.0 [1]	300.0	0.0 [1]	61.8	.3 [1]	4500.0
2 - air taxi	6.6	0.005		0.01		.5	150.0
3 - military (light)	2.5					.5	30.0
4 - military (medium)	6.6					.5	150.0
5 - military (heavy)	10.0	0.0		0.0		.3	4500.0
6 - general aviation itinerant	2.5	0.005 [2]		0.01 [2]		.5 [3]	30.0
7 - general aviation local	2.0	0.005	300.0	0.01	61.8	.5	20.0

1/ "Annual Review of U. S. Air Carrier Accidents 1967-1968," NTSB.

2/ "An Analysis of the Costs and Effectiveness of Air Traffic Control Towers," Second Interim Report, FAA, Office of Aviation Economics, September 1970.

3/ "Annual Review of Aircraft Accident Data - U. S. General Aviation 1967, 1968, 1969."

TABLE 5-3

Current Values of Time Saved Elements

	F_i	q_i	f_i $/min.
Class 1 - air carrier	---	0	9.00
Class 2 - air taxi	1.5	.10	2.80
Class 3 - military (light)	↓	.25	.42
Class 4 - military (medium)	↓	.25	2.80
Class 5 - military (heavy)	↓	.25	9.00
Class 6 - general aviation itinerant	↓	.25	.42
Class 7 - general aviation local	↓	.125	.42

5. Benefit/Cost Ratio

The benefit/cost ratio is defined as follows:

$$B/C = \frac{\text{Annual Dollar Value of Benefits}}{\text{Annual Costs for Construction and Operation of Tower}}$$

As noted in Section II, if the ratio is less than 1, the dollar value of equipment, lives, and times which are achieved is less than the dollar costs necessary to establish and maintain the facility. If the ratio is one or more, then the benefits will recoup the facility costs.

The formulas, current values of collision cost elements, accident cost elements, and current values of time saved have all been programmed and stored in a time-share computer. Immediate calculation and printout of the benefit/cost ratio can be accomplished. An explanation and examples of the computer output are described in Section VI.

ATTACHMENT 2

OTA "RISKS TO HUMANKIND" STUDY

TASKS TO BE PERFORMED

Task 1 - Conduct planning workshops

Task 2 - Establish an advisory panel

Task 3 - Perform exploratory interviews

Task 4 - Develop an inventory of risks

Task 5 - Develop case history profiles of risks

Task 6 - Analyze information flow to the public and decision-makers (case histories)

Task 7 - Compare and analyze methods of risk assessment

Task 8 - Explore perceptions of risks

A. Cultural differences

B. Historical trends

C. Recent trends

Task 9 - Develop a model of technological risks

Task 10 - Examine the origins and implementation of present government risk management policies

Task 11 - Probe estimations of the costs of risk management: public versus private risks, profits, opportunity costs, transaction costs, and social costs

Task 12 - Examine reactions to [illegible] events

A. Natural haz[illegible]

B. Technological hazards

Task 13 - Assess the implications of risk management strategies for:

A. Civil liberties

B. Civil rights

C. Social ambience

Task 14 - Analyze risks of competing systems

Task 15 - Make quantitative data more understandable

Task 16 - Report results

APPENDIX C

BIBLIOGRAPHY RELATED TO

NUCLEAR POWER REACTOR SITING POLICY

APPENDIX C

BIBLIOGRAPHY RELATED TO NUCLEAR POWER REACTOR SITING POLICY

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16. ABSTRACT *(200 words or less)* In August 1978, the Nuclear Regulatory Commission directed the staff to develop a general policy statement on nuclear power reactor siting. A Task Force was formed for that purpose and has prepared a statement of current NRC policy and practice and has recommended a number of changes to current policy. The recommendations were made to accomplish the following goals: (1) To strengthen siting as a factor in defense in depth by establishing requirements for site approval that are independent of plant design consideration. The present policy of permitting plant design features to compensate for unfavorable site characteristics has resulted in improved designs but has tended to deemphasize site isolation; (2) To take into consideration in siting the risk associated with accidents beyond the design basis (Class 9) by establishing population density and distribution criteria. Plant design improvements have reduced the probability and consequences of design basis accidents, but there remains the residual risk from accidents not considered in the design basis. Although this risk cannot be completely reduced to zero, it can be significantly reduced by selective siting and (3) To require that sites selected will minimize the risk from energy generation. The selected sites should be among the best available in the region where new generating capacity is needed. Siting requirements should be stringent enough to limit the residual risk of reactor operation but not so stringent as to eliminate the nuclear option from large regions of the country. This is because energy generation from any source has its associated risk, with risks from some energy sources being greater than that of the nuclear option.

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