GENERAL ELECTRIC
COMPANY
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ATOMIC PRODUCTS
DIVISION
ATOMIC POWER EQUIPMENT DEPARTMENT

June 16, 1961

Secretary
U.S. Atomic Energy Commission
Washington 25, D. C

Attention: Director, Division of Licensing and Regulation

Gentlemen:

Attached are six copies of General Electric's comments on the proposed Reactor Site Criteria published in the Federal Register of February 11, 1961.

Yours very truly,

George White
General Manager

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attachments

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COMMENTS OF GENERAL ELECTRIC COMPANY

ON

PROPOSED AEC REACTOR SITE CRITERIA

These comments are submitted on the proposed reactor site criteria published in the Federal Register of February 11, 1961 (26 F.R. 1224). The discussion is divided into the following sections:

I. The Purpose of Site Criteria and their Limitations

II. The Contributions of Site Considerations to Reactor Safety

III. Criteria for Exclusion Areas and Low Population Zones

IV. Criteria for Population Center Distances

V. The Proposed Appendix "A".

VI. Summary of Conclusions

I. THE PURPOSE OF SITE CRITERIA AND THEIR LIMITATIONS

General Electric welcomes the development of site criteria as a useful step in the direction of making reactor regulation more predictable and less burdensome. Reactor regulation must move in the direction of standardization in order to avoid becoming a major bottleneck when a significant fraction of all new power plant additions will be nuclear. We recognize that the transition from the present pattern of regulation on a case-by-case review basis to regulation by standards must come gradually, and that regulation by standards cannot completely supplant individual review. Preservation of flexibility in the regulatory process is of great importance, particularly at the present stage of the nuclear business. However, the need for flexibility should not let us lose sight of the crucial importance of developing standards. Because the development of standards is a difficult and time-consuming task, it is desirable to start now.

We fully concur with the statement of purpose in Section 100.1 of the Commission's proposed site criteria that "it is not possible to define such criteria with sufficient definiteness to eliminate the exercise of agency judgment in the evaluation of these sites...." Nonetheless, the issuance of site criteria now can accomplish two useful purposes. First, they should enable a utility contemplating the construction of a reactor to make at least a preliminary determination whether a proposed site is likely to be acceptable for a reactor designed with customary safety features. In the favorable case, such a preliminary determination should be possible without extensive engineering work and prolonged consultation with AEC. A negative indication, on the basis of the site criteria, should not be regarded as conclusive. It would, however, mean that detailed engineering work and consultation with AEC would be necessary before it can be determined whether the site is or can be made acceptable, because of the range and variety of engineering features which may be available to compensate for site deficiencies.

The second purpose which would be served by issuing site criteria of admittedly limited value would be to provide a basis for their development and improvement. In the regulatory area, as well as in the technical area, much "development work" is required. In both areas, actual experience is likely to lead to the fastest progress.

To permit the site criteria to be improved in the light of greater knowledge and experience, periodic revision should be required. Such revision should take place at intervals no greater than two years. We regard the inclusion of such requirement for periodic revision to be of the greatest importance.

II. THE CONTRIBUTION OF SITE CRITERIA TO REACTOR SAFETY

Before commenting on specific features of the Commission's proposed site criteria, it is desirable to place site considerations into proper prospective from the standpoint of their contribution to reactor safety. One fundamental point is that the contribution which site considerations can make to the safety of the public is relatively small, when compared to the contribution made by engineering barriers to the release of fission products. The Brookhaven report estimated the probability of a serious nuclear accident to be in a range between once in a hundred thousand and once in a billion reactor years. It is doubtful whether site conditions are likely to make a contribution to this low probability greater than one or two orders of magnitude, unless reactors were located in areas more than perhaps a hundred miles from population centers.

The suggestion that reactors be "located in the desert" is again receiving some currency. A historical and an economic note are relevant. The reactors built during the first decade of the American atomic program were generally built in very isolated locations. In the early fifties it was decided that, with the addition of a pressure tight containment sphere, the SIR prototype could be built at West Milton, near Schenectady, instead of in the Idaho desert. This precedent was followed in locating the Shippingport plant near

Pittsburgh. The principle that a contained reactor could be built near population centers has been followed ever since. It is clear that the economics of electrical energy transmission are such that nuclear power plants cannot be built at great distances from the load centers which they serve. The costs of transmitting electricity one hundred miles have been estimated to be in the range of 0.6-0.8 mills/kwh. This is equivalent to between one-quarter and one-third of the total nuclear fuel cycle cost of a large power reactor which can now be built.

The Anderson-Price Act, in effect, represents a Congressional judgment that reactors can be built sufficiently near population centers to make their use as power plants practical, and that it is consistent with the national interest to accept the remote, residual risk of a serious nuclear incident. It is obvious that a national policy of providing liability protection, for private reactors, on the scale of the Anderson-Price Act was only called for on the assumption that reactors were to be built close to population centers. This is fully borne out by the legislative history of the Anderson-Price Act. The Congressional judgment underlying the Anderson-Price Act provides the key policy decision for the establishment of reactor siting criteria.

Starting out from the premise that reactors can be built near population centers, the question becomes: How near? Two separate but related considerations are relevant. First, distance from population centers is likely to have an importance from the public acceptance standpoint, which may well exceed its significance from a technical standpoint. Second, it must be recognized that our present experience with large power reactors and their safety features is quite limited. Increased experience should result in a substantially higher level of confidence in the integrity of the engineered safety features. These considerations suggest that it may well be appropriate, for the next few years, to follow a siting policy which encourages the use of sites some reasonable distance from large population centers. As public confidence in the integrity of the engineered safety factors increases, the importance attached to distance can be progressively diminished.

Recognizing the public acceptance value of distance, it is still highly desirable to use site criteria which will make the most effective contribution to safety. As will be explained in some detail in Section IV below, we believe the arbitrary population center distance factor proposed by the Commission gives little assurance that the reactor will in fact be located so as to reduce the probability of affecting population centers. We are suggesting instead an approach which combines distance, wind direction, and other meteorological and topographical conditions so as to enable site criteria to make the most effective contribution to the reduction of the probability that a nuclear incident will affect a population center.

III. EXCLUSION AREA AND LOW POPULATION ZONE

We agree with the provisions with respect to the exclusion area and the low population zone contained in Section 100.11(a)(1) and (2) of the proposed site criteria. The use of a total radiation dose to the whole body of 25 rems and an iodine exposure to the thyroid of 300 rems represents an acceptable measure for use in these criteria. Similarly, the two hour period for the exclusion area and the period of the entire incident for the low population zone both appear reasonable.

We strongly question the desirability of specifying in Appendix A any assumptions regarding the fission product release and subsequent behavior. A number of technical objections to Appendix A are raised in Section V below. Our basic concern however is not with the specific technical judgments underlying Appendix A but rather with the assumption that uniform accident assumptions should be made. The rate of fission product release is obviously dependent on the containment system and on other features of reactor and plant design. We believe therefore that the exclusion area and the low population zone should both be based on the analysis of the maximum credible accident as calculated for the particular reactor and plant design, applicable site data, and on reasonable interpretations of the laws of nature.

IV. CRITERIA FOR POPULATION CENTER DISTANCES

Section 100.11(a)(3) specifies that the distance to the nearest population center of more than 25,000 shall be 1-1/3 times the distance to the outer boundaries of the population zones. We believe that the substitution of a rating system which would reflect all population centers in the surrounding area, and other environmental factors in addition to distance, would provide a much greater degree of assurance that site criteria will make a significant contribution to public safety. The use of distance alone may well be misleading. For example, it may be worse to locate a reactor a substantial distance from a city in a prevailing wind direction, than at a smaller distance in an unlikely wind direction.

The location of a reactor can be used independently from the engineered barriers, to reduce the probability that fission products leaving the site will reach population centers. The additional degree of safety against such effects contributed by site selection is a function of the relationship of the plant location to nearby population centers, and the probability that an airborne contaminant would be conveyed to such centers in sufficient concentration to produce an effect of concern.

Rating Method Recommended

It is recommended that a numerical rating method be developed which considers the most important factors which affect the natural value of a site. Such a method should be independent of reactor type, recognizing that the engineered safety features of any plant to be built near population centers much achieve an acceptable level of safety.

It is believed that a meaningful numerical method can be derived considering:

a. Number of inhabitants in each nearby population center

b. Distance from the site to each population center

c. Angle presented by population center as viewed from site

d. Fraction of time when various diffusion conditions exist, and

e. For each diffusion category, fraction of time that wind is in the population center angle.

For any site, the numerical "potential risk index" would be the summation of the indices considering each nearby population center. For each population center, the index would be the summation, for each diffusion category considered, of the products of population, diffusion factor, and fraction of time that wind is in the population center angle.

It is recognized that detailed study of this approach will probably reveal additional factors which should be included. For example, the index reduction factor due to atmospheric diffusion in a given distance should include the effect of topography.

It is suggested that all population centers within approximately 50 miles of the site be considered. This distance appears reasonable in view of the probability that the wind during any period of poor diffusion conditions probably would not continue beyond this distance. While greater distances might be affected with higher wind velocities, such velocities would be accompanied by correspondingly better diffusion conditions. Such a method properly measures the value of a site with regard to all population centers which are likely to be affected, and thus provides a more equitable and realistic approach than consideration of the nearest city of a certain size only.

Meteorological Data Required

This method requires the ability to postulate general fractions of the time that various broad category diffusion conditions exist at the site, and some knowledge of the wind direction distribution during each diffusion category. For most sites, these data can generally be approximated from existing nearby or regional weather stations. Due to the vast difference between good and bad diffusion conditions, the inversion period will control numerically. Great precision in the data used will not be required, as the order of magnitude of the over-all index for a site will indicate its natural value in affording protection. Any necessary meteorological projections could be made by impartial consultants.

Interpretation of Index

Following development of proper index factors and trial application to a number of sites, it will be possible to categorize index results as:

Index Range	Site Suitability
(low)	Suitable
(medium)	Questionable
(high)	Probably unsuitable

Some variations in the index ranges may be appropriate in order to reflect very large variations in the average inventory of fission products between different reactors.

Those sites determined to be "suitable" by this method would be eligible for reactors with engineered safety features considered appropriate in current practice. Those sites in the "questionable" or "probably unsuitable" category present the possibility of being made suitable if sufficient additional engineered barriers can be included in the plant design to reduce the probability of causing serious effects on large numbers of people to an extent at least equal to the reduction which would have been afforded by favorable site conditions. We would be pleased to cooperate with the Commission in the technical development of an evaluation method of this nature.

Meteorological conditions are usually of substantially greater importance than mileage in determining the value of a site from a safety standpoint. The Convair and Hanford studies which the Commission has sponsored have made significant contributions to a fuller understanding of the meteorological conditions which may affect fission product distribution. It is highly desirable that further work in this area be done and applied to the problem of reactor location.

V. COMMENTS ON APPENDIX A

The apparent objective of the proposed Appendix "A" is to provide a simplified accident analysis method for general application. Because the analysis of credible accidents is highly dependent upon the reactor and plant design and to a certain extent on site conditions, standardization of analytical methods does not appear desirable. The general use of oversimplified analysis methods will produce answers which may be dangerously lax for some applications and excessively restrictive in others. We question the need to publish any examples of analytical methods, since the public record, in the form of hazards reports on commercial reactor projects over the past several years, provides a wide variety of examples of analytical methods. In addition to these general comments regarding the purpose of the proposed Appendix A, we have a number of comments on specific technical assumptions:

1. Appendix A considers two specific modes of exposure. We question the desirability of looking at direct radiation and thyroid dose only. A preferable analytical method would reach conclusions based upon whatever modes of exposure are of significance.

2. The fission product release assumptions are apparently based on the premise that a major portion of the fission products of the core will be available for release to the enclosure in a short period of time. We question

the validity of this premise. Conservative calculations indicate that only a few percent of the core could be initially involved in an excursion, and that several hours of absence of coolant are required for a major fraction of the core to melt due to afterheat.

3. Only a minor allowance is made for fission products removed by plate-out. Considering the high probability of operation of both plate-out and washout mechanisms, it is probably unrealistic to picture the absence of such mechanisms, particularly when the period of interest is in the range of hours to days.

4. The uniform enclosure leakage assumed appears to ignore the phenomena which will decrease residual pressure and leakage. These are highly dependent upon type of containment.

5. In calculating decay within the enclosure, the use of gross fission product decay seems undesirable. The actual residual quantities of fission products present should be decayed in accordance with their individual half-lives.

6. There is no reason for ignoring radioactive decay after leakage has occurred.

7. There is no necessity for ignoring deposit of halogen and solid fission products on the ground. In the case of halogen leakage, this actually is an important method of reduction of cloud inventory. The suggested calculation method, therefore, overestimates thyroid dose due to iodine inhalation.

8. The Appendix makes no mention of elevation of release, but the results indicate that a ground level release probably was assumed. The significance of the radiological effects is highly dependent on elevation of

release, which in turn is dependent on plant design factors. Even in the case of release near the ground level, ignoring the initial dilution resulting from the wake effect of the plant buildings unnecessarily overestimates off-plant effects.

9. The calculated results apparently assume no variation in wind direction or in atmospheric stability during the entire period of release. Such assumptions appear unrealistic, particularly when a leakage period of many days is considered. The absence of wind direction diversity contributes to a serious overestimate of the hazard.

10. The Appendix assumes that the enclosure is a direct radiation gamma source. This is of course dependent on plant design features. In the example, there appears to be no reason for the arbitrary shielding factor of ten which was assumed.

VI. SUMMARY OF CONCLUSIONS

Our conclusions can be summarized as follows:

First, we endorse the development of site criteria and agree that criteria should be published at this time. The criteria should provide for periodic revision.

Second, we welcome the recognition by the Commission of the limitations of site criteria: published criteria cannot eliminate the exercise of agency judgment.

Third, we agree with the proposed provisions with respect to the determination of exclusion areas and low population zones, but recommend that calculations with respect to potential fission product release be based on an release, which in turn is dependent on plant design factors. Even in the case of release near the ground level, ignoring the initial dilution resulting from the wake effect of the plant buildings unnecessarily overestimates off-plant effects.

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Third, we agree with the proposed provisions with respect to the determination of exclusion areas and low population zones, but recommend that calculations with respect to potential fission product release be based on an analysis of the maximum credible accident taking into account the specific reactor design, rather than on the basis of any uniform, arbitrary, accident assumptions.

Fourth, we regard the proposed population center distance factor as technically unjustified, and recommend the development of a rating system which factors in meteorology and other environmental factors, in addition to distance. Such an approach provides a much greater degree of assurance that population center distance will make a significant contribution to public safety.

Fifth, we do not agree with the general applicability or the technical validity of the proposed Appendix "A" and urge that the Appendix be deleted.

George White
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June 16, 1961

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COMMENTS RECEIVED ON SITE CRITERIA

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