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UNITED STATES
ATOMIC ENERGY COMMISSION
Washington 25, D. C.

Dr. Forrest Weston

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No. E-109
Tel. Hazelwood 7-7831
Ext. 3446

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see AEC-R 2/39

AEC APPROVES REACTOR SITE CRITERIA GUIDES

The Atomic Energy Commission has approved criteria which it will use to guide its evaluation of proposed sites for stationary power and test reactors licensed by AEC.

The Commission has developed the guides so that industry, state and local officials and the general public will be familiar with the factors which are considered by AEC in judging proposed sites for reactors.

The guides reflect an attempt to provide an objective basis for reactor siting to the extent that current reactor technology allows, but do not eliminate entirely the continued need for subjective judgments both by applicants for reactor permits and licenses and by the Commission. The criteria have been established as guides for the interim period until enough experience can be accumulated with reactors to provide a more definitive correlation of factors pertinent to the question of reactor siting and to permit the writing of more definitive standards. Sufficient flexibility has been included in the guides to allow for this orderly evolution of siting standards as the industry progresses.

The guides apply primarily to power and testing reactors of a general type and design on which operational experience has been gained, but they can also be applied, with appropriate modifications, to other reactors. For reactors that are novel in design and unproved as prototypes, it is expected that the criteria will be applied in a manner that takes into account the lack of experience. Applicants for reactor construction permits may demonstrate to AEC the applicability and significance of factors other than those set forth in the guides.

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The guides were developed by the Commission in consultation with its Advisory Committee on Reactor Safeguards and following discussions with industrial groups. They were published for public comment on February 11, 1961, and 34 formal comments were received. There was widespread support of the AEC proposal to issue guides and there was general acceptance of the basic factors included in them, particularly the issuance for the first time of radiation exposure values which could be used in the design of reactors and in the evaluation of sites with respect to potential accidents.

Objective of these guides and of all Commission activities involving reactor licensing and operation is to keep the exposure of individuals to radiation at a minimum in the event, however remote, that an accident should occur with a reactor.

Factors which are considered by the Commission in judging proposed sites are:

1. Population density in the area surrounding the proposed site, and the uses which are made of this area, such as industrial, farming, residential.
2. Physical characteristics of the site, including seismology, meteorology, geology and hydrology.
3. Characteristics of the proposed reactor, including maximum power level; use of the facility; extent to which the design of the reactor incorporates well proved engineering standards; and the extent to which the reactor incorporates unique or unusual features which have a significant bearing on the probability or consequences of an accident.

An applicant is required to calculate three distances:

A. Exclusion area, the area surrounding the reactor in which the licensee has authority to determine all activities, including exclusion or removal of personnel and property from the area. Residence within this area normally would be prohibited. If residence is permitted, it must be possible to move these persons quickly in order to minimize hazard.

B. Low population zone, the area immediately surrounding the exclusion area. In this area the number of residents must be small enough so that they could be evacuated

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or other protective measures taken on their behalf in the event of a serious accident.

C. Population center distance, the distance from the reactor to the nearest boundary of a densely populated center containing more than 25,000 residents.

Public comments received following publication of the proposed guides raised objection to the appendix section which included an example of calculation distances for the exclusion area, low population zone, and population center distance for a hypothetical reactor. Objections centered around concern that the numerical values expressed in the appendix and the resulting distances represented a larger degree of inflexibility in the guides than intended.

In order to eliminate ambiguity, the example calculation has been deleted from the site criteria guides. The calculational procedure used to arrive at these distances and related explanatory information are being incorporated into a Technical Information Document 14844 which soon will be issued by AEC. This document should be helpful to industry as a reference work. The calculational approach illustrated in the TID results in distances which generally correspond with current siting practices of the Commission.

Other significant differences between the criteria guides as first published for comment and those approved by the Commission are:

1. Some editorial changes have been made to clarify the intent of the guides, particularly to emphasize their interim nature and to identify the criteria as being specific to the United States.

2. The material describing factors to be considered in evaluating sites has been reorganized to clarify the emphasis placed upon characteristics of the reactor design and the proposed operation.

3. The criteria now specifically state that the guides are directly applicable to stationary power and test reactors, thus eliminating any ambiguity about their application to mobile plants, which was not intended.

4. A section has been included to deal with the question of locating more than one reactor at a single site.

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The Commission is giving notice that it has adopted these reactor site criteria guides, 10 CFR Part 100, effective 30 days after publication in the Federal Register.

A copy of the "Reactor Site Criteria Guides" is attached.

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ATOMIC ENERGY COMMISSION
(10 CFR Part 100)
REACTOR SITE CRITERIA

Pursuant to the Administrative Procedures Act and the Atomic Energy Act of 1954, as amended, the following guide is published as a document subject to codification, to be effective 30 days after publication in the Federal Register.

Statement of Considerations

On February 11, 1961, the Atomic Energy Commission published in the Federal Register a notice of proposed rule making that set forth general criteria in the form of guides and factors to be considered in the evaluation of proposed sites for power and testing reactors. The Commission has received many comments from individuals and organizations, including several from foreign countries, reflecting the widespread sensitivity and importance of the subject of site selection for reactors. Formal communications have been received on the published guides, including a proposed comprehensive revision of the guides into an alternate form.

In these communications, there was almost unanimous support of the Commission's proposal to issue guidance in some form on site selections, and acceptance of the basic factors included in the proposed guides, particularly in the proposal to issue exposure dose values which could be used for reference in the evaluation of reactor sites with respect to potential reactor accidents of exceedingly low probability of occurrence.

On the other hand, many features of the proposed guides were singled out for criticism by a large proportion of the correspondents. This was particularly the case for the appendix section of the proposed guides, in which was included an example calculation of environmental distance characteristics for a hypothetical reactor. In this appendix, specific numerical values were employed in the calculations. The choice of these numerical values, in some cases involving simplifying assumptions of highly complex phenomena, represent types of considerations presently applied in site calculations and result in environmental distance parameters in general accord with present siting practice. Nevertheless, these particular numerical values and the use of a single example calculation were widely objected to, basically on

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the grounds that they presented an aspect of inflexibility to the guides which otherwise appeared to possess considerable flexibility and tended to emphasize unduly the concept of environmental isolation for reactors with minimum possibility being extended for eventual substitution thereof of engineered safeguard.

In consequence of these many comments, criticisms and recommendations, the proposed guides have been rewritten, with incorporation of a number of suggestions for clarification and simplification, and elimination of the numerical values and example calculation formerly constituting the appendix to the guides. In lieu of the appendix, some guidance has been incorporated in the text itself to indicate the considerations that led to establishing the exposure values set forth. However, in recognition of the advantage of example calculations in providing preliminary guidance to application of the principles set forth, the AEC will publish separately in the form of a technical information document a discussion of these calculations.

These guides and the technical information document are intended to reflect past practice and current policy of the Commission of keeping stationary power and test reactors away from densely populated centers. It should be equally understood, however, that applicants are free and indeed encouraged to demonstrate to the Commission the applicability and significance of considerations other than those set forth in the guides.

One basic objective of the criteria is to assure that the cumulative exposure dose to large numbers of people as a consequence of any nuclear accident should be low in comparison with what might be considered reasonable for total population dose. Further, since accidents of greater potential hazard than those commonly postulated as representing an upper limit are conceivable, although highly improbable, it was considered desirable to provide for protection against excessive exposure doses to people in large centers, where effective protective measures might not be feasible. 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 and reflect a more accurate guide to current siting practices. In an effort to develop more specific guidance on the total man-dose concept, the Commission intends to give further study to the

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subject. Meanwhile, in some cases where very large cities are involved, the population center distance may have to be greater than those suggested by these guides.

A number of comments received pointed out that AEC siting factors included considerations of population distributions and land use surrounding proposed sites but did not indicate how future population growth might affect sites initially approved. To the extent possible, AEC review of the land use surrounding a proposed site includes considerations of potential residential growth. The guides tend toward requiring sufficient isolation to preclude any immediate problem. In the meantime, operating experience that will be acquired from plants already licensed to operate should provide a more definitive basis for weighing the effectiveness of engineered safeguards versus plant isolation as a public safeguard.

These criteria are based upon a weighing of factors characteristic of conditions in the United States and may not represent the most appropriate procedure nor optimum emphasis on the various interdependent factors involved in selection of sites for reactors in other countries where national needs, resources, policies and other factors may be greatly different.

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SITE EVALUATION FACTORS

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g 100.1 Purpose

It is the purpose of this part to describe criteria which guide the Commission in its evaluation of the suitability of proposed sites for stationary power and testing reactors subject to Part 50 of this chapter.

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. Any applicant who believes that factors other than those set forth in the guide should be considered by the Commission will be expected to demonstrate the applicability and significance of such factors.

g 110.2 Scope

(a) This part applied to applications filed under Part 50 and 115 of this chapter for stationary power and testing reactors.

(b) The site criteria contained in this part apply primarily to reactors of a general type and design on which experience has been developed, but can also be applied to other reactor types. In particular, for reactors that are novel in design and unproven as prototypes or pilot plants, it is expected that these basic criteria will be applied in a manner that takes into account the lack of experience. In

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the application of these criteria which are deliberately flexible, the safeguards provided--either site isolation or engineered features--should reflect the lack of certainty that only experience can provide.

g 100.3 Definitions

As used in this part:

(a) "Exclusion area" means that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad, or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety. Residence within the exclusion area shall normally be prohibited. In any event, residents shall be subject to ready removal in case of necessity. Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result.

(b) "Low population zone" means the area immediately surrounding the exclusion area which contains 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. These guides do not specify a permissible population density or total population within this zone because the situation may vary from case to case. Whether a specific number of people can, for example, be evacuated from a specific area, or instructed to take shelter, on a timely basis 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.

(c) "Population center distance" means the distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents.

(d) "Power reactor" means a nuclear reactor of a type described in gg 50.21(b) or 50.22 of this chapter designed to produce electrical or heat energy.

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(e) "Testing reactor" means a "testing facility" as defined in g 50.2 of this chapter.

g 100.10 Factors to be considered when evaluating sites

Factors considered in the evaluation of sites include those relating both to the proposed reactor design and the characteristics peculiar to the site. It is expected that reactors will reflect through their design, construction and operation an extremely low probability for accidents that could result in release of significant quantities of radioactive fission products. In addition, the site location and the engineered features included as safeguards against the hazardous consequences of an accident, should one occur, should insure a low risk of public exposure. In particular, the Commission will take the following factors into consideration in determining the acceptability of a site for a power or testing reactor:

- (a) Characteristics of reactor design and proposed operation including:
 - (1) Intended use of the reactor including the proposed maximum power level and the nature and inventory of contained 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 incorporates unique or unusual features having a significant bearing on the probability or consequences of accidental release of radioactive materials;
 - (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.
- (b) Population density and use characteristics of the site environs, including the exclusion area, low population zone, and population center distance.
- (c) Physical characteristics of the site, including seismology, meteorology, geology and hydrology.

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- (1) The design for the facility should conform to accepted building codes or standards for areas having equivalent earthquake histories. No facility should be located closer than 1/4 mile from the surface location of a known active earthquake fault.
- (2) Meteorological conditions at the site and in the surrounding area should be considered.
- (3) Geological and hydrological characteristics of the proposed site may have a bearing on the consequences of an escape of radioactive material from the facility. Special precautions should be planned if a reactor is to be located at a site where a significant quantity of radioactive effluent might accidentally flow into nearby streams or rivers or might find ready access to underground water tables.

(d) 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.

g 100.11 Determination of exclusion area, low population zone, and population center distance.

(a) As an aid in evaluating a proposed site, an applicant should assume a fission product release^{1/} from the core, the expected demonstrable leak rate from the containment and the meteorological conditions pertinent to his site to derive an exclusion area, a low population zone and population center distance. For the purpose of this analysis, which shall set forth the basis for the numerical values used, the applicant should determine the following:

^{1/} The fission product release assumed for these calculations should be based upon 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. Such accidents have generally been assumed to result in substantial meltdown of the core with subsequent release of appreciable quantities of fission products.

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- (1) An exclusion area of such size that an individual located at any point on its boundary for two hours immediately following onset of the postulated fission product release would not receive a total radiation dose to the whole body in excess of 25 rem^{2/} or a total radiation dose in excess of 300 rem^{2/} to the thyroid from iodine exposure.
- (2) A low population zone of such size that an individual located at any point on its outer boundary who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a total radiation dose to the whole body in excess of 25 rem or a total radiation dose in excess of 300 rem to the thyroid from iodine exposure.
- (3) A population center distance of at least 1 and 1/3 times the distance from the reactor to the outer boundary of the low population zone. In applying this guide, due consideration should be given to the population distribution within the population center.

Where very large cities are involved, a greater distance may be necessary because of total integrated population dose consideration.

^{2/} The whole body dose of 25 rem referred to above corresponds numerically to the once in a lifetime accidental or emergency dose for radiation workers which, according to NCRP recommendations may be disregarded in the determination of their radiation exposure status (see NBS Handbook 69 dated June 5, 1959). However, neither its use nor that of the 300 rem value for thyroid exposure as set forth in these site criteria guides are intended to imply that these numbers constitute acceptable limits for emergency doses to the public under accident conditions. Rather, this 25 rem whole body value and the 300 rem thyroid value have been set forth in these guides as reference values, which can be used in the evaluation of reactor sites with respect to potential reactor accidents of exceedingly low probability of occurrence, and low risk of public exposure to radiation.

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(b) For sites for multiple reactor facilities consideration should be given to the following:

- (1) If the reactors are independent to the extent that an accident in one reactor would not initiate an accident in another, the size of the exclusion area, low population zone and population center distance shall be fulfilled with respect to each reactor individually. The envelopes of the plan overlay of the areas so calculated shall then be taken as their respective boundaries.
- (2) If the reactors are interconnected to the extent that an accident in one reactor could affect the safety of operation of any other, the size of the exclusion area, low population zone and population center distance shall be based upon the assumption that all interconnected reactors emit their postulated fission product releases simultaneously. This requirement may be reduced in relation to the degree of coupling between reactors, the probability of concomitant accidents and the probability that an individual would not be exposed to the radiation effects from simultaneous releases. The applicant would be expected to justify to the satisfaction of the AEC the basis for such a reduction in the source term.
- (3) The applicant is expected to show that the simultaneous operation of multiple reactors at a site will not result in total radioactive effluent releases beyond the allowable limits of applicable regulations.

NOTE: For further guidance in developing the exclusion area, the low population zone, and the population center distance, reference is made to Technical Information Document 14844, dated _____, which contains a procedural method and a sample calculation that result in distances roughly reflecting current siting practices of the Commission. The calculations

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describe in Technical Information Document 14844 may be used as a point of departure for consideration of particular site requirements which may result from evaluation of the characteristics of a particular reactor, its purpose and method of operation.

Copies of Technical Information Document 14844 may be obtained from the Commission's Public Document Room, 1717 H Street N.W., Washington, D. C., or by writing to the Director, Division of Licensing and Regulation, U. S. Atomic Energy Commission, Washington 25, D. C.

Authority: Sections 100.1 to 100.11 issued under Sec. 103, 68 Stat 936, Sec. 104, 68 Stat 937, Sec. 161, 68 Stat 948, Sec. 182, 68 Stat 953; 42 U.S.C. 2133, 2134, 2201, 2232.

Dated at Germantown, Maryland this _____ day of _____ 1962.

FOR THE ATOMIC ENERGY COMMISSION

Woodford B. McCool, Secretary