STANDARD FORM NO. 64

Office Memorandum • UNITED STATES GOVERNMENT

TO : A. R. Luedecke, General Manager
Headquarters

DATE: January 16, 1961

FROM : S. R. Sapirie, Manager
Oak Ridge Operations

SUBJECT: PROPOSED REACTOR SITE CRITERIA

SYMBOL: OE:RWL

The following comments on the proposed subject criteria are furnished in response to your memorandum request of December 23, 1960, enclosing Staff Paper AEC-R 2/19 dated December 10, 1960, subject "Reactor Site Criteria".

City Distance

Although the subject Staff Paper is written to offer a guide to reactor siting rather than firm regulatory criteria, no guidance is given on the method for arriving at a city distance. The proposed CFR text is explicitly silent on the fact that this distance is established on the basis that failure of the containment vessel occurs (i.e., an accident more severe than the maximum credible accident). The Staff Paper also states that the distances are large enough to protect against fatalities even under this theoretical accident. Such an approach, in our opinion, may be criticized for the following reasons:

1. By this action the AEC, although responding to requests for guidance, is still not revealing the fundamental basis of its analysis.

2. The proposed text strongly emphasizes the basis of "maximum credible" when in fact the fundamental analysis is based on the more severe "theoretical" accident.

3. This "theoretical" accident can in fact be superseded by even more severe "theoretical" accidents which can theoretically give doses high enough to cause fatalities at distances greater than the proposed city distances. We cannot review the validity of the particular uncontained accident analysis used since the premises and calculation assumptions for it are not provided in the Staff Paper.

4. The use of this criterion forces the maximum credible analysis to be based on premises which are conservative by factors of

A/30

from 27,000 to 225,000,000,000, according to statements made in Appendix "B", in order to provide for apparent consistency and nearly equivalent values for the evacuation and city distances which are calculated from the "maximum credible" and the "theoretical uncontained" accidents respectively.

In summary the proposed city distances are neither large enough to insure suitably low "theoretical" doses nor small enough to be consistent with rational accident analyses. They are presented within a apparent framework of detailed system analysis when they are in fact calculated by methods not disclosed and which, in our opinion, would be vigorously resisted by the majority of nuclear design organizations.

Evacuation Distance

1. The use of the phrase "evacuation distance" is inappropriate as evacuation may not in fact be necessary, even under an actual maximum credible accident, because of the safety factors in the calculation. Since no guidance is given on allowed population density within the subject distance, the usefulness of the calculated number is also doubtful.

2. It appears that the purposes of this section would be better served by stipulating that the public beyond the exclusion radius would not receive a dose greater than that specified in the criteria under the specified methods for calculating doses. A draft approach is provided as Exhibit A, which directly places the analysis of evacuation requirements with the applicant rather than fixing it arbitrarily in advance.

Detailed Calculations

1. Since the leak rate for calculating the various distances is specified at 0.1% per day, the proposed draft in effect implies that all future containment vessels should be designed at this value. This is not consistent with compensating safety factors elsewhere in the calculation. If the format of the calculations were preserved, a 100 MWt reactor with a containment vessel design leak rate of 0.5% per day would be required to satisfy the city distance criterion for a 500 MWt reactor, since the effective source strength for a contained accident is the available inventory at that power level times the leak rate. This is insupportable since the city distance is established on the basis of no containment whatsoever.

2. The values given for the percentage halogen release and the specified dose criteria are susceptible to change. Any such change could be offset by accepting compensating dose reductions through allowing credit for technically supportable causes such as the more accurate modification of the Sutton equation (factor of 3), wind variability (factor of 3), pressure drop in the containment vessel (factor of at least 5), and so on. The future ability to do so is reduced however by lack of recognition in the draft text of the validity of such mechanisms. This is particularly difficult to rationalize since AEC testimony before the hearing examiner on past projects has defended and supported the use of dose reduction mechanisms (rejected in the draft criteria) as realistic and acceptable. It does not appear that a simple statement that criteria must be arbitrary is sufficient justification for this position.

3. The use of 25,000 residents for a "city" seems arbitrarily high. Presumably a city of 20,000 people would not be allowed in the evacuation area. Apparently also a less than 10 MWt "testing" reactor may be located within a city of any size since such reactors are excluded from the scope of the regulations.

4. Where conversion factors are given on Pages 46 and 47 of Appendix "D", their full derivation should be given as related to values cited in the published technical literature.

Factors Affecting Design

1. We note that an exposure analysis which allows no credit for any design feature intended to prevent or mitigate the effect of a reactor accident (core flooding, containment spray, filtration system, etc.) tends to reduce the incentive for the development or incorporation of such features and thus achieves an end directly opposed to that intended; namely, to maintain and improve the public safety.

2. The use of a tabular device for reactor siting also has the effect of removing the incentive of reactor designers for a full and careful analysis of potential hazards and reduces the impetus to obtain experimental data to better understand the true magnitude of inherent hazards.

Comments of Others

1. We note that the stated opinions of both industry and ACRS are that the guidance desired by the industry should not be promulgated through incorporation into a regulatory document. Our concern

about publication of this material in its present form in the Federal Register would be greatly reduced should such guidance be provided with less restrictive content. Our Exhibit A intends to reduce the over-all restrictive effect in accordance with our above approach. As an aid to continued acceptance of new approaches to the reactor siting problem, we again recommend that the AEC encourage the use, by individuals on the ACRS and in DLR, of technical publications as a forum for discussion of current safety matters beyond the formal guidance provided in the Federal Register.

S. R. Saphrie

Enclosure:
Exhibit A

CC: W. F. Finan, Headquarters, w/encl.
F. K. Pittman, Headquarters, w/encl.
R. C. Armstrong, w/encl.
J. W. Ould, w/encl.
H. M. Roth, w/encl.
L. H. Jackson, w/encl.
L. Dubinski, w/encl.
E. E. Stokely, w/encl.
D. F. Cope, w/encl.

EXHIBIT A

Proposed Site Criteria Summary

1. Maximum acceptable calculated doses to the off-site public-at-large from a maximum credible accident shall be:

   a. 25 rem to the whole body total radiation dose.

   b. 300 rem to the thyroid from radioactive iodine exposure.

   Evacuation of population, if feasible within allowable times, may be proposed to avoid or reduce population exposure.

2. (State here acceptable methods or factors required to calculate:

   (a. Inventory of noble gases, iodines, others per MWt of core.

   (b. Conversion from curies-sec/meter^3 of iodines to calculated ingested dose.

   (c. Graphs or tabulations for acceptable integrated decay factors per unit of time for the three groups of fission products considered.

   (d. Conversion from curies-sec/meter^3 of iodines, noble gases, and others to calculated external dose.)

3. Reactor design shall include, except in unusual circumstances:

   a. Internal system for mitigating degree of or preventing core meltdown in case of MCA.

   b. Containment vessel and maximum assurance of vessel integrity in case of MCA.

   c. Containment vessel cooling system to aid in pressure reduction following MCA.

   d. Shielding and building attenuation of direct gamma source following MCA by factor of at least 10.

   Burden of proof will be on designer to justify any deviation from these requirements.

4. Assumed release to containment vessel from core inventory, unless otherwise justified by experimental data, shall be 100% of the noble gases, 50% of the halogens and 1% of the solids.

5. Vessel shall be assumed to leak at design rate throughout lifetime of accident (until ingested dose contribution from I-131 is no longer significant). Credit may be taken for reduced leakage with pressure reduction inside containment vessel if assurance of such reduction is available.

6. Further reduction of inventory available for leakage may be assumed based upon spray or filter system, settling, plate-out, etc., assuming warranted by design features and experimental evidence.

7. (Here provide the most accurate available form of the modified Sutton equation.) It should be noted that this equation assumes ground level release.

8. Pessimistic values should be used for duration and persistence of inversion conditions and wind direction based on site meteorology. (Here give standard equation for wind variability from center line.) The most unfavorable wind direction(s) shall be assumed.

9. Ground level release, inversion conditions, and no deposition are to be assumed. Values of

   u at 1 meter/sec

   n at 0.5

   $C_y C_z$ at 0.028

   shall be assumed unless more favorable values can be shown to obtain 95% of the time or more.

10. Exclusion radii shall be as follows:

Product of design leak rate at MCA conditions and thermal power level (% MWt/day)	Distance (miles)
150	0.70
50	0.33
5	0.15

(Complete table in more detail.)

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PROPOSED REACTOR SITE CRITERIA

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☐ GENERAL MANAGER ☐ ____
☐ ASST. GENERAL MANAGER ____

REMARKS:

ENCLOSURES
EXHIBIT A

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