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March 5, 1959

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Dr. J. A. Lieberman, Chief
Environmental and Sanitary
Engineering Branch
Reactor Development Division
U. S. Atomic Energy Commission
Washington, D. C.

Dear Dr. Lieberman:

This refers to the letter of February 24, 1959 from Mr. Harold L. Price, Director, Division of Licensing and Regulation transmitting a "Preliminary Draft of Proposed Site Criteria". We have made some comments on this draft and we would appreciate your forwarding copies to the Division of Licensing and Regulation.

Very truly yours,

Harry Wexler
Director of Meteorological Research

Enclosures (4)
Dr. C. K. Beck, US AEC ✓

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Comments on "Preliminary Draft of Proposed Site Criteria"

Prepared by

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March 5, 1959

General — The criteria imply, and we agree, and have so stated in various writings, that the meteorology of a site should not by itself be the determining factor in acceptance or rejection of an individual site; rather such data will assist in establishing the amount of "engineered protective devices". However, if an opportunity is available for selecting one of several possible sites for a particular reactor, the environmental factors (if the economic criteria are the same) will dictate the most suitable locations. The desirability of including meteorological information in emergency plans or accident countermeasures is not discussed in the following comments.

If, in the future, reactors, but more probably exotic nuclear facilities (e.g. fuel processing areas), are sufficiently numerous or their effluents have the longivity (e.g. C^{14}) it may not be sufficient to consider only single installations. The problem may arise as to whether the burden of demonstrating the suitability of a site in relation to the <u>total</u> of all sources is a private or a public responsibility. Obviously this is not an urgent present problem but later installations in a given area may face more stringent requirements to comply with the provisions of 50.46 1. (a).

There are, however, some points on the present practical applications of the general criteria that should be mentioned.

1. 50.46 a. (1) —Does this contemplate the inclusion of atmospheric dilution to arrive at these levels? Inclusion of atmospheric dilution may offer economic advantages to the reactor operator but might not be attractive to management (e.g. our comments on the Yankee site and subsequent conferences). Calculations by Pasquill ("A Study of the Average Distribution of Pollution Around Staythorpe", International Journal of Air Pollution, Vol. 1, pp. 60-70) and the development of a relatively simple method by Gulkowski (to be published as an ORO document) permit quantitative evaluation of dilution on an annual basis.

Yes - Part 20 permits use of atmospheric dilution.

2. 50.46 a. (2) — The limitation of a 25r (or equivalent) dose for the "maximum credible accident" if it occurs "under pessimistic dispersion conditions" places almost the entire burden of environmental protection on the reactor design, operation and containment. This statement is based on the following calculations: True

   a) Strong surface based inversions will occur, and persist for at least 2—4 hours, almost everywhere at one time or another.
   b) Winds as light as 1—2 miles per hour, persisting for 2—4 hours in a 5—10° sector can occur (the direction persistence will be rare).
   c) The accident could result in a "cold" release of fission products at ground level.

   For these conditions the source strength required to give a 25r whole body dose is approximately as follows:

   1/4 mile (400 meters) — 20 Kw of fission products
   3/4 mile (1200 meters) — 90 Kw of fission products

   ($n = 0.5$, $C_y = 0.2$, $C_z = 0.01$, $\bar{u} = 1$ mps)

   For say, a 100 Mw reactor these source strengths represent a total permissible release of .02% and .09% of the reactor fission product inventory.

   If internal exposure is considered and 10 curie-seconds/m^3 is assumed to give a dosage equivalent to 25r external whole body radiation (Marley and Fry) then (for the same meteorological conditions) the permissible source strengths are approximately:

   1/4 mile (400 meters) — 2,500 curies
   3/4 mile (1200 meters) — 13,000 curies

   These values represent, approximately 2.5×10^{-4}% and 1.3×10^{-3}% of the inventory of a 100 Mw reactor.

3. 50.46 c. — A problem in definition may arise here on two considerations. The first is strictly meteorological and occurs because real wind distributions can be nearly circular (i.e. all 16 compass points are almost equally probable) in which case the "prevailing" direction is only slightly more frequent than others, or as in the case of say the CANEL site the winds are channeled by the valley so that northerly and southerly winds are distributed almost 50—50. A good point

Secondly, if the population center is at a sufficient distance the angle subtended by its area may be a) less than the 22 1/2 degree sector defining a given wind direction and/or b) the lateral dispersion of a diffusing cloud of material may also encompass, by the time it reaches a city, less than the entire urban area. This latter situation probably is more pertinent to a "puff" release, since a continuous plume will meander sufficiently (if the wind persists in the same general direction) in 6—12 hours to cover a much wider arc.

4. 50.46 d. — Estimation of dispersion under the "most unfavorable meteorological conditions" would seem to almost eliminate the consideration of sites on meteorological grounds since, as previously mentioned, almost every site will eventually experience conditions favorable for minimum dilution. The major differences between sites is a) the frequency of such occurrences and b) how often the right combination of strong inversion, low wind speeds, and persistent wind direction result in a population center(s) being a target for appreciable lengths of time.

Secondly, it cannot be said a priori that the maximum insult to population will always occur during minimum dilution conditions. It is true that cloud concentrations will be higher in inversions but the area covered, the time available for radioactive decay, etc., would result in greater total damage for a release under more active dispersing conditions. To take an extreme example a very narrow cloud which delivered 2,000r of gamma to a total of 30 persons would have done less total damage than a more diffused, hence wider, cloud delivering 1,000r to 300 individuals. Whether or not this could be so readily assessed for the more likely smaller exposures, say 20r and 10r, respectively, is not in the meteorologist's domain.

The majority of current hazard analyses usually stop with the calculation of concentrations and/or dosages, since the designers postulate engineering safeguards which indicate that even in poor dispersion the exposure levels are innocuous. This is probably sufficient. If, however, such levels cannot be demonstrated then a more extensive analysis of total damage as a function of dispersion regimes, wind direction, etc. (following the techniques of Gomberg or modifications of WASH-740) may better indicate the suitability of a site.

An obvious comment on the population distribution question is that the criteria can, at best, apply only to the present. Forecasts of future distributions, even if accurate, would seem beyond control of the reactor operator.

The foregoing is not a criticism of the proposed site criteria but rather an examination of their implications. Most, if not all, of these points must have been considered in preparation of this draft. The flexibility of the standards has a unique value previously pointed out by Gifford, namely that much of our knowledge of reactor hazards has been developed by reactor designers considering specific devices at specific locations. The present criteria do not discourage further similar study of these problems.