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POPULATION CENTER DISTANCE CRITERIA

References:

1. Letter, R. O. Brittan to Dr. J. Tadmor, Rehovoth, Israel, January 16, 1962.
2. McCullough, C. R., "What Price Safety", Paper at Health Physics Society Meeting, Gatlinburg, Tenn., June 17, 1959.
3. "The Hazards to Man of Nuclear and Allied Radiations"-- Second Report to the Medical Research Council, Her Majesty's Stationery Office, London, 1961.
4. "Savannah, Georgia Site Report", May 1962.
5. "The Hazards to Man of Nuclear and Allied Radiations" - A Report to the Medical Research Council, Her Majesty's Stationery Office, London, 1956.
6. "Report of ICRP Committee II on Permissible Dose for Internal Radiation (1959)", Health Physics (Journal), Volume 3, June 1960.
7. "Reactor Site Criteria", Title 10, Code of Federal Regulations, Part 100 (10CFR100), February 11, 1961.
8. DiNunno, J. J. et al, "Calculation of Distance Factors for Power and Test Reactor Sites", TID-14844, March 23, 1962.

The purposes of determining a population center distance for reactor siting are:

1. To insure that, if a nuclear power plant experiences the maximum credible accident (MCA) near a population center, a large number of people are not exposed to genetic doses which may cause an undue mutation risk to offspring of parents.
2. To insure that nuclear power can be used to the benefit of mankind without undue risk to the health and safety of future generations.

The suggested criteria to be used in establishing such a population center distance for reactor siting are:

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1. The probability of a nuclear power plant experiencing the MCA during its lifetime be extremely remote.
2. The probability of public injury and damage from such accidents be low.
3. An individual located at any point on the boundary who is exposed to the radioactive cloud or radioactive fallout resulting from the postulated MCA would not receive a total integrated dose (TID) to the whole body or gonads in excess of 0.25 rem.
4. The population center distance will always be equal to or greater than the low population zone distance.
5. Dosages received by individuals residing within those areas designated as the exclusion area and low population zone will not be considered to contribute to the general population dose total from the postulated MCA.

During the evaluation of possible criteria to be used in establishing the population center distance for reactor siting, several approaches were examined. In order to justify the direction taken in this memorandum, I will attempt to list some facts and opinions on the various possible approaches examined. The most discussed and least documented approach is the man-rem per accident limit. The following numbers have been suggested in referenced documents:

1. R. O. Brittain⁽¹⁾ - 2×10^5 man-rem/accident
2. C. R. McCullough⁽²⁾ - 6.5×10^5 man-rem/accident
3. British Medical Council⁽³⁾ - 1.3×10^6 man-rem/accident for present U. S. population.
4. N. S. Savannah Project⁽⁴⁾ - 2×10^6 man-rem/accident.

All of these man-rem limits are based on the assumption that a MCA will occur once a year somewhere in the country. Also, these values are based on some fraction of the total man-rem total received per year by the population of the U. S. from background radiation. The estimate for this background total is 6.5×10^7 man-rem per year and each referenced value has arbitrarily chosen a fraction of this total that could be considered "allowable". Thus, I could not see a justification for such criteria to be used either logically or technically. Such criteria follows none of the approaches taken in evaluating reactor siting, reactor safety, or radiological safety. Specific arguments against the use of the man-rem per accident concept for establishing population center distances are:

1. Population changes in any country would necessarily

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- change the value to be used as the "allowable" man-rem per accident total.
2. Small countries with relatively small populations could not use nuclear power plants.
 3. Population density surrounding the reactor site outside the low population zone would have to remain constant or at some time reactor would have to be shutdown.
 4. The acceptable power level of a given reactor design type would be reduced for an increasing power demanding population. Thus, such a criteria would be contrary to the power demand index.
 5. Such criteria presents a variable dose index for the general population using nuclear power. Thus, individuals living in smaller population centers near nuclear plants would be "allowed" to get much larger doses than individuals in larger population centers. Previous safety criteria have never used such an approach.

The British report⁽³⁾⁽⁵⁾ states, "We have concluded that doses up to, and somewhat beyond, the 'doubling dose' need cause no undue concern to the individual as regards his own offspring. Further, we gave reasons for believing that the values for the doubling dose of radiation for human genes may be, in general, in the range of 30r to 80r. We consider, therefore, that an individual could reasonably accept a total dose to the gonads of not more than 50r from conception to the age of 30 years, in addition to that received from the natural background." The ICRP,⁽⁶⁾ however, suggests a value of 2 rems to age 30 years for average gonad dose from man-made radiation (exclusive of medical exposures). These values are not in contradiction since the ICRP value is an average whereas the British value is a maximum value for an individual. These values have been quoted to relate the proposed value of 0.25 rem emergency dose for large populations to the genetic doubling dose and to the suggested ICRP gonad dose.

The ICRP,⁽⁶⁾ also, suggests that a reduction factor of 100 be applied to all maximum acceptable levels of radiation for the general population in respect to gonad dose. Thus, if this suggested reduction factor of 100 is applied to the once in a lifetime accidental or emergency dose of 25 rem used as a guide in LOCFR100⁽⁷⁾ for radiation workers and individuals in the vicinity of a nuclear plant, the resulting once in a lifetime accidental or emergency dose for the general population would be 0.25 rem, the proposed criteria level. As reported in LOCFR100⁽⁷⁾ and TID-14844,⁽⁸⁾ such a dose level criteria for population center distances must only be used as a guide and not as an acceptable emergency dose to large populations.

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