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Washington, D.C.
August 24, 1959

Mr. Harold L. Price, Director
Division of Licensing & Regulation
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Mr. Price:

I am attaching a letter from Miles C. Leverett, Vice President of the American Nuclear Society, giving comments on the "10 CFR CHAPTER 1 POWER AND TEST REACTORS NOTICE OF PROPOSED RULE MAKING". Mr. Leverett was Chairman of the Standards Committee of the American Nuclear Society prior to becoming Vice President of the Society. In forwarding these comments I believe I must make some personal observations as follows.

I fully agree that the procedure of examining the kinds of accidents which might occur to reactors is a valid and useful one in providing the maximum safety for these machines. The difficulty comes in selecting the "maximum credible accident" and then relating the consequences of such an accident to a specific reactor in terms of the damage to the public or the employes. The layman obtains the impression that one is accepting the consequences to the public for this accident happening to the specific reactor being approved.

In the first place if the maximum credible accident or a similar accident is really at the bounds of credulity then this accident should occur very rarely in the nuclear industry - perhaps one in a thousand reactor years or some probability such as this. There are not enough reactors in existence to give any statistical data on the probability of accidents. Although it is possible on the basis of experience to predict the number and kind of accidents which can occur to a large number of similar devices, it is not possible to predict what will happen to a specific device or when this accident will occur. It should also be borne in mind that reactors are built to avoid accidents and it requires some careless or ignorant failure, and usually a number of such, to bring about an accident. It is unrealistic to say that,in the event of an accident which occurs in spite of all precautions and is really at the boundary at what one would consider credible, in the case of such an accident no one will be hurt.

There is a dilemma here in trying to use the technique of examination of accidents to assure that a reactor is adequately safe and the problem of seeming to approve the injury of people. Perhaps this dilemma can be resolved by saying that in the event of the maximum credible accident as long as one or more of the barriers protecting the public remain intact

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no one should receive a lethal dose of radiation. I believe that we can set up a relation between lethal doses and the genetic effects of lower doses given to very large numbers of people and, therefore, our criteria would be usable for judging the consequences of reactor accidents whether they give severe doses to a few people or much lesser doses to a large number of people.

As we have discussed before, this is a very difficult subject and the problem deserves more study and thought than we have been able to give it up to now. These are suggestions only in the spirit of assistance to you in the difficult problem of getting out criteria and regulations for this purpose.

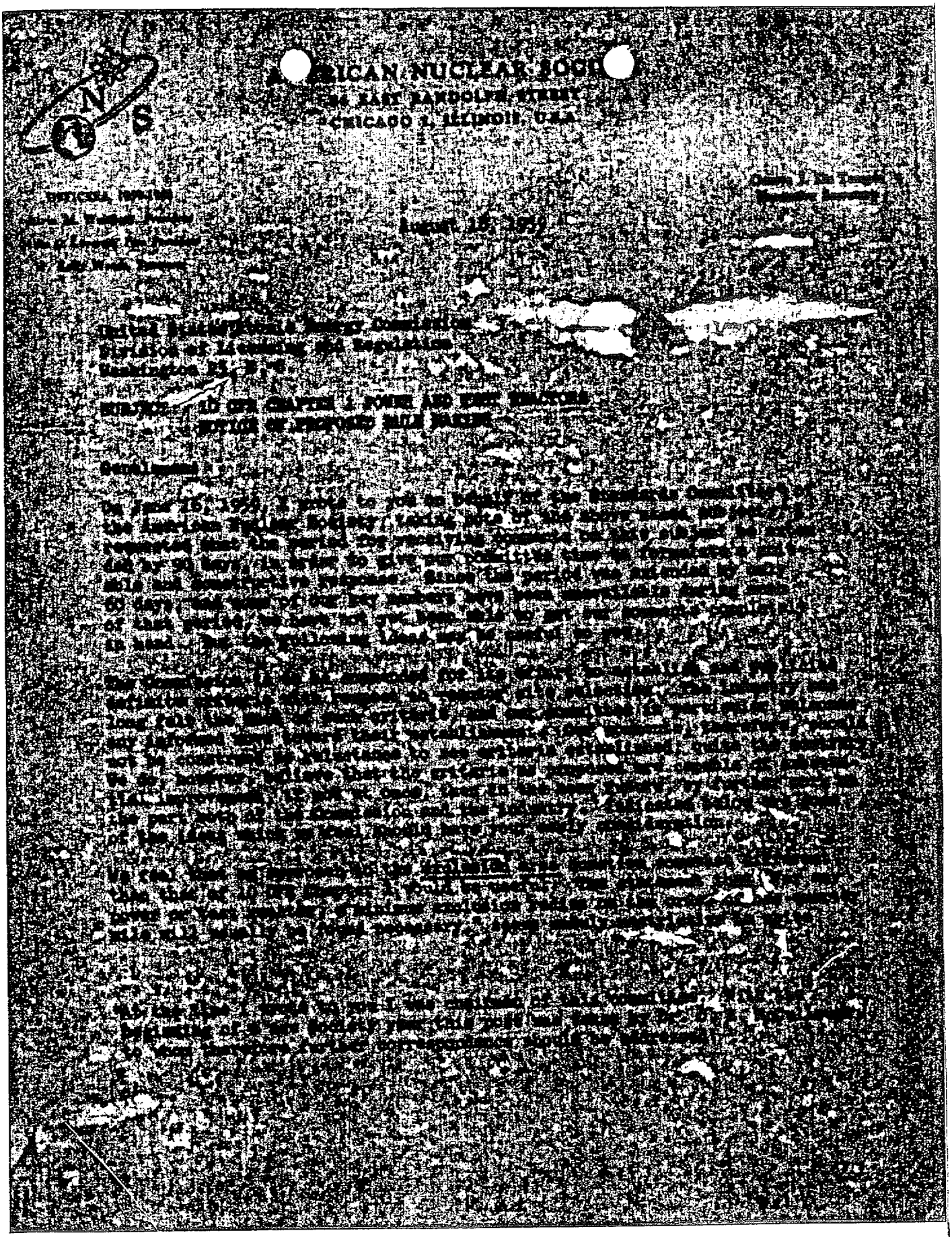
Sincerely yours,

C. Rogers McCullough

C. Rogers McCullough
Chairman
Standards Committee
American Nuclear Society

cc: Dr. Leverett
Mr. du Temple

Attachment
a/s



of its purposely flexible phraseology, since it is possible so to design test reactors of some types that accidental release of fission products from them in quantity is incredible, even in the absence of a containment vessel. In this case a very small exclusion area -- perhaps only the reactor building itself -- would be adequate. The prescribed exclusion radius for larger power reactors is likewise restrictive.

We believe that eventually it may be possible routinely to estimate by calculation the exclusion distance appropriate for any given reactor in a particular setting. Such estimates are, in fact, presently made by some groups, and the technique of making them is the subject of a project of our Standards Committee, and also of a committee of the American Standards Association (N-6).

In summary, the procedure is this:

1. The various accidents which might occur to the reactor in question are investigated to determine in which of them there would be the greatest release of fission products from the reactor. This largest accident is termed the "Maximum Credible Accident". It is further defined as being the worst accident which credibly could happen. It is evident that much depends on what one judges to be "credible" here. Experience shows that most designers and operators are too easily persuaded of the incredibility of a troublesomely large accident, so it is desirable that the MCA be reviewed by an independent informed group to be sure it has been properly chosen. It is usual to judge that any accident is credible if one can construct a physically possible mechanism for its causation, such as control system failure or malfunction, safety device failure etc., either singly or in combinations of three or four coincidentally. Containment, if provided, is usually assumed effective except for a small leakage rate. I will not further elaborate here the "criteria of credibility", but I am sure your own staff, as well as many industrial groups, could supply material for such a list. Suffice it to say that I believe that the MCA can be adequately identified and the corresponding fission product release assessed by competent groups such as exist at most major reactor installations in the USA.

2. Having determined the fission product release in the MCA, the atmospheric behavior of these fission products is next determined, assuming the atmospheric conditions to be those that will produce the greatest risk of injury to persons anywhere outside the exclusion area. This step involves determining the distribution, type, behavior and condition of off-site population. It usually requires that a number of atmospheric conditions be investigated to determine which is worst. It also requires that if there are barriers to escape of fission products from the reactor building, the efficacy of these be evaluated. Likewise, exposure to gamma radiation from fission products which escape the reactor but do not themselves escape the reactor building must be considered.

From such a calculation various results can be obtained, for example, the number of persons receiving more than a given dose in the event of the MCA, the distance to which various doses might be received etc.

We believe that the "Method of the Maximum Credible Accident" as this procedure may be called, is already sufficiently well developed and widely used to allow its adoption as a means of making a conservative determination of the safety of a particular site-reactor combination as regards accidental fission product releases, and in fact we propose the following:

"If the Maximum Credible Accident in a given reactor-site combination is calculated by approved methods to subject no person beyond the exclusion radius to more than the maximum tolerable single dose as established by competent authority, then that reactor-site combination shall be judged adequately safe."

While such a criterion of safety lacks both completeness (I feel that many reactor-site combinations not meeting this criterion are still adequately safe) and simplicity (the calculations are more difficult than simply taking an arbitrary distance like ½ mile) they do provide the designer and operator with rational means of assessing the safety of a reactor-site combination. They also provide a means of evaluating the various safety measures available, such as containment, more exclusion distance, lower power level, and meteorological control.

The adoption of this proposal as a sufficient criterion of reactor-site safety must not necessarily exclude the acceptance of reactor-sites not satisfying it, as indicated above. For example, a reactor in an isolated location may be adequately safe even though its "exclusion area", strictly speaking, is too small. Isolation in this case is, effectively, not limited by the exclusion area. Again, the MCA may be possible only during special operations, such as opening up the reactor vessel. These operations may be administratively controlled to occur only in favorable meteorologic conditions, thus effectively assuring that the MCA cannot coincide with worst atmospheric conditions. Admittedly also, there will be reactor operations of such importance to the national welfare that it is justifiable to take a larger calculated risk of chance injury to a limited number of off-site persons. I believe our safety criteria are still inadequately developed to deal with these cases by formula alone. In such cases, for some time to come, mature judgement of broad calibre, coupled with the "Method of the MCA" will continue to be our best guide. I see in this area important roles to be played by the AEC, the ACRS and industry groups.

If the proposal outlined above seems reasonable, a number of steps should be taken to test it more fully, and to make it practically applicable. Single dose maximum tolerances need to be established. Methods of calculation need to be written up and publicly discussed, criticised and accepted. One step which the Commission could take with ease and benefit would be to review existing reactor installations to determine how many would be judged a priori to be safe by the proposed criterion, and how many would require special

consideration. Some of these steps should be taken simultaneously by two or more groups to assure thoroughness and sufficiently expanding [illegible] consideration. We consider our own committee to be such a group and are working along these lines.

Because of the shortness of time and absence of some of our members, we will not attempt to comment further on the proposed rule making. We realize that this is an extremely important matter, and one requiring careful consideration. If we can be of assistance please do not hesitate to call on us.

Very truly yours,

H. E. Leverett
Vice President - American Nuclear Society