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To: A. H. Compton

Date: November 8, 1945

From: A. M. Weinberg and L. W. Nordheim

We have just had an opportunity to read a few of the German Kernphysikalische Forschungsberichte. We are writing in order to correct what we believe to be a very prevalent misconception concerning the state of the art as known to the Germans in 1945. We will proceed by posing a number of relevant questions and then answering them insofar as we can from the few reports we have been allowed to see. Presumably when more reports are made available we will be able to document our statements more fully.

I. Did the Germans know the correct lattice dimensions for a P-9U system?

Via the grapevine we had heard rumors that the Germans were experimenting with plate lattices far too rich in U. Apparently these rumors were based on very early reports which are not yet available to us. At present, however, the answer to the above question is an unequivocal yes. The March 1944 "Forschungsberichte" contain a description of experiments on various lattice arrangements performed by Bothe and Fünfer. The experiments are integral ones in which the strength of a source is measured with and without the lattice in place. The main conclusion drawn from these experiments is "eine Kombination von 20 cm D_2O und 1 cm U-Metall der Dichte 18 (wird) etwa die günstigste sein . . . Bisher hat man wohl mit einem größeren U-Bedarf gerechnet." This conclusion is exactly the same as that reached by us, on the basis of calculations in August 1943 (CP-923). The German work apparently was done at the same time as ours.

Plates seem to have been preferred because they were most convenient for experiments. The advantage of cubes was recognized as early as June 1943 (Höcker), and the use of cylinders had been suggested on technical grounds.

II. Did the Germans know the critical dimensions of the P-9 machine?

We have not had access to the reports in which critical size calculations are made. However, there are repeated references, in the reports available to us, of about 4 tons as the required amount of P-9. This figure is essentially correct.

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The Laplacians measured by the Germans are of the order 1000 x 10^{-6} cm^{-2}. This value is in excellent agreement with ours. It indicates, and this is important, that the U metal used by them was about as pure as ours.

III. What was the state of German theory of the chain reaction?

Here we are badly hampered by the unavailability of the reports. What we do have shows:

(1) Calculation of optimal lattice dimensions was understood and followed pretty much the same lines as ours. The calculated results on P-9 spheres agree well with ours.

(2) The group model for reflector calculations was introduced in early 1944. This was a little later than the time we began to use it extensively.

(3) Generally we would say their approach was in no wise inferior to ours; in some respects it was superior.

IV. Why didn't the Germans succeed in establishing a chain reaction with P-9?

The answer is simple; they did not have sufficient P-9. The latest reference is to a 1.5 ton P-9 experiment. According to our estimates, with the volume ratio they used (20:1), they would have needed somewhat less than 4 tons.

V. Are there any "scientific secrets" concerning the design of the chain reaction which the Germans do not seem to have understood?

From the general state of the art as deduced from the few reports we have seen, we would say their understanding of the principles is comparable to ours. The only non-engineering "secrets" we can think of which might affect the design of a chain reaction is the poisoning by Xe^{135}, and possibly, the properties of Pu^{240}.

VI. What bearing does this have on publication of the parts of the PPR dealing with principles of the chain reaction?

The Germans knew how to design a lattice which will work. From the practical standpoint this is all that matters. The details of elegant perturbation theory or transport theory (which would be contained in Vol. III) or the details of heat transfer calculations (Vol. IV) would tell them nothing essential to the determination of lattice dimensions. They already know how to calculate the optimum dimensions.

A question of ethics is raised by the existence of the German reports. In many cases useful information is contained therein. It is certainly extra-

ordinary, in a scientific treatise, to attribute a given result to an American author without at the same time giving due credit to his German counterpart who is known to have also done the work. Such a situation will arise for example, in Vol. III in the discussion of the multi-group methods where the Germans have duplicated our work.

VII. What bearing does this have on the general question of our "secrets"?

On this we can presume to speak only as individuals.

The general impression from the German reports is that they were on the right track and that their thinking and developments paralleled ours to a surprising extent. The fact that they did not achieve the chain reaction is primarily due to their lack of sufficient amounts of heavy water.

In one of the reports a vivid description is given of the German efforts in this respect. The heavy water factories in Norway were designed for a capacity of 3 - 4 tons a year and were successfully operating during part of 1942 and 1943. This capacity would have been sufficient for the construction of a pile. However, the production was interrupted by sabotage and finally the main factory was destroyed by a bombing attack. Toward the end of 1944 plans were made to initiate production of heavy water in Germany and to use enriched uranium in order to reduce the material requirements.

It is also fairly clear that the total German effort was on a very considerably smaller scale than the American effort. This may be due to the strained German economy or to the less favorable attitude of their government. The fact remains that an independent group of scientists, of much smaller size than ours, operating under much more adverse conditions achieved so much.

We must proceed therefore on the basis that anyone knowing what is in the German reports can establish a chain reaction, provided he has sufficient materials. The Smyth report will give additional very helpful hints. The time when others can establish a chain reaction is therefore no longer a matter of scientific research but mostly a matter of procurement. The policies of our authorities must, it seems to us, be formulated with a clear realization of these facts.

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