1 carbon

NATIONAL DEFENSE RESEARCH COMMITTEE
OF THE COUNCIL OF NATIONAL DEFENSE
1530 P STREET NW.
WASHINGTON, D. C.

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IRVIN STEWART, SECRETARY

NRD

CONFIDENTIAL

March 27, 1941

Dr Leo Szilard
Pupin Physical Laboratory
Columbia University
New York City
N. Y.

Dear Szilard:

We bought our graphite from the National Carbon Company, and it was delivered from their Cleveland plant. It is supposed to contain not over ½% of ash. Breit has had it analyzed for boron at the Bureau of Standards, and finds 2.5 parts per million, which he claims is twice as much as in graphite from the U.S. graphite Co. We get $(1.1 \pm 0.2) \times 10^{-26}$ cm^2 for the capture cross section for thermal neutrons for our material.

Some time ago I went to Cleveland and spent the day with the Brush Beryllium Company. They make beryllium which is over 98% pure, although in writing you a letter they only state 96% pure. There is something very queer in the beryllium business which I don't entirely understand. This company is actually reluctant to admit that they are making beryllium metal, and before I went down there I could not get them to say so over the phone or by writing. I think that they are afraid that someone will buy up pure beryllium from them and discover a new alloy and get rich on the patent rights without them getting any of the money. I had to reassure them that I was interested in the "radioactive" properties of beryllium before they would sell me any. I have not got a detailed analysis from them yet. There is no appreciable amount of lithium or boron in their stuff, they say. Principle impurity is magnesium fluoride, used as a flux, and beryllium carbide from the crucibles. Our measurement on the capture cross section for thermal neutrons of the stuff they sent us gives $(6.5 \pm 2) \times 10^{-27}$ cm^2. Their production at present is at the rate of about 35 lbs a week.

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~~CONFIDENTIAL~~

Dr Leo Szilard 2

Because of the high scattering cross section and low capture cross-section of beryllium I consider it of the utmost importance for the committee to start this or some other manufacturer on the production of a fairly large amount. The price could come down as quantity produced goes up.

When can you get appreciable amounts of uranium metal?

Yours sincerely

Samuel K. Allison

~~CONFIDENTIAL~~

April 1, 1941

Professor Samuel K. Allison
Ryerson Physical Laboratory
University of Chicago
Chicago, Illinois

Dear Allison:

Many thanks for your letter of March 27. I discussed its content with Fermi and we were both very much interested in the data which you gave concerning your graphite and beryllium. We wonder if you could let us know something about the method which you used in measuring the absorption of your graphite and particularly the method which you used in measuring the absorption of your beryllium.

The difficulties which stood in the way of producing uranium metal free from hydrogen have now been overcome, and at the stage which we have reached at present we could produce this metal in any required quantity in the form of a powder having a bulk density of about 9.6 grams per c.c. My feeling is that the price should not be more than $3 per pound on a cost plus 100 percent basis, exclusive of the cost of the uranium oxide which has a market price of about $2.50 per pound. We are still working on finding a satisfactory method for producing this metal in the form of sintered or fused blocks.

I believe that we should be able to reach the same stage concerning beryllium. The price that may eventually be reached will probably be considerably higher. Just how much of the available appropriation ought to be spent for this purpose is a question which perhaps ought to be discussed and decided in the near future. Otherwise it will be difficult to proceed according to a clearcut plan. I will try to form a personal opinion on this point in the light of the information which is at present available, and may write you another letter about it.

Yours sincerely,

LS:H (Leo Szilard)

cc: 1 - Pegram
1 - Fermi
1 - Szilard
2 - Mitchell

September 5, 1941

Professor Samuel K. Allison
Department of Physics
University of Chicago
Chicago, Illinois

Dear Allison:

We will need some beryllium metal which we could use in the form of plates somewhat similar to those which you showed us in Washington. We need altogether a thickness of twelve centimeters (12 cm.) or five inches (5 in.), and I wonder whether you have enough plates to spare to send us some in the near future. We need these plates for the duration, since we shall use them for the generation of photo-neutrons in a number of experiments. If you are unable to let us have such plates, will you be kind enough to let me know to whom we should write at the Brush Beryllium Corporation in order to obtain them.

With many thanks,

Yours sincerely,

(Leo Szilard)

LS:MEB

Copies
1 Pegram
1 Fermi
1 Szilard ✓
2 Mitchell

Copied by MEB 9/10/41

The University of Chicago

Ryerson Physical Laboratory

CONFIDENTIAL

September 8, 1941

MCW
OSM

Dr Leo Szilard
Physics Department
Columbia University
New York City

Dear Szilard

We are using all our beryllium very intensively now in measuring the properties of a uranium unit surrounded by a beryllium shell, and unless your proposed experiments are of greater importance in speeding the program along I hesitate to stop ours by shipping off our beryllium.

We have 370 plates of metallic beryllium ~~xxxxx~~ 1"x2"x4" on order at Brush, and whenever any portion of these arrive, we will be glad to send you some. I think that the fastest way to get beryllium would be to wait till this order starts coming along, but if you wish to correspond directly with the company, write to

Mr Leon Fletcher, Jr
Brush Beryllium Co.,
3714 Chester Ave,
Cleveland, Ohio.

Our experiments with uranium units in a beryllium shell are so encouraging that it is practically certain something is wrong with them. A BF_3 counting chamber enclosed in cadmium gives 13% more counts per unit time near a beryllium enclosed unit than at the same distance from a unit in ~~xxxxxxx~~ graphite only. We are trying to think of all the possible interpretations and test them one by one. In about 2 months we may be able to venture a guess as to whether this means anything important or not. I have felt shaky for weeks since I discovered the fiasco in our absorption cross-section for beryllium.

Yours sincerely

Samuel K Allison

The University of Chicago

Ryerson Physical Laboratory

~~CONFIDENTIAL~~

November 17 , 1941

Dr Leo Szilard
Michael Pupin Laboratories
Columbia University
New York City

MPO

~~CONFIDENTIAL~~

Dear Szilard:

I have a letter from Dr Briggs stating that he is arranging for a gram of radium mixed with beryllium to be made up for me and sent here on a rental basis of $250 per month until June 30.

I am taking it for granted that he is negotiating with Dr Boris Pregel for this stuff.

I have not seen how your beryllium-radium mixtures are prepared, but Dr Pregel told me that they are in containers which can be joined together ~~xxxxx~~ so that the entire amount which you possess can be used as a single line source. It seems to me that for the good of the project as a whole, this gram of radium being prepared for me should be put in exactly the same kind of container as you are now using, so that the entire amount owned by the committee ~~xxxxxxx~~ can be used as a single source if necessary.

If you are in touch with Dr Pregel, could you make sure that this is understood?

Our large structure is now being started. It will take quite a while to assemble as we are taking elaborate precautions against scattered neutrons entering the sides.

Yours sincerely

Samuel K Allison

November 21, 1941

Professor Samuel K. Allison
Ryerson Physical Laboratory
University of Chicago
Chicago, Illinois

Dear Allison:

I received your letter of November 17 and talked to Mr. Pregel, informing him of your wishes. He said that he does not yet have the official order, but when he receives this order he will have a container made which can be screwed onto the containers which are used at Columbia. Although the whole thing will make a source which is rather long and therefore it may not be possible to use it in general, yet it seems very desirable to have the containers standardized as you suggested in your letter.

With best wishes,

Yours sincerely,

L.

(Leo Szilard)

LS:MEB

CC: 1 Pegram
1 Fermi
1 Szilard
2 Mitchell

Allison

Metallurgical Laboratory

September 24, 1942

C. N. Cooper
R. F. Christy

L. Szilard

I have requested Fermi who is chairman of the Technical Committee to appoint a two man committee for the purpose of giving to the Technical Committee a preliminary report on the advantages and disadvantages of bismuth cooling, in which I have personally taken an interest for some time in the past. Fermi appointed you two to serve as such a committee and asked me to communicate this fact to you. He hopes that you will be able to accept.

I assume that such appointments will be submitted to the scrutiny of the whole Technical Committee in the future. This simplified procedure was adopted merely as an emergency measure pending future intensification of the work of the Technical Committee, and must not be considered as a precedent.

L. Szilard

E. Fermi, Chairman,
Technical Committee.

COPY

Wigner

Metallurgical Laboratory

October 1, 1942

S. K. Allison

L. Szilard

Dear Allison:

I feel that unless the Technical Committee takes urgent decisions on points which I am going to list below the work of my division will remain seriously disorganized.

1. A preliminary decision, whether or not we should make a detailed design for a bismuth cooled plant. I have a preliminary design of long standing for a bismuth cooled power unit and I believe that if I discussed it with Cooper and Christy they could, in about 2 weeks, report back to the Technical Committee and give some sort of an independent opinion on which a decision of the Technical Committee could be based.

2. On the basis of discussions which Condon, Compton and I had some time ago, we are committed to ask Westinghouse for a design for a bismuth pump. I wish to report to the Technical Committee on my recent visit to Westinghouse in order to reach a decision just how far we should go in this direction.

3. If the Technical Committee should decide in about 2 week's time that a detailed design for a bismuth cooled plant should be made, I would want to know whether I should take charge of preparing a detailed design for the bismuth cooled plant.

L. Szilard

COPY

66s-21

Metallurgical Laboratory

October 9, 1942

Messrs. Young, Cooper,
Szilard

Technical Council

At the meeting of the Technical Council on Wednesday, October 7, it was decided that Mr. Moore is to increase his engineering staff with the intent of actively engaging in the design of a bismuth cooled plant. Then the question of what should be done with the Cooper-Young committee arose. This question is connected with the conference to be held next Thursday with representatives of the Army, etc., in which conference we would like to give as good a picture as possible of the various schemes in our minds.

Mr. Cooper is out of town and obviously cannot prepare any report by Monday, October 12, which is the date of the next meeting of the Technical Council. In this situation, I would recommend that the following procedure be adopted.

(1) That Mr. Young and Mr. Szilard talk together concerning the bismuth cooled plant before Monday afternoon, October 12.

(2) That at the meeting on October 12, Mr. Szilard present a brief statement of the status of the bismuth cooled plant to the Technical Council and Mr. Young be invited to sit in with the Council during the presentation of this statement and the discussion of it.

The Council will then consider the question of how much emphasis shall be placed on the bismuth cooled plant and on its engineering by the representative of the Technical Council who will discuss this matter at the Thursday, October 15 session.

John A. Wheeler
John A. Wheeler,
Secretary

Samuel K. Allison
Samuel K. Allison,
Chairman

dj

COPY

Metallurgical Laboratory

November 18, 1942

Messrs. Compton
Cooper
Doan
Fermi
Hilberry
Moore
Spedding
Szilard
Wheeler
Wigner

COPY

The regular meeting of the Technical Council will be postponed until Friday afternoon, November 20, 2 P.M., in Room 209, so that we may hear a report by Professor Compton on the latest developments in Washington.

SAMUEL K. ALLISON

dj

Mum OKe!

L - M Jcone!

Compton

December 4, 1942

S. K. Allison

L. Szilard

My attendance to Technical Council Meeting.

I have been asked yesterday by various people why I did not attend yesterday's Technical Council meeting, and it is therefore perhaps useful for you to have in your files a definite statement in this connection. I am particularly anxious to avoid giving the impression that I refrain from attending the meetings of your committee because I am "sulking". May I therefore define as clearly as I can my attitude in this matter, which I believe has Compton's approval?

While I am glad to receive notices of meetings and the minutes, it is not my intention to take part in deciding organizational questions. One reason for this is the fact that the status of my clearance is at present unsatisfactory, and there may be other reasons as well. However, whenever you have some special reason for wishing that I should be present at a meeting, you can let me know, either on the official notice or by some other channel. I shall then be very glad to come to that particular meeting.

L. Szilard

CC: A. H. Compton

March 30, 1944

Mr. S. K. Allison

Mr. L. Szilard

I am writing to you to suggest that the solubility of beryllium in liquid lead and liquid bismuth be determined at 300°, 400° and 500° C and that this be done by a contract with an outside firm if our own metallurgists cannot at present assign anybody to this task.

Inclosed is a copy of a memorandum which I wrote to Dr. Compton in connection with this question.

LS:s
inc.

cc: Compton

June 14, 1944

TO: Mr. S. K. Allison

FROM: Mr. L. Szilard

The purpose of this memorandum is to put forward two proposals concerning tasks which appear to deserve attention on the part of our Laboratory in the immediate future. These two proposals are somewhat interrelated as set forth below:

1. A rough calculation seems to show that a chain reacting light water lattice could be set up with the 40 tons of metal which is at present available at X if about 1 ton of heavy water is used in a seed. I have assumed that the light water lattice has a multiplication factor of about 1 and the above favorable conclusion arises then from the fact that the migration length in the light water lattice is only about half of the migration length in the heavy water lattice.

Since we may expect that 1 ton of heavy water will be available in the near future, I propose that such a chain reacting unit be in fact put together either at Chicago or at X and be used as a powerless test unit for exploring the properties of various light water lattices. The exploration would take place by replacing a section of the light water lattice of the unit by the light water lattice which is to be tested and by observing the changes in the effective multiplication factor.

2. Lately the Laboratory has discussed, at the initiative of Mr. Weinberg, the possibility of erecting an light water uranium

lattice unit with an enriched core and it was discussed just to what extent the Laboratory should devote its efforts to this task in the near future.

As a counter proposal I now wish to submit arguments in favor of designing a unit consisting in a light water lattice with a heavy water lattice seed. The following observations hold for such a composite unit:

(a) We may expect the light water lattice to have a multiplication factor of 1. Nevertheless we may expect a unit at about 2 meters diameter with a heavy water core of about 1 tone to be chain reacting. This favorable result is due to the fact that the migration length in the light water lattice is only about half of the migration length of the heavy water lattice which forms the core of the arrangements. About 40 tons of metal might be needed for such a unit.

(b) A rough calculation shows that owing to the fact of having a migration length in the light water lattice which is half of the migration length in the heavy water lattice which forms a core of the arrangement more than 4/5 of the heat would be generated in the light water lattice. This means that our chief objection to the heavy water units which were previously considered, namely that the plutonium production per ton of heavy water is necessarily small, can be met by using such a composite unit.

In an ordinary heavy water lattice such as the Laboratory had considered formerly about 5 tons of uranium metal were contained in about

10 tons of heavy water so that about 50,000 kw could be extracted from 10 tons of heavy water. The light water unit with a heavy water seed would produce about three times as much heat per ton of heavy water in the seed than the average of the old P-9 unit (due to the flattening of neutron distribution in the heavy water lattice) and about five times as much heat in the total unit as in the seed. Therefore per ton of heavy water the composite unit would produce 15 times as much heat and plutonium as the old heavy water lattice units. ~~That~~ i.e. ~~is,~~ a unit having a one-ton heavy water seed could produce 75,000 kw and would contain perhaps 40 tons of uranium.

(c) Use of Reflector.--Mr. Friedman and I discussed somewhat the use of graphite reflectors in connection with such a composite unit. Without having made any calculations, we think that a graphite reflector on the outside of a light water lattice might have an unexpectedly large effect in a favorable direction. This is due to the fact that on the light water lattice graphite boundary of the fast neutrons emitted from the lattice a very large fraction will be slowed down to thermal energies within the lattice and ~~that~~ of those neutrons which become thermal in the graphite a large fraction will diffuse back into the light water lattice and be absorbed there rather than in the graphite. This favorable response of the light water lattice toward a reflector will make it possible to use light water lattices with a comparatively low effective k and also will flatten the neutron distribution in the light water lattice and thereby make it possible to extract the larger amount of heat indicated above.

It is not unlikely that reflector like bismuth which do not appreciably slow down the neutrons by elastic collisions would be very effective outside the light water lattice. The advantage ~~may~~ they offer is based on the fact that the mean free path of the neutrons in water is much greater for fission neutrons than resonance neutrons.

(d) Cooling of the light water lattice.--The cooling of the light water lattice presents a new problem which arose for the first time in connection with enriched light water lattice proposed by Mr. Weinberg. If we cool such a light water lattice by moving the water between the uranium rods we have to pump very large volumes in order to attain a sufficient velocity to have a good heat transfer. In this connection I had previously advocated something which might be called a parasitic circulation or a shunt circulation, i.e., a system in which the bulk of the water would be simply circulated through the light water lattice and the fresh water influx and hot water out-flow would represent only a small fraction of the total circulating volume. This system has the disadvantage that the water in contact with the uranium is not yet as cold as it otherwise could be. I am therefore at present more inclined to favor putting the whole circulating volume through a heat exchanger of a somewhat special construction and to keep the cooling water separate from the water which flows through the lattice. ~~The cross section of the cooling water~~ The heat exchanger would have to be built in such a manner as to have a small cross section for the cooling water and a large cross section for the lattice water.

Draft Leo Szilard

L 3 bis.-3

Depot

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THIS DOCUMENT HAS BEEN
TAKEN FROM A FILE OF THE
ARGONNE NATIONAL LABORATORY
AND WAS TURNED OVER TO
DR. LEO SZILARD ON
1956.

November 15, 1943

S. K. Allison

L. Szilard

I have been discussing lately with Young, Weinberg, Ohlinger and Creutz how to improve our knowledge of the potentialities of a beryllium power unit and also to make otherwise advances concerning the use of beryllium. Mr. Spedding whom I saw this morning would be very glad to work out a method of reducing beryllium fluoride by magnesium in a manner similar to the process which he has developed for the reduction of uranium fluoride. In order to be able to do so, he must, however, have a supply of beryllium fluoride.

It would seem best to arrange with Mr. Sawyer from the Brush Beryllium Company that he agree to supply Spedding with beryllium fluoride. My own personal experience with Mr. Sawyer was most excellent. I found him very cooperative, and he responded with frankness to frankness. I should hesitate, however, to approach him with such a request unless we can be reasonably sure that we can give him a fair deal.

As you probably remember, Mr. Sawyer worked at our request on the magnesium reduction of uranium tetrafluoride and succeeded in showing that this process leads to pure uranium which is practically free from magnesium. I understand that in spite of this cooperation, he was not given an equal opportunity with other manufacturers when it came to placing contracts for magnesium reduction using the technique developed by Spedding. I wonder if you would be able to obtain an assurance from the War Department to the effect that if Mr. Sawyer is now asked to cooperate in enabling Spedding to

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NATIONAL LABORATORY
AND WAS TURNED OVER TO
DR. LEO SZILARD ON

develop a similar process for beryllium ha will be given equal opportunity with other firms if the War Department should decide to place contracts for the production of beryllium from beryllium fluoride. If such an assurance could be obtained, I would be very glad to try to persuade Mr. Sawyer to act essentially as a supplier of beryllium fluoride during the next stages of the development.

A few days ago, I asked Mr. Chipman whether he would care to look into the question of solubility of beryllium in molten lead and bismuth. Preliminary experiments failed to show any attack of lead or bismuth on beryllium if I remember correctly. This, however, may be due to a protection by the oxide layer and it is necessary to know something about the solubility before we can go further in planning for the use of a Pb-Bi alloy as a cooling liquid in contact with beryllium. Unless I hear something to the contrary, I shall assume that this investigation will be carried out by Mr. Chipman and that we can forget about it until we hear the result from him.

L. Szilard

CC: J. Chipman
E. Creutz
E. Wigner
G. Young

December 7, 1956.

Dr. S. K. Allison
Director
The Enrico Fermi Institute
for Nuclear Studies
The University of Chicago
Chicago 37, Ill.

Dear Allison,

Attached you will find letter that I sent to Warren Johnson with the attached enclosure from the Rockefeller Institute. If you see any reason why I should not accept will you send me a telegram upon receipt of this to room 2134, Hotel St. Moritz, New York?

With kindest regards,

Sincerely,

Leo Szilard

encl.

THE UNIVERSITY OF CHICAGO
CHICAGO 37 · ILLINOIS

THE ENRICO FERMI INSTITUTE
FOR NUCLEAR STUDIES

Office of the Director

December 10, 1956

Professor Leo Szilard
Hotel St. Moritz
New York, New York

Dear Leo:

As far as your appointment in the Enrico Fermi Institute is concerned, I see no reason why you should not accept the offer of Mr. Bronk to be an affiliate of the Rockefeller Foundation.

When it comes to accepting money from them, however, you would have to consult Dean Warren Johnson, since none of us is completely free to make external arrangements even under the 3 Quarter contract. Warren would probably want to know what three quarters of the year you were spending with us.

Yours sincerely,

Sam

Samuel K. Allison

CC: Dean W. C. Johnson

December 16, 1956.

Dr. S. K. Allison
The Enrico Fermi Institute
for Nuclear Studies
The University of Chicago
Chicago 37, Ill.

Dear Allison,

Many thanks for your letter. I have talked to Warren Johnson over the telephone and sent Dr. Bronk a letter of which I attach a copy.

With kind regards,

Sincerely,

Leo Szilard

encl.

Personal

October 2, 1957

Dr. S. K. Allison
Director, The Enrico Fermi Institute
for Nuclear Studies
The University of Chicago
Chicago 37, Illinois

Dear Allison:

This is the letter I said I would write you.

I am leaving tomorrow morning for Europe on what you and I regard as University business, even though your present budget does not permit you to make any appreciable contribution to the expenses of the trip. I may during this trip spend some time in Paris and in Cambridge, England. I have applied to the Block Fund for a certain sum for the period from October 12th of this year to September 30th of next year, and indicated that I may charge the expenses of my stay in Paris and Cambridge to the grant if it comes through.

The purpose of my trip is to give lectures and to gather information for my research work.

The expenses of the trip to Berlin and return will be borne by the German Chemical Society. I am giving an invited paper at their meeting in Berlin on October 7th. I expect to lecture also in Heidelberg and to visit several universities in Germany, and perhaps also the University of Vienna. I plan to spend ten days or perhaps two weeks in Cambridge, England with the group assembled by F.H.C.Crick at the Cavendish Laboratory. If I go to Paris I will spend about a week at the Institut Pasteur with Jacques Monod.

Sincerely yours,

Leo Szilard

m

THE UNIVERSITY OF CHICAGO
CHICAGO 37 · ILLINOIS

THE ENRICO FERMI INSTITUTE
FOR NUCLEAR STUDIES

January 16, 1962

Dr. Leo Szilard
Hotel DuPont Plaza
1500 New Hampshire Ave.,N.W.
Washington 6, D.C.

Dear Dr. Szilard:

A small group of faculty, students and interested citizens have met informally a few times to discuss the contents of your proposed movement and the possible ways of launching it here.

It was the consensus of those present that we cannot hold more meetings unless we have definite information on the evolution of your ideas. We would welcome an immediate statement from you.

We say "immediate" because, unless we continue to stimulate it, the interest that you have undoubtedly aroused in our neighborhood - as measured by the 1500 copies of your speech that were distributed - will wane fast.

It was further suggested that the 12 man board of which you spoke be appointed as soon as possible and that, in choosing the members, its effectiveness before a Congressional committee be kept in mind.

The hope was also expressed that from now on we may keep in close contact with you.

Trusting in your prompt reply,

Yours sincerely,

letter dictated by Laura Fermi

Samuel K Allison
Samuel K. Allison

Richard K. Lashof
Richard K. Lashof

LF:lra

Paul Meier
Paul Meier

P.S. Please address reply to S. K. Allison at the Enrico Fermi Institute

announced

Folder 114

7 March 1962

S.K. Allison
The Research Institutes
The University of Chicago
Chicago 37, Illinois

Dear Allison:

Attached you will find a note with some information concerning the Movement to date. This note is not quite up-to-date but it represents the latest information that has been written up.

Sincerely,

Leo Szilard

end.