Dr. P.P. Alexander
Metal Hydrides Inc.
12-24 Congress Street
Beverly, Mass.

Dear Dr. Alexander:

I refer to the conversation which you had with Prof. Pegram concerning uranium metal about six weeks ago when you were in New York. At that time you thought that you could produce uranium metal at a price of perhaps $ 8.- per pound in lots of one ton. As you perhaps know the high hydrogen content of your present product is undesirable from the point of view of the purpose which we have in mind. I would therefore much appreciate to hear of any tentative proposals which you may be able to make at the present time concerning some sufficiently cheap process which would remove the hydrogen. I assume that your uranium could be molten in an induction furnace using a zirkonium crucible in a hydrogen atmosphere and the temperature could be brought up to perhaps 1800°, but this might be too expensive if a new crucible were required for each block of uranium. The blocks which we have in mind would be cylindrical and have a diameter of perhaps 2 to 3 inches and a height of 1 to 3 inches. I should much appreciate to have your comment on this point and if possible also a rough estimate of the cost involved at least as far as the expense for crucible material goes.

We have discussed here the possibility of lowering the melting point of the uranium by adding small amounts of certain elements which would not interfere with our purpose. Fairly

large amounts of bismuth or lead could be tolerated, but only about 2½% of iron or ~~xx~~ chromium. This point ~~should perhaps~~ seems to deserve ~~receive~~ some attention since we have to find a cheap way for producing the uranium metal and since our requirements of purity are less strict than those of most of the metallurgists.

I am raising these questions in the hope that we might have a talk about them when you will be in New York next time. I should appreciate your getting in touch with me then. If you would care to phone University 4-2700 about 9 A.M. you would be almost sure to find me at home, and we could then fix a time convenient for both of us.

Yours very truly,

Dr. P.P. Alexander
Metal Hydrides Inc.
12-24 Congress Street
Beverly, Mass.

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Yours very truly,

(Leo Szilard)
Columbia University
in the City of New York
DEPARTMENT OF PHYSICS

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton
Mass.

420 West 116th Street
New York, N. Y.
December 21, 1940

Dr. P. P. Alexander, President
Metal Hydrides, Inc.,
Box 816,
Clifton, Massachusetts.

Dear Dr. Alexander:

I wish to tell you how very much I enjoyed our conversation on Wednesday.

To the question of using a binder in sintering the uranium block, I should like to say the following: We have discussed the use of bismuth, which would be satisfactory from our point of view up to 15 per cent of bismuth, and you mentioned that the blocks will be rather brittle if bismuth is used as a binder. From some older experiments which I made a few years ago it would appear that, apart from bismuth, we could use lead up to 15 per cent or tin up to 5 per cent, as binders, without much harm. Lead would be better than tin, but we shall make some experiments to determine more accurately the tolerance for tin. Perhaps we can tolerate more than 5 per cent.

These binders might have the advantage over bismuth of yielding sintered blocks which can be subsequently pressed in a mold in order to give them a more accurate shape.

It would be preferable to prepare a sintered block from dehydrogenated uranium powder, either pure or mixed with bismuth, lead or tin. However, if the dehydrogenated uranium powder does not sinter well, there seems to be no alternative but to try the hydrogenated uranium powder and hope to get out the hydrogen afterwards.

We do not yet know how much titanium we could tolerate as a binder, but Professor Fermi will make an experiment to determine this point.

I thought I had better write you this note because in our conversation I did not mention the possibility of using lead and tin as a binder, and because you might ultimately prefer these two elements to bismuth.

Very sincerely yours,

(Leo Szilard)

January 4, 1941

Dr. P. P. Alexander,
Metal Hydrides, Inc.,
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

I am attempting to compile an estimate of cost for certain experiments, preparatory to making an application for the funds which these experiments would require. While you might not be able to make at the present time an absolutely binding bid for reducing uranium oxide to uranium metal in one-ton lots, I hope that you are able to quote us a price which will be fairly close to the final price. These are the items for which I would appreciate your letting me know your quotation:

1. For the reduction of one ton of uranium oxide to uranium metal by the calcium hydride process.

2. For the reduction of further quantities of uranium oxide to uranium metal in one-ton lots up to five tons.

3. For the dehydrogenation of one ton of uranium metal by heating the metal in a vacuum for one hour at 850°C.

4. For the dehydrogenation of further quantities of uranium metal in one-ton lots up to five tons.

Thanking you for the attention which you are giving to this matter, I am

Very truly yours,

L. S.

LS:H (Leo Szilard)

cc: 1 - Pegram
1 - Szilard
2 - Mitchell

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

January 7, 1941

Dr. Leo Szilard,
Physics Department,
Columbia University,
New York City.

Dear Dr. Szilard:

In accordance with our telephone conversation we are making fresh uranium metal now and will sinter it into bars before degassing. We may also attempt to prepare a few sintered bars with the binders you specify.

As I mentioned to you, we found that fully degassed metal if left standing for several days, cannot be pressed into bars since it becomes pyroforic. However, we are going ahead with this work as fast as we can and hope to bring with me the first samples probably next week when I will be in New York.

Answering the specific questions you asked in your letter of January 4th:

1. Basing our estimates on today's prices for various materials, I would think that we could produce the first ton of uranium at the price of $15.00 per pound.

2. For the production of uranium metal in five ton lots we could probably lower the price to $10.00 per pound.

3. The dehydrogenation of this material on a large scale would increase the price only slightly, possibly one or two dollars per pound.

We will also soon overcome the question of the storage of pure uranium without oxidation.

Please note that these prices are more or less of a guess and furthermore are based on present prices for raw materials. After the war when cheap French calcium will again be available in this country these prices probably could be reduced considerably. However, this is such a new field that the real estimate of the prices at which pure uranium could be sold could be established only after the production of at least two or three tons of this material. However I believe

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BEVERLY, MASS.

that the above figures will not be very far from the final prices for pure uranium in powdered form.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A President.

L. S.

January 17, 1941

Dr. P. P. Alexander, President
Metal Hydrides Incorporated
Box 816,
Clifton, Massachusetts

Dear Dr. Alexander:

Many thanks for your letter of January 7. We are looking forward to hearing from you concerning the sintered uranium blocks in the near future.

May I now raise certain questions in connection with your estimate of cost concerning uranium metal.

How much calcium do you need per pound of uranium?

What was the price of the cheap French calcium to which you referred and what is the present price of calcium which you would have to use?

Is there on the market a cheaper brand of calcium which is less pure, and which you might use if we would lower our requirement of purity in order to decrease the cost?

If so, how much would the price of this impure calcium be, and what is known about the amount and type of the impurity?

In order to be able to compare the calcium hydride process with other possible processes for obtaining uranium metal in one ton lots, I am rather anxious to find out the lowest price at which the calcium hydride process could be used, even if we have to sacrifice some of our requirements of purity. While hydrogen is one of the few impurities which we cannot tolerate in large amounts, other contaminants, for instance iron, could be tolerated in considerably larger amounts, and perhaps we will have to compromise on the question of purity. All this I shall be able to see clearer when I have your answer to the above questions, and if necessary we can then go into the question of the impurities of some cheaper brand of calcium.

In the meantime, your present estimate of cost will serve its purpose in a preliminary estimate of costs which we are preparing.

Very truly yours,

L. S.

LS:H (Leo Szilard)

cc: 1 - Pegram
1 - Szilard
2 - Mitchell

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

January 20, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

We had to scrap the 22 lbs. of uranium metal previously made for you since after degassing in powdered form it became pyroforic and we could not do anything with it. We have made another batch of 22 lbs. from new material and it looks excellent. We are going to sinter it into small bars and degas it afterwards. We are sure that we will produce what you desire and of acceptable quality.

With regard to the cost of uranium in ton lots, we are considering this proposition, in view of the possible lowering of requirements for purity.We would have to produce it by a different method and in the absence of hydrogen. We would like to study this question a little further because uranium metal produced by some methods comes in pyroforic state. It is of no consequence when it is produced on a laboratory scale in gram lots, but when produced on a large scale it becomes a serious problem.

I will be in New York this Wednesday and again for a few days in February during the A.I.M.M.E. convention, February 19th to 23rd, and will make sure to contact you, if not Wednesday, then in February.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

January 24, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

We have checked by telephone and wire the prices and deliveries on different equipment which will be necessary for a special production unit to take care of your orders for uranium.

A high vacuum pump of sufficient capacity - -	$ 271.00
A glass-lined 100 gal. tank - - - - - - - - - -	200.00
Filter Press - - - - - - - - - - - - - - - - - -	300.00
Filter Pump - - - - - - - - - - - - - - - - - -	150.00
Vacuum Drying Oven - - - - - - - - - - - - - -	~~150.00~~
Condenser for same - - - - - - - - - - - - - -	~~65.00~~
Vacuum Pump for same - - - - - - - - - - - - -	~~200.00~~
Stirrer for leaching tank - - - - - - - - - - -	100.00
Additional furnace and nichrome retort with cover and auxiliaries - - - - - - - - - - -	~~750.00~~
Pipe line filter - - - - - - - - - - - - - - - -	~~50.00~~
Total -	$2,236.00

In addition to this equipment we have to provide electrical wiring, piping, a ball-mill, and special hoods and a ventilation system to take care of the dust which, as you know, is quite poisenous. Furthermore, we have to build a fire-proof concrete pit and provide the necessary foundations for the machinery. We estimate the cost of this additional work at $2,000. To make room for an additional furnace we have to re-locate one of our present furnaces and provide necessary foundations for same with various piping etc.

We estimate that we will spend about $5,000. on this installation which will have a normal capacity of 100 lbs. of uranium metal per week. But by a very small alteration this capacity could be increased immediately when necessary and at very small expense to 200 lbs. per week. Furthermore, if we receive large emergency orders we could immediately convert to this work our factory equipment which is of the same design but has a very much larger capacity, so that our total out-put could be increased to one ton per week practically without additional expense.

Copied 1/29/41

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

If you could give us assurance that within the next three years your orders on an average will not be less than one ton per year, we would immediately put this project into effect and would be ready to start production on the above scale within three months.

If these expenses could be taken care of by some special appropriations and if you will furnish to us the uranium oxide, we will be able to furnish you with degassed uranium metal at a price in the order of $10 to $15 per pound. The exact price will depend on the amount of degassing since the removal of the last small amounts of hydrogen is rather difficult and expensive. The exact figure cannot be stated at present until we produce a sufficient amount of this material and you determine what amount of impurities or occluded gases could be allowed in the produced metal. With the above installation, however, we should be able to degas the produced uranium more effectively than the small sample tested for you at the Bureau of Standards, since this installation will allow us to push the vacuum down to 10 microns.

We would appreciate very much if you could let us have your answer at the earliest possible date since the deliveries on various apparatus are very slow indeed. One manufacturer informed us that the delivery might be any time up to six months or more, and this regardless of priority because practically all of his orders have priority. However, if we place the order early next week he might deliver the apparatus in question before he accepts other orders with a priority clause.

With regard to the ownership of the installation, it will be very difficult indeed to have in our factory equipment owned by someone else and therefore any equipment which will be installed in our factory will be our property. Besides, more than half of the cost of installation will be, not the cost of the equipment, but providing accommodations for same. However, if we reduce the price for you to the above figures the saving to you will be far more than the total cost of this installation.

In view of the fact that this work will be either in connection with the national defense program or purely scientific investigations, I gave you at our conference yesterday the detailed description of our process and various apparatus used. However, I would request you to consider this information absolutely confidential since it constitutes the confidential details of our process on the development of which we have spent large amounts of money, time and labor.

Very truly yours,
METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander, President.

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

January 25, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I wonder if you could let me have the sketch of the copper sphere you are going to send me so we could make the necessary fittings here for filling it with uranium or with a neutral gas. I spoke of argon but nitrogen will probably be just as good. Do you see any objection to nitrogen?

If you would not object we would like to suggest a few details about the opening in the sphere before it is made, so that we could do it easier here. In fact, if you send the sphere without any openings possibly it will be easier for us to make an opening here and then fill it in.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

President.

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FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

February 5, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

We made a few sintered bars of uranium containing 5% of tin, lead and bismuth and degassed them in a vacuum of three microns but so far we have had other difficulties with them. After cooling they cracked badly so we had to scrap this material and start again. I will bring a sample of these cracked bars when I come to New York in about two weeks.

I am inclined to think that the best results will be obtained with pure uranium or uranium sintered with 5% of titanium or silver. Do you object to the addition of 4-5% of silver?

With regard to the production of uranium in larger quantities, we are going ahead with these plans, making foundations for additional machines and have ordered some equipment which otherwise could not be obtained for six months or more. Of course it is understood that all we can expect is the production of one or at the most two tons of uranium, and future production will be determined later by whatever method will prove more economical.

With regard to the payment for the equipment, we are willing to assume these expenses ourselves. However, if some appropriation will be available to pay for part of this installation as mentioned before, we will make a very special price to you and will keep this equipment available especially for your work on uranium and possibly other Government orders.

I will be glad to hear from you with regard to the disposition of your order for 22 lbs. of uranium which we are holding for you. Perhaps it will be more convenient for you to receive this material in powder form and fill the copper sphere in your own laboratories where the final

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

degassing could be done. In case you want us to fill the sphere in our factory we would like to know the dimensions of the sphere in order to make the necessary arrangements.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

Copied 2/3/41
H. Hill

February 8, 1941

Dr. P. P. Alexander, President
Metal Hydrides Incorporated
Box 816
Clifton, Mass.

Dear Dr. Alexander:

This is to acknowledge your letter of January 25.

It would be quite satisfactory to fill in the uranium metal into the hollow copper sphere which we propose to send you in an atmosphere of nitrogen rather than argon. As soon as we have the copper sphere, we propose to mail this to you so that your men canlook at it and decide what kind of opening they want to make. Please note that it is important for us to have the uranium firmly packed and it would therefore be necessary repeatedly to shake down the powder in the sphere while the sphere is being filled.

I should very much like to be present when the filling is actually taking place and we could make use of this opportunity to discuss other matters. Since I have to attend a meeting on the 21st and 22nd in Boston, perhaps Thursday the 20 of February could be fixed as a tentative date for my visit, if this date should be convenient to you. Should I be able to get away earlier than that date, I would then telephone to you in order to fix an earlier date.

Yours very truly

L. Sz.

(Leo Szilard)

LS/eh

February 7, 1941

Dr. P. P. Alexander, President
Metal Hydrides Incorporated
Box 818
Clifton, Massachusetts

Dear Dr. Alexander:

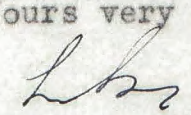
Many thanks for your letter of January 24. I should have answered it earlier but unfortunately the conference which was originally scheduled for Monday of last week has been repeatedly postponed. I have, however, informally discussed the matter with others, and hope that we shall be in a position to say more about it by the end of next week.

It does not seem possible for us to know in advance whether we shall actually purchase the first one or two tons of uranium metal from your firm. Consequently, it seems to me that we ought to contribute in some form or other towards the initial expenses of setting up the equipment which you specified in your letter of January 24. Sooner or later we shall perhaps solve the problem of sintering in a satisfactory way and we shall then be in a better position to discuss the purchase of the first ton of uranium.

Please note that we are not interested in removing the last small amounts of hydrogen which may be, as you say, difficult and expensive. The small samples which you degassed at 900°C in a vacuum of 30 or 40 microns, by heating them for the duration of one hour, showed when tested by the Bureau of Standards an amount of hydrogen which is entirely tolerable.

With reference to the last paragraph of your letter, you may be assured that the information which you gave me will be considered by me as confidential. It would be impossible for me to carry out the work with which I am entrusted unless I had knowledge of all details in connection with the manufacture of the materials which we require for our project, but such information is of course not communicated to others. Without an open discussion of all details by both parties our collaboration could hardly be fruitful, and I greatly appreciate the confidence which you have shown.

Yours very truly



(Leo Szilard)

LS:H

February 8, 1941

Dr. P. P. Alexander, President
Metal Hydrides Incorporated
Box 816
Clifton, Mass.

Dear Dr. Alexander:

Many thanks for your letter of February 5. I was very glad to hear that you have ordered some of the equipment which you specified in your earlier letter. While it does not seem feasible for us to make any promises or even half-promises concerning the first one or two tons of uranium metal which we might require, it is my personal hope that we shall be in a position to contribute to your initial expenses in one form or another.

With regard to the copper sphere, I have written to you today, and I believe we shall retain our original plan and have this sphere filled in your factory. I believe it will be useful for me to be present in order to study this operation which we may have to repeat quite often in the near future.

We appreciate very much your having tried to sinter uranium with various binders. If you could send us by mail those cracked bars we would look at them and send them to the Bureau of Standards in order to be tested for their hydrogen content. The cracking of this material would not necessarily prohibit its use for certain purposes which we have in mind.

We also appreciate your sending us some uranium bars sintered with titanium. If you are satisfied with their behavior from the point of view of sintering, we would then investigate certain physical properties of titanium itself in order to find out whether 5% of titanium can be tolerated.

Unfortunately, we cannot tolerate 4 to 5% of silver, and the use of this element for sintering is for us out of the question.

Very truly yours

L. Le

(Leo Szilard)

LS/eh

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

February 12, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I have your letter of February 8th and noted that you will be in Boston on February 21st and 22nd and suggested Thursday, the 20th, to come to our Beverly factory.

During that week I am attending the A.I.M.M.E. convention in New York and have already arranged for several important meetings which I cannot change. I will be in New York on Monday, Tuesday, Wednesday, and at least part of Thursday. However, I will be back in Beverly on Friday and therefore would suggest that you visit our factory either Saturday after your meeting in Boston, or Sunday. I am afraid that we will not be ready to fill the sphere because it will take sometime to make the necessary preparations after the sphere is received by us, and in my absence probably this will be somewhat delayed.

We will be very glad to show you our method of production of uranium. To comply with your special requirements we are changing somewhat the technic and I am sure we will be able to produce soon the material which will be safe and easier to handle in bulk.

On my schedule of New York meetings I put tentatively Wednesday morning as the time to go to your laboratory and discuss some of the questions relating to the production of the sphere. If you are still in New York on Wednesday morning perhaps it will be just as well to have a meeting in your laboratory. Since we are producing this uranium for you I will be very much interested to see your laboratories and some of the experiments which you are doing. Perhaps by this more complete exchange of information on the material and how it is used we could arrive more quickly at the best solution for its production and could assure you of a supply of material most suitable for your work.

If Wednesday is inconvenient I will be glad to rearrange my schedule and come to Columbia at any time

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

during the first part of next week. Perhaps Professor Mitchell will be there also to give additional recommendations with regard to the quality of material which might be needed in the future.

Hoping to see you in New York and later to welcome you to our factory in Beverly,

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

President.

Copied 2/13/41
H. Hill

February 13, 1941

Mr. P. P. Alexander, President
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Mr. Alexander:

Many thanks for your letter of February 12. Wednesday morning of next week would be a very good day for us to talk, and if I don't hear from you to the contrary I shall be expecting you around 9:30 A.M.

The copper sphere has now been delivered and I shall mail it to you tomorrow so you may have a look at it and give instructions to your men before you leave for New York. A second identical sphere has also been made, and we shall have it here for you to look at it when you visit us.

I do not yet know Professor D. P. Mitchell's schedule for next week, but I'll find out what day he intends to be in New York. Perhaps he can take part in the discussion.

Looking forward to seeing you next week, I am

Very truly yours,

L. L.

LS:H (Leo Szilard)

cc: 1 - Pegram
1 - Szilard
2 - Mitchell

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URANIUM-NICKEL
TITANIUM-NICKEL

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

February 16, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I am going to New York tonight and will be there for several days. I will stop at the Hotel Roosevelt and could also be reached by phone at our New York office, 230 Park Avenue, telephone Mohawk 4-9172.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

CLASS OF SERVICE

This is a full-rate Telegram or Cablegram unless its deferred character is indicated by a suitable symbol above or preceding the address.

WESTERN UNION

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SYMBOLS

DL = Day Letter
NT = Overnight Telegram
LC = Deferred Cable
NLT = Cable Night Letter
Ship Radiogram

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J. C. WILLEVER, FIRST VICE-PRESIDENT

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RV105 A510CC 2F 43 NT

RV NEWYORK NY FEB 19 1941

DOCTOR L TILARD QK

COLUMBIA UNIVERSITY PHYSICS DEPT NYK

WE'LL EXPECT YOU FRIDAY BEVERLY IF POSSIBLE BY NOON WOULD LIKE TO HAVE THE PLEASURE OF HAVING YOU FOR LUNCH I FOUND HAVE TO BE AWAY AGAIN ON SATURDAY. SATURDAY FACTORY WILL BE OPEN FOR YOU BUT NO PRODUCTION WORK WILL BE DONE

P P ALEXANDER

959P

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

March 15, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University.
New York City.

Dear Dr. Szilard:

I have your letter of March 13th. Referring to all these questions I am rather perplexed with regard to the plans for the future.

To start with, we never received any letter from Dr. Pingram. However, we went ahead on the assumption that this work is urgent and will be carried on somehow, and now the apparatus is already on order. In fact we ordered even more expensive apparatus since we believed it would give still better results.

With regard to the question of uranium dioxide, does it mean that you do not anticipate carrying on the plans of ordering 300 pounds of uranium from us? With regard to uranium dioxide, I investigated this matter and we are not going to consider this proposition at all, first of all because it will involve the installation of a different type of equipment, and it is not sure at all that the results will be satisfactory. To start with, uranium dioxide is an unstable product and after a hydrogen treatment and removal from the furnace, it will be not a definite compound, UO_2, but a mixture of oxides with different amounts of oxygen, and since it is unstable it will gradually oxidize and go back to U_3O_8. Personally I cannot see any advantage in preparing this material because U_3O_8, now available in large quantities, is really $UO_{2.6}$, which contains only slightly more oxygen than UO_2.

Furthermore, U_3O_8 is a stable compound and could be dried very thoroughly by calcining at high temperature. UO_2 after a hydrogen treatment may contain a certain amount of hydrogen adsorbed on the surface which has to be again removed by vacuum treatment. Why not go the full way and produce the material which you know is the best for the purpose or use the standard uranium oxide? If we carry on this work continuously we are quite sure that the problem of the hydrogen content will be solved along the line we discussed, namely by first treating the mixture at low temperature to completely decompose the hydride into metallic

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FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

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calcium and then raise the temperature and reduce the oxide in vacuum.

With regard to the price, in the long run, by conducting all these various experiments it will cost you more than by concentrating on one particular method and trying to reduce the price of production.

With regard to deliveries, if this material is needed in a hurry, we can even now produce it at the rate of one ton per week. And certainly we will be willing to install additional equipment to increase the production to five or even ten tons per week.

With reference to the filling of the spheres which you are going to send, of course we are going to do it in the most careful way to avoid any possible settling of the material during the later experiments. We would like to know, however, which sample was found satisfactory by the Bureau of Standards with regard to hydrogen content, because one sample had only a single vacuum treatment and the other a double vacuum treatment. I would like to ask you to wire me Monday morning which sample was found satisfactory. If a double treatment is necessary we will immediately give a second vacuum treatment to the material which we are holding for you now.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

March 21, 1941

Dr. Leo Szilard,
Physics Department,
Columbia University,
New York City.

Dear Dr. Szilard:

I have your telegram and am very sorry you were absent from your laboratory and hope that now you have recovered completely from your illness.

We have leached all the uranium made for you and now it is being carefully dried in vacuum. It will be ready for filling the spheres early next week. We have a little difficulty in deciding where to make the openings in the half spheres you sent to us.

I am scheduled to be in New York this coming Monday and will be through with our Directors' meeting by two o'clock. I am planning therefore to come to your laboratory and bring the empty spheres with me. Probably in your laboratory the modifications could be made much quicker and of course in a way which will not influence the results of your experiments. I don't think it will take more than one hour to make these changes so that I could take the spheres back with me and fill them probably Tuesday.

You will get this letter Saturday morning so if by any chance you decide to fill the spheres in your laboratory I could bring the uranium powder with me. It might save you one or two days. If you wish me to bring the uranium as well, please wire me at my home, 79 Rockaway Avenue, Marblehead, Mass. I am leaving Sunday for New York.

In case you are not planning to be in the laboratory Monday afternoon would you please leave a message in the office so that they could put me in touch with the mechanic who does this work on soldering and assembling the spheres.

Hoping to see you Monday afternoon about three,

Very truly yours,
METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

C
O
P
Y

METAL HYDRIDES INCORPORATED
12-24 Congress St., Beverly, Mass.
Mailing Address: Box 816, Clifton, Mass.

March 26, 1941

Professor G. B. Pegram
Department of Physics
Columbia University
New York City

Dear Professor Pegram:

We are installing additional equipment especially suitable for the production of uranium, and now are pleased to state that we will be in a position to produce this material in larger quantities. We will be glad to accept orders for this material when ordered in batches of 25 lbs. at the basic price of $20.00 per pound, and in ton lots, if you supply your own uranium oxide, at the basic price of $10.00 per pound.

The extra treatment such as double degassing or shipment in containers filled with argon could be arranged for a certain additional price to be agreed upon later.

Very truly yours,

METAL HYDRIDES INCORPORATED

(signed) P. P. Alexander

President

PPA:A

March 31, 1941

Mr. P. P. Alexander, President
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Mr. Alexander:

This is to acknowledge the receipt of your letter of March 26, stating that you are now in a position to accept orders for metallic uranium in batches of 25 pounds at the basic price of $20.00 per pound, and in ton lots, if the uranium oxide is supplied to you, at the basic price of $10.00 per pound. Any extra treatment, such as double degassing or shipment in containers filled with argon, would be arranged at an additional price to be agreed upon.

With thanks for your prompt response to our inquiry made when you were here last week, I remain

Very truly yours,

GBP:H

George B. Pegram

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

2 carbons

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

March 27, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

We are completing the work with the spheres which I am sending to you all filled with uranium on Friday. Mr. Davis whom you met here is going to bring personally these spheres to your laboratory Saturday morning shortly after nine o'clock. He will explain the technic which we were using in filling them. This information might be useful to you in filling other containers with uranium which perhaps could be done right in your laboratory.

As our work is progressing we are beginning to see our way clear to making sintered bars and discs of any desired dimensions, and quite free from occluded gases.

I hope that when we complete the installation of the special unit for the production of uranium you will come again to Beverly since by discussing things many technical problems could be solved much quicker than by correspondence.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

President.

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3 carbons

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

April 18, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

Referring to our conversation of April 16th on the subject of uranium, if you will need a few tons of this material to bring the experimental work to its logical conclusion, and in view of its importance, if successful we will consider making these few tons at the lowest possible price, that is at cost plus some coverage to provide extra pay for the men engaged in the preparation of this material since some stages of its production involve a certain amount of health hazard. We would consider this work as our contribution to the important work now carried on at Columbia University.

If the results of the experiments will indicate that there is no further need of material of the quality we are producing, we will not expect any re-adjustment of price or other compensation since we consider it our patriotic duty to make this contribution. However, we cannot do it indefinitely and if later on additional amounts of uranium will be needed, we would have to charge a price at which we could produce this material at a reasonable profit.

If you supply us with uranium oxide for this particular lot and we are given a priority for the necessary amount of calcium to meet the dates of delivery, we believe we can produce this material very quickly and at a very low price.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

Col 9344

LI 2 8947
13 E 38

AM [illegible]

[illegible]

Van Vleck

3 carbons

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FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

May 7, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

We are completing now the installation of additional apparatus necessary for the anticipated production of uranium. It will be ready by the 15th of this month and we would like very much to have you come during the week of May 18th - 24th. We may discuss the possible plans of production of this material in fused or sintered form which I believe will be well within the possibility of accomplishment with our equipment in the very near future.

Please let me know if a very small percentage of gold will be an objectionable impurity in fused uranium. I would like to have this information as soon as possible since we are planning additional sintering tests. Since gold has about the same density as uranium it will not lower the density of the sintered material especially if it is added in very small amounts. The very fine gold dust is so soft that it acts as an excellent binding material during the sintering and of course it's melting point is just about right for that operation.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

4 copies made 3/15/41

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

May 13, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

We had the pleasure of having Professor Mitchell visit our factory yesterday and we had occasion to discuss many subjects pertaining to the work on the material for which we just received a request for bids from the Bureau of Standards. Perhaps it would be just as well to have the first order of comparatively small size to give us a chance to study more in detail the technic of production of this material at a higher rate than we have produced it before. At the same time it leaves you entirely free in formulating your further plans.

Professor Mitchell mentioned that you want me to come to New York for a meeting this Friday. I am afraid it will be difficult for me to do this unless you think that the subject which you were planning to discuss with me could not be postponed to a later date. I am sorry I did not get your telephone call yesterday when you were trying to reach me from Columbia. I was anxious to ask you about the possibility of using gold dust as a binder.

As I mentioned, at the Massachusetts Institute of Technology Professor Wulff succeeded in pressing our uranium powder into compact discs and apparently the way is clear to make larger objects by this method. If, for instance, a die could be built in the form of a half sphere, the powdered material could be pressed into an absolutely compact and dense half sphere at a very low cost indeed. It will eliminate any possibility of blow holes and various voids inevitable when the metal is fused and cast, and also will eliminate all necessity of machining. If the half spheres could be assembled and held tightly by a thin copper envelope for instance, there will not be any need of further sintering since probably it will be of sufficient density. The whole secret is to use sufficient pressure. I did this work previously quite successfully at the General Electric Company when I was using 70 tons per square inch and no binder at all. Professor Wulff was using 80 tons per square inch. At the Bureau of Standards there are presses giving still higher pressures.

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

Professor Wulff in some of his experiments with our uranium, I think used a small amount of silver powder as a binder since he does not know and I did not tell him, for what purpose you intend to use the pressed material.

Our installation, as I mentioned, will be ready this week and next week we could start production work if we receive from you the necessary raw material free from moisture. Otherwise it would have to be calcined. In any case I hope it will be possible for you to come and look over our installation in the near future.

Starting next week we can produce 100 lbs. per day. In fact, in making our bid we indicated that the whole thousand pounds can be produced in two weeks. Of course by adding more furnaces of the same type the production could be advanced to any desired scale, a ton a day or more if so desired.

If you think it is necessary for me to come to New York for a conference I could do it some time next week. In any case I will be in New York in the near future and will make a point to call at your laboratory.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

May 23, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I just received a letter from Dr. Pegram about the oxide and simultaneously received a letter from Mr. Pregel.

Mr. Pregel says that they have instructions from Dr. Pegram to send this oxide to us and he is sending this oxide (May 20th) by freight. I am afraid there will be a little delay. So far we have not received this oxide. In the future it would be better to specify that the oxide be send either by fast freight or if in small amounts, by express.

I am writing to Dr. Pegram acknowledging his letter and mentioning that we had a very profitable conference and arrived at a solution which probably will give you the desired results, but we hope that it will be taken into consideration that we are doing this not as a profitable commercial proposition, but as our contribution to the success of the important work which is being done at Columbia University.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

P. P. Alexander.

PPA:A

Copied 5/24/41
H. H.

Miss ~~Frank~~ Sally Lawrence
WA-3-2500
Harkness Pavillon
802

Tues 11 AM

Tues 9 pm

COPY

METAL HYDRIDES INCORPORATED
12-24 Congress St., Beverly, Mass.
Mailing Address: Box 816, Clifton, Mass.

May 24, 1941

Professor D. P. Mitchell,
c/o Dr. C. J. Rodden,
National Bureau of Standards,
Washington, D. C.

Dear Professor Mitchell:

In making closer calculations we find that it will be safer to specify 1.4 pounds of uranium oxide per each pound of uranium actually produced since unquestionably there will be some losses. It will be satisfactory to me if you put a clause in the contract specifying that we will return any oxide left over from the production work, which of course is implied by the fact that the uranium oxide is not our property.

It will also be absolutely essential that there should be no delays of any kind in the production schedule. We will require therefore from you the assignment to us of a good priority number, that is AIA or something similar. Otherwise we will not get in time such supplied as additional temperature measuring instruments, an additional amount of calcium, nickel for spare retorts, etc.

We are ordering immediately spare parts for our equipment and do not expect any additional payment for them, but we have to be sure that we could produce this material at a rapid rate. Furthermore, in spite of all that may be promised by Mr. Pregel we may find that the moisture content of the oxide when delivered in Beverly will be higher than specified. In that event we would have to install immediately a roasting furnace and do the calcining of the oxide in our factory. The cost of roasting and installing additional furnace should be adjusted.

We would also expect you to give us help to obtain deferment on the draft if any of our employees should be called for military training during the period of work on this contract. We could not possibly afford any delays or dislocation of our schedules during the production of this material.

Some saving clause should be put into the contract to the effect that if we encounter unforeseen obstacles

or run into much greater losses than we expect now, we will be allowed to stop production or the situation will be reconsidered and the number of pounds of material to be produced for the given sum should be reduced.

Speaking in general, the conditions which you proposed a week ago at our first conference of course were better for our company than those we are now accepting. However, it was only after learning that the success of this experiment depends not on a small amount but on a large amount of uranium that I was willing to cooperate to the fullest extent even if it did not appear so at first during our discussion, and to do all we can to help out this situation, simply because we consider this not as a commercial proposition, but as our contribution to some important work, and hope that if something will result from these experiments we will be given large orders for the same material, which then will be profitable for us.

However, if no unforeseen obstacles and no delays due to causes beyond our control are encountered, we expect to furnish this material within six months after accepting the order and for the total price discussed at our last conference.

Very truly yours,

METAL HYDRIDES INCORPORATED

(S) P. P. Alexander

PPA:A President.

P.S. In discussing our facilities for the production of uranium I would like to ask you not to disclose the design of our equipment and other points which of course are our manufacturing secrets, to anyone outside of the organizations which are entitled to such information. PPA

0.105-6% 0.15% 4h 2a 0.18%

June 1, 1941

Copy to Dr. Szilard.

Dr. D. P. Mitchell,
c/o Dr. C. J. Rodden,
National Bureau of Standards,
Washington, D.C.

Dear Dr. Mitchell:

Yesterday we received the samples of uranium oxide referred to in your letter. We will use these samples as standard for comparison with our tests. There are six samples but there is no identification on them except the numbers. I am wondering if you could send the key to these numbers. Undoubtedly they are recorded in the log book of the laboratory where they were tested.

Our tests in general agree with yours only that our testing was carried to a higher temperature. We are going to repeat our tests at temperatures exactly measured as in your case.

To start with, the variation of the weight at higher temperature we found is due to the changing ratio of UO_3 to UO_2.

What is important for us is first to be sure that there is no appreciable moisture in the oxide, and second, that the ratio of these two oxides in the complex oxide is the same in all our runs. Otherwise the results will vary. It is for these reasons that we are planning that all shipments of oxide, after testing for moisture, should be calcined again at a definite temperature just before reduction. Of course as specified, we would like to have further shipments come directly from Canada where at the Port Hope refinery I know they have facilities to do calcining very quickly and cheaply. Mr. Pregel told me that they will not have any trouble in doing so. As we specified before, we would like to have the oxide calcined before shipment at the highest practical temperature in the order of 1100°C to 1200°C. During shipment undoubtedly it will start undergoing change but if the time of transit will be about the same on all shipments we should get uniform results and our task will be simpler.

We are ordering a new continuous furnace of larger dimension in which we plan to do among other things, the final heat treatment of uranium oxide just before reduction to metal.

The first hundred pounds of oxide shipped to us by freight has not appeared as yet in Beverly, but the second lot sent by Dr. Szilard reached us several days ago, and has been twice calcined, ground to the desired fineness, and on Friday was reduced in three furnaces to metal. Yesterday the furnaces were still too hot to be opened since highly degassed material

of this kind must be almost at room temperature before it is allowed to come in contact with air. I am going to the factory shortly but it will be too late to start leaching today so that the leaching will be done on Monday.

As soon as the second lot of one hundred pounds will arrive we will starting working on it immediately, calcining, grinding and reducing to metal, since we need as much experience as possible on running three furnaces simultaneously and studying of the details of the reactions before larger quantities of the oxide will start arriving. Of course we have no order for the second lot of a hundred pounds of oxide but I understand that there will not be any question about this order coming through.

As mentioned, we will need from you a good priority number. This first run demonstrated that our process is ideally suited for uranium on a large scale but it also indicated that it will require great precision and skill in carrying out every single operation to get the desired results and eliminate the danger of reactions proceeding too violently at certain stages of reduction. In fact, I ran all three furnaces ~~by~~ myself and probably would have to do so for a considerable time until all the details have been studied as well as necessary changes in the apparatus are made. We can also see quite clearly that we have to greatly improve our ventilation system to avoid the possibility of uranium oxide poisening when this material is handled on a fairly large scale. It is for all these reasons that we feel that this proposition is not a commercial one but simply a desire to be of service to you since by the time we get through with all our troubles and adjustments there could not be any question of profits on this first order. However, someone has to do it and all of our directors are happy that we can make this contribution.

Referring to the priority number, we will need it as quickly as possible since we have to purchase additional pyrodes which we were unable to buy lately without priority, and the most exact temperature control in this work is absolutely essential.

During the early part of the second week in June I will be in New York and will get in touch with you and Dr. Szilard.

Very truly yours,
METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A P. P. Alexander

P.S. To save on Sunday typing I am sending a copy of this letter to Dr. Szilard instead of writing him a separate letter.

P.P.A.

C
O
P
Y

METAL HYDRIDES INCORPORATED
Factory At
12-24 Congress St., Beverly, Mass., Tel. 1875

Mailing Address: Box 816, Clifton, Mass.

July 8, 1941

Dr. D. P. Mitchell,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Mitchell:

Will you please let us know by wire if the 50 lbs. of calcium hydride ordered by phone and which were sent to the Bureau of Standards will be returned to us?

I hope that Dr. Szilard took up with you the question of the charges for the last 35 lbs. of uranium which were made in accordance with his instructions and which were burned up in Boston.

I also hope he discussed with you the matter of additional charges which we have to make for special re-cast calcium which was sent to us by the Union Carbide & Carbon Corporation. So far they have not invoiced us for this material and we are wondering if you are going to pay for this special calcium bought for your experiments in the same way in which you are going to buy the distilled calcium, as I understand from Dr. Szilard. The question of new calcium which the Union Carbide & Carbon Corporation is making now should also be considered because if they charge for that special calcium more than we were paying for the standard calcium, naturally all our calculations will be upset and the price for uranium should be re-adjusted.

Very truly yours,

METAL HYDRIDES INCORPORATED

(Sgd) P. P. ALEXANDER

PPA:A

1-Pegram
1-Fermi
1-Szilard ✓
2-Mitchell

June 11, 1941

Dr. D. P. Mitchell,
c/o Dr. C. J. Rodden,
National Bureau of Standards,
Washington, D.C.

Dear Dr. Mitchell:

The samples of calcium made by the Union Carbide & Carbon Corporation prior to October of last year have been sent to Dr. Rodden by special delivery air mail, and will be in his hands tomorrow morning.

I could not understand how much impurities were in the calcium, but I suppose Dr. Szilard will explain it to me tomorrow.

It was very encouraging to hear from you that the Union Carbide & Carbon Corporation has the furnaces ready, and that there will be no delay in shipments of calcium made by the old process. Of course the necessity of using new calcium upsets our plans and unquestionably will increase tremendously the cost of production since we were counting on the absence of all delay. We have made part of that material already, and furthermore, one and a half tons of calcium which were ordered for this job have already been processed and made into calcium hydride. Now we will have to start from scratch. However, since there will be no delay on delivery of the new calcium, we may come through alright.

Therefore I signed the contract which came by air mail fifteen minutes after your telephone call, and it is already on the way back to Washington.

I am hoping that the unusual circumstances affecting this work will be taken into consideration by Dr. Briggs, and that if some unforeseen delay on delivery or increase in the cost of production should arise, that this will be taken into consideration in making the necessary adjustments.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A
cc: Dr. Leo Szilard

P. P. Alexander.

July 15, 1941

Dr. D. P. Mitchell,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Mitchell:

The filling of the forms for requesting priorities has been delayed in view of the possible changes in the apparatus which we will use in the production of larger quantities of uranium.

Additional retorts will be needed for the production of calcium hydride since it seems that the two and one half tons of standard calcium already processed into calcium hydride apparently could not be used. We would have to increase our retort capacity since otherwise we would have to use the same set of retorts for the production of calcium hydride and uranium metal. This of course would cut the speed of production and would increase considerably the cost.

We are also making plans for the production of our own calcium hydride directly from lime by our own patented process which gives a product absolutely free of the objectionable impurities now found in calcium chloride. Of course we hope that this will not be necessary and that the Union Carbide and Carbon Corporation will shortly overcome the difficulties and start the production of calcium of the desired purity and grade.

However, shortly you will receive a list of the articles for which we will need priority rating at the earliest date.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A
cc: Dr. Leo Szilard.

Copy

September 3, 1941

Dr. D. P. Mitchell,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Mitchell:

Some time ago at the suggestion of Dr. Szilard, we ordered re-cast calcium for a special run of uranium metal. Since this calcium is very much more expensive than the standard calcium we were expecting that the Bureau of Standards or Columbia University will pay for this special lot of calcium. However, after a few months the Union Carbide and Carbon Corporation finally billed us and we paid for this material. Some of it has already been used for making uranium which was charged at the regular price to Columbia in spite of the fact that the cost of the calcium used in that particular batch was about double. We had 50 lbs. of this calcium left.

As you recollect, you called us on the phone and requested us to make and send to the Bureau of Standards for Dr. Rodden's work 50 lbs. of calcium hydride made from re-cast calcium. This was done immediately and in due time a formal order came through from the Bureau of Standards for 50 lbs. of this special calcium hydride. We invoiced them for this material but they have not paid for it as yet. In fact, Dr. Rodden used only part of this material and the rest of it was returned by him and is being held in storage at our plant for further work on uranium. We are not using this material for any of our other work and consider it as the property of the Bureau of Standards for further use by Dr. Szilard.

Since this special calcium was purchased by us for the work on uranium, we naturally expect that our bill, at least for this fifty pounds, will be paid by the Bureau of Standards.

Hoping that you will straighten up this situation for us,

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A
Copy to Dr. Szilard.

President

Copy to Dr. Szilard

September 10, 1941

Dr. Lyman J. Briggs, Director,
National Bureau of Standards,
Washington, D.C.

Dear Dr. Briggs:

With regard to our contract for the supply of uranium metal, we have completed our installation of the necessary apparatus in the factory, and after overcoming some initial difficulties we were ready to start production last June. Unfortunately it was found by the research workers at Columbia University that the presence of boron in minute quantities which were never thought of by metallurgists, makes a big difference in the special reactions they are investigating. It was hoped that pure calcium free from all traces of boron could be supplied to us right away and we were waiting for this since last June. Although there is great promise that such pure calcium will be available, it is not certain when the Columbia people could make arrangements for the production and supply of such material to us.

It seems necessary therefore that the conditions of our contract should be adjusted. I will discuss these matters this coming Saturday with Dr. Pegram and Dr. Szilard in New York and I am sure the desired solution of the problem could be easily reached and submitted later for your consideration.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

President

Copied 8-4-41 L-H

Copy

August 2, 1941

Dr. G. B. Pegram,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Pegram: Subject: Thorium

In anticipation of a possible urgent demand for thorium metal we made a special batch of fifty pounds of thorium which came out of excellent quality. It is not subject to rapid oxidation and appears to be absolutely free from hydrogen. This material has been carefully dried in vacuum and packed in special cans. It will be sealed in argon before shipment. Dr. Szilard does not wish us to use other safety methods prescribed in the shipment of powdered metals.

I understand from Dr. Szilard that it will be quite important to have this material at Columbia University next week since the equipment for these experiments is ready.

You know how eager we are to cooperate in every way to facilitate the tremendous task confronting the scientists in your department. We will be glad to forward this material immediately to your department and we are not worrying about immediate payment but we must invoice this material to you when it leaves the factory. This material is already on our inventory and we should have some indication that in the near future, that is during August or September, a formal order will be forthcoming. A brief word from you that some arrangement will be made in the near future and a formal order for this material will be placed with us will be sufficient, and the material will be sent to your department by special messenger as soon as we hear from you.

We have been making and selling this material in small lots at the price of $50 per pound for several years already. However, for this special batch we have lowered our price to $20 per pound.

Very truly yours,

METAL HYDRIDES INCORPORATED

P.P.A.

PPA:A President.

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

May 26, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I am glad you sent the second lot of 100 lbs. by plane because there is no sign whatsoever of the first shipment made by freight.

We analyzed already the material and found that unfortunately it contains both adsorbed and combined moisture of not less than .8 of 1%, and some samples taken from the charge had a considerably higher moisture content. We started working on this material immediately but it must be carefully calcined at high temperature with continuous stirring.

We will work overtime on the production of this 70 lb. lot of uranium but I doubt very much that it will be dry enough and ready for shipment before Monday night.

Judging by this I think it will be safer if we start planning at once on calcining all the future shipments regardless of the specified calcining in Canada, because it will increase the cost but it will be safer. As you know the moisture produces a violent reaction when any uranium compound is reduced either with calcium or with sodium by any process. On a laboratory scale it is not apparent but when you have 50-70 lbs. in the charge or even 20 lbs. the reaction is quite violent.

Of course it will be desirable to insist on the calcination of the oxide before shipment so that at least part of the moisture will be removed. It could be pointed out that the domestic producers were supplying us with uranium oxide which tested .005 of 1% of moisture.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

P. P. Alexander.

Copied 5/29/41 H.A.

PPA:A

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

May 27, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

With further reference to uranium oxide, if this oxide is already in New York and it could not be calcined somewhere without delay, then it will be just as well to send all of it to us immediately. We have no facilities as yet for calcining it at a fast rate but we could start calcining it in small batches and probably by the time the order comes through we would have enough to start.

In the meantime we will order a suitable furnace for calcining the oxide at a fast rate. The only thing we will need is the assignment to us of a priority number so that we could order a special retort made of chromium nickel alloy.

The cost of calcining at our plant will be high yet it will be far cheaper than to lose time by waiting. As I said, the only way we can produce uranium for you at such a low price is to eliminate any possible delay.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

Copied 5/28/41

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TITANIUM-NICKEL

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

May 28, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard;

We are having trouble with the uranium oxide which you sent to us by air mail. Our first tests showed that it contains considerable moisture. Therefore we had to calcine it yesterday all day long at 900°C. Our tests this morning indicated that on heating to 950°C the loss is still .45 of 1% and by calcining the samples in the laboratory to the still higher temperature of about 1000°C the tested samples lost about 3%. It means that it contains either some volatile compounds or combined moisture in considerable amounts and we have to eliminate this volatile matter, whatever it is, before we can start the reduction to metal. Therefore we have to calcine again today in vacuum at high temperature.

We cannot go too high in stationary furnaces because the material will sinter. Therefore it will be quite imperative for us to build the proper calcining furnace with rabbling arms, just as quickly as possible. We are going ahead with this plan already. The only thing we need now is a priority number on this job so that we could obtain the necessary nickel. I hope you will discuss this matter with Dr. Mitchell and Dr. Pegram. We will do the best we can to push this work through but we need your help to do it quickly.

There is no sign of any kind of the first shipment of oxide sent by freight. Was it sent from New York or from Canada?

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander

Copied by
L. L.
5/29/41

June 2, 1941

Dr. P. P. Alexander, President
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

Many thanks for your letters and also the copy of the letter which you wrote to Mitchell on June first. May I suggest that you send me also in the future copies of all letters which you write to Mitchell in connection with this matter, so that you need not write me another letter, except when you want to communicate additional information. Dr. Mitchell will receive automatically copies from us of all letters which you write to any of us at the Physics Department.

Being in a hurry, I just write you today that from the telephone conversation which I had with Mitchell I gather that the 6 samples which he sent you have a moisture content of .15 to .18 per cent, as determined by heating the samples in nitrogen to about 800°C and condensing the water vapor. I wonder whether this is too much for you, and whether you need drier material. As you mentioned in your letter, the gain or loss of weight on heating may be due to changes in oxygen content.

If your requirements as to dryness are very strict, it might perhaps be a good plan for you and D. P. Mitchell or myself jointly to visit Port Hope and talk to the chemists on the spot. The uranium oxide could be shipped from Canada in sealed tin cans, which need not be opened until you actually use it. In this way the content would not change while the material is in stock.

Could you please let me know by telegram what is the highest moisture content which you could stand without much inconvenience.

Sincerely yours,

L. S.

(Leo Szilard)

LS:FLL

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

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NZ3 33 DL=MARBLEHEAD MASS 3 730A

DR LEO SZILARD=

DEPT OF PHYSICS COLUMBIA UNIVERSITY=

BELIEVE REFINERY CANADA TEMPORARILY CLOSED QUICKER TREAT FIRST TON OUR FACTORY MOISTURE CONTENT SHOULD BE LOWER CAN BE CORRECTED HERE DESIRABLE SEND FIRST HALF TON IMMEDIATELY OUR FACTORY SECOND HUNDRED POUNDS NOT RECEIVED=

P P ALEXANDER.

827A.

SZILARD. COPIED BY FLL JUNE 3, 1941

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

Copied 6/4/41
H. H.

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METAL HYDRIDES INCORPORATED

FACTORY AT
12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875
MAILING ADDRESS: BOX 816, CLIFTON, MASS.

June 3, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I received your Special Delivery letter this morning which I have already answered in part by wire as requested. I am also sending a copy of this letter to Dr. Mitchell as requested.

Last week I was informed that the Port Hope refinery is temporarily closed since they have a large amount of radium and especially uranium oxide in stock. Their stocks are especially high on uranium oxide since the export of this material to Europe has been stopped, and in the past they were not successful in disposing of the surplus of the oxide in this country. It will be necessary to check up as soon as possible whether their Port Hope refinery is entirely closed or whether some departments are still running on part time. I could write directly to Mr. La Bine, president of the company, who showed me their Port Hope refinery some time ago. However, perhaps this point could be checked up through Mr. Pregel. I probably will see him next week when I come to New York. He knows that I was developing various uranium-nickel alloys for many years and the question of moisture, etc. I discussed with him long before Columbia University began its present investigation. Your thought that we should visit the Port Hope refinery of course is very good and personally I will be most anxious to visit that refinery again and discuss various points with their chemists. But first of all we have to find out whether the refinery is open or not, second, we have to get permission from the president of the company, and third, we have to find out if their chemists will be allowed to give us the desired information. As you know, some of the details in the manufacturing processes are guarded as manufacturing secrets and most valuable information is never given out. Merely walking through their refinery will not give us this information.

The results which Dr. Mitchell obtained at the Bureau of Standards on the loss by ignition check up very well with ours.

First of all the oxide should be as free from moisture as possible. Otherwise it will slow down very much our very first operation. Second, it must be of uniform composition. That is,

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

the ratio between UO_2 and UO_3 should be constant in all lots. As you know uranium oxide is an unstable compound and during various treatments or even when standing in air it changes its composition. For instance, you may, by some treatment, produce almost pure UO_2 but it will not remain in that state and gradually part of it will oxidize to UO_3. Furthermore, it will not oxidize entirely to UO_3 but will reach a certain state of equilibrium which will be different under different conditions. For continuous production therefore it will be quite imperative before treating successive lots to give them a preliminary treatment, bringing various lots to the uniform condition, whatever it may be. It is for this reason that I am beginning to believe that the best solution will be to give the preliminary treatment which of course is calcining under special conditions of temperature and atmospheric control, in our own factory in spite of the fact that I hate the thought of adding this additional operation to our process. As far as immediate steps are concerned, I believe that to eliminate the delays which are the most costly part of the whole process, it will be better if the first ton of oxide be shipped to us right away from New York so that we could start putting it in the right condition so that when the order will come through we will be ready to start immediately the production of metal. Probably this will be the quickest and in a way the cheapest solution unless you know some place where they will be willing to calcine this first ton without delay under given conditions and without danger of contamination with other materials, such as silica and other materials which may come from refractory bricks of the calcining furnace. The only place where I think the calcining could be done quickly and without contamination is the Port Hope refinery. Their small furnace was running continuously on this particular operation and they know how to do it. But to get freshly calcined oxide from Port Hope even if they open up the factory right away for this particular operation will take considerable time and I am sure if we wait for them we will be without oxide by the time the order for uranium will be put through.

The hundred pounds of oxide which was sent originally by Mr. Pregel by freight is still in transit somewhere and has not shown up as yet in Beverly. This is only a small illustration of what we can expect on shipments from Canada.

The uranium made last week seems to be of excellent quality and is now being air dried.

Very truly yours,
METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A
cc: Dr. D. P. Mitchell.

P. P. Alexander.

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METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

June 4, 1941

3 carbons

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

Your first lot of 70 lbs. of uranium metal has been made. It was air dried and is tonight going into a vacuum oven for twenty-four hours. It will be shipped to you Friday morning.

It was tested by grinding in a mortar and heating to over 150°C without ignition. It is not pyroforic. In fact, we are absolutely certain that none of the lots will have any pyroforic properties. Some of the samples of the powder were hammered on the anvil into tiny flakes, indicating that the metal is ductile and could be pressed without a binder.

The first lot of 100 lbs. of oxide finally arrived at four P.M. today. Unless it is free from moisture which is most unlikely it will be calcined tomorrow and ground to the desired fineness Saturday.

At the same time we are making alterations on our furnaces since this first run indicated that some changes had to be made.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A
cc: Dr. D. P. Mitchell.

P. P. Alexander.

Copied by FLL June 5.

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DR LEO SZILARD=

DEPT OF PHYSICS COLUMBIA UNIV=

AFTER THINKING OVER DO NOT LIKE NONDELIVERY CLAUSE BUYING UP MARKET CHARGING DIFFERENCE TO US ITS NOT FAIR TO OUR COMPANY WHICH IS DOING UTMOST HELP OUT SITUATION APPARENTLY NO RECOGNITION GIVEN US FOR MAKING CONTRIBUTION AND NOT MERELY SEEKING COMMERCIAL PROPOSITION BEFORE SIGNING CONTRACT WOULD HAVE TO ADD OUR OWN CLAUSE QUALIFYING OUR RESPONSIBILITY=

P P ALEXANDER METAL HYDRIDES INC=

SZILARD=

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

June 7, 1941

Dr. P. P. Alexander, President
Metal Hydrides, Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

As I mentioned to you over the telephone, the printed form of the contract makes it clear that in case of non-delivery the contractor should not be liable to pay damages if the delay in delivery is due to unforeseeable causes beyond the control of the contractor, etc.

Since you feel uneasy about this point, I have telephoned Mitchell and suggested that he should try to insert a paragraph in the printed form of the contract. As a tentative suggestion for such a paragraph I put forward the following text.

> "The manufacture of the uranium metal under the present contract will be carried out by Metal Hydrides Incorporated by a process which has not previously been applied on an industrial scale. It is therefore understood that technical difficulties might be encountered in the manufacturing of this metal which might prevent delivery of the specified amount of 7000 pounds of metal within the specified period of six months. In interpreting the foregoing paragraph of this contract such technical difficulties will be considered as unforeseeable causes of delay beyond the control of Metal Hydrides Incorporated."

I have explained to Mitchell that if much delay would be caused in placing the contract by inserting such a paragraph into the printed form, it would hardly appear worth while holding up the contract on this score. It would seem inconceivable that in case of non-delivery due to technical difficulties, Dr. Briggs should want to go beyond cancelling the contract. In this case you would have received payments for the amount of metal delivered within the specified six months period, and would not make further deliveries.

On the other hand, if a paragraph somewhat along the lines that I have suggested could be inserted without causing much delay, it would certainly do no harm to anybody.

I hope very much that it will be possible to send you a contract signed by Dr. Briggs either with or without some such inserted paragraph into the printed form at the latest by Tuesday.

As soon as the contract is signed by both parties, I can ship you by Railway Express 1000 pounds of uranium oxide from the New York stock, and the later deliveries would then be made direct from Port Hope in tin cans and contain, so we hope, less moisture. About 5 tons of oxide could be delivered to you, according to Mr. Pregel, within six weeks, so that I do not anticipate any delay on this score.

As I mentioned to you before, we really ought to have for the purpose of our experiment 14,000 pounds of metal rather than 7000. Accordingly, we have asked for an appropriation for another 7000 pounds ofmetal and we hope that we shall have a favorable answer to our request sometime before September.

With best wishes,

Yours sincerely,

L. S.

(Leo Szilard)

LS:H

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

June 8, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

Your seventy pounds of uranium were ready yesterday but during the packing we discovered that part of it was not sufficiently dried. Therefore we had to take it out from the cans and dry this part again overnight. Today it passed all the tests and is already packed in the box and ready for shipment. If it were possible I would send it by air express but according to government regulations, powdered metals cannot be sent by air unless special permission is requested. The box is too heavy to be send by messenger since one man cannot carry it. So we are forced to wait until tomorrow morning and will send it the first thing by railway express special delivery. It will be in your laboratory without fail Tuesday morning.

I am sorry you will be disappointed, but we cannot send out material which is either not suitable or not safe for transportation or handling. As you know, uranium metal cannot be sent in moist condition since accidentally it may be overheated during transportation and be partially oxidized.

Numerous samples from this lot were taken out and given exhaustive tests to be sure the material is not pyroforic and is quite safe to handle. Of course in the factory we purposely handle this material before shipment in a much rougher way than you will ever handle it in the laboratory. Also the test specimens are heated to a considerably higher temperature than specified in our contract.

In handling dry uranium powder, however, as in the case of a number of other metal powders, you have to be extremely careful to avoid the generation of static charges and the production of sparks which will ignite the material. In filling various containers you have to use metal spoons, metal funnels, and preferably connect them from time to time with the ground. Also to handle small lots at a time. You can put on the tray a certain amount for immediate filling and the rest of it can be in the can away from your work. It is also desirable as much as possible to transfer the material by spooning and not by pouring it in a continuous stream through the air which creates dust (an explosive mixture) and of course is not good to breathe.

Please excuse my giving you such detailed and possibly unnecessary information, but I feel that in this new field we have to cooperate very closely and share all available information to achieve the desired results.

copied 6/9/41 FLL

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

In connection with the pyroforic qualities, you will remember that we had only one lot which came out that way and we know now how to control this condition. Furthermore, that particular lot which showed strongly pyroforic properties and part of which was kept for further observation, is being tested from time to time. After standing for a considerable time, apparently it loses its pyroforic properties. Yesterday I was testing again samples from that material and found it far less pyroforic. In fact, I am almost inclined to think that after awhile it will lose its pyroforic properties entirely. This is extremely important of course since it indicates that uranium in service will have a tendency to become safer to handle in whatever apparatus it will be used as time goes on. In other words, the pyroforic qualities as found also in the case of other similar materials are encountered only in freshly prepared material and that they gradually die away. It is another reason why I would like to have more time between actual production of the material and shipment to you. Then we will be sure that nothing will happen to the material after it leaves our factory.

We have started already working on the second lot of one hundred pounds of uranium oxide. By the way, we found on the first lot, that a hundred pounds of uranium oxide gives about seventy pounds of metal. We had to add only a very small amount of uranium produced from our own oxide to make up the seventy pounds of metal which we are shipping to you Monday morning.

Please be assured that we are working on this problem and will continue to do so seven days a week, to give you all the uranium you need as quickly as we can. But at first we have to go slowly and be on the safe side. It is for this reason I wish the uranium oxide could be sent to us as quickly as possible so that we could start working on it as soon as possible.

I just received the priority forms from Professor Mitchell with his recommendations and will return them to him promptly. As I can see now, we will need a number of additional apparatus and instruments of which we never thought before we started this work.

I will see you next week either Thursday or Friday when I will be in New York.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

copied 6/9/41 FLL

PPA:A
cc: Professor D. P. Mitchell.

P. P. Alexander

June 9, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

Enclosed you will find an order for an unspecified amount of beryllium powder, 200 mesh or finer. For purposes of our bookkeeping I had to give a price and I specified $50 according to the estimate which you gave me over the telephone. The amount which you will deliver to us will depend on the amount which you happen to get out of your furnace, and for that reason the order does not give any specific amount.

I hope that you will be able to furnish one pound or more of this material. We will have samples tested by the Bureau of Standards for oxygen and let you know the result.

There is no terrific hurry about this matter and if you should be able to make this powder within the next two weeks that will do very nicely.

Yours sincerely,

L. Sz.

LS:H (Leo Szilard)

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

June 14, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816, Clifton, Massachusetts

Dear Dr. Alexander:

Am I correct to assume that the twenty-five pounds of metal which you supplied to us (preceding the delivery of seventy pounds of metal) was made from uranium oxide obtained from Carbide and Carbon?

If this assumption is correct, some of the boron may have come from this oxide which we have so far not tested for boron.

Could you please, therefore, if my assumption is correct, send a few pounds of the Carbide and Carbon oxide which you used in the fastest manner to Professor D. P. Mitchell, care of Dr. Hodden, National Bureau of Standards, Washington, D. C. Could you please label this sample "uranium oxide sample 101" for future reference.

Yours sincerely,

L. S.

(Leo Szilard)

LS:FLL

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

420 West 116 Street
New York, N. Y.
June 15, 1941

D. P. P. Alexander
Metal Hydrides Inc.
Beverly, Mass.

Dear Dr. Alexander:

I have given further thought to the proposal of trying to cut down the cooling time of the furnace by introducing hydrogen into the furnace at a certain point of the cooling of curve.

Since it is very important to establish as quickly as possible that we can produce uranium metal with the required purity and since I am at present worried not only about boron but also about nitrogen I would prefer for the time being to have all metal produced cooled in as good a vacuum as possible. Let us hope that we shall quickly overcome this phase of the work and then we can start experiment about reducing the cooling time.

Please note that we do not want to use for the time being any other uranium oxide but Canadian uranium oxide which is being tested by us for boron. I expect that you will receive Monday a letter from Mitchell asking you to make one furnace load of uranium metal using some of the recast calcium which Kinzel promised to send you. If you have not enough uranium oxide left either from the lot which I sent you by air express, or from the lot which Pregel sent you by freight then please send me upon receipt of this letter a telegram to Columbia so that I can see to it that you receive with greater speed another 100 lb. of umnium oxide. Perhaps it would be better to send this oxide from our stock at Columbia in order to have it reach you within twenty-four hours rather than from Port Hope. Of course, the stuff which we will send you would contain more moisture and you might therefore prefer to get stuff from Port Hope. If you send me a telegram you might indicate which of the two alternatives you prefer.

~~Please prepare a~~ representative sample ~~of the lot which you~~

Please prepare a representative sample of uranium oxide which you will reduce with the recast calcium obtainedd from Dr. Kinzel and lebel this sample URANIUM OXIDE sample 102. You might prepare such a representative sample by mixing a number of small portions of the lot which you propose to use or by thoroughly mixing the whole lot which you propose to use and then removing the sample to be analyzed. The sample should then be sent to D. F. Mitchell, care of Dr. Rodden, National Bureau of Standards, Washington, D. C.

Perhaps you could also prepare a representative sample mixed from a number of small lots from the recast calcium which you actually use in the next reduction and label it CALCIUM sample 201 and send it also to Mitchell.

With best wishes,

Yours sincerely,

L. S.

(Leo Szilard)

LS/JB

June 17, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

I am writing to let you know that the 100 pounds of uranium oxide are being shipped today by railway express, addressed to your factory, in response to your telegram which arrived today.

Sincerely yours,

L. Sz.

(Leo Szilard)

LS:FLL

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

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

June 17, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I just received a telegram from Professor Mitchell requesting us to make 35 lbs. of uranium metal using re-cast calcium, 200 lbs of which were received from the Union Carbide & Carbon Corporation. The representative sample of this calcium has been taken from the batch and will be sent today by air express to Dr. Rodden. Yesterday we sent him a sample of uranium oxide produced from domestic ore by the Union Carbide & Carbon Corporation. It was marked Sample "101". The new calcium has been processed already into calcium hydride and as soon as we receive from you an additional batch of uranium oxide we will make immediately 35 lbs. of uranium metal.

The contract was signed last week but was held up on account of the bond for the full amount of the contract, that is, $40,000. We had to pay $100 for this bond to the insurance company. However, it was sent to Washington yesterday by special delivery and Dr. Briggs probably has it on his desk already.

We are experimenting with a special way of filling vessels with powdered uranium which eliminates the dust problem and gives a very much higher density* than that obtained when the vessel is filled by powdered material simply by shaking it. If we are successful with these experiments we could undertake the filling of all the vessels in our factory. This will simplify your problem and eliminate delays and any danger in handling after it leaves our factory.

If the analysis on the re-cast calcium will show that it is satisfactory for the reduction of oxide, we would like very much to start immediately the production of uranium with this calcium ~~and~~ than to wait until the Union Carbide & Carbon Corporation is ready to supply us with the new grade of calcium free from undesirable impurities.

In agreeing to such a low price on uranium we assumed that there will not be any delays in production and that we could start immediately by producing 75-100 lbs. per day. In fact, to eliminate any delays we bought three tons of calcium metal and one and one half tons of this calcium have already been processed into calcium hydride. Now if we could not use this calcium hydride we have to start from scratch and you can easily see why we are so anxious to start production now as soon as possible even by using

* $d = 10$.

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

more expensive calcium since delays cost us much more.

Please be assured that we will do everything possible to facilitate your great task in developing the use of this material for a special purpose and in fact, all our plans are to orient all our activities and to specialize on the production of uranium metal by gradually dropping other fields less essential at the present time. It is becoming quite apparent that in the production of high purity uranium the factory must run exclusively on the production of that metal, otherwise we could never be sure of small contaminations of the material, insignificant in ordinary fields of metallurgy but unacceptable in this particular case. In return we would like to ask you to do all you can to expedite matters and reduce delays which for a new small concern like ours are very costly indeed.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander

P.S. The sample of uranium oxide sent to Dr. Rodden was marked #101 as requested in your letter of June 14th, and not #102 as mentioned in your letter of June 15th.

PPA.

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

June 22, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard;

Referring to your inquiry on the subject of thorium metal, please note that we are producing this metal now in small lots for various laboratories and our price in pound lots is $50.00 per pound. The metal comes in the form of fine powder and is degassed in vacuum at high temperature for several hours so it is essentially gas free metal. The purity is in the order of 99.5% depending on the oxide used on that particular job. In 50 lb. lots our price will be considerably lower, and in view of the importance of the experiments you are planning to undertake we are willing to produce this 50 lbs. lot at the price of $20.00 per lb.

Please note that our check up on the price of sufficiently pure thorium oxide indicated that it is rapidly rising and already is in the range of $5-$7 per lb. The metal is radio-active and we have to take extreme care during its production.

Please note that in view of the fact that in the last few weeks we have received inquiries for the production of this metal for export to England, we are investigating this whole field and probably in a year or so we will be in a position to produce this metal on a large scale and at a lower price.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

June 22, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

Referring to your inquiry on the subject of drying uranium oxide, this operation could be performed by anyone possessing special equipment very quickly and at a low cost. In our case, however, our equipment was designed for an entirely different purpose.

Of course we can dry any oxide to any degree but it will be a long operation and comparatively quite costly since our special equipment must be cleaned before and after in a most thorough way on account of the poisenous character of uranium oxide. This requires great care and of course will be costly. To dry three tons of uranium oxide and afterwards grind it since it does sinter, will cost about $400.

However, if you cannot send your oxide back to Canada for drying, and if no one else is willing to do it for you, we will be glad to do this job for you.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

June 22, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

The date of my trip to Washington is not definitely settled. If it be during the latter part of next week I will endeavor to stop in New York on my way to Washington.

We were developing a method of producing our own calcium hydride made directly from lime and with that calcium we have already reduced various refractory oxides on a small scale such as chromium, zirconium and titanium. There will be a little difficulty in applying it to the reduction of uranium oxide yet if we finally build our special furnace for this calcium hydride production and if we overcome the anticipated difficulties with the reduction of uranium oxide it will give us a method of production of uranium on a large scale, that is several tons a day, with an absolute guarantee of the complete absence of boron since we can always find calcium oxide which is absolutely free from boron compounds. In that case we will be entirely independent from the supply of a suitable calcium chloride and metallic calcium. This, of course, is in the future. However, we are going ahead with this scheme and have already ordered a continuous furnace of 6' internal diameter.

Unfortunately on account of priorities this furnace instead of being already installed in our basement probably will not be ready for another eight or twelve months and possibly longer. I am writing you on this subject merely to indicate the future possibilities of production of uranium absolutely boron-free on a large scale. It is this subject which I would like to discuss with you at our next meeting.

If I could not manage to stop on the way to Washington, I will try to spend half a day in New York on my return trip.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

pPA:A

P. P. Alexander.

CLASS OF SERVICE DESIRED			
DOMESTIC		CABLE	
TELEGRAM		FULL RATE	
DAY LETTER		DEFERRED	
NIGHT MESSAGE		NIGHT LETTER	
NIGHT LETTER		SHIP RADIOGRAM	

Patrons should check class of service desired; otherwise message will be transmitted as a full-rate communication.

COPY OF WESTERN UNION TELEGRAM

June 23 1941

P. P. ALEXANDER
METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

PLEASE HAVE SAMPLE OF FIFTY GRAMS OF THORIUM OXIDE WHICH YOU PLAN TO USE SENT TO DOCTOR MITCHELL CARE OF RODDEN NATIONAL BUREAU OF STANDARDS WASHINGTON D. C.

L. SZILARD
~~DEPARTMENT OF PHYSICS~~
~~COLUMBIA UNIVERSITY~~
~~NEW YORK, N. Y.~~

COPIED FROM ORIGINAL IN THIS COLLECTION

WESTERN UNION

1201

R. B. WHITE, PRESIDENT
NEWCOMB CARLTON, CHAIRMAN OF THE BOARD
J. C. WILLEVER, FIRST VICE-PRESIDENT

CLASS OF SERVICE

This is a full-rate Telegram or Cablegram unless its deferred character is indicated by a suitable symbol above or preceding the address.

SYMBOLS

DL = Day Letter
NT = Overnight Telegram
LC = Deferred Cable
NLT = Cable Night Letter
Ship Radiogram

The filing time shown in the date line on telegrams and day letters is STANDARD TIME at point of origin. Time of receipt is STANDARD TIME at point of destination

NZ6 16 XC=BEVERLY MASS JUN 24 1038A
DR LEO SZILARD=
TUPIN LABORATORY COLUMBIA UNIV=

JUST FOUND SAMPLES THORIUM OXIDE LEFT FROM PREVIOUS ORDERS SENDING IMMEDIATELY BY AIR MAIL DOCTOR RODDEN=
P P ALEXANDER METAL HYDRIDES INC.
1113A

CLASS OF SERVICE

This is a full-rate Telegram or Cablegram unless its deferred character is indicated by a suitable symbol above or preceding the address.

WESTERN UNION

1201

R. B. WHITE
PRESIDENT

NEWCOMB CARLTON
CHAIRMAN OF THE BOARD

J. C. WILLEVER
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BB11 26/25 NT=MARBLEHEAD MASS 23

DR LEO SZILARD= QR

1941 JUN 23 PM 11 16

DEPT OF PHYSICS COLUMBIA UNIV NYK=.

PLANNING ORDER THORIUM OXIDE AFTER RECEIVING YOUR ORDER WILL SEND IMMEDIATELY SAMPLE FOR ANALYSIS GUARANTEED 99% PURE PLEASE WIRE IF WE CAN EXPECT THIS ORDER=

P P ALEXANDER.

99%.

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

"HYDRIMET" PRODUCTS

TITANIUM HYDRIDE
ZIRCONIUM HYDRIDE
TITANIUM METAL
ZIRCONIUM METAL
URANIUM METAL
THORIUM METAL
VANADIUM METAL

"HYDRIMET" PRODUCTS

COPPER-TITANIUM
COPPER-ZIRCONIUM
CHROMIUM-NICKEL
CHROMIUM-IRON
BERYLLIUM-NICKEL
URANIUM-NICKEL
TITANIUM-NICKEL

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

June 26, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I have your two telegrams and will go ahead with the making of thorium metal but I do hope that the appropriation will come through and that you will not have to use your own money to conduct this experimental work.

I must know right away whether the thorium oxide of the quality supplied by the Maywood Chemical Works is alright to use for making thorium metal for you. I sent two samples of thorium oxide to Dr. Rodden, one from the Maywood Chemical Works which I previously used on the production of high purity thorium and another sample obtained from the Philipp Brothers, Inc. They are only brokers and I do not know the origin of their oxide.

Please let me know by wire if it will be alright to use on your order the oxide from the Maywood Chemical Works. Then I will order immediately the necessary supply from them.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

communication. PRESIDENT CHAIRMAN OF THE BOARD FIRST VICE-PRESIDENT

Send the following message, subject to the terms on back hereof, which are hereby agreed to

C O P Y

Physics Department
Columbia University
New York City
June 26, 1941

DAY LETTER

TO: DR. P. P. ALEXANDER
METAL HYDRIDES, INC.
12-24 CONGRESS STREET
BEVERLY, MASSACHUSETTS

DECISION ON FIFTY POUND ORDER FOR THORIUM DELAYED STOP IF NO ORDER IS PLACED PERSONALLY WILLING TO PAY FOUR HUNDRED DOLLARS ON DELIVERY FROM MY SALARY AND RETURN TO YOU THORIUM FREE OF CHARGE AFTER ONE YEAR STOP WOULD APPRECIATE YOUR STARTING REDUCTION AT ONCE ON BASIS OF THIS GUARANTEE

L. SZILARD

Copies to: 1--Alexander
1--Fermi
2--Mitchell
1--Pegram
1--Szilard

C O P Y

Physics Department
Columbia University
New York City
June 26, 1941

DAY LETTER

TO: DR. P. P. ALEXANDER
METAL HYDRIDES, INC.
12-24 CONGRESS STREET
BEVERLY, MASSACHUSETTS

DECISION ON FIFTY POUND ORDER FOR THORIUM DELAYED STOP IF NO ORDER IS PLACED PERSONALLY WILLING TO PAY FOUR HUNDRED DOLLARS ON DELIVERY FROM MY SALARY AND RETURN TO YOU THORIUM FREE OF CHARGE AFTER ONE YEAR STOP WOULD APPRECIATE YOUR STARTING REDUCTION AT ONCE ON BASIS OF THIS GUARANTEE

L. SZILARD

Copies to: 1--Alexander
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2--Mitchell
1--Pegram
1--Szilard

MESSAGE	LETTER
NIGHT LETTER	SHIP RADIOGRAM

Patrons should check class of service desired; otherwise message will be transmitted as a full-rate communication.

WESTERN UNION TELEGRAM

Physics Department
Columbia University
New York City
June 26, 1941

TO: DR. P. P. ALEXANDER
METAL HYDRIDES, INC.
12-24 CONGRESS STREET
BEVERLY, MASSACHUSETTS

FORTY OR EVEN THIRTY-FIVE POUNDS OF THORIUM POSSIBLY SUFFICIENT FOR NEXT EXPERIMENT STOP THEREFORE IN ABSENCE OF GOVERNMENT ORDER YOU MAY CUT DOWN AMOUNT ESPECIALLY IF MORE CONVENIENT TO HAVE SMALLER CHARGE IN FURNACE

L. SZILARD

Copies to: 1--Alexander
1--Fermi
1--Mitchell
1--Pegram
1--Szilard

communication.

Physics Department
Columbia University
New York City
June 26, 1941

TO: DR. P. P. ALEXANDER
METAL HYDRIDES, INC.
12-24 CONGRESS STREET
BEVERLY, MASSACHUSETTS

FORTY OR EVEN THIRTY-FIVE POUNDS OF THORIUM POSSIBLY SUFFICIENT FOR NEXT EXPERIMENT STOP THEREFORE IN ABSENCE OF GOVERNMENT ORDER YOU MAY CUT DOWN AMOUNT ESPECIALLY IF MORE CONVENIENT TO HAVE SMALLER CHARGE IN FURNACE

L. SZILARD

Copies to: 1--Alexander
1--Fermi
1--Mitchell
1--Pegram
1--Szilard

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

July 3, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

This morning we had a visit from a representative of the Bureau of Explosives who was investigating the cause of the ignition of our package during its transfer from one train to another.

It appears that 35 lbs. of uranium which was sent yesterday afternoon, during the re-loading from one train to another in Boston, got accidentally overheated or was unduly shaken up with the result that the uranium started to burn. Since the ordinary fire extinguisher used by the attendant did not stop the combustion they called a special truck from the nearest fire department which tried to put out the fire with water, which also did not do any good. So they simply removed the package to an isolated place and let the contents burn up.

The uranium on this order after it was reduced to metal was standing in our factory for a week and it was handled in different ways. Since it was lumpy at first it was crushed to powder, loaded into cans which were standing uncovered for 24 hours. Then the cans were filled with nitrogen, sealed and left standing for another 24 hours. Nothing abnormal could be detected. Representative samples of this material were tested to be sure the material was not pyroforic, that is by crushing and rubbing in the mortar and heating to 100°C for fifteen minutes. No ignition or overheating was detected. The cans were tightly bound with wire which was connected to the outside of the box so as to ground the cans and avoid any possibility whatsoever of an accummulation of static charges due to the rubbing of the particles if they were shaken. The packed box was standing in the factory for several hours before it was shipped. Furthermore a representative sample which was collected from different parts of the produced material was left in the factory and was tested today to see if it is pyroforic. The material was ground in the mortar and then heated for fifteen minutes to exactly 100°C in air without showing any signs of ignition or sparking. We feel therefore that we did every possible thing in our power to assure the safety in the production and transportation of this material to you.

Now the question is of the charges for this material. Of course we fully insured this material before it was shipped by express and we can collect the full amount from the express company. However, it will give very undesirable publicity. So far, except for the representative of the Bureau of Explosives no one knows what was in the package.

Copied 7/7/41
H. H.

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

If we start collecting insurance we have to give full information of what material was packed in the box and to whom it was going. Furthermore, if the express company finds out that the contents were uranium they may object to paying the insurance on the grounds that it is a new mysterious explosive with which scientists are experimenting and will refuse to pay. Therefore we would have to bring the action into the courts. This again will create still more publicity.

I am wondering therefore if it would not be much better and cheaper in the end to all concerned if you agree that this material was a part of your seven thousand pound order and allow us to charge you in accordance.

The real cause of this fire is of course a mystery but perhaps the next shipment we will forward to you by special truck and then we will be sure that it is not accidentally overheated or too roughly handled, which perhaps was the cause.

Please let me know what decision you will take on the above and also if you wish us to go ahead next Monday with the production of thorium metal for you, or first replace the 35 lbs. of uranium, and then proceed with the thorium metal.

Please note that our factory will be closed on account of the holiday until Monday morning.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

July 7, 1941

Dr. P. P. Alexander
Metal Hydrides, Incorporated
Beverly, Massachusetts

Dear Dr. Alexander:

Many thanks for your letter of July 3. The question concerning the charges for the material which has been lost is one which is connected with your Government contract and I am therefore referring this question to D. P. Mitchell.

As I told you over the telephone, it is not our intention to repeat the order for 35 pounds of uranium since the analysis of the sample which you sent to Washington shows that this uranium made from recast calcium contains too much boron. The next lots of uranium will either be made from distilled calcium, which we would supply to you, or from fresh calcium made by Kinzel. In any case we would let you know as soon as we are ready to order the next lot of uranium which we hope will be very soon.

I have therefore asked you over the telephone to make no uranium for us until further notice, and rather start on the thorium if you have a furnace available.

It seems to me that it would be very important for us fully to understand how it is possible that uranium in an enclosed container can heat up and cause fire. I thought that perhaps this phenomenon could be understood by assuming the following: After leeching and drying a certain fraction of the uranium is oxidized to some oxide lower than U_2O_3. This mixture of uranium metal and certain uranium oxides could then transform into U_2O_3 spontaneously and develop heat. If this theory were correct, then it would be worth while to attempt the following: To take a lot of uranium metal which has been leeched and dried, place this lot into one of your furnaces in good vacuum, and heat it up to a temperature as high as possible without going so high as to risk the danger of uranium attacking the wall of the furnace. If

your vacuum pumps are not good enough, maybe a tray containing calcium hydride could be placed on top of the uranium in the furnace to prevent an oxidation of the metal during this operation. After this operation the furnace would have to be allowed to cool and then carbon dioxide would have to be admitted into the furnace in order to prevent adsorption of oxygen.

I wonder whether you and Mr. Davis think that this experiment should be performed? Of course it would be best to use pyroforic uranium for this test in order to see at once whether or not the proposed treatment makes the uranium non-pyroforic.

Yours very truly,

L. Sz.

LS:H (Leo Szilard)

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

P. S. An alternative theory for the spontaneous heating up of uranium in a closed vessel, which I have discussed with Professor E. P. Wigner of Princeton and also with Professor Pegram and Professor Fermi, would assume that part of the uranium metal is present in a form of extremely fine crystals in a quasi-amorphous state, and that the heat which is developed is due to re-crystallization. If this theory were correct, then it seems to me we should still try the same remedy suggested above, i.e. heat up the uranium metal powder in vacuum to a high temperature.

Would you be kind enough to let us know whether the uranium metal which you shipped and which burned up was packed in glass jars or in tin cans, and whether the jars or cans were enclosed in wooden boxes? We are naturally anxious to learn all the circumstances of the accident so as to be able to make better plans for the future.

1 of 3 carbons

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

July 9, 1941

copied 7-11-41 LH

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

In accordance with your previous request and your letter of July 7th we are proceeding now with the production of thorium metal. Unless we will have excessive losses the total amount produced will be 50 pounds.

With regard to uranium, I noted with great interest both theories giving tentative explanations of the cause of the burning of the last shipment of uranium. However, by long training I am essentially a reaearch engineer and guide my developmental work only by concrete facts obtained through direct experimentation. It is a slow and cumbersome process but in engineering and manufacturing fields it gives safe results.

We had a similar problem in the production and shipment of pure degassed titanium metal in powder form. When we first produced a few hundred pounds we had so much trouble with small fires during its handling and packing that our losses in money in the production of this material were far more than what we could produce economically even on a very small scale. But we kept on and one by one the difficulties were eliminated. Now we know how to produce and keep titanium metal in storage in our factory in ton lots indefinitely without any deterioration whatsoever. We found a safe method of packing and shipping this material and during the last two years we have produced and shipped without any accidents several tons of pure degassed titanium powder. In the case of uranium we know now how to produce and keep in the factory with perfect safety and without any deterioration uranium metal in powder form. Now comes the problem of a safe method of packing and shipping it, and the only way to do it is to keep on producing it in increasing quantities. There will be some fires and some losses but that is the price of any new development. We are doing all we can on our part and certainly don't expect to make very much profit on this order. In fact, by this time it is a physical impossibility.

On the other hand I am hoping that the Bureau of Standards or whoever finances this research work, will agree to accept its part of the additional charges or losses during the production of the first few hundred pounds of the material which was never produced before anywhere except in gram lots.

I am suggesting first of all for the sake of arriving quickly and safely at the desired solution, not to wait until some special grade of calcium be produced, but to go ahead and

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

keep on producing in small lots but continuously the material which will be necessary to experiment with. The problem of packing, transportation and storage is independent from other problems connected with it and therefore should be solved without delay. Uranium so produced probably will not be pure enough for your final use but it will be perfectly alright for experiments on pressing into spheres, sintering if so desired, etc. and of course could be used for experiments which are now being conducted by Dr. Urey on a small scale. Anyhow this is the price of the development which both parties to the contract must share equally.

With regard to the cause of the actual fire in Boston, I have no theory but I listed every possible cause including even sabotage, and one by one we are investigating them. The Bureau of Explosives and the Federal Bureau of Investigation who were already on the job are of the opinion unofficially at least that it was due to some perfectly natural causes. It should be taken into consideration that the temperature and humidity in the factory and in Boston were unusually high. The uranium was packed in a regulation wooden box which formed with the packing a very good heat insulation, and without any question the box was handled very roughly during transportation, perhaps even being thrown about. If any slight overheating due to the friction of the loose powder, slight surface oxidation produced by traces of moisture left, or any other cause occurred, the heat could not be dissipated and the temperature in the cans rose above 100°C and possibly to 130°C which is the ignition point of uranium in air. Since the cans were filled with nitrogen the ignition was not very rapid since uranium combines with nitrogen at low temperatures only slowly but it does form nitrides.

With regard to the tightness of the cans, of course if a vacuum was established inside of the cans, the air would leak through since this type of can never could be considered as vacuum tight.

However we have to find out how to do these things efficiently and safely before we start production of pure uranium which you could not afford to lose by any such cause as that.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A
cc: Dr. D. P. Mitchell.

P. P. Alexander.

P.S. I would have to make another trip to New York to have a conference with you and Dr. Mitchell. + P.P.A.

P.S.S. Dr. Rodden said you object to traces of Chlorine. Well we can do all the leaching with acetic acid so there will not be any Cl.

HOTEL WASHINGTON
WASHINGTON, D.C.

July 10, 1941

Dear Dr Szelard,

This morning I had a very pleasant conference with Dr. Briggs. He told me not to worry about the dates and that everything will be alright. Of course I did not bother him with technical details or various difficulties and problems we have to solve. Dr Rodden was here and showed to me all their work by James Process. He is coming to Beverly next week. I had also a very pleasant afternoon at the Naval Res. Lab. I will spend all day tomorrow in a patent office to take care of my various pending applications. I will be in Beverly Saturday morning.

Very truly yours,
P.P. Alexander

4 copies
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METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

July 12, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I discussed with Dr. Briggs the business side of the production of uranium. In the development of production on a factory scale of such an unusual metal as uranium, there are and there will be so many problems to solve that unless the process is carried on more or less continuously and over a considerable period of time we could not expect to get the desired results. If high purity is necessary the whole factory must be run continuously on the production of this particular metal, otherwise contamination could not be avoided.

Dr. Briggs asked if I will be willing to extend this order or rather to accept a new one for another seven thousand pounds at the same price which would give us a longer period to work out all the difficulties. I indicated my willingness to do so and told Dr. Briggs that if more costly calcium will be required or other costly additional operations be introduced, the price should be adjusted. Probably he will discuss this matter with you and Dr. Mitchell at some future time.

At Dr. Briggs' request Dr. Rodden stayed over one day so I had the pleasure of meeting him and looking over his laboratory and experimental set-up where they are producing uranium chloride and pure uranium by the James process. I understand that when the late Professor James of the University of New Hampshire used this process many years ago, he produced small amounts of extremely pure uranium, in the order of 99.9% pure. Dr. Rodden who came to the Bureau also from the University of New Hampshire of course knows all the details of that process and undoubtedly will gradually increase the scale from a purely laboratory experimental one to a scale where larger quantities could be produced. I doubt, however, that a very large scale of production could be undertaken by this process without considerable further development.

I can see the great advantage of this process for the production of small fused discs or other small solid objects. However, with the increase in the size of the charge per crucible the difficulties will increase many fold. The larger masses of metal after reaction will not cool off quickly enough and as you know, molten uranium will attack and reduce every known refractory. The products of reaction, that is calcium chloride, might be trapped in blow-holes and the usual voids present in all rapidly fused and solidified material. I doubt very much if complete spheres of fairly good size and free from blow-holes and impurities could be cast by this method. To produce sound castings it

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BEVERLY, MASS.

will be imperative to make a second fusion of the produced metal in a high vacuum high frequency furnace, and I understand that Dr. Rodden agrees with me on this point. However, it is too early to say anything about the process. I only hope that Dr. Rodden will continue to develop this method for a considerable time yet at the Bureau of Standards, and gradually enlarge the size of his ingots before the process is transferred to our factory.

Dr. Briggs suggested that to speed up our development I could send to Dr. Rodden directly any samples which should be analysed. Now we are coming to a stage in the process where the chemical control must be most rigid and the check analysis made periodically in at least two independent laboratories, otherwise we may run into great difficulties and lose unnecessarily quite a lot of material.

With regard to the causes of spoilage of uranium due to overheating and burning, we are making a most thorough check on all the samples which were made during the last few years. As I said, we have no theory as yet but everything points to surface oxidation as the cause; first, due to the moisture left in the powder after incomplete drying, and second, to the infiltration of air. We have some glass jars kept now over a period of more than a year with apparently tightly screwed tops, and yet one can see the gradual oxidation which progresses from the top layer downwards. In some jars the oxidation affected only the very thin top layer, whereas in the oldest specimen the oxidation reached from the top almost to the bottom of the jar, and the demarkation between the very dark material and the light brown can be clearly seen.

We have also a fairly good idea of the cause of the burning of the last shipment which was also caused by the oxidation. Only in this case it was accelerated by the extreme heat and humidity and probably by the throwing of the box during the re-loading. The moisture of course reacts with the uranium producing oxidation and overheating and the released hydrogen produces over-pressure and finally the prying off of the lid. If the already over-heated material was spilled inside of the wooden box on more or less damp excelsior packing, further overheating and ignition followed very rapidly.

On the other hand, the uranium which we kept in stock for long periods of time under conditions which excluded oxidation completely, remains absolutely unchanged and of bright silver color, and no overheating of any kind was observed.

We are going ahead with our experiments and further investigations and at our next meeting we will discuss these

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BEVERLY, MASS.

matters in detail. However, it is becoming quite clear that first consideration should be given to a better design of the container and a more thorough drying of the material sealed in it, and also some other changes in the production proceedure.

Part of your thorium metal has already been produced and is being dried. It appears to be of excellent quality and absolutely free from hydrogen.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

P. P. Alexander.

PPA:A
cc: Dr. D. P. Mitchell.

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7-14-41 LH

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

July 15, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

Please note that our investigation of all the samples of uranium previously produced points more and more to the fact that the change and deterioration are due to oxidation. This is especially rapid in a moist atmosphere. The moisture reacts with uranium, oxygen combining with the metal, and the released hydrogen is adsorbed and even absorbed by the metal and the excess of it mixes with the other gases present and builds up an over-pressure in a closed container. I wonder if you could find out whether the uranium which you have in your laboratory, if sealed in tight containers, is subject to these changes and if over-pressure is built up inside the container.

If the oxidation is intense the volume of the material will also increase since the density of the oxide is much smaller than that of the metal itself.

It seems that the remedy will simply consist, as you suggested, in thorough drying of the uranium powder before it is sealed in the vessel, and second, the prevention of infiltration of air which of course contains moisture.

In the factory we have a method of preserving uranium metal indefinitely without any danger of oxidation but I am wondering if this method will be allowable in your case. I would like to know, therefore, which of these elements mechanically mixed in small percentages, say 2% to 5%, will be undesirable; namely carbon, silicon, lead, tin, calcium, sodium, argon and helium.

It seems that the problem of preserving uranium will not be very complicated, and if the engineers have already overcome the difficulty of preserving and using metallic sodium in large quantities, certainly we should be able to solve a simpler problem of handling uranium.

Please note that in the past we had similar difficulty in the production of powdered cobalt alloys. When freshly prepared these alloys react with moisture and during drying quite often catch fire. However, we have already overcome this difficulty and are now producing these alloys without trouble.

Very truly yours,
METAL HYDRIDES INCORPORATED

P. P. Alexander

Copied 7-16-41 LH

PPA:A
cc: Dr. D. P. Mitchell

P. P. Alexander

July 15, 1941

Dr. P. P. Alexander
Metal Hydrides Inc.
Beverly, Mass.

Dear Dr. Alexander:

Many thanks for your letter of July 12. I believe it will be useful for us to discuss various questions in connection with uranium metal sometime in the near future and it would be nice if Dr. Davies could also participate. For the present I do notwant to raise any new questions which would involve a lengthy correspondence, and the following points are mentioned only for purposes of having them on record for our next conference.

It seems that the various samples of uranium metal, whfch we obtained from you, are oxidized to very different degrees. The 25 pound sample which was ordered by Columbia, and part of which was filled into a brass box and copper half sphere, had only about 1% of oxide, whereas the 70 pound sample had almost 10% of oxide. These figures are based on the analysis by the Bureau of Standards, but a difference was clearly visible even at rough inspection of the material. The second sample was according to your communication, first packed moist into the cans and was then taken out again and dried. It was rather lumpy in appearance.

I wonder if it is feasible to dry all uranium in vacuum at room temperature simply by putting the leeched metal powder into one of your furnaces and setting the pumps going. I am raising this question partly because the nitrogen content of the metal is rather close to the danger limit and because some of the nitrogen might come from drying in air.

It might be a good idea also to keep a check on the nitrogen content of your calcium hydride.

I hope that you are right in assuming that the nitrogen content of the uranium in the can was re-

sponsible for the chemical reaction which lead to the fire in transit. Sometimes I fear that powder of uranium metal, when contained in a sealed container which has a small hole or crack, might be able, if accidentally heated up, to consume both nitrogen and oxygen thus creating vacuum and sucking in more air, etc. If the uranium powder is able to act in this manner it will be very important for us to be aware of such effects. If, on the other hand, uranium would consume only oxygen, then a small crack in the can would not be dangerous because the oxygen of the air could reach the uranium metal only very slowly through diffusion processes. I believe this question should be settled by straightforward experiments since it is quite essential for our future work to know what precuations we must take.

You will very likely hear from Mr. D. P. Mitchell tomorrow concerning an order for 35 pounds of uranium metal made from distilled calcium which will be delivered to you by Kinzel. It would be useful to discuss the particular method of drying and leeching which you propose to apply on this 35 pound lot before you actually start its manufacture.

Please note that an analysis for hydrogen made by the Bureau of Standards on the 25 pound lot of uranium metal, which you supplied us, gave a hydrogen content of .012 percent which is about 3 times higher than the usual value. I am writing to the Bureau of Standards to find out if this value is to be taken seriously.

Yours very truly,

L.S.

(Leo Szilard)

LS:lh

Copies

1 Pegram
1 Fermi
1 Szilard
2 Mitchell

July 16, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

Many thanks for your letter of July 15. Since I wrote you yesterday we had the following experience.

We had some of the uranium metal, out of the 70 pound lot which you supplied us (that is the last lot which we received), in a can which was half empty because we had already used half of the contents of the can. This can was sealed with wax and had been left undisturbed for weeks in our laboratory. When we opened this can yesterday we found it difficult to lift the lid and we have the impression that there was a vacuum in the can. As soon as the lid came off the contents of the can burst into flames. We did not even touch the uranium powder and the ignition took place spontaneously upon contact with the air in the can.

We thereupon opened another can which contained 11 pounds of uranium metal. This can had not been opened previously, it was in the state in which it was supplied by you except that upon its receipt we sealed the top with paraffin wax in order to prevent oxidation. Before we opened this can we made a tiny hole in the top so as to prevent a rush of air when we removed the lid. A minute or so after we had made this hole the lid was removed, whereupon the contents of the tin burst into flames spontaneously. Again we did not touch the uranium powder in the tin can and it ignited within the can. Please note that, as previously stated, the lot of uranium from which this uranium came, had a uranium oxide content of about 10%.

These pyroforic performances above referred to took place at the Stevens Institute of Technology. Dr. Zinn and I went there in order to visit Professor Comstock and also in order to press some uranium metal and some uranium oxide. Since we were prepared for such pyroforic phenomena, had sand ready and took other precautions, there was no inconvenience whatever caused by these occurrences in Professor Comstock's laboratory.

I should like to place the following suggestions on the record for discussion at some later date.

1. Not to use nitrogen for filling the cans, but rather carbon dioxide.

2. After reducing the uranium in the furnace in vacuum and after cooling of the furnace, to let in carbon dioxide rather than nitrogen or air.

3. To make an experiment in obtaining non-pyroforic uranium metal by mixing the uranium metal, soon after leeching and drying, with carbon tetrachloride to which (a) paraffin or (b) stearic acid has been added in such amounts that after driving off the carbon tetrachloride the paraffin or stearic acid content of the uranium does not exceed 1/2, or 1%.

I understand from a conversation with Mr. Lashe and Professor Comstock that some such method has been successfully used with certain other pyroforic metal powders.

4. It occurs to me that if uranium metal powder were leeched by a solution which contained a small amount of copper sulphate, or some other similar salt, a thin copper deposit might be obtained on the surface of the uranium powder grains, and I wonder if such a thin copper film would not offer protection against ignition.

Please note that all the above suggestions are tentative in character and are made only for the purpose of having them on the record for our next oral discussion.

Yours very truly,

LS:H (Leo Szilard)

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

July 17, 1941

Dr. P. P. Alexander, President
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

Thinking over the general situation of the uranium metal production, I now feel inclined to think that the proper way to proceed would be the following:

To start production of one lot of uranium after the other, under carefully controlled conditions, and to investigate the properties of each lot both right after manufacturing and at certain intervals of time after exposure to air. Of course, uranium so manufactured will, for the time being, be useless for our experiments, but I am quite sure that we ought to take this loss in order to save time later.

This experimental production could proceed on a regular schedule, but would be necessarily slow since it is essential to discuss the conditions to be used for the production of the next lot after the manufacture of each lot.

At our next meeting we could work out the details of how to keep in touch with each other without tying up too much of your time and ours. By keeping a journal, in which the whole history of a lot is recorded, and by using some mechanical method of obtaining a carbon copy, which you could send to us, we could avoid time consuming correspondence.

Mr. Pregel has been instructed to ship to you five tons of uranium oxide so that it is certain that you will not run out of this material.

I also hope that you will soon be in the position of having boron-free calcium. There was a hitch in this respect in so far as the analysis of

the flake calcium chloride of the Pittsburgh Plate Glass Company, which appeared to be free from iron, proved to be in error. In the meantime, however, we found certain more expensive brands of calcium chloride which appeared to be all right. This work is being pushed very strongly and within a few days we may find satisfactory samples of some cheaper brand of calcium chloride. Anyway I do not think we should wait for this but should start experimental production of uranium metal at once.

This is, however, a matter which I cannot decide alone, and I propose to discuss it with Professor Pegram and Professor Fermi within the next few days. By Monday at the latest I hope you will hear from us.

I wish to tell you that I do not feel at all discouraged by the recent pyroforic experiences, as I am quite convinced that this is a problem that can be solved, though I fear that it will require very carefully controlled operations and the full attention of both of us.

With best wishes,

Yours sincerely,

L Sz

(Leo Szilard)

LS:H

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

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

July 17, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I have your two letters with regard to uranium and noted various points which you will bring up for discussion.

We have in the factory about 130 lbs. of uranium produced at different times. We are checking up, especially on 20 lbs. of uranium which was produced about eight months ago. These various lots are kept in cans and jars. None of these lots show signs of heating or pyroforic properties. Periodically we test the powder from various lots by grinding, heating or pouring through air.

I am quite confident that we are on the road to finding a solution, and not only prevention but entire elimination of any possibility of accidental fires.

The sooner we have a meeting the better it will be. I can be in New York for one day either Monday or Tuesday, but Mr. Davis will not be able to come with me since he has definite duties in Beverly. To have a joint meeting of all four of us, you, Dr. Mitchell, Mr. Davis and myself, you would have to plan to come to Beverly.

We had a very pleasant visit from Dr. Rodden and showed him our factory and process.

Please let me know if calcium or helium are detrimental when present in small percentages in uranium.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

cc: Dr. D. P. Mitchell.

Copied 7/18/41

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

July 18, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I have your letter of July 17th and heartily agree with your suggestions of starting careful production of uranium in small consecutive lots with most thorough control of all the factors involved. This really is the only way to solve the problem.

Your suggestion of depositing a thin layer of copper on the produced uranium seems to me an excellent one. If at the end of the leaching we will treat uranium with a solution of copper sulphate we may coat every particle of uranium metal before it is even removed from the filter press with a thin but effective layer of copper which will prevent oxidation and also will act as an excellent lubricant for pressing all the powder into solid blocks. Such pressed material should give very high density of some 16 or 17, and it also will remove the undesirable characteristics at its very source by preventing the reaction of moisture with produced uranium.

If such pressed bars be sintered at say, 1100°C, the copper will melt and will form a network of fused copper, holding the uranium grains. It might result in a product such as Elkonite, which is tungsten powder mixed with powdered copper and then sintered. It is used extensively in industry.

We started these experiments right away and this morning had the following indications. Copper is deposited from copper sulphate solution very rapidly on sintered uranium. When powdered material was treated there was some precipitation but not uniform, apparently the conditions were not quite right.

We are also making special runs on uranium which will be treated at higher temperature. We have indications that merely by increasing the temperature of the treatment it will be possible to get the sintered blocks right from the beginning.

Over a year ago we had a small order from Dr. Mitchell for sintered discs or blocks. I believe Dr. Mitchell still has them. I wonder if you could analyze those blocks for boron. They were made quite a long time ago from French calcium.

I am very glad to see that you are not discouraged by the first unfortunate results which are inevitable in the production of any new material. I am more in favor now than ever of going ahead with our process because I am convinced

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BEVERLY, MASS.

that the James process will present far more difficulties when attempted on a large scale than our process. And it will require a very much longer time to perfect that process to get sufficient amounts of material. On a small scale it gives good results but all the difficulties are still ahead of them. However, I am absolutely open-minded and when they will be ready to turn over their process to us, I will be glad to use it in our factory.

Next week we are completing 50 lbs. of thorium metal which seems to be of excellent quality. When it is finished, properly dried, and we are sure it is not pyroforic in any way, I will ask Mr. Davis to bring this lot to you personally. I hope that in a week or ten days he will be through with his factory inventory which ties him up to Beverly. I don't think we can go to New York together at any time since one of us must be in the factory for any emergency.

With regard to the combustion of the material in cans which you lately opened, the evidence is continually accumulating to the effect that this is due, first, to the moisture, and second, to boron. You know that boron under certain conditions forms very unstable compounds which ignite spontaneously in contact with air, and a minute amount of this material will be enough to set the charge on fire.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

Copied 7-19-41 LH

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

July 19, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

As I said before, it is quite essential that we cooperate more closely since apparently the problem of uranium production is far more complicated than merely making some standard product under specifications agreed upon in advance. It is a new thing and many changes will be necessary before entirely satisfactory results from every point of view will be obtained.

I feel quite strongly that you should take us much more into your confidence than at present, otherwise we are working in the dark. I feel it will be quite necessary to have a meeting in New York or even in Washington and lay out a definite program of proceedure.

1. A method of chemical control of the raw materials which you supply to us or which will be supplied under your specifications, such as uranium oxide and calcium.

2. A method of closer cooperation on technical matters.

3. Periodical check tests on the final products should be made to supplement results obtained either in our laboratory or at the Bureau of Standards. In my estimation this is absolutely essential to final success.

4. Immediate intensive work on finding the best method of packing, transportation and storage of uranium.

5. Experiments on the production of uranium by our own calcium hydride in case boron-free calcium could not be supplied by the Union Carbide & Carbon Corporation.

6. A method of sintering uranium particles or crushed blocks into definite geometric forms such as bars, spheres, etc.

I feel that on the subject of general direction of this research which is really a research problem and not one of a supply of standard material, I should communicate directly with you as I do now; on the matter of chemical tests directly with Dr. Rodden; on matters concerning orders and finances directly with Dr. Mitchell. Periodically all of us should have brief meetings with Dr. Pegram for his general suggestions and advice. We are doing all this already but a more definite procedure should be put into effect.

Very truly yours,
METAL HYDRIDES INCORPORATED
P. P. Alexander
P. P. Alexander.

Copied 7-21-41 LH
PPA:A

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

July 19, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

Following quickly your suggestions the following results were already obtained.

Copper is displaced from copper sulphate solution by uranium, but precipitated copper does not adhere to uranium in the way it does to iron. Our tests definitely demonstrated that copper particles simply drop by gravity and adhere only to the rough surface such as that of sintered uranium. It is a purely mechanical coating and a very imperfect one. This method of coating uranium with copper will be ideal but this is a problem of electrochemistry. The problem will be solved much quicker if you consult some of the expert electrochemists at Columbia University, and then we could adopt that method.

As an alternative we made a mechanical mixture of freshly reduced uranium with 2% of very fine copper powder. The mixture was pressed into a bar and then sintered at about 1050°C. It gives quite compact material. At a higher temperature, that is between 1100°C and 1150°C, copper forms an alloy with uranium which melts at that temperature. The cast alloy seems to be of very high density and hardness. Otherwise it looks exactly like vacuum fused uranium. These experiments show two possibilities of producing either sintered material or cast material at low temperature.

We are following also your second suggestion, that is of treating the freshly reduced uranium with carbon tetrachloride containing solid hydrocarbons in solution. This probably could be used right away since it prevents oxidation effectively. The question is, what percentage of hydrocarbons in the form of a coating you will allow in the final product.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

P. P. Alexander.

PPA:A

Copied 7-21-41 LH

July 19, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Beverly, Mass.

Dear Dr. Alexander:

Many thanks for your letter of July 18. Since I hope to discuss all these matters with you personally, I wish to comment only on one point of your letter since this point apparently has a bearing on experiments which you have already started.

It seems to me that if one wishes to attempt to coat the uranium powder with copper, the copper salt should be added to the leeching solution so as to come into contact with calcium protected uranium. If one attempted to coat with copper, uranium powder which has already been leeched and dried, it seems to me one might run into difficulties because of the oxide coating of the uranium grains.

Yours sincerely,

L S.

LS:lh (Leo Szilard)

Copies

1 Pegram
1 Fermi
1 Szilard
2 Mitchell

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

July 21, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

Many thanks for your letter of July 19. I personally fully agree with your suggested scheme of cooperation, with the proviso that if you communicate directly with Dr. Rodden on questions of analysis I should like to have a carbon copy of the correspondence both at your end and at the Bureau of Standards end.

My suggestion of coating uranium grains with copper by leeching the fresh uranium powder with a dilute solution of a copper salt was a tentative one and I made it only for the purpose of future reference. However, I still feel that even if the copper coating does not adhere, such a coating might serve a useful purpose. It might, for instance, make it possible to take the fresh, leeched and coated powder, press it and sinter it. Such a sintered or fused block might have the advantage that it can be made with a lower copper content than the sintered blocks obtained by mixing copper powder with uranium powder. There may be some difficulty connected with the fact that one will not be able to add the copper salt to the leeching solution until all the calcium oxide has been washed away and the solution has become neutral. I do not know whether or not the solubility of calcium hydroxide or the alkaline reaction of calcium acetate (if you use acetic acid for leeching) is sufficient to precipitate copper oxide from copper sulphate. Could you use dilute hydrochloric acid for leeching?

However, perhaps we should not continue the discussion of any further details and leave all technical questions to be discussed at a future conference.

Yours very truly,

L Sz.

LS:H (Leo Szilard)

P. S. I am returning to you the article from the READER'S DIGEST by Bruce Bliven with many thanks. It is nasty but I have seen more vicious ones.

L. S.

July 22, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

In confirmation of my letter of July 21, and in answer to questions which you asked in some of your previous letters, please note that ½% of copper in uranium causes 1% loss in one of our most important characteristic values and it is doubtful whether we could use materials with a larger copper content. For this reason, if you want to make any tests using the method of mixing copper powder with uranium powder and sintering, it would be best to start with ½% of copper.

Helium would be perfectly harmless even if absorbed in fairly large quantities. I am not so sure about argon and I am not able to answer this question right away. However, I shall see if I can find any information which will give us an indication. But in as much as it is rather unlikely that uranium should bind argon, there is a good chance that argon could be used if necessary.

In using paraffin or stearic acid we would not object to the use up to 1% by weight. However, it would be necessary to heat up the pressed uranium bodies made of such paraffin coated uranium powder in vacuum to 900 centegrades in order to get rid of practically all of the hydrogen which is contained in 1% of paraffin or stearic acid.

Yours very truly,

L. S.

(Leo Szilard)

LS:lh

Copies
1 Pegram
1 Fermi
✓1 Szilard
2 Mitchell

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

July 23, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I have your letters of July 21st and 22nd. Of course it is understood that you will have every copy of the analysis or request for analysis on any sample of material made for you which we may send to Dr. Rodden. By sending to him directly I will be able to request information about how he analyzes and this is extremely important because otherwise different analyses made by him, or by us, or by anyone else will not correspond and will be quite worthless.

For instance, as he explained to us here, in analyzing for hydrogen, he does not dry his apparatus previous to the analysis, nor does he dry the sample, so that the hydrogen reported may be only hydrogen occluded in the sample or it may be moisture adsorbed by the powder and which we know is almost inevitable in this damp weather. Possibly the reported figure gives the sum of the two components.

From your point of view possibly it is immaterial how hydrogen is present, whether in the form of moisture or in occluded state, but for us it is of paramount importance to know in which form it is present since it will modify entirely our procedure of manufacturing. If it is occluded hydrogen we have to give a much more thorough degassing during longer periods, have different charges, etc. If it is moisture our previous degassing counts for nothing, if we handle the produced material in such a way that it can re-absorb moisture from the air.

If the sample is sent by you we have no right to ask Dr. Rodden under what conditions he analyzes your sample, but if the sample is sent directly from here then we can request him to state definitely under what conditions the analysis was made.

Again, with regard to the fusion. Dr. Rodden states that he has no trouble at all in re-melting the uranium, even in the apparatus with very imperfect vacuum which he is using. And yet the research laboratory of the General Electric Company and of the Westinghouse Company entirely failed to re-cast uranium metal, that is, it can be fused only once but not the second time according to their experience. They were using the most perfect vacuum available, probably to a small fraction of a micron. And the men who were doing these experiments were

research workers who were working with thorium, uranium and similar materials for a great many years. Here again there is some discrepancy which simply shows that unless we use exactly the same methods of testing we never could get the same results, and all our efforts might be hampered by misunderstandings. So for these reasons I believe it will be of great help if the samples for chemical analysis are sent by us directly to Dr. Rodden.

I also mentioned that from time to time an additional check analysis should be made by some independent first-class laboratory such as we could find at the Institute of Technology. Of course the final specifications on the materials must come from you because no matter what analysis the Bureau of Standards shows or what purity we can produce or guarantee, or anyone else can indicate, if the material does not work when it is used by you, that's the end of it.

I am glad you do not see great objection to helium or argon. We developed a method and were using it quite successfully for several years in shipping pure thorium in dry state, which as you know is rather dangerous to handle on account of the possibility of ignition by electrostatic sparks. We have a special method of packing and filling the containers with helium or argon. In that way we eliminate any possibility whatsoever of ignition during transportation or storage. And if it was successful with thorium I would think it could be applied to uranium. Of course in any case you could provide us with your own helium which you could easily obtain from the Government at a low price. I believe for Government work it could be purchased for an extremely low price, something like one or two cents per cubic foot.

I noted also your suggestion about coating with paraffin. We made a small test sample which is now being exposed in a thin layer to the air of the laboratory, and so far does not show any oxidation. This will be a very simple way of handling material during storage and transportation. Before final use the small percentage of paraffin could be either removed by washing with carbon tetrachloride, treating in vacuum and then filling the container with helium, or as you suggested by heating to a high temperature in vacuum.

The method of coating with copper should also be followed up as fast as it could be done, but this problem is for electrochemists and we are waiting for your advice on this point. The copper sulphate solution of course could be

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

added to the leaching tank after the leaching is done and the uranium left to settle on the bottom of the tank. The acid solution containing calcium chloride or calcium acetate is decanted and a copper sulphate solution added. We are doint these operations quite frequently on other materials.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A P. P. Alexander.

P.S. The second check on sintering uranium with copper powder gave the same good results. We press material in a very small laboratory press and yet the sintered material has a density of 14.5 with sufficient pressure, that is 80 tons instead of 10 tons, and with a small amount of copper we probably will get a density of 18 or more.

We are also investigating the possibility of mixing powdered uranium with Wood's metal which is really an alloy of bismuth, lead and tin. If this powdered alloy is mixed with uranium and the sphere is filled with the mixture it could then be heated in vacuum above 60°C, the melting point of Wood's metal. Wood's metal will fuse and fill the pores between the uranium particles. On solidification the whole mass should be transformed into a solid block. Of course there are other combinations of bismuth, lead and tin which melt at a somewhat higher temperature, namely 93°C or 94°C. The trouble is that we do not know what elements are really objectionable for your experiments and what percentage of them will be allowed. However, I am sure we are on the right road and before long will find a suitable solution.

P.P.A.

✓ Copied 7-24-41 LH

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

July 23, 1941

Dr. P. P. Alexander, President
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

I understand that 35 pounds of distilled calcium have been sent to you by Kinzel. This amount of calcium has been bought from some appropriation which is used for our purposes by the Bureau of Standards. I wish to ask you to use these 35 pounds of calcium for making the next lot of uranium metal on your contract with the Bureau of Standards. The primary purpose of this experiment is to see whether the uranium made with this boron-free calcium will also be boron free. Another object of this experiment is to obtain, for the purpose of some experiments which we propose to carry out at Columbia, some boron-free material.

I would very much appreciate knowing in advance what substance you propose to use for leeching and how you propose to carry out the drying of this lot. In view of the special purpose of this lot, no binder of any sort should be used and none of the methods for making the powder non-pyroforic, which involve the use of foreign substances, should be applied.

Please note that some of this batch will have to be filled in a brass container which you have filled on a previous occasion, and I shall return to you the brass container for this purpose.

I hope to see you soon, but in the meantime there is no reason why, on receipt of this letter, you should not start on the 35 pounds of distilled calcium.

Since this work falls under your contract with the Bureau of Standards, and since financial matters are involved for which I cannot assume the responsibility, I shall ask Professor Pegram to initial this letter.

Very truly yours,

L Sz

LS:H (Leo Szilard)

initialed
G.B.P.

July 23, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

We had a conference today with Professor Pegram and I proposed that, pending the delivery of boron-free calcium, a regular production at the rate of 35 pounds per week be started using a boron-containing ordinary calcium hydride. This has been decided upon in principle, but you should get a confirmation order from Professor Pegram. There may be a delay of a few days since Professor Pegram would like, as a matter of courtesy, to inform Dr. Briggs as to this decision.

My present plan is to visit your factory Monday or Tuesday of next week and discuss all the details which will facilitate keeping each other informed without taking too much time off for correspondence. If either of these days would be convenient to you, please let me know. I shall send you a telegram as soon as I know the day and have my plane reservation.

Yours sincerely,

L. S.

LS:H (Leo Szilard)

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

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URANIUM-NICKEL
TITANIUM-NICKEL

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

July 24, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I just received your two letters and will be glad to see you on Monday, which is the best day for us.

We will start working on distilled calcium today which first of all must be converted into calcium hydride. The technic of doing this is different than that adopted for the handling of standard calcium. However, on Monday we will open the furnace when the calcium hydride will be made and you will see the difference.

We will also start making uranium at the rate of 35 lbs. per week with the standard calcium.

Fifty pounds of thorium have already been made for you. As soon as we receive your instructions about shipment we can finally pack it in special cans, seal in argon and forward it to you. Thorium is not subject to oxidation and can be preserved indefinitely even in air without appreciable changes. Filling the cans with argon is merely a protection against electrostatic sparks which may be generated by shaking the cans during transportation. The ignition point of thorium is also very much higher than that of uranium. On the whole it is much safer material to handle. What would you think of preparing sintered uranium-thorium alloys? From our point of view it will be quite feasible and probably will give very dense material.

If by any chance you could not come on Monday I will be glad to see you any time but on Tuesday and Wednesday some other people are coming to discuss other problems and part of the day I would have to spend with them. Iam enclosing a timetable. The quickest way to reach the factory would be to go from the Air Port to Boston in the Air Lines bus. From their terminal you could take a taxi to the North Station. Please call me either from Boston or from the Beverly station on arrival and we will pick you up at the station.

Very truly yours,
METAL HYDRIDES INCORPORATED

P.P.Alexander

P.P.Alexander.

rcpied 7-25-41 LH

PPA:A
Enc.

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CHROMIUM-IRON
BERYLLIUM-NICKEL
URANIUM-NICKEL
TITANIUM-NICKEL

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

July 30, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

We have good news for you. We succeeded in fusing uranium powder in vacuum at a temperature of 1200° C. The whole fusion came out in one solid ingot (170 grams) of bright silver color. We are going ahead and follow up these tests, and will immediately install a larger furnace to produce larger ingots. It is too early to say very much about it, but it looks as if we were approaching very nearly the solution which we are looking for.

Mr. Davis will bring this ingot for your examination and tests when he brings the fifty pounds of thorium made for you.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander.

✓ copied 7-31-41 LH

July 30, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

I understand from Professor Pegram that he already has Dr. Brigg's okay to our starting experimental production of uranium metal, without regard to its boron content, at the rate of 35-50 pounds a week. No doubt you will have a written confirmation from Professor Pegram within a few days.

I wonder whether you would agree that we should do as many experiments as possible and in each experiment use the minimum amount of material which is required to get industrial experience. I am thinking of batches of about 20 to 25 pounds which can be obtained in one single leeching operation. We certainly do not want any mixed batches, half of which may have been leeched under certain conditions and the other half of which may have been leeched under other conditions. I would put forward the following tentative proposals.

The first batch should be made with distilled calcium, using about half of the distilled calcium which was sent to you by Union Carbide and Carbon. This batch should be reduced and leeched only once and the reduction should take place under conditions in which dehydrogenation is not complete. We are willing to put up in this batch with any amount of hydrogen in the hope of obtaining a more stable product.

The second batch should be made with the rest of the distilled calcium. It should be reduced, taken out of the furnace, broken up, some calcium hydride added and reduced again. It should be leeched only once and its treatment should be as closely as possible similar to the treatment which you gave to the 25 pounds of uranium which you delivered to us, and part of which you filled into a copper sphere and the brass box. This batch should be dehydrogenated either in the first or in the second reduction process, according to which of these two

alternatives were used for the 25 pound batch referred to above.

The third batch should be made with ordinary calcium hydride, and instead of producing pure uranium an attempt should be made to produce a beryllium-uranium alloy. Uranium oxide of rather fine mesh should be mixed with 10% by weight of fluffy beryllium oxide, and then reduced with calcium hydride in the hope that in the presence of uranium oxide the beryllium oxide will be reduced and the beryllium will form an alloy with uranium. This experiment could be carried out on a 15 to 20 lb. lot.

I wonder how you feel about the chances of this batch No. 3? You might find it difficult to mix beryllium oxide and uranium oxide homogeneously because of the different specific gravities which will tend to separate these two powders.

I am ordering two pounds of fluffy beryllium oxide so as to have it at hand for the purpose of this experiment. You might use any kind of uranium oxide of fine mesh for the purpose of this experiment so that this experiment could be started even before you receive the Canadian material.

I am enclosing a list of data which would have to be included in the logbook, and new items should be added to this list at the rate at which they occur to us.

Yours sincerely,

L Sz

LS:H (Leo Szilard)

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

symbol above or preceding the address.

UNION

R. B. WHITE, PRESIDENT — NEWCOMB CARLTON, CHAIRMAN OF THE BOARD — J. C. WILLEVER, FIRST VICE-PRESIDENT

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DR LEO SZILARD, DEPT OF PHYSICS= 1941 JUL 31 PM 12 42

~~COLUMBIA UNIVERSITY~~= Kings Crown #Room 116

THIS MORNING WE DUPLICATED EXPERIMENT ON FUSION OF URANIUM. SECOND INGOT HAS OVERALL DENSITY OF SEVENTEEN. DONT ANTICIPATE ANY TROUBLE MAKING FUSED URANIUM FROM SPECIALLY REDUCED POWDER=

P P ALEXANDER.

✓ Copied 8-1-41 LH

SZILARD.

COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

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NIGHT LETTER		NIGHT LETTER	
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Patrons should check class of service desired; otherwise the message will be transmitted as a telegram or ordinary cablegram.

COPY OF WESTERN UNION TELEGRAM

11:15 A. M.
August 1, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 616
Clifton, Massachusetts

CONGRATULATIONS. KINDLY WRITE ME DETAILS WHEN CONVENIENT.

Szilard

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

August 1, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

We have now reached the point where we are to start our experiment on thorium and I wonder if you could let me have 35 pounds of this metal by Wednesday of next week.

Since we are not yet able to decide whether this metal will be bought by the Bureau of Standards or by Columbia, or used under the arrangement which I suggested to you, it is perhaps best not to invoice this material for the present. You could consider it for the time being simply as your property which is stored in New York rather than in Beverly. I do not know enough about bookkeeping to know if such a thing is possible, but if it is possible it will probably be the simplest.

I hope that within two or three weeks the matter can be settled, but it will be extremely inconvenient for us to wait with our experiment since the equipment is now ready for use and may not be available later.

Yours sincerely,

L Sz

(Leo Szilard)

LS:lh

Copies
1 Pegram
1 Fermi
1 Szilard
2 Mitchell

✓ Copied 8-4-41 LH

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

August 1, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I am glad you were pleased with the results we are getting now with uranium. The solution of the problem is extremely simple and consists merely in effective means of preventing oxidation.

If uranium is fused on the first day after being leached there is no trouble in fusing it. If, however, the fusion has to be postponed, the powdered uranium after leaching must be protected from oxidation. We do this by moistening the powder after drying with carbon tetrachloride containing about 1-2% of paraffin. Then the powder so treated is dried and can be stored without danger of oxidation. Before fusion or use by other means the powder can be rinsed again with pure carbon tetrachloride which removes completely the thin film of paraffin which covers every particle. However, this is not necessary if heat treatment is given because the powder so treated can be pressed very easily at small pressures in bars of convenient size, placed in the crucible and heated in vacuum for fifteen minutes at 1200°C. Of course every trace of paraffin, hydrogen and any other occluded gas is removed by this treatment. The uranium powder melts and forms a sound ingot.

Mr. Davis made another ingot today which he is sending to you with a complete description of the method of treatment, temperatures, etc. We checked up the overall density of this small ingot and again we found it is equal to 17 in spite of a small blow hole which we could see. This checks up very well with our previous tests on fused uranium. The ingots containing small imperfections had a density of 17 and up to 18. The highest density which we found on a very small ingot made some two years ago was 20.3, which probably is the true density of uranium and probably to that value we will gradually approach even on the large ingots.

I am wondering if you could send part of this ingot to Dr. Rodden for his analysis, and ask him to analyze it for boron. Perhaps the fusion in vacuum especially if done in a properly designed furnace and at a somewhat higher temperature would remove or at least reduce the boron content.

Very truly yours,
METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

Copied 8-4-41 LH

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TITANIUM-NICKEL

METAL HYDRIDES INCORPORATED

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

August 2, 1941.

Dr. Szilard,
Pupin Laboratories,
Columbia University,
New York City.

Dear Sir:

I am inclosing a sample of fused Uranium metal which I made from our lot #533. The oxide was reduced June 10 using Canadian oxide and Boron-containing Calcium hydride.

The metal had been stored unleached, so a sample was selected at random and leached in the usual way, dried with alcohol and ether.

When thoroughly dry the powder was treated with paraffin dissolved in Carbon Tetrachloride, paraffin being 2% by weight of the Uranium.

After evaporation of the Carbon Tetrachloride, the sample was pressed, placed in a combustion boat in a quartz tube and melted at 1200°C. in high vacuum.

The temperature was held at 1200° for ten minutes. When thoroughly cold the sample was removed. There was no attack whatsoever on the tube or sillimanite boat. The ingot has the shape of the boat but having contracted in the melting it did not adhere to the sides, and fell out on inverting the combustion boat.

The density of the ingot is 17, exactly as one previously produced without paraffin treatment.

The powder from which this ingot was made analyzed 98.7-99% Uranium.

The shipment of Canadian Uranium oxide has arrived and we will reduce some of this on Tuesday, Aug. 5th with Calcium Hydride from distilled Calcium.

Very truly yours,
L. W. Davis

L. W. Davis.
Factory Superintendent.

LWD/FAD

Copied 8-4-41 LH

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

August 2, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I have your letter of August 1st. The fifty pounds of thorium we made for you are of excellent quality. They have been dried in vacuum, put into cans and are ready for shipment. We are only waiting to fill the cans with argon and that will be done tomorrow.

On account of our inventory system it is essential that we bill this material when it is shipped from our factory. You know how eager we are to cooperate with you, but the only way out which will permit you to start the experiments without delay is for Dr. Pegram to send us word to the effect that eventually a formal order will be issued. Enclosed please find a copy of my letter to him.

Please also note that we cannot split this batch and send you only thirty-five pounds, and at the same time keep the price which was agreed upon for the whole batch. In other words, we made this special batch as one special run and agreed to charge you $1,000 for this material, regardless of how many pounds we may send you, whether fifty or thirty-five.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

P. P. Alexander.

PPA:A
Encl.

August 6, 1941

Dr. P. P. Alexander, President
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

Samples of the fused uranium block which you sent me were sent to the Bureau of Standards on Monday with a request for an urgent analysis for hydrogen. May I ask whether the sample of which this fused block was made has been treated with a filter press and if so how often air was blown through it?

I would like to have a small sample of uranium metal powder <u>not</u> coated with paraffin for the purpose of an analysis for hydrogen. Could you possibly have, as quickly as convenient, such a small sample prepared from your lot No. 533, i.e. the same lot which was used in preparing the fused ingot? This sample should be dried, and it would be best if you sent it to me so that I can label it and send it to Dr. Scherrer. I am rather anxious to have this information at the earliest possible date because it will influence the decisions which we have to make in the near future.

I am thinking of flying to see you one of these days in order to have another conference. There are a number of things which we have to discuss and in the following I would like to put some of these points on record for a later discussion.

(1) In order to obtain boron-free calcium we shall probably have to depend on the collaboration and good will of at least two firms, one to purify calcium chloride and another one to electrolyze this special calcium chloride. I should like to raise the question whether it would not be a wise policy to purchase commercial calcium metal and to distill it in your plant, possibly using an equipment which allows us to distill the calcium and to convert it into calcium hydride in one operation.

(2) On my last visit to Beverly I suggested that the leeched uranium powder be dried by washing it with alcohol and ether rather than by the previously used methods. You expressed some doubts whether such an operation can be carried out safely on an industrial scale. I understand that this method of drying was used on a sample which was subsequently successfully fused. While it is certainly too early to assume that this method of drying is really necessary, and while we might find that drying in vacuum is equally satisfactory, we should perhaps design some equipment (in order to be prepared and on the safe side) which would make it possible to wash with alcohol and ether in a closed system using nitrogen or carbon dioxide rather than air within the system.

Yours sincerely,

LS:H (Leo Szilard)

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

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URANIUM-NICKEL
TITANIUM-NICKEL

METAL HYDRIDES INCORPORATED

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

August 12, 1941

Dr. Leo Szilard
c/o Dr. C.J. Rodden
National Bureau of Standards
Washington, D.C.

Dear Dr. Szilard:

Attached to this letter are two ingots of Uranium. One is labeled Uranium #614 - F4, August 11, 1941. This was made from distilled Calcium, hand-leached, 100 grams pressed, and coated with 2% paraffin. It was heated to 1200°C. slowly (over a period of 70 minutes) and held there 10 minutes. The other ingot is labeled #612 - F3, August 12, 1941. This was made from machine-leached Uranium, vacuum dried, Carbon di-oxide admitted to oven, pressed without binder. It was heated as quickly as possible and held 10 minutes at 1200° C.

An ingot of #614 with 2% paraffin was started with quick heating, but the stopper was blown from the tube without warning in the same manner as happened Thursday last.

I have talked with the General Electric Company on Arsem furnaces, and they are sending literature and prices. As soon as they arrive I will forward you a copy at Columbia.

Very truly yours,

METAL HYDRIDES INC.

L. W. Davis

L.W. Davis
Factory Supt.

LWD:mac

August 14, 1941

Dr. P. P. Alexander
Metal Hydrides Inc.
Box 816
Clifton, Mass.

Dear Dr. Alexander:

I am writing you concerning the 50 pounds of thorium metal which you have made in your factory. We hope that this amount of metal will be purchased by the National Bureau of Standards for the price which you quoted, i.e. $1,000. Since however we cannot be quite certain about this point, Columbia University is prepared to take over 35 pounds of your metal for a price of $700 if the National Bureau of Standards does not purchase this metal within the next four months.

Since I am not authorized to enter into financial commitments on behalf of Columbia University, I am asking Professor G. B. Pegram, the director of the project for which this thorium will be used, to countersign this letter.

Yours sincerely,

L. S.

LS:LH

Leo Szilard

Copies

1 Pegram
1 Fermi
1 Szilard
2 Mitchell

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URANIUM-NICKEL
TITANIUM-NICKEL

August 18, 1941

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

Dear Dr. Szilard:

I wish to thank you for the courtesy you extended to me on Saturday, and to confirm the procedure for the next large batch of Uranium metal.

We are using lot #612, and machine-leaching 15 pounds of the metal. Immediately upon removal from the filter press 2 pounds will be dried with alcohol and ether, and coated with 2% paraffin; 13 pounds will then go into the drying oven and when dry, probably after 24 to 36 hours in the drying oven, in vacuum, at room temperature, Carbon dioxide will be added. Four pounds of this dry Uranium will be stored in a glass jar which contains a fresh piece of Calcium metal. The remaining 9 pounds will immediately be coated with paraffin and stored in a can.

We have not yet received the letter you spoke of in which Dr. Pegram authorizes us to supply 35 pounds of Thorium metal. Would you kindly check this to see if this letter has left your office?

Very truly yours,

METAL HYDRIDES INC.

L. W. Davis

L.W. Davis
Factory Supt.

LWD:mac

copied by MEB 8/19/41

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

August 28, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I was informed yesterday that the Dow Chemical Company has started the production of high purity calcium. Judging by the description given to me they are using some kind of distillation process. However, I am not certain as yet since I have not seen any samples of their calcium. In small lots their price is $2.50 per pound. In ton lots it should be very much lower.

I hope you will investigate this possibility of getting pure calcium as soon as you can since our losses are mounting to a prohibitive figure.

Besides the investment in special installations and building concrete pits, etc. which are now standing idle since June, we are paying the Union Carbide & Carbon Corporation more than nine hundred dollars per week for calcium which we bought for your work and which so far we have not been able to get rid of. Our contract with the Union Carbide was a mistake but a contract is a contract. It is a moral as well as legal obligation and we have to honor it.

Therefore we hope that you will do everything possible to solve the problem of calcium as soon as possible so that we could start the production of uranium on the scale specified in our contract.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander

copied by MEB 8/29/41

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

August 28, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

On my return I was informed by Mr. Davis that you requested him to carry on a series of experiments on the production of uranium in fused ingots.

You know how eager we are to cooperate in every way with you, but from our point of view these experiments should be treated quite separately from our production of powdered uranium.

It is not so much the additional expense which we would incur as the diversion of our attention from our main problem which must be solved before anything else is undertaken, which is objectionable. This main problem is the development of the technic of handling powdered uranium on a factory scale without undue danger to the health of our employees and in a way which will eliminate any possibility of its oxidation and possible combustion during transportation and storage. Furthermore, before the production of fused ingots, we have to produce uranium in powder form. Therefore let's solve this problem first.

You physicists have no conception of the difficulties engineers have to contend with in the production of special materials on a factory scale. We are also bound by various government regulations and laws with which we have to comply.

If the production of uranium in ingot form is advisable and desirable we will be glad to undertake such work for you but this must be handled quite separately from our main problem and of course should be made the subject of a separate agreement which will include the expense on special materials such as crucibles, quartz tubes, the time spent by skilled personnel, and of course the overhead for such work.

I envy the good fortune of pure scientists who do not have to be bothered with such prosaic matters as costs. Unfortunately I cannot run our business without due consideration to the material side.

METAL HYDRIDES INCORPORATED
BEVERLY, MASS.

We will make a few additional fused ingots for you but before going ahead and making a large number of such ingots I would suggest that we discuss the problem of the installation of proper equipment, expenses, etc.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander

Copied by MEB 8/29/41

METAL HYDRIDES INCORPORATED

Factory at 12-24 Congress St., Beverly, Mass.

Mail Address: P. O. Box 816, Clifton, Mass.

INVOICE NO. 5116

INVOICE DATE 8/30/41

SOLD TO National Bureau of Standards,
Washington, D.C.

TERMS: Net 30 days

			Unit price		
		C O P Y			
#29909	200#	Uranium Metal Produced and Stored for you in our Beverly Factory as per our Agreement	5 71	$1142	00
		Part Order against #29909			

copied 9/1/41 MEB

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

September 8, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

If you can come to Beverly probably it will be best if you do so, since on my next trip to New York I may not be able to come to Columbia University after our Directors' meeting.

As time is passing and apparently there is no hope of getting immediately three tons of distilled calcium, some adjustment must be made in our contract. This matter whould be settled at a meeting with Dr. Pegram and Dr. Briggs, but of course you and I have to get together and discuss this matter in detail so as to agree on a program which will be proposed for the settlement of this matter.

There is also a small matter in connection with the shipment to us of uranium oxide from Canada which we will discuss at our next meeting.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

September 16, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

We received a small shipment of a special grade of calcium from the Kemet Laboratories. We did not order this material and probably it was sent to us at your request.

The examination indicated that this material was made by the now abandoned process of the distillation of calcium from calcium silicide. As I informed you, we were using this material before and it is of excellent quality except that it is badly contaminated with nitrogen. In fact the smell of ammonia is almost overpowering when the container is opened.

We will hold this material for your examination and will not attempt to do anything until you decide whether it is suitable or not.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander

Columbia University
in the City of New York

DEPARTMENT OF PHYSICS

October 4, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

I wish to confirm the following agreement which Columbia University proposes to enter into with you. We will pay you $1,000.00 each month payable at the end of the month for the following six months. In consideration of this payment you will carry out such experiments on the production of non-pyroforic fusible uranium metal powder as will be agreed upon between you and ourselves. If requested by us, you will prepare up to eight (8) batches of uranium metal per month and deliver it to Columbia University. The uranium oxide for these batches will be supplied by us, and we shall also reimburse you for your expenses $2.50 per pound of uranium delivered under this agreement.

The first payment under this agreement is due on the 31st of October, 1941, for work which you may carry out for us during this month. The agreement can be voided by us during the proposed six months' period if and when you start the production of uranium metal under your contract with the Bureau of Standards before the end of the six months' period.

Since I am not authorized to enter into any financial commitments on behalf of Columbia University, I shall ask Professor G. B. Pegram to countersign this letter.

Yours very truly,

(Leo Szilard)

George B. Pegram

George B. Pegram

LS:MEB

copied by MEB 10-9-41

Alex

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

October 7, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

As you probably know from Dr. Rodden, the plans for the production of distilled calcium in our plant are being drawn up and this will be quite a relief to you since it may eliminate one of the biggest troubles you had.

We also had a letter from Dr. Briggs absolving us from the delivery of uranium on any specified date. This much was accomplished, yet I hope that now we will get together and formulate plans for work on uranium during the next experimental period.

I expect to be in New York shortly after the 15th and perhaps we could get together and outline a program which to my mind should include:-

1. More thorough reduction of the metal
2. Speed of cooling
3. More precise technic of leaching
4. Covering with paraffin or other protective medium
5. Fusion into small bars, first by intermittent operation and second in a semi-continuous furnace

Unless we do all this now, precious time will be wasted and we will not be ready to start production work under new conditions and with new materials when they will be available to us.

Hoping to see you soon either in New York or Beverly to discuss all these problems,

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander

CLASS OF SERVICE

This is a full-rate Telegram or Cablegram unless its deferred character is indicated by a suitable symbol above or preceding the address.

WESTERN UNION

(57).

1201

R. B. WHITE
PRESIDENT

NEWCOMB CARLTON
CHAIRMAN OF THE BOARD

J. C. WILLEVER
FIRST VICE-PRESIDENT

SYMBOLS

DL = Day Letter
NT = Overnight Telegram
LC = Deferred Cable
NLT = Cable Night Letter
Ship Radiogram

The filing time shown in the date line on telegrams and day letters is STANDARD TIME at point of origin. Time of receipt is STANDARD TIME at point of destination

PA1970 21 NT=PHILADELPHIA PENN 22

1941 OCT 22 PM 11 58

DOCTOR L SZELARD=

GR =COLUMBIS UNIVERSITY NYK=

INSTRUCTED DAVIS START PREPARATION TWENTY KILOS AS REQUESTED CAN NOT ALLOW SHIPMENT DRY METAL UNTIL MY RETURN WILL BE BEVERLY SATURDAY=

=P P ALEXANDER.

copied by MEB 10/24/41

CLASS OF SERVICE

This is a full-rate Telegram or Cablegram unless its deferred character is indicated by a suitable symbol above or preceding the address.

WESTERN UNION

1201

SYMBOLS

DL = Day Letter
NT = Overnight Telegram
LC = Deferred Cable
NLT = Cable Night Letter
Ship Radiogram

A. N. WILLIAMS, PRESIDENT
NEWCOMB CARLTON, CHAIRMAN OF THE BOARD
J. C. WILLEVER, FIRST VICE-PRESIDENT

The [illegible] and day letters is STANDARD TIME at point of origin. Time of receipt is STANDARD TIME at point of destination

NAJ8 41 DL=CN PHILADELPHIA PENN OCT 23 1200P

DR L SZILARD=

COLUMBIA UNIV DEPT OF PHYSICS=

THE MEDAL WILL BE PARAFIN COVERED IN ARGON CANNOT SHIP DRY METAL WITHOUT PROTECTION OUR BILLS FOR PREVIOUS WORK ARE STILL UNPAID PLEASE EXPEDITE PAYMENT TOMORROW WILL BE NEWYORK 230 PARK AVENUE TELEPHONE CALLS SHOULD BE CARE OF T LINDSLEY OFFICE=

P P ALEXANDER.

1251P

copied by MEB 10/24/41

ARGON 230.

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

$$\frac{1}{16} + \frac{1}{64} = \frac{1}{x^2}$$

Mr Bennet

$$\frac{1}{4^2} + \frac{1}{8^2}$$

CLASS OF SERVICE DESIRED			
DOMESTIC		CABLE	
TELEGRAM		ORDINARY	
DAY LETTER	X	URGENT RATE	
SERIAL		DEFERRED	
NIGHT LETTER		NIGHT LETTER	
SPECIAL SERVICE		SHIP RADIOGRAM	

Patrons should check class of service desired; otherwise the message will be transmitted as a telegram or ordinary cablegram.

COPY OF WESTERN UNION TELEGRAM

2:15 P. M.
October 23, 1941

Dr. P. P. Alexander
Penn Athletic Club
Rittenhouse Square
Philadelphia, Pennsylvania

Leaving for Washington today. Sorry cannot see you this week. Twenty kilogram dry metal filled into sphere useless for us if paraffin coated. Shall transport sphere myself if shipment by rail impossible.

Szilard

copies made
and distributed
by NH

copied by MEB 11-10-41

Alexander

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

November 7, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

As per your advice we leached a sufficient amount of uranium to fill the spheres which you sent to Mr. Davis some time ago. The material has been thoroughly dried and is being kept in vacuum. But we did not fill the spheres so far since we don't know if you want these spheres to be sent to you right away. Please let us know about your plans. It will probably take only half a day to fill the spheres.

On account of the combustion of thorium powder in your laboratory we thought that your plans might be somewhat modified and you might decide right away to change from powdered to fused uranium. In this connection I was investigating the cost of equipment required to fuse uranium and was given the figure $5,500 for complete equipment necessary to produce 100 lbs. of fused uranium per day.

I would like to suggest that you give a thought to starting immediately the work on the installation of additional equipment for the production of uranium in fused form. This is the best form for your purpose on account of the highest density and of course it will eliminate entirely all danger of handling powdered uranium after it leaves our factory. It is really not fair to complicate your highly scientific work with the necessity of using materials which require very special technic in handling. However, we should not wait until all the other problems of distillation of calcium and the purification of uranium oxide are finished before attacking the problem of the fusion of uranium. The work on all three problems should be carried on simultaneously.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander

Alex

November 10, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

Many thanks for your letter of November 7. I am quite sure that we shall want to use uranium in fused form rather than in the form of powder, and, as soon as you think that you have collected all the information which we need, I should appreciate an opportunity to discuss with you and Mr. Davis this question. It would be very helpful if you could also make a statement as to the additional cost which you would want to charge for the transformation of powdered uranium into fused uranium, since your present contract with Dr. Briggs covers the manufacture of powdered uranium only. Could you possibly send me details relating to the equipment for which you have a quotation for $5,500.00.

It will be probably best to have our next conversation at Beverly, but, since I am unable to fix a date as I am rather tied down in New York, I should be interested to learn if you plan to visit New York in the near future. I was sorry that I missed you when you were here on October 24. After that date I was so busy -- partly due to Dr. Zinn's accident and partly due to other causes -- that I had to neglect that aspect of our work in which you are most interested.

Yours sincerely,

(Leo Szilard)

LS:MEB
CC: 1 Pegram
1 Fermi
1 Szilard
2 Mitchell

Alex 1

November 10, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

Referring to your letter of November 7, I would like to add that it will be very satisfactory for us that you should keep the uranium powder thoroughly dried in vacuum until the time arrives when we actually need the copper sphere into which this powder has to be filled. I should be glad to be present when this operation takes place. I suggested to Dr. Davis to moisten the uranium with carbon tetrachloride, put it into the sphere wet and dry off the carbon tetrachloride completely after the powder has been filled into the sphere.

Yours sincerely,

L

(Leo Szilard)

LS:MEB
CC: 1 Pegram
1 Fermi
1 Szilard
2 Mitchell

copies to Dr. Davis
Metal Hydrides
and
Dr. Marshall

copied by MEB 11-18-41

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

November 14, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I have your letters with regard to uranium which you want to be leached and packed in the containers you are sending to us. We will go ahead with this work as soon as we obtain the carbon tetrachloride. Lately it was put on the full priority list and we cannot obtain a single pound of it from any source without a good priority number. We have written already to the Bureau of Standards and hope they will issue a sufficiently high priority number to us to obtain this material.

Do I understand correctly that the proposed scheme of holding part of our equipment for further work on uranium during this experimental period is now abandoned and all further experimental work with uranium will be held in abeyance until pure uranium oxide and pure calcium hydride are available? Of course you know how eager we are to do any experimental work on uranium, but we cannot go ahead without sufficient appropriations to cover our work.

Hoping to see you in New York in the near future and discuss our future plans,

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

P. P. Alexander

copied by M&B 11-19-41

METAL HYDRIDES INCORPORATED

FACTORY AT

12-24 CONGRESS ST., BEVERLY, MASS., TEL. 1875

MAILING ADDRESS: BOX 816, CLIFTON, MASS.

November 18, 1941

Dr. Leo Szilard,
Department of Physics,
Columbia University,
New York City.

Dear Dr. Szilard:

I am sorry to tell you that our vacuum pump which we were using continuously on the drying oven, finally had to be shut down for repairs.

On account of priorities the spare parts cannot be obtained for a week or possibly two, so that we will be held up on leaching uranium as per your last letter.

We are writing to the Bureau of Standards asking them to help us out with better priorities because with AlA priority the whole thing could be fixed up in a day or so.

I am planning to be in New York during the first week in December and will make a point to see you at that time.

Very truly yours,

METAL HYDRIDES INCORPORATED

P. P. Alexander

PPA:A

President

Not sent

November 22, 1941

Dr. P. P. Alexander
Metal Hydrides Incorporated
Box 816
Clifton, Massachusetts

Dear Dr. Alexander:

Many thanks for your letter of November 14. With regard to the second paragraph of your letter I wish to say the following: As I repeatedly told you, we are most anxious that experimental production of uranium should proceed without waiting for pure calcium and pure uranium oxide. This production would require the use of one of your furnaces for purposes of reduction of the oxide, perhaps some new equipment to paraffinate the uranium powder after reduction, some equipment to press this powder into a block or a cylinder in order to have it in a suitable form for being fed into an electrical furnace, and an electrical furnace sufficiently large to produce a cylindrical ingot of about three and one-half kilograms (3-1/2 kgs.).

Columbia University is prepared to spend up to seven thousand dollars ($7,000.00), in order to cover the cost of a certain experimental production of uranium metal in your factory, up to the time at which production of pure uranium will start in your factory under your contract with

the National Bureau of Standards. Of these seven thousand dollars ($7,000.00) Columbia University is prepared to spend about three thousand dollars ($3,000.00) for equipment which we would loan you for use during the above-mentioned experimental period. The rest of the seven thousand dollars ($7,000.00) would be spent in the following way: You would receive one thousand dollars ($1,000.00) per month for every month during which you prepared six (6) batches of powdered uranium metal and produced about five (5) ingots of about three and one-half kilograms (3-1/2 kgs.) each from every batch of uranium powder which you have produced.

In order to compensate you for your expenses for materials we shall pay you in addition to the above-stated one thousand dollars ($1,000.00) per month, two and one-half dollars ($2.50) for every pound of uranium metal which you reduce and leach for the purposes of this work. Of the materials required, we shall furnish you only the uranium oxide which you may take from our stock which you have stored for us in your factory.

Since I am not authorized to make any financial commitments on behalf of Columbia University, I am asking Professor Fermi to countersign this letter. In the absence of Professor Pegram, Professor Fermi has been authorized to

make financial commitments for the purposes of our work on behalf of Columbia University.

Yours sincerely,

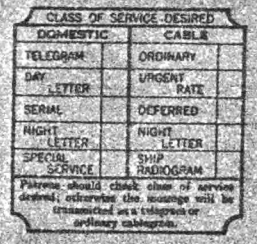
(Leo Szilard)

Enrico Fermi

LS:MEB

Copies

1 Pegram
1 Fermi
1 Szilard
2 Mitchell



E Teller 330

COPY OF WESTERN UNION TELEGRAM

STRAIGHT WIRE

February 17, 1942

DR. P.P. ALEXANDER
METAL HYDRIDES, INC.
BEVERLY, MASS.

LEAVING FOR CHICAGO WEDNESDAY FOUR PM IF YOU WANT CHICAGO ORGANIZATION TO HELP OUT PLEASE WRITE ME SPECIAL DELIVERY LETTER CARE OF COLUMBIA UNIVERSITY ALSO SEND CARBON COPY ADDRESSED TO ME CARE OF A H COMPTON UNIVERSITY OF CHICAGO . PLEASE INDICATE WHAT ARRANGEMENTS YOU MADE WITH MURPHREE AND WHAT SUPPLEMENTARY ARRANGEMENTS YOU WOULD SUGGEST

L SZILARD