Form AEC-94
(March 19, 1947)

UNITED STATES
ATOMIC ENERGY COMMISSION

COVER SHEET AND ROUTE SLIP FOR CLASSIFIED MATERIAL

	TO	INITIALS	DATE
1	Dr. R. K. Wakerling	RKW	4/19/50
2		HPK	6/28/50
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
	FROM		

U. S. GOVERNMENT PRINTING OFFICE 16—56298-1

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

SECRET
S-E-C-R-E-T

AB-415
UCRL-729

THIS DOCUMENT CONSISTS OF 6 PAGES
NO. 5 OF 11 COPIES, SERIES A

MINUTES OF MTA PROGRESS MEETING
TUESDAY, APRIL 11, 1950

DECLASSIFIED

PRESENT: UCRL - Alvarez, Brobeck, Cooksey, Farly, Gordon, Latimer, Lawrence, Lofgren, Longacre, Martin, McMillan, Norton, Panofsky, Powell, Reynolds, Serber, Sewell, Thornton

CRDC - Cope, Kent

AEC - Ball, Fidler

CLASSIFICATION CANCELLED
BY AUTHORITY OF THE DECLASSIFICATION BRANCH USAEC
BY B Foskett 3-29-57
SIGNATURE OF THE PERSON MAKING THE CHANGE DATE

Alvarez: Where we have x-rays in our present linear accelerator they are bad only insofar as they require shielding. It is estimated that only 1 milliampere of current goes into their production and this constitutes no drain on the present oscillator. However, the field emission varies as the area so that in the large machine we might get into a serious loading problem. The difference between measured and calculated current for this purpose is of the order of 10^{20}. The current density is given by the equation $J = Ke^{\frac{-W^{3/2}}{F}}$

Thus making the field larger or the work function smaller gets you into trouble. Under certain conditions if you cut the work function in half you get a change in field emission by a factor of 10^{13}. We need to determine what types of surfaces behave well in the vacuum which we have to use instead of the type of vacuum used in tube development work. We have one piece of evidence that tungsten grids don't seem to be very much trouble. On the grids in the linear accelerator we know that the field intensity is 4 or 5 times greater than it is on the flat surface and in this case they only double the total field emission, so that probably tungsten in a poor vacuum has low field emission. I am quite confident that we will find a surface which will give us so little field emission that we will hardly ever see it. I should also say that these observed field emissions are very independent of pressure; 20 times the pressure doesn't change the value very much. Tungsten should be very good. They will try tungsten and we might try some other things that are a little more practical. Panofsky suggests that we try chromium as he says in x-ray tubes chromium stands up very well while many other surfaces go bad.

Gordon: The tank now has flat panels on each side where the transmission lines will terminate. There are also positions for four pairs of lines, also at the bottom of the tank there will be a flat surface where the tracks are mounted to transport the drift tubes and still another flat on top of the tank where the drift tubes will be supported. We have therefore decided to make the liner a polygon with

SECRET
S-E-C-R-E-T

DECLASSIFIED

18° sectors. This gives an effective diameter of 57.4 feet on the low energy end and 51.55 feet on the high energy end. We are trying to fix 8 feet as a practical diameter for the drift tubes at the high energy end of the 60 foot tank, so that we will have some leeway to play with for the remaining 640 feet of the accelerator. At the moment we are making 1/2 drift tubes for cell tests at about 800 megacycles in order to get a more accurate idea in this low energy end of the accelerator. We have also drawn up a 1/10 scale cavity for this geometry with these panel sides and with this taper. This is ready to be released but we don't have the drift tubes to put in it yet. We have to keep creeping up on drift tube dimensions by a series of successive approximations.

Alvarez: There is one additional degree of freedom that has not been mentioned in that one can change the gap slightly. You could make the drift tubes all the same diameter and change the ratio of diameter to length. It might also be mentioned that if we make a split in the drift tubes on a median plane for convenience and for tuning we might install remote control equipment to make this adjustment.

Gordon: The aperture represented at the low energy end starts at 9" and increases in successive drift tubes to 18", 24", 30", 36" and then remains constant at 36". This beginning aperture has been scaled down from 12" to 9" on the basis of the increased field penetration due to the change of frequency up to 12.2 megacycles.

We also have some information on the focusing magnets and their approximate weights, sizes, and power requirements. They are looking fairly practical. We have a 1/2 drift tube at the beginning and a 1/2 gap at the end to give a total of 7 1/2 drift tubes and 7 1/2 gaps. The following table gives the value of the required field strength over 1/2 the repeat length (center to center distance between gaps) along the axis of the drift tubes. This is the value of H over 1/2 the repeat length to give the proper value of the integral H^2dl.

Drift Tube H	2000 amp/in^2 Tons Cu	Tons Fe	KW Power	3000 amp/in^2 Tons Cu	Tons Fe	KW Power
1. 8800	9.4	--	183	5.0	2.7	220
	9.4	4.7	184	5.3	4.2	233
2. 6400						
3. 5400						
4. 4700						
5. 4300						
6. 4000						
7. 4000 *	10.8	8.0	212			

* No. 7 Drift tube values incorrectly given at meeting for former values of field of 4800 gauss for L

SECRET

DECLASSIFIED

MINUTES OF MEETING APRIL 11, 1950

Our analysis indicates that it is more economical of material to make the drift tube magnets as long as practical. We haven't carried this analysis completely through but for some earlier values calculated for a field of 4800 gauss for 1/4 of the repeat length, the power and total weight of copper plus iron decreased as we increased the ratio of length to diamter. This is shown on the following tabulation.

1/d	kw power	total wt Fe plus Cu
0.38	153	14.1
0.76	121	12.2
1.14	116	9.6

Brobeck: What about the time schedule?

Gordon: We hope to have in the shop within the next two days drift tubes for the 800 megacycle test cavity which will give us the dimensions with which to design the drift tubes for the 200 megacycle cavity.

Brobeck: How are the magnet tests going on the remaining drift tube magnets?

Sewell: The initial test data should be completed tonight.

Gordon: In the actual design of the magnets for the first two drift tubes where we have the highest current density, we have a configuration which looks quite practical. We have a 9/16" square conductor with a 5/16" diameter hole for water cooling. Winding these up in spiral pancakes and running water through the center, it turns out that we need a current of 715 amperes and a voltage of 308 volts. We will have 32 such pancakes. These will be in series electrically and in parallel for cooling water. For a 30° temperature rise, a pressure of 38 psi is required for the cooling water.

Alvarez: Is the magnet to be canned so that it can run at atmospheric pressure so that water leaks in the hose won't bother you?

Gordon: That is what we had planned.

We have made some calculations on weights on the drift tubes. We estimate the first drift tube will weigh about 11 tons and be three feet long and the last drift tube should weigh about 24 tons and be about 14 feet long

Brobeck: I want to point out that power requirements for the focusing magnets are higher than I had previously estimated by about a factor of 3.

SECRET

SECRET

DECLASSIFIED

MINUTES OF MEETING APRIL 11, 1950

It looks like these power requirements are going to add up to about 1800 kw for the 60-foot tank. This means more cooling water will be required and also more motor generator power. This raises our total power requirement.

Norton: We have enough leeway.

Brobeck: The last drift tube will require 250 kw and is 14 feet long. This is about 20 kw per foot, for 700 feet to give a total of about 14,000 kw.

Lawrence: What has changed this power requirement?

Brobeck: A higher value for H^2dl. We are now having to provide the magnetic field over twice the length that we had originally planned on. (Not stated at meeting: About 40% of the increase was due to the increase in frequency from the original 10 mc to the present value of 12.2 mc.)

Sewell: There is also an additional factor of 25% added in to provide extra focusing, thus making them 1 1/3 stronger than needed to just overcome the electric defocusing. The original figures were to require 4800 gauss over a distance of 1/4 the repeat length; we are now having a minimum of 4000 gauss over twice this length. This is now to be provided over 1/2 the repeat length.

Alvarez: What size drift tubes are you using up toward the high voltage end? Could you make the magnets larger and put in more copper?

Sewell: I am pretty sure we can.

Alvarez: More copper should be cheaper than 10,000 kw of power. How many tons of copper do you have near the high voltage end?

Sewell: 10.8 tons per drift tube. These drift tubes are 14 feet long.

Lawrence: This gives a total copper requirement of 600 tons. You could certainly cut the power requirement in two by using more copper. Is there going to be any r.f. problem from the requirement of very heavy supports for these large drift tubes?

Alvarez: I don't think so. The currents will just flow around the outside. There will be a negligible power loss. It might also be worthwhile investigating increasing the outer diameter of the drift tubes, thereby reducing the required diameter of the tank. We might use 10 foot drift tubes down at the far end.

SECRET

DECLASSIFIED

MINUTES OF MEETING APRIL 11, 1950

Brobeck: I think we have plenty of room in that last drift tube. I don't think we want to change the liner dimensions.

On other mechanical work the building 52 set-up is now scheduled to turn on the first week of June and the tank drawings were just finished yesterday. The tank will be 12' in diameter. The first oscillator will have an RCA tube in it. The present plan is to follow it with a Federal tube shortly after.

Martin: We are planning on having drawings to show to the possible fabricators of the large tank by the end of this week or the first of next. We are allowing one month to get bids in; we hope by the 20th of May to place a firm order with someone for the 60' tank construction.

Brobeck: I would like to ask people's opinion about the refrigerating system for the vacuum pumps.

McMillan: We would certainly like to go to as low a temperature as possible.

Brobeck: We have been discussing how low the temperature should be. They had it down to -40° F on the Bevatron model, and that seemed to improve things.

Lofgren: I think it would be worthwhile to do some experiments. We ran as cold as we could. I might add this, in the new vacuum chamber we are using for the ion source tests, we pumped down in five hours to a vac of 5×10^{-7} millimeters. This is with a refrigerated baffle whose temperature was below -40°F.

Brobeck: A baffle temperature of -100° F is possible with Freon refrigeration. CRDC is looking into the refrigerating system. They are to investigate temperatures between -40° and -100° F. They want to find out how far down it is possible to go.

Lofgren: That shouldn't take long to find out on a test set-up. That could be found out in a couple of weeks.

Brobeck: There is another matter of pump oil. We might have to make provisions for periodically raising the temperature to allow the oil to flow back into the pumps if we use very low temperature baffles.

Norton: On electrical developments we have put out the bid for specifications for the power supply for the 60' unit. This is now being processed by CRDC and we expect to have it in about 30 days. In addition we have talked with Westinghouse on the new tube development and are also talking again with Federal on the same problem. Nothing has happened outside of this except that we have started on the

SECRET

DECLASSIFIED

MINUTES OF MEETING APRIL 11, 1950

oscillator for the test cavity set-up.

Lofgren: On the ion source we did get 1/2 ampere a couple of weeks ago, and also again today for a short while, that is, with the old equipment. That 1/2 ampere is total ionization.

Alvarez: I would like to report on pressure tests in the linear accelerator because we have results that look quite encouraging. On the linear accelerator we originally found that if we raised the pressure, the machine would not excite. We have never seen any high voltage breakdown in the tank. The thing that happens is that when you raise the pressure from the normal operating range of 0.3 microamps the pre-exciters just stop pre-exciting, so that you cannot put on the main oscillators. Don Gow has been doing work on this and has finally found that if you increase the power available from the pre-exciters you can keep on running the pressure up. The pressure at which you can run is proportional to the amount of power available to the pre-exciter. So far we have operated at 1.5×10^{-4} millimeter pressure and things are still all right. If you divide this pressure by a factor of 20, which is the ratio between the wave lengths of our present linear accelerator and the big one we are designing, one would predict that no difficulties should be found in operating at a pressure of 1×10^{-5} millimeter.

Brobeck: On the cyclotron we had discussions last week. It looks like a six months' time lag between the cyclotron and the linear accelerator. This was originally three months. The dimensions of the linear accelerator were pinned down on the 15th of March. It looks like the 15th of September would be a reasonable time for fixing the dimensions of the cyclotron.

Lawrence: In view of this time lag I don't think that the cyclotron need to be discussed in these meetings for a while until it develops to the point that we have significant progress to report.

Latimer: I am going to visit Argonne to study the metallurgical problems. There needs to be more work done on the nuclear physics of the target.

cc: 1/A W. B. Reynolds, UCRL
2/A John Q. Cope, CRDC
3/A H. A. Fidler, BAO
4 J. Norton, UCRL
R. K. Wakerling, UCRL 5a
6 W. M. Brobeck, UCRL
7 A. Tammaro, COO
8 K. S. Pitzer, WOO
10/11 R. H. Ball (3 file copies)
9/A W Elliott

SECRET DECLASSIFIED

ENGINEERING NOTES

SUBJECT: SPECIFICATIONS FOR MTA LINAC

THIS DOCUMENT CONTAINS 1 PAGES
THIS IS COPY 8 OF 8 SERIES

NAME: Brobeck, W. M.

DATE: Revised: April 7, 1950

Beam particles	Deuterons
Approximate beam energy	30 Mev
Tank diameter - inside	60 ft.
Cavity length	60 ft.
Drift tube gap to repeat length ratio	.25
Cavity equivalent inside diameter at injection end	57.3858 ft.
Cavity equivalent inside diameter at exit end	51.5500 ft.
Approximate drift tube outside diameter at exit end	7 ft.
Frequency	12.2 Mc/sec. (Wavelength = 80.616 ft.)
Beam duty factor	20%
Average beam current	50 ma
Average beam current during pulse	250 ma
Peak copper loss estimated	10 MW
Peak beam load	7.5 MW
Total peak RF output	17.5 MW
Oscillator input at 60% plate efficiency	29.2 MW
Oscillator power supply rating	30 MW
Tentative beam pulse duration	25 milliseconds
Tentative repetition rate	8 per sec.
Injection voltage	300 KV
Equilibrium phase angle	26° ($\cos 26^\circ = .90$)
Number of accelerating gaps	7 1/2
Entrance aperture	9 in.
Exit aperture	36 in.

Machine is to be designed to permit extension to 350 Mev with minimum change in the initial 60 ft.

Focussing magnets are to be provided in the drift tubes.

WMB:FP

SECRET