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MINUTES OF MTA PROGRESS MEETING
TUESDAY, APRIL 18, 1950

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

CRDC - Kent, Maker

AEC - Ball, Fidler

Brobeck: Pumps will probably be obtained from Oak Ridge. We plan to have DPI jets installed in the baffles of the pumps. DPI may bid on refrigerated baffles . We may have to make some provision for periodic defrosting of the baffles - perhaps eight out of the 48 pumps could have their gate valves closed and be defrosted at any given time so as to allow the oil to thaw out and return to the reservoir.

Panofsky: Are we making provisions to take care of back streaming, in order to minimize deposition of oil on metallic surfaces which might give rise to discharges?

Alvarez: It would be best if the surfaces were not sensitive to back streaming.

Brobeck: Power may have to be left off the 32" pumps until the pressure is below the value at which back streaming occurs.

Thornton: Have you given any thought to operating the heaters in the diffusion pumps at reduced power?

Martin: We had considered running at full voltage only when the tank pressure was high.

Brobeck: There have been no important changes in tank design since last week.

Martin: We are sending out final bids on Friday for the 60-foot tank. (Comments on provision of openings through the tank liner at positions of the diffusion pumps.) These openings will cost us quite a bit of power. We have arbitrarily established standards that we are not going to attenuate the pumping speed by more than 20% or dissipate more than 200 kilowatts of power. We expect to do much better than this.

Panofsky: The radiation loss is more than we had thought. The radiation loss varies not as the sixth power of the wavelength, as we had expected, but rather more nearly as the fourth power.

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Martin: We calculate we are going to require openings aggregating 300,000 square inches to provide adequate pumping speed.

Panofsky: Our calculations on radiation loss are on the assumption that we are radiating into free space. This is true if the radiation sees iron only, but will not be true if it sees copper.

Brobeck; It looks as though about 100 degrees of the liner will have to be perforated almost continuously with 1/8 inch holes, spaced 3/8 inches apart. This perforated area will be 46 feet long.

Alvarez: Have you taken into account the fact that these various holes are all going to radiate in phase?

Panofsky: No, I have not.

Alvarez: I think this should be taken into account. Radiation will be much different with all of them radiating in phase. The holes in the 40' linac tank may be responsible for the low Q compared with theoretical

Panofsky: The linear accelerator liner we without drift tubes had a Q of 110,000. This dropped to 70,000 when put in drift tubes. The original liner had pumping slots already.

Martin: If these are 1/8 inch holes and the skin thickness is 1/2 the diameter of the holes, does this effect the problem?

Panofsky: No.

Alvarez: The radiation loss will be greatly reduced if we use tubes rather than holes through a thin sheet.

Panofsky: I will recalculate the radiation loss. 1/8 inch holes are surely too small.

Brobeck: There is one point Haydon Gordon brought up. We are going to provide one foot for changing the mean length of the tank and we would like to know whether this will be enough.

Gordon: We will have to maintain some latitude for repositioning the ends of the liner so that we can change the ratio of G/L. The tank has been designed to be 62 feet long, thus leaving one foot at each end for adjustment in the length of the liner.

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Panofsky: We should not freeze the position of the end diaphragm, so that we can change the positions of the drift tubes to tune the tank instead of having to trim the drift tubes.

Brobeck: What dimensions should we specify on the vacuum tank in order to allow for this adjustment.

Alvarez; I would make the spacing close on the input end and leave several feet at the output end. Then you can always push the drift tubes down until they resonate on a different frequency. This is not a very serious problem. If you want to make some changes you can always push the drift tubes down the line and operate on a slightly different frequency.

Maker: You can make this adjustment at the expense of a structural change but that would take some time. The drift tubes will be mounted from 4-foot holes and in the present design will have a leeway in positioning of $\pm$ one foot.

Alvarez: That will be enough. In any given tank if you design drift tubes that will make it resonate on some frequency, so I don't think we should alter the final design of the tank. We can always eliminate the 1/2 drift tube and move the rest of the drift tubes down.

Panofsky; The only substantial uncertainties that we have in regard to placement of the drift tubes is at the low energy end, where the distances are small to begin with. In this region the transit time determines how much energy these particles get and we won't know how to calculate this exactly until Sewell gets his model tests under way.

Sewell: We are going to builda 10:1 model which will have a full scale dimension of 60 feet over-all. It may go a little over that when we adjust the length to get it tuned just right.

Brobeck: I don't think you'd want to build over 60-foot equivalent length for the model.

Alvarez; We will have loose end pieces on the liner but you won't be able to move them very much because of the taper in the liner. We could flex the end pieces a little bit for adjustment. If you have any trouble with the tank being too long you can just make the liner diameter smaller.

Brobeck: The liner diameter is going to be frozen pretty soon.

Alvarez: There are so many variables that you have at your control I don't see that there is any concern.

Brobeck: I think 60 feet should be the upper limit on length.

Panofsky: Is the schedule any different than it was a few weeks ago?

Brobeck: I was talking to Alex Hildebrand at Cal Development. We don't have an official figure yet but we are going to get together with the officials of Cal Development and decide on some firm dates. Hildebrand has the feeling that we can shorten the time required by a couple of months. That is based on optimistic tank manufacturing schedules.

Maker: I don't know what your philosophy on scheduling is here. The only way to get the thing built quickly is to make a schedule you can't meet, in other words, where everything has to work favorably, if you make a schedule in which you put allowances then you can't take advantage of the favorable things. The only way you can make such a schedule is to have it understood by everybody that it's that kind of a schedule and that you probably won't make it. We have found out - after educating our management - that we can get them into the habit of accepting a schedule that we thought we could just barely make it if everything was favorable and then they didn't censure us too much if we didn't make it.

Brobeck: That is the kind of schedule we are talking about. We gave a wrong figure last week on the power requirements for the focusing magnets. The figure should have been 14,000 KW rather than 10,000 KW. Power for the last drift tube will be 256 KW, whereas I think we had it down as 212 KW.

Sewell: We have also discovered that increasing the cross section of the copper conductors does not save us as much on resistance losses as we had thought, because of the increased length of conductor required.

Reynolds: Does the reduced diameter of the beam help you any?

Panofsky: The beam does just what we predicted it would do - that is, it is no worse than we thought it was going to be. We have found the following things: (a) the stable acceptance phase angle is nearly 90°. Of this 90°, nearly 80° is completely stable and will carry the beam all the way. The 9-inch injected beam will blow up to about 3 feet in the first four or five drift tubes and stay at that diameter, with perhaps a slight reduction due to relativistic effects, throughout the rest of the tank. To put it another way, the worst particle will never exceed the 3-foot diameter. All of our calculations are scaled from an input aperture of 9-inches. If the injector ends up at 4-inches diameter than we might later decide to reduce the drift

tube apertures and thereby save some power for the focusing magnets.

Alvarez: This would not make much difference in the first machine because the power requirements of the focusing magnets will not be too large.

Panofsky: I would not believe that at the present time we would be justified in going to a smaller diameter.

Gordon: In regard to the focusing magnets we are investigating the effects of conductor sizes in connection with voltage and cooling requirements. It turns out that the last four drift tubes in the 60-foot tank will have essentially identical magnets. This considerably simplifies the design problems. The first 3 drift tubes will have magnets of varying sizes, getting longer toward the high voltage end. We will require 180 KW for the first drift tube and about 250 KW in the last drift tube. These figures are based on a current density of a little more than 3,000 amperes per square inch and that really squeezes us to get the magnets inside the drift tubes.

Brobeck: For these magnets the saturation losses in the iron are only estimated and the power requirements may turn out to be higher than this. At present we estimate power requirement for the magnets will be 1800 KW for the 60-foot tank.

Gordon: Would you predict any changes in behavior from using brass rather than copper drift tubes and mountings for the 1/10 scale model?

Alvarez: It will lower the Q but will not affect the shapes of the drift tubes.

Sewell: I think it would be wise to make them out of brass and cover them with silver. Making them of brass would considerably simplify the machining problem.

Panofsky: We had an experience with this problem in the linear accelerator in which we found that the silver plating had to be expertly done in order to avoid a large reduction in Q.

Alvarez: The skin depth in copper is about 0.3 mil and you will want the silver plating to be several times this thickness.

Brobeck: We have started investigating the problem of heating of the drift tubes due to stray beam. By May 15 we should have all of

the dimensions of the drift tubes and by this time Sewell should have electric field plots which will determine the positions of the drift tube supports.

Panofsky: Until we have the field plots we won't have an accurate figure on the power requirement. We won't know the exact shape of the drift tubes until we have the field plot.

Alvarez: We should just go ahead and make the drift tubes and let Sewell in his model tests determine where to place them in order to give the proper field gradient.

Sewell: It will be about two weeks before we get anything together with drift tubes in it. The tank drawings are ready to go into the shop.

Panofsky: It would be useful to build the model with metal stems as soon as possible. I don't think there is much question where the drift tubes should go but there is some chance that there might be an objectionable modes involving currents in drift tube supports which would fall right on top of the main mode. We need to get the field measurements so that the theoretical people can get on with their next calculations on transit time losses. The things that should be done are: first, to put in the non-conducting supports, then make the field plot, locate the drift tubes, then make a field plot along the axis, then determine the magnetic field throughout the entire tank so that we can calculate losses in every piece of metal.

Norton: There is no change to report in the status of electrical equipment.

Brobeck: The Building 52 oscillator test is still scheduled for June 1. This is going to cost us a lot of money because we can't shop around for the parts. If we order the tank from Mare Island Navy Yard, it is going to cost us $1.10 a pound, which is about twice what we expected to pay. Then the spherical head for the liner may cost us up to $5,000. This tank is 15 feet high and 12 feet in diameter.

Lofgren: There is no change to report on the ion source. One line of attack on the development of the ion source is to construct a large version of a Van de Graaff generator that is a d.c. source. Then there is a second step to provide chopping. We are going ahead on this but in parallel with it there is another scheme in which in the first section there will be a radio frequency of 12 megacycles so that we can extract the ions just over that portion of

the phase when we want it. It appears that the easiest way to get started will be to resurrect a piece of calutron equipment. We have rebuilt a calutron unit with very few modifications. The source has now been mounted in the vacuum tank and the oscillator is now in the shop. This will be ready for test in a couple of days.

Maker: We need to know how much room you will require for the ion source so we can determine the position for a crane rail, which will be necessary for use in connection with removing the cover for the opening in the enclosure of the tank through which the drift tubes may be removed. We have planned to allow eight feet from the center line of the tank to the crane rail - will that be enough room for the ion source?

Lofgren: I don't know the exact dimensions of the ion source, but this sounds as though it would leave us enough room.