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UCRL-1134
Technology - Materials
Testing Accelerator

UNIVERSITY OF CALIFORNIA
RADIATION LABORATORY

Contract No. W-7405-eng-48

CALIFORNIA RESEARCH & DEVELOPMENT COMPANY
Contract No. AT(11-1)-74

MINUTES OF MTA PROGRESS MEETING
HELD FEBRUARY 13, 1951

Russell H. Ball

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RESEARCH SERVICE BRANCH
Atomic Energy Commission
Berkeley Area
Berkeley, California

MINUTES OF MTA PROGRESS MEETING
HELD FEBRUARY 13, 1951

Present: UCRL: Alvarez, Baker, Brobeck, Byerly, Cooksey, Cork, Farly, Judd, Kane, Kilpatrick, Latimer, Lawrence, Lofgren, Longacre, McMillan, Norton, Panofsky, Reynolds, Serber, Sewell, Street, Thornton, Twitchell

CRDC: Fissati, Hildebrand, Maker

AEC: Ball, Fidler

G.E.: Smith, Webster

Westinghouse: Andrews, Hulse, Kresser

N.A.A.: Parkins, Taylor, Smith, Donoghue, Howard

Brobeck said that, since the porosity of ceramic materials suitable for fabrication of the insulated portion of the target cone within the beam precessor has proved to be unsatisfactory, consideration is being given to two alternative designs. One of these would utilize a plastic cylinder outside of the ceramic one, with provision for evacuation of the annular space between the cylinders. The other design would utilize a glass cylinder. Negotiations are now under way with the Corning Glass Company regarding the fabrication of a glass section. It is hoped these negotiations will succeed in obtaining a significant reduction in the price being quoted by Corning for this fabrication.

Brobeck said that there is a growing desire to eliminate from the vacuum system the sources of organic vapors, since it appears that organic materials in the residual gas will contribute strongly toward discharges and sparking from the drift tube surfaces. Lofgren said that until recently it had been intended to paint all metal surfaces exposed to the vacuum with glyptal. This decision had been reached on the basis of the use of this technique with the 184" cyclotron and many other pieces of vacuum equipment. Garner, of RCA, has informed us that tests on vacuum systems used to evacuate electron tubes indicate the quality of a vacuum is not dependent solely upon the pressure of the residual gas but depends to a large degree upon its composition, organic components being particularly deleterious. In view of this a review of the vacuum system of Mark I has been undertaken to eliminate sources of organic vapors insofar as possible. Four steps have been suggested to minimize sources of organic vapors. These are: redesign of the pump gate valve to eliminate entrance of lubricant into the vacuum; the use of special surface coatings or the

use of bare surfaces; the conversion of the liquid air traps to baffles of 100% geometry; and the control of the temperature of the tank wall.

The present pump gate seal utilizes a chevron-type seal which introduces into the vacuum system the film of oil adhering to the valve-supporting shaft. Consideration is being given to the construction of this type of seal from a slippery plastic like teflon and the use of a highly polished chromium-plated shaft so as to eliminate the necessity for lubrication. Hildebrand said that CRC has had some successful experience with this type of seal. Lofgren said that an alternate possibility to glyptal painting of the vacuum surfaces is to sand-blast the iron and leave it bare and prevent rusting by dehumidifying the air with which the vacuum is broken. He said he has found literature references to the fact that at humidities below 50% iron rusts very slowly. Panofsky said that the iron which has been exposed to vacuum rusts much more than iron which has not been so exposed, so that humidities lower than 50% will probably be required. Lofgren said he has a vacuum system which is about two months old and which has spent roughly 1/3 of its time exposed to the normal Berkeley atmosphere and has shown no evidence of rusting. This lends some support to the hope that rusting of the Mark I tank might be prevented by using dehumidified air. Another alternate is the use of a metallic coating. For this purpose one needs a metal which does not oxidize readily and which is sufficiently malleable to permit its application by spraying followed by shot peening and which has a very low vapor pressure. One metal which satisfies these criteria is tin. Samples of iron have been coated with tin, using a spray gun, and these samples have been subjected to a number of after-treatments intended to produce a satisfactory impervious bond between the iron and the tin. The after-treatment comprised vigorous rubbing of the sprayed surface with a metal bar to minimize porosity. The samples were tested by immersing them in water and leaving them until the water evaporated. This type of exposure to uncoated samples resulted in a uniform coat of rust on the bare metal. The sprayed samples which had been given little or no after-working showed some rust spots. Those samples which had been worked most thoroughly by burnishing showed no evidence of rusting. Other samples were sprayed with copper and given similar after-treatments. The result with copper was less satisfactory than with tin, probably because of increased difficulty in working the copper onto the surface.

Lofgren said that engineering design studies are underway to determine the feasibility of converting the liquid air traps to baffles of 100% geometry. Panofsky asked if consideration had been given to the use of hot filaments near the diffusion pumps to carbonize oil vapors from that source. Lofgren said that Garner informed him that electron tubes using thoriated tungsten filaments cannot be evacuated with oil diffusion pumps but require mercury pumps instead, due to the contamination of the tube filaments with oil vapor. They have found in laboratory tests, however, that the use of an oil diffusion pump with a liquid air trap is satisfactory if a hot filament is placed near the diffusion pump to decompose the oil vapors originating from the pump. When this was tried the gauge

pressure rose by a factor of about 12 but the tubes evacuated on this equipment operated satisfactorily. The implication is that the pressure rise was due to the decomposition of the organic vapor and that the gas resulting from the decomposition does not contribute to surface contamination. Panofsky suggested the use of a hot wire grid in the pump manifold. The decomposition of the oil vapor in this region would probably not contribute much to the tank pressure because the decomposition would be taking place in a region of high pumping speed. Lawrence suggested that tests of this suggestion be conducted on the new cavities now being built by Lofgren and on the L-2 cavity to be constructed at Livermore.

Lofgren said that indications are that the temperature inside the shielding will vary between 120° and 140° F. It was observed on the quarter-scale bevatron model that a 15° F increase in temperature resulted in doubling the tank pressure. Although the surface-to-volume ratio in Mark I will be much smaller than was the case with the quarter-scale bevatron model, tank temperatures this high may lead to serious outgassing. This dependence of pressure on the tank temperature was found to hold over the temperature range from 60° F to 95° F. Should these experimental results be directly applicable to Mark I we may be faced with a serious out-gassing problem if the tank is to run as high as 120° to 140° F. He suggested that ventilation might be increased to reduce the tank temperature.

The question of whether to continue with the present plan of painting the interior surface of the Mark I with glyptal or to stop all glyptal painting and sand-blast those components already so coated was extensively discussed. It was the consensus of the group that, pending the outcome of numerous tests of coating materials and techniques, the Mark I tank should be left bare. All of the Chapman valves which have been installed to date will be left with the glyptal on them but no more parts are to be painted. Maker said that the decision to erect the tank of bare steel will transfer the cleanup operations from the fabricator's shops to Livermore since pieces will have to be sand-blasted just before they are installed. Maker said cost estimates are now being made for the installation of a dehumidifier to supply air at 50% humidity at a rate sufficient to let the tank down to air in four hours.

Maker suggested metallizing the surface of Mark I by vaporizing filaments under vacuum. Alvarez said it would be extremely difficult to vaporize the many pounds of material which would be required. Panofsky suggested that the surface might be brush-painted with silver. Brobeck said that tests of this method are now being run. Hildebrand said that an investigation has been made by CRC metallurgy department of the various commercial methods for coating metals and have found none of them to yield a truly impervious surface. Panofsky said that all that is required for Mark I is a surface of low porosity so as to supply a high degree of retardation to the oxidation of the iron. Brobeck said that the decision reached was to leave the tank uncoated until the first pump down, by which time a determination will be made as to whether coating of the tank will be necessary. Lofgren suggested that excess dehumidifying equipment might be found at the Mare

Island Navy Yard, since numerous ships have been de-mothballed at that yard.

Maker said that some of the Oak Ridge tanks at Y-12 were treated with Oakite 87. The application of this material, however, required application at 140° F followed by a hot rinse and treatment with a hot dichromate solution. Such a procedure appears completely impractical for a big tank. It is planned to try a sample of Oakite 33, which puts on a phosphite coating.

Brobeck said further study has been given to the voltage gradient which should be used in Mark II. The desired particle energy is 350 Mev, so that the tank length is inversely proportional to the voltage gradient chosen. Electron emission and sparking are the two phenomena associated with high voltage gradients which have been examined. Shown in Figure 1 below is the experimental data presently available on the magnitude of electron loading in Mark I as a function of voltage gradient.

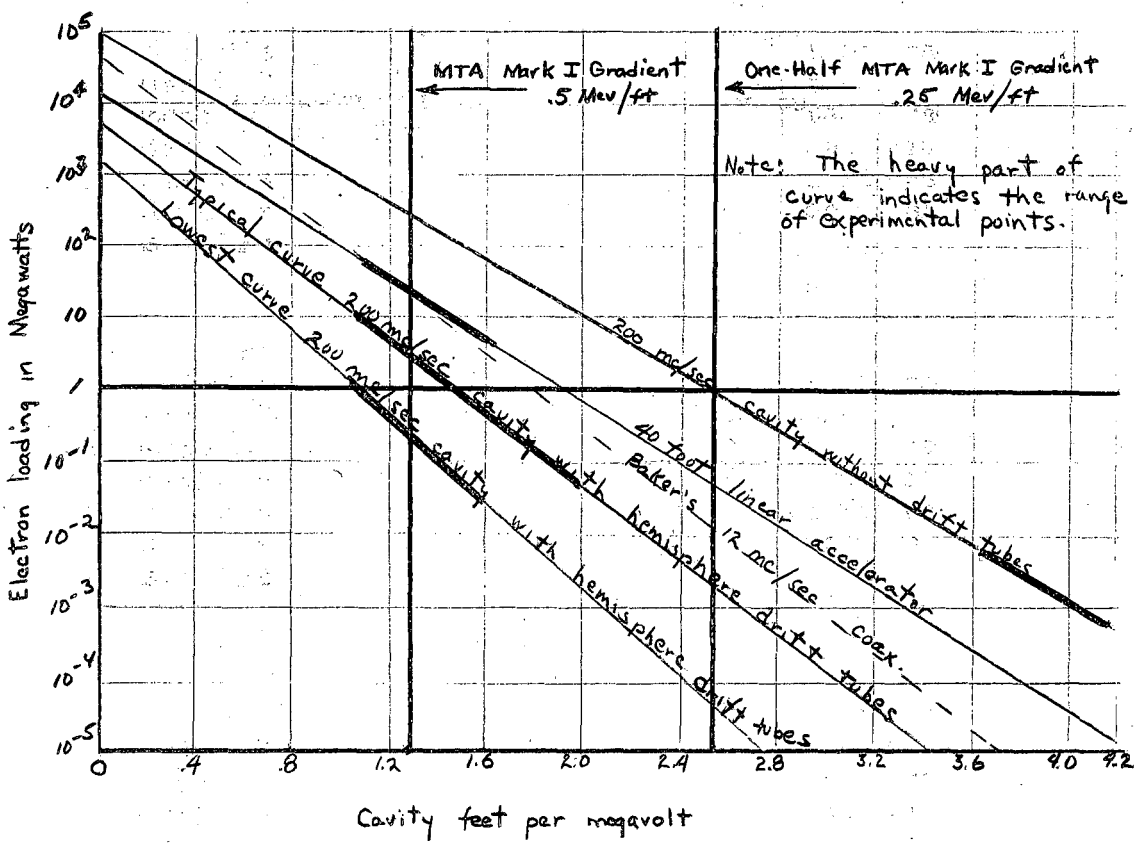

Figure 1.

The current has been assumed proportional to the area and has been assumed to be independent of frequency. It looks as though Mark I may have more than one megawatt dissipated in electron loading. It is therefore considered advisable to reduce the Mark II voltage gradient to 1/2 that to be used on Mark I. This will make Mark II 1500 feet long. Alvarez said that he is confident that the electron loading problem can be solved in view of the fact that in the B-1 cavity the X-ray production occurs primarily in discrete spots, thereby indicating that the majority of the surface is in a satisfactory condition. He added that it would be advisable, however, to base the Mark II design on a 1500-foot tank. Brobeck stated that the skin power loss will be considerably reduced by using the lower voltage gradient. The peak skin power loss would be reduced from about 110 to 52 megawatts. This corresponds to a reduction of the average skin power loss in Mark II from 31 to 15 megawatts. Hildebrand pointed out that the increase in the length of the tank does not necessarily adversely affect the economics of Mark II because the saving in power equipment will allow the increased cost of the longer tank to be paid off in a reasonable length of time. Panofsky said that the power required for focusing magnets is dependent only upon the final particle energy and not upon the voltage gradient. He added that the extension of the tank to 1500 feet would definitely eliminate the possibility of operation at 20 mc due to problems of mode separation.

Maker said that one of the specifications for Mark II is to be able to heat the vessel to 125° C. He said this would result in an expansion of almost 2 feet in the length of the vessel. If the machine is firmly supported at its midpoint this means that each end would move one foot. This expansion would make it desirable to cluster the oscillators as near the center of the tank as possible. Brobeck said the tank might be supplied with expansion joints but Maker felt the use of these would introduce serious electrical problems. Alvarez said that this thermal expansion of the tank will change the resonant frequency but not the mode of resonance.

Brobeck said that consideration is being given to the insertion of a circular electrode at the midpoint of each gap in the high energy end of Mark II in order to act as a voltage divider between the end faces of adjacent drift tubes and thereby reduce the probability of sparking. If these electrodes are used it may prove possible to apply bias to these rather than to the drift tubes themselves and thereby eliminate the necessity of insulating the drift tubes and of isolating the drift tube power supplies. He said there is also the problem of trimming or leveling the voltage along the length of the tank. Study is now being given to a means of expanding or contracting the ends of the drift tubes by remote control to accomplish this. An experimental model of this type of adjustable drift tube will be tested during the long drift tube test in Mark I.

Brobeck said that it is desired that roughing of the Mark II tank be accomplished in between 1 and 4 days, depending upon the cost of the equipment. He said the upper limit on the number of high vacuum pumps which may

be required is the number which can be mounted below the tank. This maximum would be 2000 32-inch diffusion pumps. The cost and engineering problems of installing this number of pumps will be looked into. Longacre is now preparing a table of the dimensions of the drift tubes for Mark II. There will be about 80 drift tubes in the 1500-foot tank.

Maker said that a study is being made of a number of techniques which can be utilized by the fabricator to achieve a satisfactory surface on the copper liner for Mark I. Surface treatment of the liner sections will be required after soldering of the cooling tubes in order to remove the resultant heavy oxide coating from the copper. Sand-blasting has been suggested for cleaning these liner sections, each of which will be 9 by 60 feet. It has been found, however, that sand-blasting leaves a surface condition which results in an approximate 15% reduction in RF conductivity of the copper cavity. Burnishing with a bronze wheel gives good results, while the use of a German silver wheel, although probably impractical for large-scale use, gave a very good surface. A study will be made of the RF conductivity of copper as a function of the grit size of emery paper used to polish the surface. Alvarez said that these tests should be made at 12 megacycles since the magnitude of the increased resistance would be a function of the ratio of surface irregularities to the RF skin depth. Twitchell said the furnace used for brazing cooling tubes to the liner sections is open at both ends and rolls along the length of the 60-foot liner sections. Because of this design it does not appear practical to use a control atmosphere to eliminate the severe oxidation of the copper surface.

Norton said the Radiation Laboratory has concluded a series of discussions with a group of RCA representatives relative to the design and development of a 6-tube cluster oscillator for Mark II. The discussions were to acquaint them with the thinking that has gone on at the Laboratory for the past several months. They will now go back east and talk with their top management concerning methods which they consider suitable for accomplishing this job. We will not know their findings for approximately 30 days.

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