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Technology - Materials
Testing Accelerator

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Contract No. W-7405-eng-48

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

MINUTES OF MEETING OF NTA REVIEW COMMITTEE HELD MAY 1, 1951

Russell H. Ball

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MINUTES OF MEETING OF MTA REVIEW COMMITTEE
HELD MAY 1, 1951

Present: UCRL: Alvarez, Brobeck, Farly, Latimer, Lofgren, Moyer, Norton, Panofsky, Thornton, Van Atta

CR&D: Hildebrand

AEC: Ball, Fidler, O'Donnell

Moyer reported on shielding requirements for Mark II. He said that the measurement of neutron yields by the use of the water tank containing manganese sulfate solution measures only the total neutron yield, whereas a determination of shielding requirements necessitates at least an approximate knowledge of the production of neutrons by individual processes and the angular and energy distributions for the several processes. There are 3 such processes effective--namely: evaporation, stripping, and recoil. The latter process is one wherein a single nucleon within a deuteron makes either single or multiple collisions with single nucleons within the target nucleus and thereby ejects one or more nucleons.

For the evaporation process the angular distribution is isotropic and the effective energy will be a few Mev. For the stripped neutrons their distribution is in a direction within small angles to that of the incident deuteron beam and their energy is taken as 1/2 that of the deuterons. For the recoil neutrons the distribution used is $f(\theta) \propto \cos\theta$ and the energy has been taken as $1/2\ E_d \cos^2\theta$. The cross-section and angular distribution for the stripping are available from the Serber theory. Total yields are available from the Pittsburgh data at 15 Mev, and we have yield data at 200 Mev available from work done at Berkeley. The agreement is good for the high energy data and misses the low energy data by a factor of about 5. Chambers has studied yield data from copper at 190 Mev. He has taken all of the cross-sections which yield neutrons and has found the total cross-section for the production of a neutron to agree within a factor of 2 with the data of Crandall and Moyer. For the calculation of shielding requirements four different assumptions as to the magnitude and pattern of beam losses were used and calculations were made on the basis of each. These cases are as follows:

A. 20% beam loss uniformly distributed along the length of the accelerator.

B. 2% beam loss uniformly distributed as in "A".

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C. 20% beam loss exponentially distributed along the length of the accelerator on the basis of a reduction by 1/e in 200 feet.

D. A 2% beam loss exponentially distributed as in "C".

On the basis of any one of the assumptions A through D one knows the amount of beam lost at each point along the axis of the accelerator. From this, and knowing the assumed cross sections, one can calculate the number of neutrons produced by evaporation, stripping, or recoil, together with their energy and angular distributions. One can then perform a numerical integration along the axis to determine the required thickness of shielding at each point to give a neutron flux outside the shielding of 10 neutrons cm^{-2} sec^{-1}. The drift tube magnets intercept the high energy stripped neutrons and thus eliminate them from consideration for the purpose of shielding requirements.

Calculations of required shielding thicknesses for each of the above cases were made at 500-foot intervals for the 1500-foot Mark II machine. The results of these calculations are shown in Table 1 below for Cases A and C.

		Entrance End 1500 ft.	1000 ft.	500 ft.	Exit End 0 ft.
Case A	125 ma	5.0 feet	6.7 feet	9.5 feet	13.6 feet
	500 ma	5.6	7.5	10.6	15.0
Case B	125 ma	4.0	5.5	8.0	11.6
	500 ma	4.7	6.3	9.0	13.0
Case C	125 ma	6.0	6.7	8.0	9.2
	500 ma	6.6	7.5	9.0	10.6
Case D	125 ma	5.0	5.5	6.2	7.0
	500 ma	5.6	6.3	7.2	8.4

Table 1.

The choice of the shielding thickness required for the roof of the accelerator building has been made empirically on the basis of experience with the shielding of the 184" cyclotron. With this instrument it has been observed that for a 5-foot wall thickness the roof needs to be 1.5 feet thick, while for a wall thickness of 15 feet the roof thickness should be 4 feet.

Hildebrand said that in view of the empirical relation given for determining the roof thickness it appears that the actual thickness of roof shielding will be decided on the basis of structural requirements.

Panofsky said that Mark II is being designed so that that half of the injected beam which must be rejected will be lost within the first 50

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or 60 feet and essentially no beam is expected to be lost beyond that point. On this basis Case C above is the most reasonable maximum beam loss to be provided for. He added that it is planned to add an automatic device to turn off the machine if too large a fraction of the beam is being lost.

In answer to a question by Alvarez, Moyer said that the shielding requirements listed in Table 1 above will handle the X-ray shielding requirements without the requirement of additional thickness.

Panofsky recommended installation of foundations heavy enough to support shielding thicker than the 10.6-foot maximum thickness given above for Case C so as to permit the installation of a shielding wall 15 feet thick if necessary. He pointed out that the 15-foot shielding would be required for a 20% beam loss under a very unfavorable assumption as to distribution and is the maximum beam loss that could be tolerated and yet permit the machine to be considered operable. There is therefore no point in providing foundations for shielding any thicker than the 15 feet required for this type of operation.

Hildebrand suggested that perhaps the shielding costs could be reduced by making the shielding thinner in areas where there will not be need of operating personnel or, he added, one might also put all of the equipment on one side of the vessel and place the opposite side of the vessel near the canyon wall and thereby reduce the concrete shielding requirements on the canyon side.

Hildebrand said that CR&D will design for Case C (500 ma) with foundations and layout permitting a change to Case A, and subject to study of possibilities in preceding paragraph.

Brobeck requested Moyer to include in his report on shielding the magnitude of the radiation field inside the shield. This information is needed to estimate the effects of the radiation on insulation and other materials inside the shield.

Hildebrand said the conduit through the shielding in Mark I will not be sealed so that if we experience trouble in deterioration of insulation the conduit will be tapped and air blown through.

Farly reported on present status of the RCA tube development contract. RCA is chiefly concerned in the modification of the 5831 tube to a new style called the A-2332. The latter number is the code name for the shielded grid type of tube. The conversion of the 5831 into the

A-2332 involves removing alternate filaments and replacing them with T-shaped shield structures whose footings are imbedded in the slots from which the filaments were removed. The problem then is to increase the emission from the remaining filaments to produce a tube capable of one megawatt output. RCA wants to maintain the physical size of the 5831. The estimated life of the thoriated tungsten filaments of the A-2332 tube is 10,000 hours. The A-2332 is provided with a turbulent type of cooling which will permit the dissipation of at least one megawatt from the anode structure. Filament emission is estimated at 2 amperes per square centimeter and the tube is estimated to be capable of 500 KW for CW operation. The total filament emission current will be 125 amperes with a plate voltage having a maximum of 20,000 volts and a minimum of 1500 volts. The tube for pulsed operation is estimated at one megawatt power, although this requires the total theoretical filament emission current so that it may be necessary to increase the filament temperature somewhat for pulsed operation. The tube operates with 80% efficiency at 500 KW output and at 70% efficiency for an output of 700 KW. The amplification factor of the tube was reduced from 50 to 8 when an attempt was made to increase filament emission by broadening the filaments. RCA has listed the following as among their plans for the immediate future:

1. Expedite the construction of their new building.

2. Contact and assist vendors in every possible manner to facilitate delivery of equipment.

3. Place orders for additional equipment.

4. Produce three new A-2332 tubes.

5. Produce several experimental A-2332 tubes in which the electrodes are about 20% longer.

6. Proceed with the design and construction of a suitable test set.

7. Proceed with stockpiling of parts usable on either the 5831 or the A-2332.

8. Continue the unit shield structure studies directed toward compact geometry and, if time permits and if the structure provides any promise, proceed with the design of an experimental A-2332 embodying this feature.

9. Continue extrusion of beam forming and other structures which would reduce construction time and improve quality.

10. Interview construction personnel.

The contract involves 2.3 megabucks for development and production preparation, of which $850,000 is for development only, the remainder being for stockpiling of material and the hiring of manpower so as to permit the undertaking of the construction of the required number of the production model tube. The anticipated cost for the total required number of tubes is 5.7 megabucks.

Norton said he talked with Garner of RCA today and was informed that they are trying to increase the length of the filaments by 20% and hope to have a tube of this type with them when they arrive next week. They plan to test the present A-2332 as well as the new A-2332 on the present pantograph structure. They also plan to test the A-2332 containing the 20% longer filaments. Garner of RCA is coming to the laboratory to get more information on the design of cluster oscillators. RCA is scheduled to submit a proposal for construction of the cluster oscillators by the middle of June.

Hildebrand expressed the opinion that the RCA contract for tube construction should properly be a subcontract under CR&D.

Alvarez recommended that we explore the possibility of having burned out 2332 tubes restrung with new filaments in order to cut down the cost of tube replacement.

Hildebrand said that 90% of the machine tools are now on hand at Livermore and it is expected to have the machine shop ready to go in 6 weeks, although it may be the first of July before the shop is completely staffed with machinists. Temporary additional power will be available for the drill hall in about 8 weeks. Foundations for the injector drydock will be poured in about 3 weeks. The 21st of May has been set as the date for initial evacuation of Mark I for a strength test. Mercury pump experiments will be resumed next week.

Lofgren said that the present limitation on achieving full design output from the injector lies with the present rectifier. The power supply for the Mark I injector will have a higher rating than the one being used for the test set-up.

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