UNIVERSITY OF CALIFORNIA — BERKELEY

~~SECRET~~

UCRL- 1093
c. 2

DECLASSIFIED

~~RESTRICTED DATA~~

~~This document contains restricted data as defined in the Atomic Energy Act of 1946. Its transmittal or the disclosure of its contents in any manner to an unauthorized person is prohibited.~~

TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 5545

RADIATION LABORATORY

~~SECRET~~

UCRL-1093
c.2

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.

4

UNIVERSITY OF CALIFORNIA
Radiation Laboratory

Cover Sheet
Do not remove

INDEX NO. UCRL-1093
This document contains 9 pages
This is copy 23 of 28 Series A

DECLASSIFIED

Issued to UCRL Info. Div.

~~SECRET~~
Classification

Each person who receives this document must sign the cover sheet in the space below

Route to	Noted by	Date	Route to	Noted by	Date
Crane	~~7/6/57~~ JTC	7/6/57			

DECLASSIFIED

SECRET

SECRET

UCRL-1093
Technology - Materials
Testing Accelerator

UNIVERSITY OF CALIFORNIA
RADIATION LABORATORY

Contract No. W-7405-eng-48

CLASSIFICATION CANCELLED
BY AUTHORITY OF THE SAN MTA
DOCUMENT REVIEW COMMITTEE.
ON 2-3-57 DATE E. Abbott SIGNATURE

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

MINUTES OF MTA PROGRESS MEETING
HELD JANUARY 16, 1951

Russell H. Ball

RESTRICTED DATA

This document contains restricted data as defined in the Atomic Energy Act of 1946. Its transmittal or the disclosure of its contents in any manner to an unauthorized person is prohibited.

Berkeley, California

SECRET

SECRET

DECLASSIFIED

STANDARD DISTRIBUTION: Series A	Copy Numbers
Atomic Energy Commission, Washington	1-4
Oak Ridge National Laboratory, X-10 Site	5
Carbide and Carbon Chemicals Division, Oak Ridge, Y-12 Site	6
Patent Branch, Washington	7
Technical Information Service, Oak Ridge	8-12
University of California Radiation Laboratory	13-28

RESEARCH SERVICE BRANCH
Atomic Energy Commission
Berkeley Area
Berkeley, California

MINUTES OF MTA PROGRESS MEETING
HELD JANUARY 16, 1951

Present: UCRL: Baker, Brobeck, Brown, Byerly, Cooksey, Cork, Chun, Dimmick, Farly, Gordon, Gow, Judd, Kane, Kilpatrick, Latimer, Lawrence, Lofgren, Longacre, Martin, Martinelli, Norton, Panofsky, Richardson, Serber, Sewell, Street, Twitchell, Van Atta, Wallace

CRDC: Cope, Crandall, Davis, Hansen, Hildebrand, Kent, Maker, Powell, Waithman

AEC: Ball, Fidler

Westinghouse: Andrews

Duke University: Newson

Gordon said that the design of the mechanism for adjusting and requirements for observing the drift tube positions in Mark I have been completed during the past week. Drift tube positioning is required because of the strong magnetic forces between adjacent drift tubes. The adjusting mechanism involves a motor-driven jack screw placed at one of the legs of the tripod drift tube support stem structure. Two legs of the tripod are provided with manual adjustments, while the third is provided with the motor-driven jack screw. During installation of the drift tubes, lateral and vertical positioning adjustments will be made. The adjusting mechanism on the drift tube support stem will be used to restore the drift tubes to their proper operating positions after the magnetic forces develop between adjacent drift tubes when the focusing magnets are turned on. Two general methods have been considered for determining the axial position of the drift tubes under operating conditions. One of these would utilize a strain gauge mounted near the top of each drift tube support stem which would be calibrated so as to indicate the drift tube position. The second method would utilize a light source on one side of the tank and a group of photo cells at the edges of the drift tube shadow cast on the opposite wall of the tank. In the table below are given, for drift tubes 1 through 8, the permissible tolerances in drift tube positions, together with the percentage of the gap represented by these tolerances and the range of distances over which it is desired that it be possible to measure the position of the drift tubes. It should be noted for drift tubes 2 and beyond that the percent of gap figure given is the maximum corresponding to the added displacements of two adjacent drift tubes.

drift tube No.	1	2	3	4	5-8
tolerance on drift tube position	0.2" (1)	0.25"	0.5"	0.5"	0.5"
% of gap corresponding to above tolerance	5% (2)	5.1% (3)	5.8%	5.7	4.5 (4)
range over which position must be measured	1"	2"	4"	4"	4"

Table 1.

(1, 2, 3) These values were reported at the meeting as 0.1", 2½% and 4% respectively, but were later revised to the above values.

(4) There is a slight reduction in the percentage figures for the remaining drift tubes due to increasing gap lengths.

The optical system referred to above offers some difficulties in installation, particularly as regards finding space for the location of the required nozzles on the tank, whereas the strain gauge method involves difficulties of insulating against the d.c. drift tube bias voltage of about 15 KV. The initial positioning of the drift tubes will be accomplished by aligning each one with the aid of a transit which will view each drift tube individually at right angles through windows along the length of the tank. The maximum magnetic loads on some drift tubes during the start-up period before all of the magnets have been turned on will reach 7,000 pounds or more, which corresponds to a displacement of approximately 7 inches. The instrumentation required in connection with the drift tube operation will require meters to read magnet current, drift tube position, position of the supporting tripod, the rf voltage on the stem, and raise-and-lower switches for the magnet current and drift tube position. Since the rf current which flows through the by-pass condensers on each drift tube stem is critically dependent upon the drift tube position it will be necessary, in order to avoid overloading the by-pass condensers, to make the necessary adjustments to compensate for the magnetic forces before the rf power is turned on.

Each of the drift tube stems contains an array of connections. Among these there is a main bolt carrying the main load of the drift tube which runs down one side of the stem. Opposite this is an auxilliary bolt to aid in resisting the bending moment at the joint between the drift tube and stem due to magnetic

forces. There are two leads for supplying power to the focusing magnet and which also carry cooling water for the magnet. There are two additional leads carrying cooling water for the shell. There are also miscellaneous electrical leads. Each of the connections at the joint between the drift tube stem and the drift tube is provided with a double gasket joint provided with a pump-out tube. There are 12 leads for thermocouples, plus a pressurized lead for supplying 20 kilovolts to supply any clearing fields which may be required in the drift tube bores. There are two 4-KV coaxial leads for uses yet to be determined. There is also a water-cooled lead for carrying 600 amps at 110 volts to supply power to the resistance heaters.

Van Atta said, in connection with the precessing of the ion beam from the accelerator, that consideration is being given to the use of Lissajous patterns. The presently contemplated circular sweeping reduces the ratio of peak to average intensity from its original value of about 50 to 1 down to about 5 to 1. Recent target studies indicate that the most favorable geometries are those which would require the beam to be swept over a square or rectangular area. Lissajous figures employing frequency ratios of 3/2 up to 7/6 are being studied.

Studies have been made recently on a target employing a graphite lattice with uranium slugs. This type of target is limited by the maximum power level at any one point. In order to achieve a rather uniform distribution of power level the lattice assumes the configuration of an igloo, in the center of which is placed the primary-secondary target array. The size of the igloo is determined by the allowable thermal flux, which in turn is determined by the incident fast flux from the target. The maximum value of thermal flux being considered is 3×10^{13}. A 50% increase in flux over the Hanford maximum is made possible by the use of depleted material. With the use of a pulsed beam the primary-secondary target array would be approximately 9 feet square and the interior volume of the igloo would have a square cross-section of about 25 feet in each dimension. The thickness of the lattice would be approximately 5 feet, followed by a 2-foot thickness of reflector. This arrangement is sketched in plan view in Figure 1.

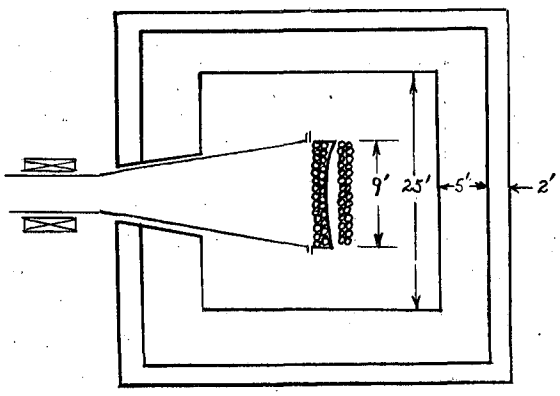

Figure 1.

delete

Brown said that the use of a primary and secondary target which is small relative to the lattice tends to equalize the thermal flux throughout the lattice. It may turn out that the distribution of fast neutrons from the target will be anisotropic, since neutrons escaping laterally will be absorbed in the target material to a larger extent than those escaping in the forward and backward direction. For this reason the fast flux incident on the lattice may be such as to render desirable a lattice of other than rectangular cross-section. In order to equalize cooling requirements throughout the lattice and to maximize the total production obtainable, it is necessary to equalize, insofar as possible, the thermal neutron flux, since the limiting value on the flux is determined by the thermal load created at the point of maximum flux. The thermal flux at the face of the lattice will be about 15 times higher than the incident fast flux. The variations in thermal flux within the lattice will be less pronounced than the variation of the flux of fast neutrons incident upon the lattice by a factor of 10-15, which is the ratio of thermal flux to fast flux, provided the target can be made small relative to the lattice. The distribution of neutron flux across the width of the lattice will depend upon the multiplication factor k and upon the thickness of the lattice. Using the Hanford unit cell and uranium depleted to 0.49% U^{235}, the value of k lies in the range of 0.87 - 0.90. The flux distribution across the lattice is as shown in Figure 2.

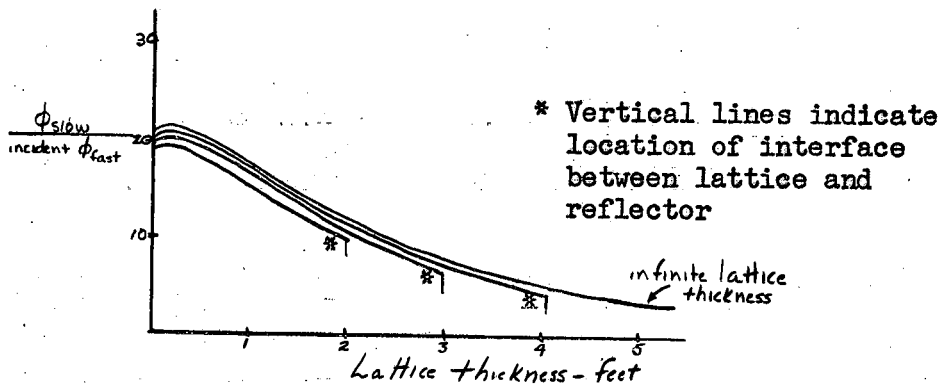

Figure 2.

It will be noticed that the flux has dimished by a factor of about 5 after having passed through 5 feet of the lattice. If the maximum flux at the peak of the curve is taken as 3×10^{13} then the flux after 5 feet of the lattice is down to slightly less than 10^{13}. Since this latter flux is still in the usable range for production purposes this suggests that it might be advisable to continue loading the lattice beyond 5 feet. With a lattice 5 feet thick one would obtain about $2\frac{1}{2}$ - 3 moles of plutonium per mole of incident fast neutrons. The flux distribution for an infinite lattice thickness is seen to depend upon the multiplication factor k, and hence upon the degree of enrichment of the material with which the lattice is loaded. Lawrence suggested that the lattice be made quite thick so as to permit the use of load patterns appropriate for

delete

a wide range of enrichments. Brown said the maximum flux obtained is approximately proportional to $\sqrt{\frac{1}{1-k}}$ while the production is proportional to 1/1-k. However, for given values of k and thickness of lattice the maximum flux is largely determined by the magnitude of the incident fast flux. Shown in Figure 3 is the flux distribution through an infinite lattice for several values of k.

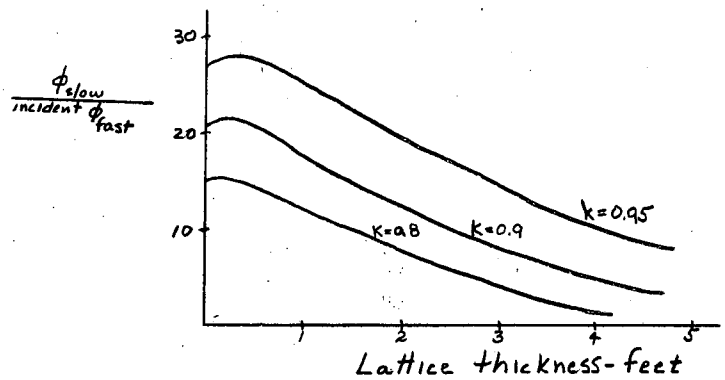

Figure 3.

From this figure it can be seen that as the enrichment of the U^{235} is diminished it becomes increasingly desirable to change from graphite to heavy water as the moderator because of the approximately 25% improvement in the value of k which can thus be achieved.

Brobeck said that from a lattice of the type described above the total production would be that of about 3 Hanford piles, whereas the heat removal required would be that of 2 Hanford piles. It would therefore be necessary to design for about 60,000 gallons of cooling water per minute.

Richardson summarized the present status of the 15" radius electron accelerating model of the Thomas-type cyclotron. The model now employs a 180° dee so oriented that one of the 3 hills of the pole faces bisects the dee. The energy of the X-ray beam has been determined by measuring the absorption curve of the X-rays produced from a tantalum target. The electron energy as measured by this method is 60 KV. Electrons of this energy have the same velocity as do deuterons of 250-Mev. The circulating electron currents have been measured using a shielded probe. The shielding on the probe was 1.7 mg/cm^2 of aluminum foils so that only electrons of energy greater than 28 Kev will penetrate the probe. This probe is useful for measuring the beam current only beyond a radius of about 12 inches, and beyond this radius the beam current and its variation with radius are rather well known. It has been found that beyond a radius of 15 inches the beam is dependent upon the dee voltage. The variation in electron current with the dee to ground voltage is shown in Table 2.

Dee to Ground Voltage	Electron Current
800 volts	5 μa
600 volts	1 μa
400 volts	0.2 μa
280 volts	10^{-3} μa *

*corresponds to 120 turns

Table 2.

In table 3 are given the approximate theoretical numbers by which the above dee to ground voltages must be multiplied to obtain the full scale voltages required for various dee geometries of a deuteron accelerator.

Dee Geometry	Dee Voltage Factor
Two 180° D's	x 1850
Three 120° D's	x 1400
Three 60° D's	x 2400

Table 3.

1-2-34

One thing which is known to contribute to the requirement for high dee voltages is the disparity between the theoretical and actual magnetic field shapes. Until now it has not been possible to measure the magnetic field more accurately than $\pm$ 2%; Sewell, however, has now developed a method which should allow it to be determined within 0.1%. It is planned to add more trimming coils to the magnet faces. These will be more closely spaced than those now used and of a contour conforming to the actual orbits of the electrons so as to allow more delicate adjustments of the magnetic field to be made. It has been found that if the d.c. voltage on the dummy dee is made the same as the dee bias the required dee voltage threshold is diminished. In connection with beam removal, two current measuring probes have been placed outside of the magnet along the radii of the two hills of the magnet not covered by the dee. It has been possible to get the beam divided equally between these two probes or, by imposing local variations in the magnetic field, to cause the beam to register entirely on one or the other of the probes. Among the experimental work remaining is the establishment of the lower dee voltage threshold; also

DECLASSIFIED

a study of the dee bias required and the measurement of the radial variation of beam intensity, especially at radii of less than 13 inches. It is also desired to measure the phase of the electrons and phase variations with radius. However, the present oscillator is not sufficiently stable to permit these latter two measurements to be made. It has also been found possible to vary over a considerable range the axial dimension of the electron beam which leaves the machine.

Hansen reported that the steel framework for 6 bays of the accelerator building at Livermore have been erected. All of the structural steel for the building has now been delivered to the site. The end ring on the east end of the vacuum tank has been installed and about 1/3 of the last ring on the west end has been installed. The welding of the tank is 70 to 75% complete. The floor is being prepared for the power distribution building The foundation for the motor generator for the oscillator power supply has been installed and the building walls are now being back filled. The foundations for the motor generator sets for power supplied for the drift tube magnets and beam precessor have been finished. The installation of the mechanical vacuum system is being completed in the pit below the vacuum vessel. The basin for the cooling tower is being poured today. Thirty-two of the 640 required shielding blocks have been poured and the more recent ones have been within tolerance. The soldering of cooling tubes on liner panels will begin during the next week. An attempt is being made to cover through a single contract the installation of power supplies for the oscillator, drift tube magnets and beam precessor. The heavy electrical power equipment for power supply 1 is now being received.

DECLASSIFIED

SECRET