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PHYSICS DIVISION

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REPORT FOR MONTH ENDING OCTOBER 31, 1945

L. W. Nordheim

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New Unit

The theoretical work on the general features of the new unit has in the main been finished. A summarizing report is being prepared. Mr. Scalettar has treated the effects of gaps in a control curtain as necessitated by pipe connections. He finds that in good approximation the percentage change in critical radius will be proportional to the percentage of gap opening with a factor of order unity.

The setup for turbulence studies (Saxon) has shown that photographs of bubbles introduced in the liquid give a satisfactory means of determination of velocity fluctuations. Measurements on flow through straight pipes are in progress. A large pump for driving a pile model is being installed.

The arrangement for the measurement of photo-neutrons in P-9 (Bernstein) has been completed and is ready to go. An experimental determination of the heat evolved in thorium under neutron bombardment (Borst) is under way. These measurements are being undertaken to obtain more accurate values on the cooling requirements of the thorium rods in the new unit. The critical experiments on solutions of 25 in P-9 have been actively discussed, and it is hoped that work on this fairly extensive program will start soon.

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General Physics Research

Section I - (Snell)

Measurements on critical amounts of enriched material contained in a solid mock-up of hexafluoride have been made with assistance of a group from Site Y (Baker, Newson, Kupferberg). Criticality has actually been realized with mixtures with hydrogenous materials.

The C^{14} factory has been operated steadily. Considerable work has been done on a "hard" radiation apparently emitted by the C^{14}. The present evidence is strongly in favor of the assumption that it is a gamma radiation of an energy in the range of 30 to 70 kv emitted by the carbon itself and not by impurities.

The measurements on neutron temperature in the pile by absorption have been resumed. The method consists in the measurement of activities in manganese flakes in the pile either unshielded or shielded by boron containing Pyrex plates. The plates are calibrated with neutrons of known energy in a neutron spectrometer. The average neutron energy at the center of the pile, uncorrected for the Maxwellian distribution, has been found to be about 0.070 ev (preliminary value), in good agreement with the thermal maximum of 0.067 ev observed with the neutron spectrometer.

Work on photo-neutron yields from various sources has been resumed.

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Section II - (Weinberg)

In addition to the continuing work on the new unit, several other investigations have been initiated.

In connection with the preparation of the fast oscillator, the space-time distribution of the neutron density due to an absorber of oscillating strength has been calculated. In case the oscillator is situated on the axis of a cylindrical pile, the response can be described as a superposition either of waves travelling outward or of waves travelling in the direction of the cylinder axis.

Calculations have been made for water lattices with slightly enriched material as seeds for unenriched lattices. It appears that workable piles could be obtained with comparatively moderate amounts of slightly enriched material.

An alternative method has been developed for calculation of thermal utilizations in a cell geometry. The new method takes into account the actual geometry of the cell (square or hexagonal), and it is hoped that it may remove the discrepancy between observed thermal utilization in water lattices and those calculated by the Wigner-Seitz cell method.

Section III - (Wollan)

A new pile oscillator with 200 c. p. s. has been developed and will be installed shortly. It is expected that the new instrument will permit direct measurements of k, the age and migration area of the pile.

[redacted]

A new reciprocator, which gives a 3-ft swing, has been installed for the 1 c. p. s. oscillator, and is being tested. Various refinements, such as a synchronizer between the motions of the absorber and the galvanometer, a photo-electric circuit for measuring the average amplitude of the galvanometer swing and the design of a selective 1 c. p. s. amplifier are in progress.

The crystal spectrometer has been used to measure the total cross-sections of iridium for slow neutrons. The two resonance levels below 2 ev, found previously by other observers, have been verified. The heights of the resonance peaks are, however, considerably greater than reported so far. This is probably due to the better resolving power in the new measurements.

Absorption measurements have been made on short-lived gamma rays from fission in order to determine the fraction of those of high energy. A uranium sample, exposed in the pile for 1.5 min, is brought out by the fast pneumatic tube and its gamma intensity with various absorbers is followed for twenty seconds. Evaluation of the runs made is in progress.

Other work concerned the 180° beta ray spectrometer, the preparation of soft gamma ray sources and the design of a cloud chamber and magnet for the determination of the energies of capture gamma rays.

Section IV - (Borst)

The neutron spectrometer has been used for measurements of the fission cross-section of 25 as a function of energy. This experiment

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is still in progress. The apparatus for the separation of measurable quantities of X^{135}, for use in the neutron spectrometer, has been completed.

The arrangement for measuring photo-neutrons from fission has already been mentioned in connection with the new unit.

The fissionability of slow neutrons of Pa^{233}, reported last month, is subject to doubt since the sample may or may not have been contaminated with U^{233}. A new sample is being investigated now. Also samples of Th^{231}, known as UY, are being prepared for fissionability studies. The UY is obtained by separation of Th from U in equilibrium with UY. The requirements of U decontamination are very severe (factor 10^{-12}). A special process has been developed, but satisfactory results are not yet available.

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Physics Section I

A. H. Snell, Section Chief

Total technical personnel (including supervision)..... 11 (this period)

Problem Assignment Number	Subject	Status	Percentage of Section Manpower Report Per.	Next Per.
PX1-7	C^{14} Production	Active	30	30
PX6-4	Neutron Temperature in Pile	Active	10	10
PX8-1	Gamma Ray Spectra	Inactive	0	0
PX8-2	Photo-Neutron Sources	Active	10	10
PX10-2	Water Lattices	Active	5	0
PX10-4	Be^{10}	Inactive	0	0
PX10-6	Fast Neutron Yields	Inactive	0	0
PX14-1	Criticality of Vessels	Active	30	20
163-X39P	Service Flux Measurements	Active	5	10
PX5-14	Lattice Layer	Inactive	0	0
PX8-4	Mean Gamma Energy per Beta	Inactive	0	10
PX5-15	Controls	Active	10	10
		Total.....	100	100

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PX1-7 - C^{14} Production - (Norris, Meiners, Schuler)

The factory ran steadily during the past month, and we have now about 27 mc on hand. One mc was shipped out during the month. Analyses are being made on the gas emerging from the extraction train, and they show about 17% oxygen, zero CO_2 and zero combustible gas. Analyses for nitrogen were not made. Considerable work has been done on the "hard" radiation emitted by C^{14}, and conviction is growing that it is a real gamma radiation, of energy in the range of 30 to 70 kv. Magnetic deflection experiments show that it is not hard beta radiation. Two considerations imply strongly that it does not originate in impurities, viz. (1) it is hard to see how anything but carbon would carry through the drying and extraction train of the factory and precipitate activity in the barium hydroxide bubbles; (2) samples of ages differing by four months give almost identical absorption curves for the hard radiation, and also give about the same relative strength of the hard radiation compared to the main beta radiation. If an impurity is involved, its half-life must, therefore, be of the order of years. The possibility of bremsstrahlen is being investigated, but looks remote in view of the low energy of the primary betas.

The energy of the supposed gamma radiation, as quoted above, was measured by the absorption coefficient of the radiation in aluminum and copper, and the absorption in aluminum of the photoelectrons ejected from a thin foil of lead. The results of these measurements are not very consistent, but all indicate an energy of some tens of kilovolts.

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PX6-4 - Neutron Temperature in Pile - (Branch)

During this month absorption measurements leading to the calculation of the neutron temperature in the Clinton Pile have been resumed. The total cross-section of the Pyrex glass absorbers used has been measured in a monochromatic, collimated beam of neutrons of known energy, obtained with L. B. Borst's neutron spectrometer. From preliminary measurements of the transmission by these absorbers of neutrons near the center of the pile (at the terminus of the pneumatic tube conveyor), the neutron temperature appears to be about 820° A. This corresponds to an energy of 0.070 ev, which is in good agreement with the thermal maximum of 0.067 ev observed with the neutron spectrometer. Additional activations are being made to increase the statistical accuracy.

Since the total cross-section almost entirely consists of the 1/v boron cross-section, the macroscopic cross-section of the Pyrex absorber was assumed to be

$$\sigma = \frac{\text{a const.}}{v} = K/\sqrt{E} \quad .$$

The cross-section of Pyrex plates of thickness δ was measured directly by placing the Pyrex plates in a monoenergetic neutron beam obtained with the spectrometer. The transmission, I/I_0, is related to the cross-section by

$$I/I_0 = e^{-\sigma\delta} = e^{-K\delta/\sqrt{E}} \quad .$$

The $K\delta$ for the Pyrex plates used was measured to be $0.077 \pm 0.002\ (\text{ev})^{\frac{1}{2}}$.

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The details of the experimental procedure will be described in a forthcoming final report. Briefly, the method consists of exposing calibrated manganese flakes with and without faces protected with identical Pyrex plates of known $K\delta$, with precautions being taken to eliminate activation of the detectors by neutrons incident on the edges rather than on the faces. Difference measurements are made with and without cadmium to eliminate the activities induced by epi-cadmium neutrons. From A_0, the thermal activity induced in the flakes not covered with Pyrex, and A, the thermal activity in covered flakes, the most probable energy, kT, of the activating neutrons is computed from the relation

$$A/A_0 = \int_1^{\infty} e^{-uK\delta/\sqrt{kT}} \, u^{-2} \, du = E_2(K\delta/\sqrt{kT}) \quad .$$

Where $E_2(K\delta/\sqrt{kT})$ is an $E_n(x)$ function, (tabulated by Placzek in MT-1), in which $n = 2$ and $x = K\delta/\sqrt{kT}$. This relation is only an approximation and is derived on the assumption that all the thermal neutrons have an effective velocity equal to the most probable velocity in a Maxwellian distribution. A more exact expression in which the neutrons are considered to have a Maxwellian velocity distribution has been derived and will be numerically integrated to obtain neutron temperatures as more accurate data are taken.

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The transmission of the absorbers in the pile from the few preliminary measurements is roughly 0.478. From the relation given above

$$A/A_o = E_2(.077/\sqrt{kT}) = 0.478$$
$$\sqrt{kT} = 0.266$$
$$kT = 0.070 \text{ ev}$$
$$T = 820^\circ A$$

PX8-2 - Photo-Neutron Sources - (Sternberg, Barker)

The paraffin pile has been reconditioned, and work has started on obtaining new and more accurate data on photo-neutron yields.

PX5-15 - Turbulence Studies - (Saxon)

Measurements are being made upon a set of photographs of bubbles in liquid streaming through a straight pipe, with a view to checking theory. The photographic technique is adequate, but a better camera is needed. A large pump has arrived for driving the proposed pile model.

PX14-1 - Criticality of Vessels - (Schrader, Barker, Snell, Abelson, Newson, Baker, Kupferberg, Hoyt)

Availability of a large amount of enriched material has made it possible to obtain actual critical measurements on a mock-up of hexafluoride.

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This mock-up is a mixture of black oxide and fluoro-carbon oil, containing about the right amount of fluorine. The mixture is contained in 1" cubes of aluminum foil, and can be handled as "dry" material. Measurements are being made on lattices containing varying amounts of built-in hydrogenous material, completely paraffin-tamped.

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Physics Section II [redacted]

A. M. Weinberg, Section Chief

Total Technical Personnel (including supervision) ..... 8 (this period)

Pile Oscillator Theory (Schweinler)

The pile response caused by an absorber whose strength oscillates with frequency $\omega/2\pi$ can be represented either as a superposition of waves which travel out from the absorber, or as a superposition of standing waves, each corresponding to a different pile harmonic. The travelling wave representation is most appropriate at high oscillation frequency. If the pile is cylindrical (radius R and height H), and the oscillator is on the axis at $z = z_o$ this representation can be written as

$$\frac{\delta n}{n}(r,t) = \mathcal{R}\frac{2\delta k}{J_o(\mu_{o1} r/R)} \frac{R^2}{2} \sum_{\ell=1}^{\infty} \frac{R_o(\gamma_\ell r, \gamma_\ell R)}{I_o(\gamma_\ell R)} \sin\frac{\ell\pi z}{H} \sin\frac{\ell\pi z_o}{H} e^{i\omega t}$$

$$= \mathcal{R}\frac{2\delta k}{J_o(\mu_{o1} r/R)} \frac{H}{2} \sum_{n=1}^{\infty} \frac{J_o(\mu_{on} r/R)}{J_1^2(\mu_{on})} \frac{F_n(\alpha_n z, z_o)}{\alpha_n} e^{i\omega t}$$

the unit of length being the migration length, the unit of time being the generation time, and $\mathcal{R}$ denoting "real part of". Herein $\frac{\delta n}{n}$ is the fractional change in neutron density, δk is the amplitude of the maximum k change caused by the absorber, $F_n(\alpha_n z, z_o)$ is defined in CP-2907, μ_{on} is the nth zero of $J_o(x)$, $R_o(x,y) = I_o(x) K_o(y) - I_o(y) K_o(x)$, and

$$\gamma_\ell^2 = \frac{\ell^2 \pi^2}{H^2} - \frac{\pi^2}{H^2} - \frac{2.405^2}{R^2} + \frac{\beta\omega^2}{\omega^2 + \lambda^2} + i\omega\left(1 + \frac{\beta\lambda}{\omega^2 + \lambda^2}\right),$$

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β being the fraction of delayed neutrons and λ their average period. The first form of $\frac{\delta n}{n}$ is a superposition of waves travelling radially outward; the second form is a superposition of waves travelling in the z direction. The radial wave solution was developed because it is appropriate for calculating the response to be expected in the proposed "fast" oscillator experiments.

Enriched water lattices (Cashwell)

Calculations on critical sizes of enriched water lattices as seeds for unenriched lattices are continuing. At a volume ratio of $2H_2O$: 1 U, and with an infinite unenriched lattice as a reflector, the critical amounts of enriched material in the seed are as follows:

25 concentration	Critical mass	Power in reflector: Power in seed
0.85%	7.1 T	2.2
1.0%	1.3 T	3.7

The plutonium to power production ratio is 1.09 higher in the 0.85% seed than in the 1.0% seed.

Thermal utilization in hexagonal cell (Murray)

The thermal utilization in a lattice is usually calculated for a circular cell and the result then applied to the actual square or hexagonal cell. The corrections to the thermal utilization introduced by deviations from circularity have generally been computed by the Wigner-Seitz method. An alternative method is to consider the lattice points as sinks in a medium in which neutrons are produced, the neutron distribution is then the sum of effects due to all the sinks. By application of Poisson's summation formula

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this sum can be made to converge rapidly. This scheme which in principle is more accurate than the Wigner-Seitz method is being applied to the water lattices in an effort to clear up the present discrepancy between calculated and observed thermal utilization.

Split Control Curtain (Scalettar)

The control curtain in the enriched pile will contain a gap through which inlet and outlet headers can go. To investigate the effect of this gap the following problem was solved: a black curtain partly surrounds a cylindrical pile of fundamental Laplacian $-\mu^2$, the angle subtended by the opening in the curtain being α_0; to calculate the critical pile size as a function of the angle of opening. The rigorous critical equation is in the form of an infinite determinant. In first approximation explicit formulae for the increase in critical radius, ΔR, can be given for the following cases:

(a) Small slit in curtain: $\alpha_0 \ll \pi$

$$\frac{\Delta R}{R_0} = - \frac{1}{\pi} \frac{\alpha_0}{2\pi}$$

(b) Small Cadmium Strip: $\delta_0 \equiv 2\pi - \alpha_0 \ll 2\pi$

$$\frac{\Delta R}{R_0} = \frac{1}{R_0} \frac{J_0(R_0)}{-U_0'(R_0)} \frac{\delta_0}{2\pi}$$

where $U_n(R) = J_n'(\mu R) - \gamma J_n(\mu R) \dfrac{K_n'(\kappa R)}{K_n(\kappa R)}$,

$\gamma = D_{II}\,\kappa / D_I\,\mu$, D_{II} and D_I are diffusion constants in reflector and

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pile, and $\varkappa$ is the reciprocal diffusion length in the reflector. These simple formulae show that the percentage change in critical radius is proportional to the percentage of slit opening or strip size, the constants of proportionality being of the order unity.

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Physics Section III

E. O. Wollan, Section Chief

Total technical personnel (including supervision)..... 10 (this period)

Problem Assignment Number	Subject	Status	Percentage of Section Manpower Report Per.	Next Per.
PX6-1	Pile Oscillator	Active	24	24
PX10-5	Energies of Delayed Neutrons	Active	10	0
PX10-8	Crystal Spectrometer	Active	20	22
PX10-16	Characteristics of Fission Products and Neutron Induced Activities	Active	6	6
PX11-1	Soft Gamma Sources	Active	6	6
PX10-18	Short Half-life Gamma Energies	Active	22	22
	Capture Gamma Energies	Active	10	20
		Total.....	100	100

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PX6-1 - Pile Oscillator - (Moak, Strong, Koch, Wollan)

Work on the equipment for the new 200 c. p. s. pile oscillator is nearing completion and should be ready for installation within two weeks. It is expected that with this equipment values for K, τ and M^2 may be obtained. If the sensitivity can be made great enough, values for K may be obtained for exponential or less than critical piles.

A new type reciprocator has been installed for the 1 c. p. s. pile oscillator. It consists of a 3 foot diameter aluminum pulley-wheel mounted on a small washing machine unit which rotates the pulley-wheel back and forth through an angle of approximately 180°. The boat containing various absorbers is drawn back and forth in the pile by means of a wire connected through a series of pulleys in endless-belt fashion. Tests with the reciprocator show the presence of a spurious signal which is not proportional to absorber sizes and is approximately 90° out of phase with the smaller signals due to absorbers. Microphonic difficulties may be the cause and a new detector arrangement is being installed with this in mind. A lubrication difficulty has been encountered with the ball bearing pulleys buried inside the pile. Oilless bearings are being tried for smoother operation of the reciprocator system. Some discussion has been held concerning the design of a high-selectivity 1 c. p. s. amplifier which would greatly improve the signal-to-noise ratio of the electronic system. A special photoelectric synchronizing circuit has been built which will hold the motion of the absorber in synchronism with the motion of the galvanometer. This will serve to keep the

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galvanometer swinging at its maximum steady-state amplitude. A photo-electric circuit for measuring the average amplitude of the galvanometer swing is under construction.

PX10-5 - Energies of Delayed Neutrons - (Burgy, Willard)

A final report on this problem is being prepared.

PX10-6 - Crystal Spectrometer - (Peterson, Sawyer)

Our results on the total cross-section of iridium for slow neutrons confirm those of Havens, Rainwater, and Wu (Report M-2224) and those of Sturm and Turkel (Report CF-3209) in showing two resonance levels in the region below 2.0 ev. The heights of the peaks, however, are considerably greater than those previously reported. Our samples consisted of solutions of $IrCl_4$ in D_2O contained in quartz cells 0.5 cm thick. They were analyzed for iridium content by Mr. Paul Thomason of Mr. Hume's section of the Chemistry Division.

A comparison of the results of the different observers is given in Table I. The values attributed to Havens, Rainwater and Wu are either taken from Report M-2224 (in the case of the thermal value) or quoted by Sturm and Turkel in CF-3209. Those attributed to Sturm and Turkel were reported by Sturm at the September, 1945, information meeting held at Clinton Laboratories. Our figures are as yet uncorrected for the reduction in peak values due to resolving power. A final report is being prepared.

[redacted]

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TABLE I

Havens, Rainwater, Wu		Sturm, Turkel		Peterson, Sawyer	
Energy, ev	σ_{max}, barns	Energy, ev	σ_{max}, barns	Energy, ev	σ_{max}, barns
0.62	480	0.635	538	0.62	2950
1.24	450	1.35	610	1.27	1900
0.025	$\sigma = 422$	0.025	$\sigma = 393$	0.05	$\sigma = 260$

PX10-16 - Characteristics of Fission Products and Neutron Induced Activities - (P. W. Levy)

The counters of the 180° beta-ray spectrometer have been completely rebuilt and all materials that might absorb alcohol vapor have been removed. Meanwhile, an attempt was made with the photographic spectrograph to photograph the photoelectrons emitted by a gold radiator surrounding a C^{14} gamma ray source. The problem is still one of obtaining a source of sufficient specific activity.

PX11-1 - Soft Gamma Sources - (P. W. Levy)

The preparation of one curie indium source of gammas is still being investigated. Initial tests have shown that the specific activity obtainable from a 10 gm solid piece of indium in a reasonable time is too low by a factor of 5. Lead absorption curves show a half-thickness corresponding to .22 mev

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and an indication of a harder gamma, of approximately .5 mev, which is probably due to an impurity.

In addition, we have been asked to prepare eight more iridium sources. These are to be two each of .5, .25, .05, and .01 curies. The preparation of these is well under way.

PX10-18 - Short Lived High Energy Gamma Rays from Fission Products of 25 - (Rose, Willard, Burgy)

Absorption methods were used to search for hard gammas from the fission products of 25. The fast pneumatic tube in the X-pile was used to expose about 1.2 gms of uranium for one and one-half minute periods and then to bring the sample out in about .3 sec. The gamma radiation intensity was observed with a Geiger counter tube and recorded by photographing the interpolation lights on a scale-of-64 scaler with an oscilloscope camera recorder. The decay of the sample was followed for 20 seconds after the sample was removed from the pile. Iron plates were used as absorber with lead for shielding and collimation. A total of 241 decay runs were made over a range of absorber from 0.25" to 9.00" of iron. Observation of the film has not been completed, and a compilation of energies and relative intensities will be given in a later report.

Determination of Energy of Capture Gamma Rays - (Koch, Burgy, Willard)

Helmholtz coils for a 6" cloud chamber and auxiliary parts have been designed and are under construction. Preliminary tests on shielding and on the photography of electron tracks are being made.

[redacted]

Physics Section IV

L. B. Borst, Section Chief
S. Bernstein, Associate Section Chief

Total technical personnel (including supervision)..... 8 (this period)

Problem Assignment Number	Subject	Status	Percentage of Section Manpower Report Per.	Next Per.
PX10-7	Fissionability of 40-10	Inactive	0	0
PX10-8	Neutron Diffraction	Active	25	25
PX10-10	Deuterium Gamma Ray Spectrometer	Inactive	0	15
PX10-14	Poisoning Coefficients	Inactive	0	0
PX10-15	Photoneutrons from Fission	Active	35	35
PX10-17	Fissionability Studies	Active	30	15
	Heat Evolution from Bombarded Thorium	Active	10	10
		Total.....	100	100

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PX10-~~12~~ 7 - Fissionability of 40-10

Inactive

PX10-8 - Neutron Diffraction - (Hasbrouck, Osborne)

The counting rate, using a fission chamber having an active surface 1" x 14" oriented at grazing incidence to the neutron beam, has been compared to the counting rate of a similar boron chamber at various energies within the Maxwellian maximum. Measurements have also been made by activating an indium foil. These measurements are being continued at higher energies, and will be reported at a future date.

The apparatus for separating measurable quantities of Xe^{135} is now complete. Dummy runs will be started shortly.

PX10-10 - Deuterium Gamma Ray Spectrometer -

No work has been done on this experiment during this period. We are waiting for the arrival of an oil diffusion pump.

PX10-14 - Poisoning Coefficients

Inactive

PX10-15 - Photoneutrons from Fission - (Bernstein, Ulrich, Wolfe)

The fast pneumatic tube in Hole 50 has been released for use in this experiment. The water tank and D_2O sphere are in place and connected. The pneumatic tube assembly has been assembled. Fission chambers and circuits are nearly ready. Equipment tests will be made during the coming week.

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PX10-17 - Fissionability Studies - (Dial, Floyd)

In the last report Pa^{233} was reported to have a cross-section of about 50 barns. This result was obtained upon the assumption that little or no U^{233} contamination existed in the sample. To support this view, an estimated analysis was quoted. Further work by members of the Chemistry Division has shown that the conditions of the precipitation of MnO_2 were not optimum. The precipitation was carried out in one-half normal acid at room temperature. Under these conditions a gelatinous precipitate is formed which may carry significant amounts of U. The quoted cross-section must, therefore, be withdrawn.

A second sample was prepared consisting of 1.38 mc of Pa^{233}. The precipitations were carried out in three normal acid at 95° c. Under these conditions less than 1% carrying has been observed. An aliquot was measured for alpha emission. The total alpha count for the whole sample was 110 alphas per minute. This is equivalent to $5 \times 10^{-3} \mu c$ of U^{233}, or a 10% contamination. A considerable fraction of this alpha count is undoubtedly due to Th^{232} remaining after separation. Fission track analysis is being followed as a function of time. No definite results can yet be quoted.

Samples of Th^{231}, known as UY, have been prepared by Th separation from U in equilibrium with UY. The requirements of chemical separation are extremely severe. Since U decontamination must be carried out to a factor

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of 10^{-12} within a few hours, no satisfactory results are yet available. The chemical process used is outlined below:

The UY (Th^{231}) and UX_1(Th^{234}) are separated together from an ether solution of 1.5 kg $UO_2(NO_3)_4$ by extracting into saturated NH_4NO_3 solution. The Th is carried from the extracting solution with LaF_3, then removed from the La by $Ce(IO_3)_4$ precipitation. Reduction of the Ce^{++++} to Ce^{+++} allows the Th to be carried down with about 1.6 mg $Th(IO_3)_4$ precipitate, leaving the Ce behind. The Th is mounted as $Th(OH)_4$, giving about 0.5 mg of mounted material. For the fissionability study, advantage was taken of the difference in half-lives (24 h for UY compared to 24 d for UX_1) to maximize the ratio of UY to UX_1. A preliminary removal of all Th isotopes was made three days before the sample was extracted, allowing the UY to grow to .88 of saturation, compared to a small amount of UX_1.

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