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REPORT OF THE CHEMISTRY DIVISION FOR THE MONTH

SEPTEMBER 15 - OCTOBER 15, 1945

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Warren C. Johnson

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SECTION C-I

S. G. English, Section Chief
R. W. Stoughton, Assistant Section Chief

CX3-1 - Hanford Process Problems (D. Miller)

D. R. Miller is continuing work on the Plutonium Project Record.

CX3-2 - Basic Chemistry of Plutonium (J. Dam, K. Kraus, J. Manion, G. Moore, L. Werner, L. Gevantman)

A. Acid-Base Titrations of Pu(VI)

"Blank" titrations of $HClO_4$ solutions showed that after flushing with nitrogen no difficulties due to CO_2 should be expected in corresponding plutonium titrations.

A titration of an 8.91×10^{-4} M Pu(VI) solution in 1.20 M NO_3^- yielded the values $pK_1 = 5.45$ and $pK_2 = 5.9$ assuming the reactions

$$PuO_2^{++} + 2\,H_2O \longrightarrow PuO_2(OH)^+ + H_3O^+ \qquad (K_1)$$

and

$$PuO_2(OH)^+ + 2\,H_2O \longrightarrow PuO_2(OH)_2 + H_3O^+ \qquad (K_2)$$

Furthermore, it was found that further hydrolysis probably yields $PuO_2(OH)_3^-$ with a $pK_3 = 9.7$ for the reaction

$$PuO_2(OH)_2 + 2\,H_2O \longrightarrow PuO_2(OH)_3^- + H_3O^+ \qquad (K_3)$$

A titration of a 7.1×10^{-4} M Pu(VI) solution in 1 M ClO_4^- yielded the values $pK_1 = 5.3$ and $pK_2 = 5.8$ assuming the reactions indicated above. Again good constancy of pK_3 values was observed, further substantiating that $PuO_2(OH)_3^-$ is the Pu(VI) ion at high pH. However, the number of equivalents of OH^- per mole of Pu was observed to be 2.23 between the two inflection points instead of the expected 2. The reason for this deviation is not clear.

It should be pointed out that the constants K_1 and K_2 were calculated on the assumption that the simple equations shown above represent the reactions occurring. However, in spite of the fair constancy of the values, there is reasonable doubt that the reactions are that simple.

B. Summary of Spectral Studies of Pu(VI) in Solutions of High pH

Attempts to observe carefully the spectrum of a solution of Pu(VI) at pH 7 to 8 were not successful due to two factors: 1) very rapid reduction of Pu(VI) to Pu(V), 2) precipitation of the resulting Pu(V) as a colorless compound.

[redacted]

[redacted]

These effects were found to be sufficiently rapid so that the first readings taken on the spectrophotometer could not be reproduced after the remainder of the spectrum had been examined. Furthermore, it should be pointed out that since the Pu(VI) spectrum in the region of 569 millimicrons is not well known, a reasonable doubt exists concerning possible calculations of the amount of Pu(V) present.

Two observations were in agreement with those of G. E. Moore (see C) who carried out experiments in the same pH region, 1) rapid reduction of Pu(VI) to Pu(V) occurs in solutions of high pH (ca. pH 7), 2) as the pH is increased the characteristic absorption peak for Pu(VI) in the region of 850 millimicrons is slightly shifted to higher wave-lengths. The value for the extinction coefficient at this wave-length was in poor agreement with that of G. E. Moore for solutions of pH slightly higher than 7. The significance of this discrepancy has not been emphasized since the values for the Pu concentrations were doubtful due to precipitation of the Pu(V) compound. The valence state of the Pu in the compound was established by dissolution of the precipitate in 0.01 N HCl and examination of the spectrum. The spectrum indicated that nearly all Pu was present as Pu(V) while the small amount of Pu(VI) which was present probably was due to incomplete washing of the precipitate. The precipitation of the white insoluble compound of Pu(V) at pH 7 was not observed by J. R. Dam during the course of alkaline titration of PuO_2^+.

It is possible that the high Na^+ concentrations used here decrease the solubility of the Pu(V) compound, since the titrations involved no more than 0.001 M Na^+ as compared to 1 M Na^+ used in the spectral studies.

It was observed in one case that the total Pu concentration dropped from 113 to 70 mg over a period of 7 days concurrent with the formation of the Pu(V) compound. During this time no peak at 569 millimicrons characteristic of Pu(V) could be detected. This indicates that the concentration of Pu(V) in solution and therefore also the solubility of the Pu(V) compound is very low, though equilibrium is apparently only slowly attained.

In view of the observations noted above, it seemed desirable to investigate the possibility of using a holding oxidant. NaOCl was selected and its spectrum studied at pH 7. It was found that the interference of its spectrum with that of Pu(VI) was negligible at mole ratios of NaOCl 2 and is not serious at somewhat larger ratios.

Oxidation of Pu(V) by ca. 0.01 M NaOCl was studied at room temperature and appeared to be complete within 1-2 hours. It is concluded that NaOCl will serve as a satisfactory holding oxidant for Pu(VI) in solutions of pH around 7.

The spectrum of Pu(VI) will be re-examined in the presence of NaOCL.

C. <u>Spectrophotometry of Pu(VI)</u>

This represents the second part of an investigation of the absorption spectra of the various Pu(VI) ions in perchlorate solutions in the pH region 0 to 7.

[redacted]

(The first part was an investigation of Beer's Law on the Pu(VI) absorption bands at 831, 953, and 984 millimicrons in 1 M $HClO_4$ and 1 M $NaClO_4$.) Spectral analyses of Pu(VI) at acidities less than 0.1 M hydrogen ion have been only incompletely investigated. The problem of obtaining good absorption spectra of the Pu(VI) ions at lower acidities is complicated by at least three factors: a) possible polymerization of Pu(VI), b) the effect of carbonate on the Pu(VI) spectrum, and c) the presence of Pu(V) produced through "self-reduction" of Pu(VI). All three factors are being currently investigated.

D. Hydrolytic Behavior of Thorium

An investigation has been started to check on the possibility of polymerization of thorium in analogy to the polymerization of Pu(VI). The experimental attack chosen was to check on possible changes in the absorption spectrum of thorium at higher pH, since the polymerization of Pu(IV) is most easily detected by increased absorption in the ultra-violet and since the "usual" thorium spectrum does not have any absorption bands in this region. Since this increased absorption is supposedly due to scattering by the large particles in the polymeric Pu(IV) solutions a similar increase in extinction coefficients in the ultra-violet would be expected on polymerization of thorium.

E. Spectrophotometry of Polymeric Pu(IV)

A number of spectral curves of polymeric Pu(IV) solutions were taken at various pH values (up to pH 3.5) and low plutonium concentrations.

F. Plutonium Peroxide Systems

An apparatus has been built to permit spectrophotometric analyses and pH measurements at low temperatures.

It is hoped that near 0° C. reduction of Pu(VI) by peroxide is slow enough to permit some estimation of the solubility of Pu(VI) in peroxide solutions. Furthermore, it is planned more thoroughly to study the rate of reduction of Pu(VI) by peroxide at low temperature at various pH values.

The catalytic effect of Ag^{+} on the oxidation of Pu(V) by peroxide has been investigated. However, the results were negative for a perchlorate solution containing 0.1 g Pu/l, 0.01 M $AgNO_3$ and 0.01 M H_2O_2. Furthermore, no strong catalytic decomposition of H_2O_2 was noted under these conditions.

CX3-3 - Recovery of Plutonium from Laboratory Wastes (E. DeWitt, F. Halbach, K. Kraus)

Two grams of plutonium have been recovered during this period, and this material is now being put into final form for re-use.

The recovery of U^{235} from laboratory wastes has been started; methods for recovering very low concentrations of uranium are being studied using U^{233} tracer.

[redacted]

CX3-4 - Development of Radiochemical Analytical Procedures (L. Brown, M. Koshland, D. Koshland)

Analysis for Plutonium in Urine

Since it is planned to establish a urinalysis laboratory at Clinton Laboratories, a study of various procedures has been started. IR resins are being used extensively for this purpose at Chicago. The use of a TTA solvent extraction method has been suggested by members of the Berkeley project. A thorough evaluation of possible methods was considered desirable. In the studies at Clinton Laboratories, main emphasis has been placed on procedures involving precipitation or solvent extraction because these methods have so far received less attention.

The method eventually used must fit the following limiting conditions: 1) contamination should be kept at a minimum; 2) the time and man-hours required in any technique must fit in with the proposed schedule; 3) the method used must provide a separation factor of 1,000 of plutonium from uranium if a counting method is used. If a photographic technique is substituted, the analytical method should insure a 10^5 fold separation of plutonium from uranium.

The precipitation methods which have been investigated are 1) bismuth phosphate, 2) bismuth iodate, 3) magnesium hydroxide, and 4) calcium oxalate.

In order to separate the plutonium from high concentrations of inorganic salts such as would be present after a precipitation, solvent extraction methods have been under investigation. The preliminary experiments were limited to two types of precipitates--lanthanum hydroxide and calcium oxalate. Three solvents have been studied--hexone, ether, and TTA in benzene. In precipitation methods, the necessary separation factors were not obtained; however, sufficiently large factors were obtained to be encouraging. The precipitation-solvent extraction procedures which are more cumbersome than the all-precipitation methods increase the chances of contamination and increase the effort required per analysis. Further work on improving these methods and testing them on urine is in progress.

CX5-1 - Compounds of Uranium and Plutonium Suitable for Use in Homogeneous Piles (A. Germany, J. Hunt, G. Johnson, W. Knox, J. Kroner, R. Leininger, R. Scott, L. Spector, D. Koshland)

The change in peroxide concentration as a function of time in bombarded U^{235} solutions is being studied. Samples are now being frozen immediately on cessation of bombardment and they are not thawed until just before analyses are made. The results of the first series of bombardments are shown in Table 1.

The solids in equilibrium with a $NaHCO_3$-uranium system are being investigated. The precipitates appear to be a mixture of phases containing low carbonate to uranium ratios (less than 0.2) and sodium to uranium ratios between 0.4 and 1.0.

[redacted]

TABLE 1

PEROXIDE AND GAS FORMATION AFTER TEN MINUTES BOMBARDMENT AT 20° C.

Conditions: 0.5 ml, 4 g/l U^{235}, 0.5 M Na_2CO_3, 3650 KW, 10 min., 20° C., Pd colloid protected by protalbinate.

Sample Number	Palladium Concentration mg/l	H_2O_2 N x 10^3	Gas Produced cc	Material Bal.* H_2/O_2
1	0	6.1	0.284	1.85
2	10	9.0	--	--
3	10	7.0	--	--
4	10	7.5	0.276	2.26
5	10	7.8	0.262	1.97

*Total H_2 to O_2 ratio including O_2 equivalent of H_2O_2 in solution (Should be 2)

Further work on the rate of decomposition of H_2O_2 by catalyst has been performed. The work has been concentrated mainly on evaluating the effect of variables such as agitation, surface area, and aging.

An examination of the spectra of uranium in carbonate solutions is being undertaken.

The solubility of UO_4 in sulfate systems at low pH is being investigated. The information may enable us to evaluate the feasibility of a sulfate solution for the reactor of the homogeneous unit.

Further work on the characteristics of UO_4 precipitates confirms the hypotheses mentioned previously that the composition was unaffected by the conditions of precipitation.

CX5-9 - The Recovery of Plutonium and Uranium from Chain Reacting Solutions
(E. Turk, D. Koshland)

The carrying of uranium by corrosion products expected to form in the reactor of a homogeneous pile has been studied in both sodium carbonate and sodium bicarbonate solutions. Four types of tank liners have been assumed--aluminum, beryllium, columbium, and lead. Assuming corrosion figures obtained by the Technical Division, the following conclusions are indicated.

1) The carrying of uranium by the corrosion products at the assumed corrosion rates is small in all cases (3 per cent or less even after 40 days operation). This means that a centrifugation or filtration step for the periodic removal of fission product poisons appears to be quite feasible.

2) In sodium carbonate solutions, increasing temperature appears to increase the amount of fissionable material carried by aluminum and beryllium. In the case of lead, no distinct trend was noted.

3) In sodium bicarbonate solutions, increasing temperature appears to cause a slight decrease in the carrying of uranium by both aluminum and lead.

4) Columbium, if present as columbate, should be soluble even after 40 days' operation. Beryllium was found to be soluble in bicarbonate solution.

5) Increasing the concentration of carrier material increases the amounts of uranium carried.

6) Carrying by aluminum is greater from a sodium bicarbonate solution than from a sodium carbonate solution. Carrying by lead appears to be somewhat greater in the sodium carbonate solution.

7) Carrying by lead decreases with increasing sodium carbonate concentrations.

CX9-1 - Isolation of U^{233} from Thorium and Its Compounds (J. Barrick, E. Bohlmann, D. Lincoln, C. F. Booth, G. E. Creek, O. Hill, K. Kennedy, J. McBride)

Studies in order to determine the effect of calcium nitrate concentration on extraction efficiency have continued.

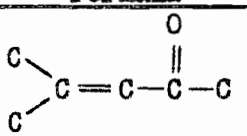
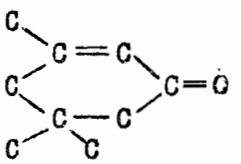
Experiments have been performed to determine the effect of pH on the uranium and thorium extraction efficiencies. The data indicate that there is little, if any, effect when dibutyl cellosolve is used as a solvent between pH 0.5 and pH 3.5. Further experiments have been carried out varying the volume of "scrub" solution to "feed" solution and pH.

Comparisons have been made of the extraction efficiencies for uranium and thorium using isophorone and mesityl oxide. These have been compared with dibutyl cellosolve and dibutyl carbitol. The results are shown in Table 2.

TABLE 2

URANIUM AND THORIUM EXTRACTION BY ISOPHORONE AND MESITYL OXIDE

Conditions: 3 N $Ca(NO_3)_2$, 2 N $Th(NO_3)_4$, natural pH, tracer U^{233} and UX_1

Solvent	Formula	Per Cent Extraction	
		Uranium	Thorium
Mesityl Oxide		79.0	7.8
Isophorone		>59 *	40
Dibutyl Cellosolve	C_4H_9-O-CH_2-CH_2-O-C_4H_9	14.4	1.2
Dibutyl Carbitol	C_4H_9-O-CH_2-CH_2-O-CH_2-CH_2-O-C_4H_9	69	3.7

*This value is probably low because of the large Th extraction.

[redacted]

Both the new solvents give extractions that are too high. Studies on solvent mixtures have continued. The results are shown in the tables below.

TABLE 3

MESITYL OXIDE-N-BUTYL ETHER MIXTURE

Conditions: 3 N $Ca(NO_3)_2$, 2 N $Th(NO_3)_4$, natural acidity, tracer U^{233} and UX_1

Volume %		Per Cent	Per Cent
M.O.	B.E.	Uranium	Thorium
0	100	0.94	0.131
25	75	13.4	0.04
50	50	45.0	0.176
75	25	81.5	1.54
100	0	79.0	7.78

TABLE 4

MESITYL OXIDE-DIBUTYL CELLOSOLVE MIXTURE

Conditions: 3 N $Ca(NO_3)_2$, 2 N $Th(NO_3)_4$, natural acidity, tracer U^{233} and UX_1

Volume %		Per Cent	Per Cent
M.O.	D.B.C.	Uranium	Thorium
0	100	14.4	1.23
25	75	40.5	0.04
50	50	67.6	0.24
75	25	80.3	1.30
100	0	79.0	7.78

TABLE 5

MESITYL OXIDE-DIBUTYL CARBITOL MIXTURE

Conditions: 3 N $Ca(NO_3)_2$, 2 N $Th(NO_3)_4$, natural acidity, tracer U^{233} and UX_1

Volume %		Per Cent	Per Cent
M.O.	D.B.C.	Uranium	Thorium
0	100	69.0	3.69
25	75	76.0	1.03
50	50	79.8	1.88
75	25	80.0	2.66
100	0	79.0	7.78

[redacted]

[redacted]

TABLE 6

MESITYL OXIDE-NITROMETHANE MIXTURE

Conditions: 3 N $Ca(NO_3)_2$, 2 N $Th(NO_3)_4$, natural acidity, tracer U^{233} and UX_1

Volume %		Per Cent Uranium*	Per Cent Thorium
M.O.	N.		
75	25	---	2.92
90	10	---	4.28
100	0	---	7.78

*The spread of the material was unsatisfactory on these plates, giving high adsorption.

Cells 2 and 4 of Bank 2 in the 706-C Building are still in the process of preparation for the assembling of extraction equipment.

A 12-inch bowl continuous centrifuge has been received and is being set up to test centrifugation separation of the MnO_2-SiO_2 precipitate from some dummy dissolver solutions.

A mock-up solvent extraction column has been set up and controls are being calibrated.

CX11-1 - Geiger Tube Development (R. Butenhoff, A. Jarrett)

Report writing and servicing were the principal functions of this group during this period.

CX11-4 - Development and Construction of Alpha-Counting Equipment (C. Borkowski, J. East, R. Dandl, O. Flatau, J. Parsons)

The forty-eight channel alpha pulse analyzer circuits and amplifier have been completed and are ready to be assembled as soon as the six-foot relay cabinets have been received.

[redacted]

[redacted]

SECTION C-II

C. D. Coryell, Section Chief
T. H. Davies, Associate Section Chief
H. A. Levy, Associate Section Chief

CX4-2 - Hot Atom Chemistry (W. Burgus, R. Edwards, H. Gest, C. Stanley, R. Williams)

The isomeric transition of 32 d Te^{129*} to 72 m Te^{129} has been studied in aqueous solutions and in gaseous TeF_6 (MonN-15). The chemical changes accompanying this decay have been found to vary with changing conditions and show an apparent maximum yield of 55%. Similar experiments with 90 d - 9.1 h Te^{127} have shown analogous chemical changes with a maximum yield of 85%. Since the chemical situations for the two isomeric transitions were identical, the 32 d Te^{129} cannot be more than 65% internally converted, in contradiction to previous estimates of yearly 100%.

Studies have been made of the distribution among several valence states of fission product iodine species produced in uranyl carbonate solution by pile bombardment. To simplify interpretation of results, tests were conducted on the uranium solutions only after the 6.7 h I^{135} had decayed. Accordingly the results are confined to 8 d I^{131}, 2.4 h I^{132}, and 22 h I^{133}. These were separated into iodate, periodate, and an iodide + iodine fraction by chemical methods which will be described elsewhere. The results are given in Table 7 to an accuracy estimated at ±5%.

TABLE 7

DISTRIBUTION OF SEVERAL IODINE ISOTOPES AMONG SEVERAL VALENCE STATES

	2.4 h I^{132}	22 h I^{133}	8 d I^{131}
$I_2 + I^- + IO^-$ Fraction	81%	49%	41%
IO_3^- Fraction	13%	42%	50%
IO_4^- Fraction	6%	9%	9%

Inspection of the ancestry of the three iodine isotopes has yielded no clue to the surprising contrast in distribution shown.

Improved methods have given the distribution of fission selenium from UNH bombarded and dissolved in water as 5% in the selenate state, 95% in the selenite. When uranyl carbonate solutions were bombarded, 9% of the activity was found as selenate, 91% as selenite.

The yield of Br^{83} as BrO_3^- from SeO_3^{--} tracer decay shows no appreciable variation with pH in neutral and alkaline solutions (30-40%). Lower values obtained in acidic solutions may be explained by the interaction between BrO_3^- and SeO_3^{--}

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[redacted]

during the decay period. At tracer concentrations in neutral solution the per cent Br^{83} daughter as BrO_3^- decreases with time at room temperature. Interactions between BrO_3^- and SeO_3^{--} have been investigated at higher concentrations in neutral solutions and found to be too slow to account for the results.

A sample of selenium metal placed in the pile in April was removed and dissolved in HNO_3, giving a Se^{75} sample of high specific activity. The radiations of Se^{75} are being investigated further with this material.

CX4-3 - Fission Product Radiochemistry (L. Glendenin, J. Marinsky)

A Clinton pile doughnut, irradiated 126 days (11/12/43 to 3/16/44) and cooled 18 months, has been dissolved and certain fission product fractions isolated. Analyses indicated about 360 mc of gross fission product activities, and the Pu content was estimated at ~10 mg. A search for Se^{79} activity (anticipated to be long-lived) was unsuccessful. The Pd fraction was also inactive but will be examined further in the low-absorption counting apparatus for the presence of Pd^{107}, which is predicted to be long-lived.

The rare earth fraction from one-half of the doughnut was put through an amberlite column separation using ammonium citrate elutriant at pH 2.65. A preliminary 5% oxalic acid wash for the purpose of removing Pu was found to remove UX completely, but not the Pu. A study of the elution curve showed the order of elution to be Y, Eu, element 61. A search is being made for the long-lived Sm^{151} activity recently reported by L. Lewis from mass spectrographic studies.

Two samples containing several micrograms of the isolated 2-3 year element 61 activity are being prepared for spectrophotographic examination by H. Pomerance, and for mass spectrographic analysis by L. Lewis (Chicago) to verify our assignment of mass 147.

Physico-chemical Problems Associated with Homogeneous Piles (L. Goldring, H. Levy, R. Money, G. Strickland, N. Ballou, J. Goldstein, R. Bersohn, B. Selikson)

Hydrolysis of Uranyl Ion

A detailed study has been made of hydrolysis data presented by Longsworth (A-380, Fig. 1 and 2) consisting of a) pH measurements of solutions of UO_3 in HCl with mole ratios UO_3:HCl ranging from 0 to 1 at total chloride concentration of 0.1, 0.5, and 1.0, and b) pH measurements of solutions of UO_2Cl_2 at various concentrations. The Longsworth equilibrium ($2\ UO_2^{++} + H_2O \quad U_2O_5^{++} + 2\ H^+$) provides a satisfactory interpretation except at high values of the ratio UO_3:HCl, where deviations of the data from the calculated values in the direction of lower pH appear. The constant for the above equilibrium was evaluated as $(1.3 \pm 0.1) \times 10^{-6}$; the greater precision reported by Longsworth (1.35×10^{-6}) is felt to be not justified. Attempts were made to interpret the deviations at high UO_3:HCl values in terms of formation of the trimeric ion $U_3O_8^{++}$; however, the resulting computation appeared too laborious in relation to the contemplated results.

[redacted]

Spectrophotometric data from solutions similar to those described above are to be collected in order to supplement Longsworth's pH information. Preparation of hydrated UO_3 for this purpose by the method of Longsworth is now under way. Studies of the composition of this solid are being made in cooperation with members of Section C-I.

Studies of the Uranyl Salicylate Complex Ion

Further interpretation has been made of spectrophotometric data obtained from 0.0015 M UO_2^{++} in solutions of various concentration of sodium salicylate at pH 4.4. The data are fairly well represented by the two equilibria:

$$UO_2^{++} + Sal^- \rightleftharpoons UO_2Sal^+, \quad K_1 \approx 2600$$

$$2\ UO_2^{++} + H_2O \rightleftharpoons U_2O_5^{++} + 2\ H^+, \quad K_2 \approx 1.35 \times 10^{-6}$$

However, significant deviations of the data from theory appear at low salicylate concentrations where the second (Longsworth) equilibrium is important; suggesting that the Longsworth equilibrium is not an adequate description of the hydrolysis of uranyl ion under the conditions of the experiment.

Another complete set of spectrophotometric measurements was made on a series of solutions of 0.0015 M UO_2^{++} in sodium salicylate for which the ionic strength was held constant at 0.1 M by addition of $NaClO_4$. The data were again fairly well represented by the above equilibria; however, the value of K_1 was decreased to approximately 2000. This behavior is in agreement with that expected from activity considerations. Deviations of data from theory again appear at low salicylate concentrations.

Solid Compounds of Uranium

In a search for a solid uranium compound to be used as starting material for solubility studies, a solid having a uranium to sodium ratio equal to that of $Na_2U_2O_7$ was prepared in the following manner. Sodium uranyl acetate was prepared by mixing equal volumes of saturated solutions of sodium nitrate, sodium acetate, and uranyl acetate. After washing with water the solid was ignited. It was found that appreciable reduction of the uranium to the dark green tetravalent state took place when the solid was ignited in air unless the material was spread thinly over a wide area. Two samples ignited in this manner for three hours at a temperature of 300° were analyzed with the following results:

TABLE 8

	Per Cent Uranium	Per Cent Sodium	Mole Ratio U/Na
A	72.6%	7.15%	0.98%
B	74.5%	6.66%	1.08%
Calculated for $Na_2U_2O_7$	75.0%	7.25%	1.00%

[redacted]

An attempt to eliminate reduction is now being made by ignition of the solid in contact with platinum gauze while a stream of oxygen passes over the surface.

Physico-Chemical Calculations

A compilation of the physical properties and physical constants relating to the systems H_2O-CO_2 and D_2O-CO_2 has been undertaken and is nearly completed. Such constants as K_1 and K_2 of H_2CO_3 and D_2CO_3 have been determined as a function of temperature, as has also been the ion product of H_2O and D_2O at various temperatures. The solubility of CO_2 in H_2O and in D_2O has been calculated over the pertinent temperature range. The dielectric constants and viscosities have been obtained as functions of temperature.

Calculations have been made of the pH of a 0.1 M $NaHCO_3$ solution at 75° and the vapor pressure of CO_2 above it.

Polarographic Studies

Solutions of 0.001 M $UO_2(ClO_4)_2$ in 0.1 N $KClO_4$ and 0.001 M UO_2Cl_2 in 0.1 N KCl have been studies polarographically under various conditions of pH. The perchlorate system gave waves which appear irreversible; consequently, work on it has been dropped in favor of the chloride system where conditions appear more favorable.

Three polarographic waves have been observed in mildly acid solutions of UO_2Cl_2. The first of these, for which $E_{\frac{1}{2}} = -0.18$ volts (vs. SCE) corresponds to a single electron reduction, appears to be reversible, and does not change position or form when the pH of the solution is varied from 1 to 3. The following reaction is tentatively assigned to this reduction.

$$UO_2^{++} + e^- \rightleftharpoons UO_2^{+}$$

The second and third waves are not resolved and are probably irreversible. The half-wave potential is roughly -0.9 volts (vs. SCE) at pH 1 and shifts to more negative values as the pH is increased. The total diffusion current corresponding to these latter waves is roughly twice that of the first; hence it appears that they correspond to a two-step reduction $U(V) \rightarrow U(IV) \rightarrow U(III)$. All of these observations are in agreement with those of Harris and Kolthoff (CC-2702; JACS 67, 1484, 1945).

[redacted]

[redacted]

SECTION C-III

G. E. Boyd, Section Chief

CX3-5 - Basic Studies on Separation Processes (B. Ketelle, L. Myers, A. Adamson, Q. Larson)

Studies on Complex Ion Formation - The Citrate Complexes of the Trivalent Rare Earths

Two additional series of ion exchange experiments have been performed--one with lanthanum and the other with yttrium. In these the exchange of tracer activity was studied as a function of the total citric acid concentration at approximately a constant pH of 2.3. The best interpretation of the data appears to be that the complexes formed are $La(H\ Cit)_{1.4}$ and $Y(H\ Cit)_{1.4}$ with dissociation constants of 4.3×10^{-8} and 4.5×10^{-9} respectively.

These data are not in agreement with the earlier experiments (MonN-15) where "chemical" concentrations of yttrium gave the complex to be Y(H Cit) with a constant of 1×10^{-6}. The discrepancy is being studied further by making a similar study of the lanthanum citrate complex using lanthanum carrier. The explanation of the difference between these more recent tracer experiments and the previous "carrier" experiment is not understood unless there is some real difference between the solution chemistry of the rare earth ions at these two concentration levels.

Inorganic Chromatographic Separation Theory

Studies of the rate of adsorption of cerous ion when present in tracer concentrations have been completed for four systems and the results are tabulated in Table 9 below:

TABLE 9

System	Valence of Ce = 3			Valence of Ce = 2		
	K_{eq}	k_1	k_2	K_{eq}	k_1	k_2
0.1 M KCl + KR	120	2.4	0.02	1200	2.4	0.002
0.2 M KCl + KR	290	2.9	0.01	1450	2.9	0.002
0.1 M HCl + HR	17	---	(0.7,0.02)	170	---	(0.07,0.002)
0.2 M HCl + HR	17	2.57	0.15	85.6	2.57	0.03

The various constants are defined as follows:

$$K_{eq} = \frac{N_{CeR}}{N^n_{HR}} \times \frac{C^n_{H^+}}{C_{Ce}}$$

[redacted]

where N = mole fraction,
C = concentration,
n = charge of Ce ion in solution, and where k_1 and k_2 are the forward and reverse rate constants for the reaction:

$$Ce^{+n} + nHR \underset{k_2}{\overset{k_1}{\rightleftharpoons}} CeR + nH^+.$$

The constants K_{eq} and k_2 were experimentally determined, and k_1 was calculated. The magnitudes given are not to be taken as final values, but as a preliminary indication of the behavior of the systems.

Conclusions are tabulated as follows:

1. The rate determining step in each of these four systems followed the laws of mass action, not of diffusion.

2. In the KCl systems it was necessary to assume a charge of <u>two</u> for the cerous ion in solution in order to get agreement between the equilibrium and rate constants.

3. In the HCl systems a charge of <u>three</u> for the cerous ion in solution was required in order to obtain a constant value of the equilibrium constant.

4. Neither the assumption of a doubly or a triply charged cerium ion in solution gave a constant value of k_2 in the 0.1 M HCl system. Two rates were observed in this system, a fast rate ($k_2 \approx 0.7$) which accounted for about half of the total adsorption, and a much slower rate ($k_2 \approx 0.02$) which accounted for the rest of the adsorption. This slower rate is identical in value to the slow rate observed in the 0.1 M KCl system.

An experiment, designed to determine the number of hydrogen ions desorbed when cerium was adsorbed has been completed. A 0.1 M solution of Ce^{+++} containing 0.05 M HCl was shaken with sufficient HR to give about 50% adsorption. Analysis of the initial and final solutions indicated that for every mole of Ce adsorbed, 3.3 moles of H^+ were desorbed. This clearly indicates that in solutions of pH 1, cerium ion does not behave as if it had a charge of two, but rather, one of three.

<u>Rate Mechanisms in Adsorption Processes</u>

The detailed rate and equilibrium study of the monovalent ions is being completed with the determination of the constants for the ammonium-sodium system. As an introduction to the study of divalent ions, the rate and equilibrium constants have been determined for the uranyl chloride plus HCl system. Uranium was present as U^{233} tracer. The rate constants are as follows: for diffusion, $D = 3.66 \times 10^{-7}$ cm^2/sec; for chemical exchange, $k_2 = 1.87$ $(moles/l)^{-2}$ sec^{-1}. This chemical rate constant is for the reaction:

$$2\,H^+ + UO_2R \rightleftharpoons UO_2^{++} + 2\,HR$$

The equilibrium constant for the exchange (uncorrected for activity coefficients) was 3.27.

[redacted]

[redacted]

Studies on Anion Exchange Adsorption

A quantitative determination of the amounts of various anionic fission products which appear in the initial uranium-free effluent from the adsorption step in the IR-1 separation was carried out with the following results.

TABLE 10

Fission Species	Per Cent of Fission Product Activity in Uranium-free Effluent
I (β)	12.0
Te(β)	22.5
Ru(β)	17.8
Mo(β)	7.6

The strong adsorption of radio-iodine when formed as a fission product is in striking contrast to the results from a similar type of experiment wherein iodine activity (24 m) was added to inactive UNH as iodide ion and where immediate and complete break-through was observed. The strong adsorption of fission tellurium as shown by Table 10 was also noted earlier, whereas Ru activity was virtually unadsorbed in contrast to the above result. The very strong adsorption of Mo is of interest and suggests that this activity may occur as cation in solution.

CX3-6 - Solvent Extraction Procedures (O. Neville)

Considerable time has been spent in evaluating the U^{233} tracer technique which has been used to determine uranium concentrations owing to a difficulty which has arisen from the fact that short-lived alpha emitters from the thorium decay chain are extracted also in good yield along with uranium when either xanthates or carbamates are used as complexing agents in solvent extraction.

At present the best complexing agents which have been found for the separation of uranium (2.78×10^{-5} molar) from thorium (1 molar) by solvent extraction methods are the following.

TABLE 11

Complexing Agent	Per Cent Uranium Extracted
Potassium isopropylxanthate	73.2%
Potassium cyclohexylxanthate	78.0%
Sodium diethyldithiocarbamate	86.0%

[redacted]

Ten different organic solvents have been studied as extracting agents for uranium using the complexing agents. In general, the best solvent for the separation has been found to be methyl n-amyl ketone, when the above reagents were used.

Considerably better uranium extraction was obtained by adding the complexing agent to the organic phase rather than to the aqueous phase before the extraction. This difference may be due either to decomposition of the reagent by the acidic solution, or to the formation of an insoluble organo-uranium complex which was adsorbed on the walls.

CX4-4 - Experimental Use of C^{14} (W. Leslie)

Work is being continued on the adaptation of a proposed scheme of synthesis of hexone to semi-micro scale. Isovaleric acid has been prepared from measured quantities of CO_2 (0.05 g mole) generated by acidification of Na_2CO_3 with 6 M HCl. The reaction of the CO_2 with the Grignard reagent was carried out in all-glass, closed system. When two equivalents of Grignard reagent were allowed to react with one of CO_2, an 88% yield of isovaleric acid was obtained. If the ratio of reagent to CO_2 was 1:1.2, the yield was only 70%. Other ratios were not investigated.

Since steam distillation followed by neutralization of the distillate offers a convenient method for the purification and isolation of isovaleric acid prepared in small quantities by the Grignard reaction, it was desirable to prepare isovalerylchloride from the Na salt of the acid. Sodium isovalerate has been reacted with an excess of thionyl chloride, and the excess thionyl chloride removed by distillation. The residual material was extracted with anhydrous ether, and yields determined on aliquots of this solution. Experiment has shown that a solution of dilute hydrochloric acid containing sulfurous acid, may be distilled (after oxidation of S(IV) by MnO_4^-) until half the volume was distilled without collecting acidic material in the distillate. On this basis, the yield of acid chloride has been determined by steam distillation (after oxidation of S(IV)) of aliquots of the ether solution of acid chloride, thionyl chloride, and possibly anhydride. Titration of the distillate should yield the quantity of isovaleric acid present. The yields obtained in three successive experiments have been 63, 73, and 86%. This latter yield was obtained employing purified thionyl chloride.

CX5-7 - The Chemistry of Gas and Peroxide Formation (A. Brosi, E. Conn)

Further work has been done on the radiochemistry of palladium. There appear to be at least two activities with half lives longer than 13 hours. In addition to 26 h Rh other activities with the chemistry of rhodium have been found. Some activity has been found in a ruthenium fraction indicating a low cross section for a Pd (n,α) Ru reaction with pile neutrons. None of these samples have been counted long enough for analysis of the decay curve.

[redacted]

SECTION C-IV

W. E. Cohn, Section Chief

CX1-9 - The Preparation of Radio Isotopes from Fission Materials (E. Tompkins, R. Garber, D. Harris, M. Hawkins, P. Schallert, G. Parker, G. Hebert, D. Ballantine, A. Ross, C. Vanneman, H. Zeil)

Development of Remotely-controlled Processes

Originally, it was thought necessary to rush the column development program for early use. However, it has become apparent that the urgency is less than anticipated making it possible to consider extensively such factors as ease and certainty of control, simplicity and other characteristics of a reliable production system. Each part is being thoroughly tested and modified before incorporation into the unit, which is being designed for operation by one man from a single control panel.

Complementary work, including the search for optimum flow rates, volumes, etc., and the design and construction of ionization chambers, continues.

A pressure vessel for the extraction of carrier-free P^{32} from sulfur has been designed and should be ready for testing this month. This should make it possible to prepare curie amounts of P^{32} from kilogram quantities of sulfur.

The Hot Laboratory

All old metal equipment in Bank 2 is at least partially dismantled and readaptation of Cells 2 and 4 is temporarily suspended. Only the glass apparatus remains intact. The decontamination of an active spill which occurred on October 2 (due to spray from the dissolving of an unsuspected amount of old metal left in the Ba-job dissolver) is nearly complete.

Both dissolvers in Bank 1 are in working order. Modifications of the second-stage ether-extractor, making it suitable for precipitations directly out of super-juice, have been made. New types of ionization chambers, making it possible to monitor column eluates for weak beta and for alpha activities, are in the design and construction stages; this is a joint effort with Borkowski's group. An 8-foot adsorption column is being designed to operate in connection with the precipitator in Cell 4; the principal use of this will be for rare-earth fractionations.

CX1-10 - The Preparation of Radio Isotopes Not Occurring in Fission (P. Tompkins, B. Finkle, J. Khym, R. Overman)

The CeO_2 precipitation method for separation of bulk Ce from carrier-free Pr^{143} was tried in order to prepare several mc of the latter for Chicago. The bulk

[redacted]

of the Ce was removed as CeO_2 and by tributyl phosphate extraction, the remainder as iodate, following which the carrier-free Pr^{143} was filtered out of alkaline solution on a filter paper.

The carrier-free $Y^{86,88}$, separated from deuteron-bombarded Sr last month, shows hitherto unreported X-rays ($\sim$15 Kev, $\sim$90 mg/cm^2 Al half-thickness) and secondary electrons ($\sim$ 38 mg/cm^2 Al half-thickness) in addition to the gamma radiation expected. These radiations were established by measurements in magnetic fields and with the elimination of back-scattering. Y^{86} is reported to be a pure (K capture) gamma-emitter of 105-day period; Y^{88} is reported as an 87-day (K capture) gamma-emitter and as a 2-hour positron emitter. Both Y^{86} and Y^{88} could be present in our material. We see no way of establishing the mass number short of mass spectrographic analysis, which requires more material than we have at hand. This uncertainty complicates the use to which we intended to put the material and the softer radiations complicate the counting procedures.

<u>Shipments 9/14 - 10/12</u> (* indicates carrier-free activity)

1 c Sr* - Clinton Laboratories
1 c P* (in 5 lbs S) - Berkeley
450 mc Y* - Chicago
3 mc Pr* - Chicago

SECTION C-V

D. N. Hume, Section Chief

<u>CX7-1</u> - <u>Analytical Service</u> (W. Byerly, P. Tomason, U. Koskela, L. Nutting, H. Hemphill, G. Sadowski, J. Hudgens, F. Bruce, J. Sattizahn, S. Rasmussen, D. Black, H. Mahlman, J. Otto, H. Pomerance, B. Collins (T-1), S. Reynolds (T-1)

The major effort of the Section has continued to be exerted on samples from the new pile development program. The number of requests for ionic analyses has continued to rise and due to the time-consuming nature of the samples, the backlog has increased to around 400. The rebuilding of rooms 33-35 is now complete and the elimination of rust, dust and fumes is equally beneficial to the results of micro-analyses and the morale of the members of the Ionic Group. The renovation of Room 31 is under way. Some effort is being directed toward working out a method of water treatment to minimize the excessive corrosion now taking place in the power plant and the steam lines. The distilled water in 706-A has been examined and found to be of very poor quality, copper and other substances being present to the extent of milligrams per liter. It is planned to provide analyses of distilled water at frequent intervals in the future.

[redacted]

During the period September 15 to October 15, requests were made for 2032 analyses. The breakdown into groups requesting service and types of analyses required is as follows:

	Heavy Isotopes	F. P.	Gross Activity	Ionic	Spectrographic
Chemistry	19	72	19	145	17
Technical	3	17	673	1015	14
Physics	--	--	--	--	2
Health	--	--	1	--	2
Other	--	--	--	31	2

CX7-2 - Research and Development of Analytical Procedures (W. Boldridge, C. Nelson, A. Stehney, J. Sattizahn, F. Bruce)

The laboratory study of the polarography of uranium and peroxide in carbonate and bicarbonate media has been continued with very favorable results. Unless unforeseen difficulties due to radiation arise, it appears that it will be feasible to determine uranium and peroxide directly in the effluent solution from the boiler. No difficulty should be encountered in determining free peroxide between 10^{-1} M and 10^{-4} M in an operating bicarbonate boiler. In a carbonate boiler it should be possible to determine free peroxide directly and complexed peroxide by difference. Plans have been outlined for experiments to measure the build-up of peroxide and the equilibrium peroxide concentration in an enriched uranium solution suspended in one of the vertical holes in the Clinton pile. This should give a direct test of the workability of the polarographic method for peroxide determination under irradiation as well as useful information about the actual levels of peroxide in an operating boiler. Because of the close tie-in with the gas evolution problem, these experiments are being planned in collaboration with members of Section C-VI.

The testing of the thiocyanate method for the determination of uranium has been completed and a report is in preparation. The work on the direct determination of carbonate in boiler solution has been completed. A memorandum on the present status of laboratory remote control analyses of boiler constituents is being issued. Reports CC-3100 on the polarographic analysis of active barium preparations, and CN-2815, the fission product analysis manual, were issued in this period. Preliminary experiments on an activation method for the determination of small amounts of thorium have begun. Attempts are being made to find a satisfactory way of isolating uranium tracer from thorium solutions for mounting and counting.

[redacted]

SECTION C-VI

N. Elliott, Section Chief
E. Shapiro, Associate Section Chief

CX1-8 - Production and Purification of Tritium (G. Jenks, J. Knight, E. Shapiro, J. Boyle, D. Richardson, T. Novey)

Tritium has been obtained by out-gassing the discarded tritium apparatus at 500° C. About 27 cc of tritium have been recovered, as estimated by ionization measurements.

The study of the diffusion of tritium from lithium fluoride is continuing.

CX4-1 - Study of the Distribution of Half-lives and Energies Among the Fission Products (R. Metcalf)

The problem has been theoretically studied assuming several possible half-life distribution functions. The results indicate that experimental half-life measurements will give a reasonable estimate of the limiting half-life.

CX11-5 - Development and Construction of Special Electronic Equipment (H. Weaver)

Work is continuing.

CX5-6 - Fission Product Gases (R. Livingston)

The removal of fission product gases from uranium solutions is being studied. Data have been collected but not yet analyzed.

CX5-7 - The Chemistry of Gas and Peroxide Formation Induced by Radiation in Water Solutions (E. Shapiro, J. Boyle, D. Richardson R. Metcalf)

Gas formation in the presence of Pd-on-charcoal catalysts has been measured at temperatures in the range 20°-80° C. The catalyst is very effective at preventing gas formation. No quantitative data have been obtained in the latest work.

Research on the polarographic method of peroxide determination is continuing in collaboration with Section C-V.

[redacted]

[redacted]

SECTION C-VII

M. Burton, Section Chief
(M. Bowman, J. Ghormley, A. Miller, R. Penneman)

CX5-20 - Effects of Heavy Particles on Water and Aqueous Solutions

Essentially the problem of gas production in a homogeneous pile is to reduce the efficiency of the reaction $H_2O \rightsquigarrow H_2 + \frac{1}{2} O_2$. The original statement of the physicists was that no gas was wanted. The present statement is that no gas production can be permitted. The solution, obvious even before the problem was raised in connection with homogeneous piles, was to resort to a catalyst which in the ideal case would actually prevent gas production or, as a less ideal solution of the problem, cause the hydrogen and oxygen to recombine instantaneously as soon as they appear in the gas phase. The types of catalysts which can be used are obviously homogeneous and heterogeneous and the latter may be suspended or in colloidal form. It is interesting to consider the sizes of the catalyst particles and their relative numbers in the solution and what limitations are set on a possible mechanism for the reaction by such sizes and numbers. The catalyst particles can vary in size from 0.25μ for colloidal particales to 25μ for the largest acceptable particles of catalysts in which palladium has been precipitated on charcoal. In the concentrations of catalysts considered, the distances between nearest particles are 10^{-3} cm in the former case and 10^{-1} cm in the latter case. Thus we see that in the extremely favorable case there are 10^9 particles of catalyst per cc as compared with $\sim 0.3 \times 10^{23}$ molecules of water and 0.02 M uranyl solution approximately 1.2×10^{19} uranyl ions per cc.

The mechanism of the decomposition of H_2O by radiation involves in a very early stage the production of H atoms and OH radicals. The H atoms combine very readily with each other to form H_2 molecules. The OH radicals do not combine readily with each other to form H_2O_2 but, on the basis of the consideration just given, they probably do not survive very long as hydroxyl radicals. Their most likely fate seems to be to collide with and oxidize a uranyl ion before they can meet either a H_2 molecule or a particle of catalyst on which the H_2 is held. There is, of course, a possibility that the oxidized uranyl ions might yield H_2O_2. Thus we see that the three reactions on which we will probably have to depend for the separation of the formation of H_2 and O_2 are: 1) a direct reaction between H_2 and O_2 on the surface of the catalyst in the solution, 2) a catalyzed reaction between H_2O_2 and H_2, 3) a catalyzed reaction between oxidized uranyl ion and H_2.

These conclusions indicate the desirability of investigations in the radiation field. The less favorable case was the first reaction. If it can be made to go rapidly enough by a choice of suitable catalyst, it is very likely that our problem will be solved. The immediate objective will be to cause reaction by the H_2O_2 at a rate of 0.06 cc per cc second. At the present time three runs with oxygen added in excess after pre-treatment of the suspended catalyst with hydrogen gives initial rates of $\sim 8 \times 10^{-3}$ cc per cc second at 30° C. It is

[redacted]

possible that operations at a high temperature may give somewhat improved results. Other studies on catalyzed reaction between hydrogen and hydrogen peroxide indicate that the rate will be about four times as great. Work has now reached a point where studies of the effect of hydrogen activation of the catalyst in solutions exposed to radiation are now desirable.

One of the serious problems may be the poisoning of the catalyst by fission products. Consequently, the possible use of homogeneous catalysts has been considered seriously. In general, it would seem desirable to reduce the concentration of such catalysts to a level of about 10^{-3} M. Thus we see again that the hydroxyl radicals will probably react with uranyl ion before they reach the catalyst. We see as possible desirable homogeneous reactions 1) the reduction of the catalyst by atomic hydrogen, and 2) the oxidation of the reduced form of the catalyst by the oxidized uranyl ion. It seems evident, consequently, that a search for suitable catalyst material for operation in the pile should be made among suitable negative ions which can be readily reduced from an oxidized to a reduced state and re-oxidized under these conditions. Such a search is now under way.

Supplementary to the work on the effect of catalysts, we have also been investigating the rate of production of gas in the pile under non-catalytic conditions. When the Clinton pile is kept constant in the range 3600 to 4000 KW and the concentration of U^{235} is increased over a wide range (in 0.3 M $NaHCO_3$) a deviation of about 10 per cent from linear at U^{235} concentration equal 3 g per liter is observed. It has not yet been established whether this is an intensity or a concentration effect. Studies at 70° C. indicate that H_2 production at the higher temperature is about 15 per cent lower than at the lower temperature. Further experimental work in under way to verify these results.

CX5-18 - Radiation Effects on Organic Solvents

An automatic distillation column is under construction. This will be used for the preparation of pure solvents for studies of the effects of radiation on solvents. Techniques to be used in the radiation runs using fission activities are being developed. If time is available, some solvents will be exposed in the Chicago generator shortly.

REPORTS ISSUED BY CHEMISTRY DIVISION FROM 9/15 TO 10/15

Report Number	P. A. No.	Author	Title
CN-2212	213-X67C	Cooper Fries	The Potassium Carbonate Dissolution Type Metathesis of Lanthanum Fluoride
CP-2186	231-X10C	Butenhoff	The Effect of Anode Wire Position on Mica Window Geiger Tube Characteristics
CN-3293	203-X63C	Rose	Scavenging from Pu(IV) Solutions
CN-2815	335-X42C	Hume Ballou Glendenin	A Manual of the Radiochemical Determination of Fission Product Activities

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DISTRIBUTION OF TECHNICAL PERSONNEL IN THE CHEMISTRY DIVISION
FOR THE PERIODS SEPTEMBER 15-OCTOBER 15, OCTOBER 15-NOVEMBER 15

P.A. No.	Title	No. of Men Past Month	No. of Men Next Month
	Section C-I		
CX3-1	Hanford Process Problems	1	2
CX3-2	Basic Chemistry of Plutonium	5½	6
CX3-3	Recovery of Plutonium from Laboratory Wastes	1	1
CX3-4	Development of Radiochemical Analytical Procedures	½	1
CX5-1	Compounds of U and Pu Suitable for Use in Homogeneous Piles	8½	8
CX5-9	Reovery of Pu and U from Chain Reacting Solutions	1	1
CX9-1	Isolation of U^{233} from Thorium and its Compounds	7½	8
CX11-1	Geiger Tube Development	2	2
CX11-4	Development and Construction of Alpha Counting Equipment	5	3
CX11-5	Development and Construction of Special Electronic Equipment	0	2
	Vacations	1	0
	Supervision	2	2
	Total Personnel Section C-I	35	36
	Section C-II		
CX4-2	Hot Atom Chemistry	5	5
CX4-3	Fission Product Radiochemistry	1½	1½
	Physico-Chemical Problems Associated with Homogeneous Piles	7½	7½
	Plutonium Project Record	2½	3
	On loan	1	1
	Supervision	1	1
	Vacations	1	1
	Total Personnel Section C-II	19½	20
	Section C-III		
CX3-5	Basic Studies on Separation Processes	4½	3½
CX3-6	Solvent Extraction Procedures	1	½
CX4-4	Experimental Use of C^{14}	1	1½
CX5-7	The Chemistry of Gas and Peroxide Formation	1	2
	Vacations	½	½
	Supervision	1	1
	Total Personnel Section C-III	9	9
	Section C-IV		
CX1-9	Preparation of Radio Isotopes from Fission Products	11	11
CX1-10	Preparation of Radio Isotopes Not Occurring in Fission	4	4
	Supervision	1	1
	Total Personnel Section C-IV	16	16

[redacted]

P.A. No.	Title	No. of Men Past Month	No. of Men Next Month
	Section C-V		
CX7-1	Analytical Service	15	16
CX7-2	Research and Development of Analytical Procedures	4	4
	Supervision	1	1
	Total Personnel Section C-V	20	21
	Section C-VI		
CX1-8	Production and Purification of Tritium	4½	4
CX5-6	Fission Product Gases	1	1
CX11-5	Development & Construction of Special Electronic Equipment	1	1
CX5-7	The Chemistry of Gas and Peroxide Formation Induced by Radiation in Water Solutions	2	2½
CX4-1	A Study of the Distribution of Half-lives and Energies Among the Fission Products	½	½
	Supervision	1	1
	Total Personnel Section C-VI	10	10
	Section C-VII		
CX5-20	Effects of Heavy Particles on Water and Aqueous Solutions	2	3½
CX5-18	Radiation Effects on Organic Solvents	1	1
	Vacations	1½	0
	Supervision	½	½
	Total Personnel Section C-VII	5	5
	Total Technical Personnel of the Division		
	Section C-I	35	36
	Section C-II	19½	20
	Section C-III	9	9
	Section C-IV	16	16
	Section C-V	20	21
	Section C-VI	10	10
	Section C-VII	5	5
	Divisional	5	5
	Total Personnel	119½	122

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