

BEST AVAILABLE COPY

RECORD

COPY

UNCLASSIFIED

(CLASSIFICATION)

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

DOCUMENT NO.

HW-70806 RD

DATE
8/28/61

COPY NO.

CIRCULATING COPY

RECEIVED 300 AREA

SEP 30 1961

RETURN TO

TECHNICAL INFORMATION FILES

TITLE

CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL
INVESTIGATIONS -- JANUARY-JUNE, 1961

AUTHOR

Edited by W. A. Haney

DISTRIBUTION

| | NAME | BUILDING | AREA |
|-----|---------------------------------|----------|-------|
| 1. | D. E. Anderson | 271-B | 200-E |
| 2. | G. E. Backman | 3746 | 300 |
| 3. | J. R. Bovington | 2719-W | 200-W |
| 4. | D. J. Brown | 222-U | 200-W |
| 5. | J. H. Brown | 1760-D | 100-D |
| 6. | R. E. Brown | 329 | 300 |
| 7. | B. F. Campbell | 2704-W | 200-W |
| 8. | V. R. Chapman/ R. E. Roberts | 2704-E | 200-E |
| 9. | J. P. Corley | 1704-F | 100-F |
| 10. | E. Doud | 271-T | 200-W |
| 11. | R. F. Foster | 3746 | 300 |
| 12. | R. G. Geier | 1760-D | 100-D |
| 13. | W. A. Haney | 325 | 300 |
| 14. | G. L. Hanson | 202-S | 200 |
| 15. | M. K. Harmon | 202-S | 200 |
| 16. | O. F. Hill | 326 | 300 |
| 17. | J. F. Honstead/ J. L. Nelson | 222-U | 200-W |
| 18. | E. R. Irish | 329 | 300 |
| 19. | P. C. Jerman/R. B. Hall | 1760-D | 100-D |
| 20. | B. F. Judson | 202-A | 200-E |
| 21. | R. L. Junkins | 328 | 300 |
| 22. | C. E. Linderorth | 325 | 300 |
| 23. | L. M. Meeker | 2704-Z | 200-W |
| 24. | W. H. Reas | 326 | 300 |
| 25. | L. C. Schwendiman | 325 | 300 |
| 26. | R. H. Silletto | 2704-W | 200-W |
| 27. | A. J. Stevens | 3746 | 300 |
| 28. | R. E. Tomlinson | 2704-W | 200-W |
| 29. | M. T. Walling | 325 | 300 |

| | NAME | BUILDING | AREA |
|-----|-------------|----------|------|
| 30. | 300 File | 3760 | 300 |
| 31. | Record Copy | 3760 | 300 |
| 32. | Extran | | |
| | 33-41. 2/12 | | |

BEST AVAILABLE COPY

ROUTE TO

PAYROLL NO.

LOCATION

FILES ROUTE

SIGNATURE AND DATE

THIS DOCUMENT IS PUBLICLY
AVAILABLE

UNCLASSIFIED

(CLASSIFICATION)

TO: Files

CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

January - June, 1961

Prepared by Members of the
Chemical Effluents Technology Operation

Edited by: W. A. Haney

August 28, 1961

Chemical Research & Development Operation
Hanford Laboratories Operation

Hanford Atomic Products Operation
Richland, Washington

Operated for the Atomic Energy Commission by the
General Electric Company under Contract No. AT(45-1) -1350

TABLE OF CONTENTS

| | <u>Page</u> |
|---|-------------|
| INTRODUCTION | 1 |
| I. Interpretation of Ground-Water Monitoring Data | 1 |
| Special Monitoring Well Samples | 1 |
| 200 East Area | 1 |
| 200 West Area | 3 |
| II. Plant Waste Disposal Practice | 5 |
| Chemical Processing Department | 5 |
| (1) Waste Tank Leak Detection | 5 |
| (2) Treatment of Condensate Wastes | 6 |
| (3) Removal of Plutonium from 234-5 Building Waste | 7 |
| (4) Waste-Mineral Reactions | 7 |
| Irradiation Processing Department | 9 |
| (1) HPR Decontamination Wastes | 9 |
| (2) Fission Product Release Experiments | 11 |
| (3) Pilot-Scale Study of Reactor Effluent Decontamination Using Aluminium Beds | 12 |
| III. Well Drilling Summary | 13 |
| IV. Appendix (Monitoring Well Gross-Beta Analyses) | 14 |

CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS

January - June, 1961

Introduction

The Chemical Effluents Technology Operation performs research to investigate the chemical and physical aspects of environmental contamination resulting from the disposal of plant effluents or from potential process incidents. This report is primarily concerned with plant assistance research in the field of waste disposal during the period January through June, 1961.

Ground-water monitoring results utilized in this report were obtained from samples collected routinely by the Environmental Studies and Evaluation Operation and analyzed by the Radiological Chemical Analysis Operation.

I. Interpretation of Ground-Water Monitoring Data (W. A. Haney)

Special Monitoring Well Samples

During this report period, large volume samples from six selected wells were obtained and given special analytical processing to further detail the radioisotopes which are included in routine "gross beta" determinations. Samples were analyzed for the predominant long-lived isotopes of interest in separations wastes. Results of these analyses, Table I, are in good agreement with recent routine sample analytical results (Appendix). Also, these results confirm previous observations which showed Ru^{106} - Rh^{106} to be the major radiocontaminants in the ground water.

200 East Area

Figure 1 is a map of the 200 Areas showing the extent of detectable ground-water contamination as indicated by analyses of routine samples collected during the period January - June, 1961.

TABLE I
RADIOISOTOPIC ANALYSES OF SPECIAL MONITORING WELL SAMPLES

(concentrations in units of $\mu\text{c/cc}$)

| <u>ISOTOPE</u> | <u>299W-11-12</u> ^{(1)*} | <u>299W-18-3</u> ⁽²⁾ | <u>Well</u> <u>299W-19-3</u> ⁽³⁾ | <u>299W-26-3</u> ⁽⁴⁾ | <u>399-1-3</u> | <u>699-26-15</u> |
|-------------------------------------|-----------------------------------|---------------------------------|--|---------------------------------|-----------------------|-----------------------|
| Total alpha | $<3.8 \times 10^{-8}$ | $<1.3 \times 10^{-8}$ | $3.6 \times 10^{-7**}$ | $<3.6 \times 10^{-9}$ | 3.8×10^{-7} | $<7.3 \times 10^{-9}$ |
| Gross beta | 8.4×10^{-7} | 6.6×10^{-8} | 5.3×10^{-7} | 7.0×10^{-7} | 4.4×10^{-7} | 4.5×10^{-8} |
| Cs ¹³⁷ | $<3.2 \times 10^{-9}$ | $<5.9 \times 10^{-9}$ | $<2.1 \times 10^{-9}$ | $<8.7 \times 10^{-9}$ | $<4.3 \times 10^{-9}$ | $<6.3 \times 10^{-9}$ |
| Total Sr | $<8.0 \times 10^{-9}$ | $<1.0 \times 10^{-8}$ | $<3.8 \times 10^{-9}$ | $<4.9 \times 10^{-9}$ | $<3.7 \times 10^{-9}$ | $<4.6 \times 10^{-9}$ |
| R.E. + Y | $<3.1 \times 10^{-8}$ | $<1.3 \times 10^{-8}$ | ----- | $<2.2 \times 10^{-8}$ | ----- | $<2.4 \times 10^{-8}$ |
| Fe ¹⁴⁷ | $<2.5 \times 10^{-8}$ | $<2.5 \times 10^{-8}$ | ----- | $<4.1 \times 10^{-8}$ | ----- | $<2.3 \times 10^{-8}$ |
| Ce ¹⁴⁴ | $<2.6 \times 10^{-8}$ | $<2.4 \times 10^{-8}$ | $<3.1 \times 10^{-8}$ | $<2.7 \times 10^{-8}$ | $<4.3 \times 10^{-8}$ | $<8.4 \times 10^{-9}$ |
| Co ⁶⁰ | $<1.4 \times 10^{-7}$ | $<1.4 \times 10^{-7}$ | $<2.1 \times 10^{-7}$ | $<1.5 \times 10^{-7}$ | $<1.4 \times 10^{-7}$ | $<1.4 \times 10^{-7}$ |
| Ru ¹⁰⁶ | 1.0×10^{-6} | $<3.5 \times 10^{-7}$ | 4.7×10^{-7} | 1.1×10^{-6} | $<3.8 \times 10^{-7}$ | $<2.6 \times 10^{-7}$ |
| Zr ⁹⁵ - Nb ⁹⁵ | $<5.0 \times 10^{-7}$ | $<2.0 \times 10^{-7}$ | ----- | ----- | ----- | $<2.2 \times 10^{-7}$ |

* These superscript numbers refer to the approximate well locations as indicated by encircled numbers on Figure 1.

** Routine uranium analytical results for this well are in agreement with this total alpha value.

HW 10-26-72

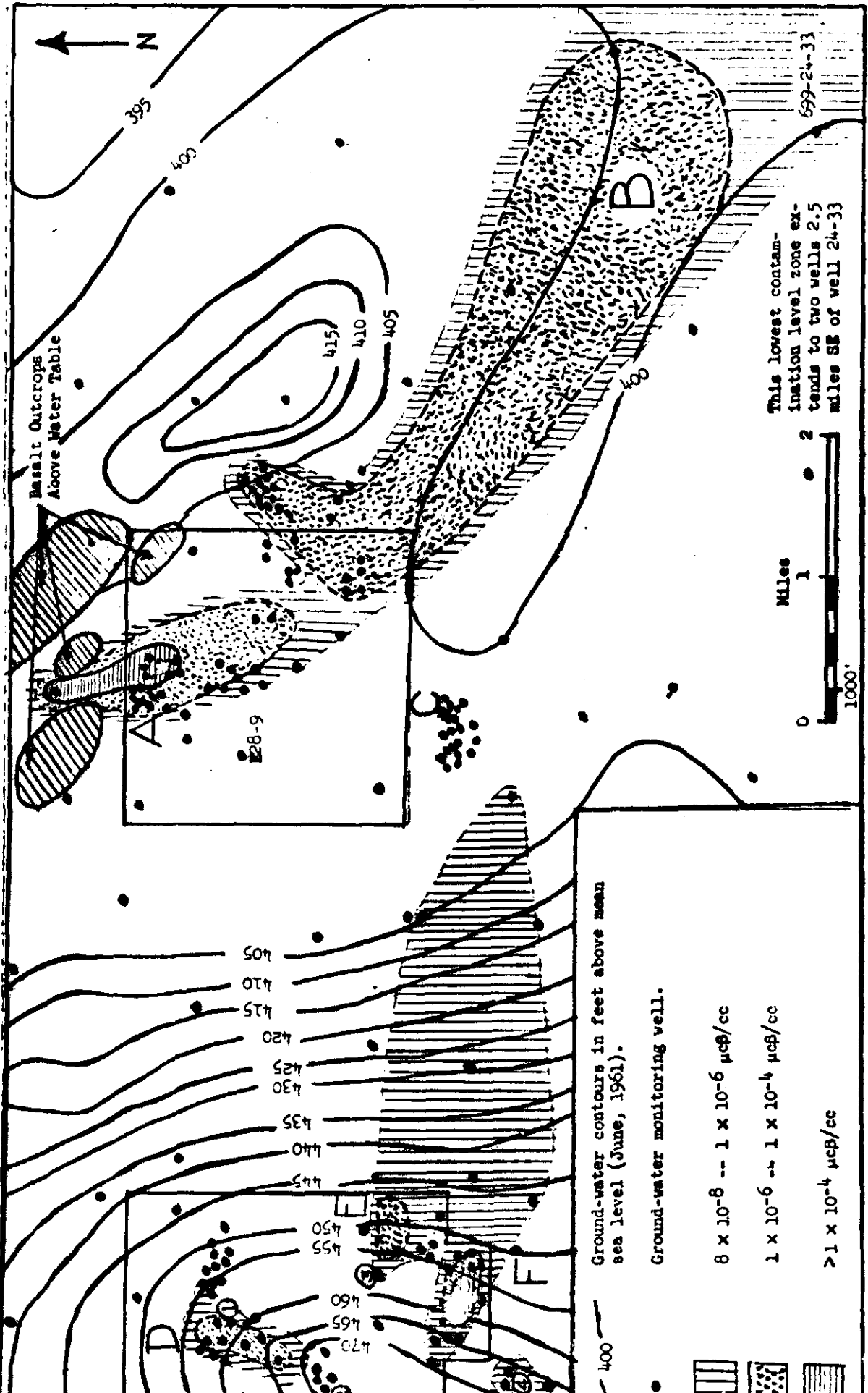


FIGURE 1 -- Map of Separations Area Showing Probable Extent Of Ground-Water Contamination, June, 1961

The most noticeable change in the areal extent of the contamination zones resulting from the discharge of waste to ground in 200 East Area occurred at Site B, Figure 1. Recent analyses showed low but positive concentrations of radiocontaminants in wells 699-26-15 and 699-20-20 which are located 2.5 miles east and southeast respectively of well 699-24-33, the southernmost well previously containing radioisotopes. Based on the date at which radionuclides were first detected in well 24-33 (mid 1958), movement over the 2.5 miles to wells 26-15 and 20-20 has occurred over an interval of about 2.5 years.

Only minor changes were noted in the contaminated ground-water zones at Sites A and C, Figure 1, during the current report period. The areal extent of the zone at Site C continues to decrease, and only two of the twenty-one wells at this location contain concentrations of beta emitters above the routine detection limit of 8×10^{-8} $\mu\text{c}/\text{cc}$.

The maximum average gross beta-emitter concentration at Site A was detected in well 299E-33-17, 5.4×10^{-4} $\mu\text{c}/\text{cc}$. The maximum Co^{60} concentration 8.2×10^{-5} $\mu\text{c}/\text{cc}$, was also detected in well 299E-33-17.

200 West Area

Three major areas of ground-water contamination in 200 West Area are shown on Figure 1 as Sites D, E, and F. Only minor changes were noted in the areal extent of contaminated ground water under 200 West Area.

Maximum gross beta-emitter concentrations for the three sites in 200 West Area for this report period, together with maximum concentration averages for the previous quarter are presented in the following table.

TABLE II
MAXIMUM AVERAGE CONCENTRATIONS OF GROSS BETA ACTIVITY
IN 200 WEST AREA WELLS

| <u>SITE</u> | <u>WELL NUMBER</u> | <u>JANUARY - JUNE, 1961</u> | <u>OCTOBER - DECEMBER, 1960</u> |
|-------------|--------------------|-------------------------------------|-------------------------------------|
| D. | 299W-15-4 | $4.0 \times 10^{-6} \mu\text{c/cc}$ | $2.9 \times 10^{-6} \mu\text{c/cc}$ |
| E. | 299W-19-2 | $2.1 \times 10^{-6} \mu\text{c/cc}$ | $2.9 \times 10^{-6} \mu\text{c/cc}$ |
| F. | 299W-22-14 | $1.8 \times 10^{-2} \mu\text{c/cc}$ | $2.3 \times 10^{-2} \mu\text{c/cc}$ |

Only one well in 200 West Area contains concentrations of long-lived fission products greater than routine detection limits. Well 299W-22-2 continues to show the presence of Sr^{90} ; the maximum concentration detected this period was $6.2 \times 10^{-7} \mu\text{c Sr}^{90}/\text{cc}$ which is a factor of three greater than the maximum concentration detected from October - December, 1960. The source of the Sr^{90} is the 216-S-1 & 2 cribs which were abandoned in 1956.

II. Plant Waste Disposal Practice

Chemical Processing Department

(1) Waste Tank Leak Detection (W. A. Haney, R. W. Nelson)

Probing of the five shallow and two deep wells near the 106-TT underground waste tank with a gamma scintillation probe produced results which correlated quite well with the soil sample analytical results. Peak readings were noted in all but the northeast well at depths between 45 and 65 feet (0-20 feet below the level of the tank bottom). Wells showing the peak readings monitor a tank segment of about 120° and are located from 10 to 20 feet from the cylindrical wall of the vessel. The highest readings were noted in wells south-east of the tank. Correlations of soil sample analyses and probe readings showed a response of about 50,000 c/m for soil containing

3×10^{-4} $\mu\text{Ci}/\text{gram}$ ($90\% \text{Ru}^{106} - \text{Rh}^{106}$); uncontaminated soil background count was 300-700 c/m.

Subsequent probings of the shallow wells with the neutron moisture probe showed the contaminated soil mass contained 10-15 volume per cent moisture with a background moisture content of from 3 to 6 per cent in the uncontaminated soil zones.

The proposed system to supplement liquid level readings for detecting leaks in fifteen active underground waste storage tanks, utilizes seven vertical wells around and three horizontal laterals under each of the vessels. The shafts will be probed routinely with radiation detection instruments to detect possible waste leaks.

(2) Treatment of Condensate Wastes (J. M. Skarpelos)

Experiments in the Micro Pilot Plant continued evaluating clinoptilolite for decontaminating Purex Tank Farm Condensate. The decontamination ability of a conventional synthetic organic ion exchange resin was also explored. Ammonium hydroxide was found in the waste at concentrations varying from 0.004M to 0.02M; its presence explains many difficulties encountered in trying to obtain the expected cesium capacities of various ion exchange materials. A steam stripper was constructed and is in operation to reduce the concentration of ammonia and other interfering substances in the MFP feed stream. A boil-off rate of about 6 per cent of the stripper feed rate resulted in decontamination factors for ammonia, butyl phosphates and hydrocarbon concentrations of 25, 150 and 7 respectively. Radiiodine is the significant isotope present in the overhead stream. The bottom stream which serves as feed to the MFP was treated further by passage through activated carbon to reduce the residual organic. Over 8,000 column volumes of this waste were passed through

a cation exchange resin (Amberlite IR-120) in the hydrogen form. Based on preliminary analytical results, strontium, cerium, zirconium and niobium radioisotopes were present in the column effluent at concentrations less than 10 per cent of their MPC_v. Cesium was present in concentrations less than 10 per cent of MPC_v for the first 5600 column volumes, and ruthenium was in concentrations less than MPC_v for 800 column volumes.

(3) Removal of Plutonium from 234-5 Building Waste (A. E. Reisenauer,
L. L. Ames)

An exchange column of Florida pebble phosphate, a commercially available natural apatite, was found to adsorb plutonium from 234-5 Building sump waste in laboratory tests (HW-70041). Approximately 90 per cent of the plutonium from 415 column volumes was adsorbed on a phosphate mineral bed through which waste was passed at a flow rate which provided a residence time of 3.25 minutes. Prompt elution of the mineral with 1M Na₂CO₃ recovered more than 90 per cent of the adsorbed plutonium in 2.8 column volumes. Elutions performed after a time lapse of three days removed only about 10 per cent of the plutonium, probably because of diffusion along radial crystal boundaries. Recharging the pebble phosphate bed with Na₂HPO₄ was necessary before reloading with plutonium. No visible deterioration of the bed occurred during three charge-recharge cycles. If prompt elution of the plutonium-loaded bed is not practical, the column may be dissolved in four column volumes of 6M HNO₃ to recover the plutonium.

(4) Waste-Mineral Reactions (J. L. Nelson, L. L. Ames, B. W. Mercer,
K. C. Knoll)

Laboratory experiments were performed to study further the elution of cesium from beds of clinoptilolite. The selective adsorption of cesium by this zeolite is known to be related to the size and charge of the cesium ion. Elution experiments were therefore performed with

ammonium and potassium ions because of their similarity to cesium. Solutions of ammonium nitrate, ammonium chloride and potassium chloride were found to be about equal in their ability to elute cesium. Various concentrations of ammonium nitrate solution from 0.5M to 10M were found to elute cesium at equal rates per mole of ammonium ion present. Clinoptilolite columns were also experimentally eluted with 2M nitric acid since this eluate would make a desirable feed for a calcination process. This resulted in very slow cesium elution compared to either ammonium nitrate or ammonium sulfate. Ammonium hydroxide was even less efficient than nitric acid. Radiostrontium is rapidly eluted from clinoptilolite by ammonium nitrate or sulfate solutions, more than 99% being removed in the first column volume.

Laboratory experiments in which neutralized Purex high-level waste was passed through columns of phenolic resin indicated a cesium adsorption capacity equivalent to about 30 bed volumes of the waste. In these studies the equivalent cesium adsorption capacity represents the bed volumes required to achieve 50 per cent breakthrough of the influent radiocesium. The same adsorber was found to have an equivalent cesium adsorption capacity of about 200 bed volumes for aluminum decladding waste. The principal chemical difference between the two wastes is the excess caustic present in the decladding solution. Therefore, a series of equilibrium experiments was performed with phenolic resin and cesium solutions containing various concentrations of caustic. The equilibrium systems all contained 6M sodium, the extra sodium added as the nitrate. The sorption of cesium increased significantly with increased OH^- concentrations in the range studied (1.2-3.0 M OH^-). The differences observed in the cesium adsorption capacity of the resin between decladding waste and Purex neutralized waste can thus be explained by differences in the hydroxyl ion concentrations.

A subsequent adsorption study was performed with a column of phenolic resin utilizing Purex high-level waste supernatant solution which was made 2.8M in OH^- . The column was operated at a slow flow rate giving a residence time of nearly two hours. Forty bed volumes of waste were passed through the column with a cesium decontamination factor of $>10^4$, and 50 per cent breakthrough was not achieved until about 150 bed volumes were treated. This high capacity for cesium may be achieved with rather simple and inexpensive treatment of the influent solution.

Laboratory studies were performed in support of an evaluation of possible hazards associated with the transport of large amounts of radiocesium in casks containing a zeolite on which this fission product is adsorbed. Columns of Decalco and clinoptilolite were loaded with Cs^{137} from a neutralized, high-level Purex waste. After washing, the rates of elution of cesium from each of the columns were measured using special "river water" containing the dissolved salts found in a typical mid-western river. Twenty column volumes of this water eluted 0.63 per cent of the Cs^{137} from the Decalco and 0.07 per cent of the adsorbed Cs^{137} from the clinoptilolite.

Irradiation Processing Department

(1) NPR Decontamination Wastes (W. N. Koop)

A remote crib site was tentatively selected for the disposal of NPR neutralized or scavenged decontamination wastes. The proposed site is north of Gable Mountain and about 4 or 5 miles southeast of 100 M Area. Water-table contours indicate that the phosphate-rich crib effluent will enter the Columbia River downstream of existing reactors. While laboratory studies showed poor removal of phosphate ion from neutralized phosphoric

acid waste, the soil uptake of ten radionuclides of concern in the waste was adequate for controlled crib disposal at this particular site.

Soil column experiments were conducted using supernatant liquid similar to that which would result from a multistep reactor cleaning operation (stainless steel portion). More than 99 per cent of the radionuclides of cesium, barium, zinc, cerium and strontium which were added to the synthetic waste were removed by the soil. The effective cesium removal was particularly encouraging since this isotope is not scavenged appreciably by the precipitate formed upon mixing the three cleaning solutions.

Laboratory studies were performed to determine the effects of mixing phosphoric acid (carbon steel decontamination) solution and multi-step (stainless steel decontamination) solution on radioisotope scavenging. The precipitate which forms upon mixing the three multi-step decontamination solutions was dissolved when unneutralized phosphoric acid cleaning solution was added in amounts approximating the expected waste generation rates, 78-93 volume per cent phosphoric acid solution. Neutralization of the mixture with NaOH reprecipitated $MnCl_2$ which scavenged 99 per cent of the cerium, 95 per cent of the strontium and 90 per cent of the zinc from the waste. The ineffective scavenging of cobalt (about 65 per cent removal) was shown to be caused by the EDTA introduced with the peroxide-carbonate solution which is the initial cleaner used in the multi-step process. Cobalt removal on the order of 95-98 per cent was obtained by the addition of iron, calcium, or stable cobalt scavenging agents at concentrations in the waste of 200, 200, and 10 ppm respectively. Some improvement in cerium, strontium and zinc removal was also realized from the addition of these supplemental scavenging agents.

(2) Fission Product Release Experiments (R. K. Hilliard, D. L. Reid,
L. F. Coleman)

Experiments investigating the effect of irradiation level on release of fission products during reactor accident conditions were completed. A maximum exposure of 1.4×10^{20} nvt (450 mwd/T) was attained. The experimental conditions were controlled so that only the irradiation level varied in any single test series. Three test series were conducted at temperatures of 1000, 1200 and 1444°C. The results showed that irradiation level has only a nominal effect on the release of most of the isotopes analyzed. In general, the per cent released increased slightly with increasing burnup. The uranium oxidation rate also increased at burnups above 10^{19} nvt, which may explain the higher release values.

A brief study was made on the hazard of shipping recovered fission product cesium and strontium. Samples of cesium adsorbed on Decalson ion-exchange material were heated for 2-hour periods in flowing air and helium atmospheres to simulate an accident where the shipping cask was involved in a fire. Less than one per cent of the cesium was released, and no release was detectable at temperatures below 1300°C. Strontium carbonate samples heated for 2-hour periods to a maximum temperature of 1500°C released less than 0.14 per cent of the strontium. In a single test conducted at room temperature in which the air velocity was increased by a factor of eight, a release of 0.7 per cent was obtained. This indicated that entrainment of the small (1-4 micron) particles was a more important mechanism for release of strontium than high temperature volatilization.

Full-size unirradiated Hanford fuel elements, both aluminum and Zircaloy-2 clad, were heated in tests simulating single element "burning" accidents. The purpose of the tests was to determine the capability of

the jackets to contain the molten uranium and thus impede gross fission product escape. The aluminum jackets alloyed rapidly with the uranium forming a continuous high melting shell which was partially effective in containing the melt. Some elements retained their original shape up to temperatures 300°C above the uranium melting point; others flowed uranium immediately after reaching the melting point. No free flow of uranium occurred with Zircaloy cladding even after an hour at 1300°C in air, though the Zircaloy was completely destroyed by oxidation and diffusion.

(3) Pilot-Scale Study of Reactor Effluent Decontamination Using Aluminum Beds
(H. G. Rieck)

Increased pressure drop across the pilot-scale aluminum shavings bed at 100-D Area required that the unit be operated at a reduced flow rate during the last four months of this report period. The pressure drop increase resulted from an algae-like material which collected in the front section of the bed. The source of this material is probably from growths in the retention basin.

The performance of the bed at a flow rate of six feet per minute was established from data collected during two full months of operation. The average removal efficiencies for radionuclides of concern are shown in Table III.

TABLE III
AVERAGE RADIOISOTOPE REMOVAL EFFICIENCIES--PILOT SCALE
ALUMINUM BED STUDIES

| <u>Isotope</u> | <u>Per Cent Removed</u> |
|-------------------|-------------------------|
| As ⁷⁶ | 53 |
| P ³² | 47 |
| Mn ⁵⁶ | 71 |
| Cu ⁶⁴ | 68 |
| Zn ⁶⁵ | 62 |
| Pb ²³⁹ | 19 |
| Cr ⁵¹ | 8 |

Investigations with experimental columns indicate that decontamination efficiencies were lower when the water treatment process utilized nitrate instead of sulfate ion. When alum feed rates were raised, lower decontamination efficiencies resulted except in the case of Zn^{65} and Mn^{56} . The tests were terminated before column equilibrium was established, therefore the results must be considered tentative until confirmatory data are available.

III. Well Drilling Summary (R. E. Brown)

| <u>Company</u> | <u>Well</u> | <u>Feet Drilled</u> | <u>Date Completed</u> | <u>Total Feet</u> | <u>To Water</u> | <u>To Basalt</u> |
|-------------------------------|-------------|-------------------------|---------------------------|-----------------------|---------------------|----------------------|
| Hatch Drilling Co. | 299W-15-96 | 70 | 1-9-61 | 70 | no | no |
| " " " | 299W-15-98 | 10 | 1-4-61 | 70 | no | no |
| " " " | 299E-16-1 | 238 | 1-12-61 | 483 | yes | yes |
| " " " | 699-67-51 | 300 | 1-30-61 | 300 | yes | no |
| " " " | 699-69-45 | 250 | 1-31-61 | 250 | yes | no |
| A. M. Janssen Drilling Co. | 299W-11-13 | 282 | ----- | --- | yes | yes |
| " " " | 299E-34-1 | 245 | 6-23-61 | 245 | yes | yes |

IV. AppendixTABLE I-A

Average Concentrations of Gross Beta-Emitters, January - June, 1961
 (Detection Limit is 8×10^{-8} $\mu\text{c/cc}$ at 95% C.L.)

| <u>Well</u> | <u>Concentration</u> ($\mu\text{c/cc}$) | <u>Well</u> | <u>Concentration</u> ($\mu\text{c/cc}$) |
|---|--|-------------|--|
| <u>200 East Area</u> (prefixed by 299) | | | |
| E28-1 | 6.6×10^{-7} | E13-1 | 6.0×10^{-8} |
| E28-2 | 2.2×10^{-6} | E13-2 | 1.0×10^{-9} |
| E28-3 | 4.0×10^{-8} | E13-3 | 5.0×10^{-8} |
| E28-4 | 1.0×10^{-7} | E13-4 | 1.1×10^{-7} |
| E28-5 | 5.1×10^{-6} | E13-5 | 5.0×10^{-8} |
| E28-6 | 4.0×10^{-7} | E13-6 | 1.1×10^{-7} |
| E27-1 | 1.2×10^{-5} | E25-2 | 1.9×10^{-5} |
| E23-1 | 2.2×10^{-7} | E24-1 | 1.3×10^{-5} |
| E28-7 | 2.4×10^{-7} | E25-3 | 2.0×10^{-5} |
| E26-1 | 3.0×10^{-8} | E25-4 | 4.0×10^{-6} |
| E33-16 | 5.8×10^{-4} | E24-4 | 1.5×10^{-7} |
| E33-15 | 1.0×10^{-3} | E24-5 | 8.0×10^{-8} |
| E33-12 | 6.3×10^{-4} | E17-1 | 2.1×10^{-5} |
| E33-17 | 5.4×10^{-4} | E24-2 | 1.1×10^{-5} |
| E33-13 | 2.1×10^{-4} | E25-1 | 5.0×10^{-6} |
| E33-14 | 1.8×10^{-4} | E33-19 | 1.4×10^{-4} |
| E33-11 | 2.2×10^{-4} | E33-20 | 1.3×10^{-4} |
| E33-9 | 2.0×10^{-4} | E13-7 | 4.0×10^{-8} |
| E33-8 | 5.1×10^{-5} | E13-8 | 1.0×10^{-8} |
| E33-1 | 2.5×10^{-4} | E13-9 | 3.0×10^{-8} |
| E33-2 | 1.9×10^{-4} | E13-10 | 2.0×10^{-8} |
| E33-3 | 4.2×10^{-4} | E13-11 | 2.0×10^{-8} |
| E33-4 | 1.8×10^{-4} | E13-12 | 3.0×10^{-8} |
| E33-7 | 1.2×10^{-5} | E13-13 | 4.0×10^{-8} |
| E33-10 | 1.0×10^{-8} | E13-14 | 7.0×10^{-8} |
| E33-6 | 9.0×10^{-6} | E24-7 | 6.1×10^{-7} |
| E33-5 | 8.0×10^{-6} | E25-5 | 2.2×10^{-6} |
| E33-18 | 9.5×10^{-5} | E25-6 | 6.6×10^{-6} |
| E24-3 | 7.0×10^{-8} | E25-9 | 1.7×10^{-6} |
| E13-16 | 3.0×10^{-8} | E19-1 | 3.0×10^{-8} |
| E25-7 | 2.5×10^{-5} | E26-5 | 6.0×10^{-6} |
| E25-8 | 2.8×10^{-5} | E13-20 | 4.0×10^{-8} |
| E13-15 | 5.0×10^{-8} | E26-4 | 3.8×10^{-6} |
| E13-17 | 3.0×10^{-8} | E25-10 | 8.6×10^{-6} |
| E13-18 | 3.0×10^{-8} | E26-2 | 6.4×10^{-6} |
| E13-19 | 3.0×10^{-8} | E26-3 | 6.0×10^{-6} |
| E33-21 | 2.0×10^{-8} | E27-3 | 4.0×10^{-8} |
| E24-8 | 2.8×10^{-5} | E17-2 | 9.6×10^{-6} |
| E28-8 | 3.0×10^{-8} | E17-3 | 8.7×10^{-5} |
| E28-9 | 5.0×10^{-8} | E25-11 | 4.2×10^{-5} |
| | | E25-12 | 5.0×10^{-8} |

(Table I-A Cont.)

| <u>Well</u> | <u>Concentration</u> ($\mu\text{c/cc}$) | <u>Well</u> | <u>Concentration</u> ($\mu\text{c/cc}$) |
|---|--|-------------|--|
| <u>200 East Area</u> (prefixed by 299) | | | |
| E32-1 | 4.0×10^{-8} | E25-13 | 5.0×10^{-8} |
| | | E16-1 | 5.0×10^{-8} |
| <u>200 West Area</u> (prefixed by 299) | | | |
| W11-1 | 1.4×10^{-7} | W22-10 | 1.7×10^{-5} |
| W11-2 | 7.0×10^{-8} | W22-11 | 4.0×10^{-8} |
| W11-3 | 4.0×10^{-8} | W22-15 | - |
| W11-4 | 6.0×10^{-8} | W22-16 | 4.2×10^{-6} |
| W11-5 | 5.0×10^{-8} | W23-2 | 6.0×10^{-8} |
| W11-6 | 5.0×10^{-8} | W23-3 | 2.6×10^{-7} |
| W11-7 | 1.3×10^{-7} | W22-12 | 2.1×10^{-2} |
| W11-8 | 5.0×10^{-8} | W22-13 | 3.3×10^{-3} |
| W11-9 | 6.0×10^{-8} | W22-14 | 1.8×10^{-2} |
| W11-10 | 5.0×10^{-8} | W26-3 | 1.4×10^{-6} |
| W12-1 | 5.0×10^{-8} | W22-17 | 3.4×10^{-6} |
| W10-3 | 2.5×10^{-6} | W22-1 | 1.6×10^{-7} |
| W10-4 | 2.8×10^{-6} | W22-2 | 1.6×10^{-6} |
| W11-11 | 7.0×10^{-7} | W15-5 | 3.0×10^{-8} |
| W11-12 | 1.2×10^{-6} | W19-1 | 4.0×10^{-8} |
| W14-1 | 1.8×10^{-7} | W22-19 | 2.0×10^{-5} |
| W10-5 | 3.0×10^{-8} | W23-4 | 1.7×10^{-6} |
| W15-2 | 1.0×10^{-8} | W22-20 | 1.3×10^{-5} |
| W10-1 | 3.0×10^{-8} | W 6-1 | 5.0×10^{-8} |
| W10-2 | - | W19-2 | 2.1×10^{-6} |
| W15-3 | 2.6×10^{-6} | W19-3 | 4.1×10^{-7} |
| W14-2 | 2.0×10^{-7} | W21-1 | 5.0×10^{-7} |
| W15-4 | 4.0×10^{-6} | W22-21 | 6.0×10^{-7} |
| W15-1 | 3.5×10^{-6} | W18-2 | - |
| W23-1 | 1.3×10^{-7} | W18-5 | 4.0×10^{-8} |
| W22-4 | 8.0×10^{-8} | W15-6 | 4.0×10^{-8} |
| W22-18 | 2.3×10^{-4} | W18-1 | 3.0×10^{-8} |
| W22-5 | 8.0×10^{-5} | W18-3 | 5.0×10^{-8} |
| W22-6 | - | W18-4 | - |
| W22-7 | 1.1×10^{-6} | W19-4 | 2.0×10^{-8} |
| W22-8 | 5.0×10^{-7} | W22-22 | 3.0×10^{-8} |
| W22-9 | 4.5×10^{-6} | W22-23 | - |
| | | W22-24 | 3.0×10^{-8} |
| <u>300 Area Wells*</u> | | | |
| 399-3-2 | - | 399-1-3 | 3.5×10^{-7} |
| 399-3-3 | - | 399-1-4 | 2.5×10^{-7} |
| 399-3-1 | 2.5×10^{-7} | 399-8-2 | 6.0×10^{-8} |
| 399-2-1 | 3.1×10^{-7} | 399-6-1 | 5.0×10^{-8} |

* Activity in these wells is in agreement with uranium analyses

(Table I-A Cont.)

| <u>Well</u> | <u>Concentration</u> ($\mu\text{c/cc}$) | <u>Well</u> | <u>Concentration</u> ($\mu\text{c/cc}$) |
|--|--|-------------|--|
| <u>300 Area Wells*</u> | | | |
| 399-1-1 | 2.3×10^{-7} | 399-4-1 | 1.3×10^{-7} |
| 399-1-2 | 2.8×10^{-7} | 399-5-1 | 1.8×10^{-7} |
| 399-8-1 | 7.0×10^{-8} | 399-8-3 | 5.0×10^{-8} |
| <u>600 Area Wells</u> (Prefixed by 699) | | | |
| 827-E14 | 5.0×10^{-8} | 8 8-19 | 2.0×10^{-8} |
| 34-51 | 5.0×10^{-8} | 17- 5 | 2.0×10^{-8} |
| 25-55 | 3.0×10^{-8} | 2- 3 | 4.0×10^{-8} |
| 24-33 | 1.1×10^{-6} | 812- 3 | 2.0×10^{-8} |
| 19-43 | 3.0×10^{-8} | 831- 1 | 7.0×10^{-8} |
| 20-20 | 1.0×10^{-7} | 8-17 | 4.0×10^{-8} |
| 35-9 | 1.0×10^{-8} | 8 7-34 | 1.2×10^{-7} |
| 8-32 | 3.0×10^{-8} | 10-54 | 3.0×10^{-8} |
| 40-24 | 3.0×10^{-8} | 12-64 | 4.0×10^{-8} |
| 40-33 | 7.0×10^{-8} | 50-53 | 4.6×10^{-4} |
| 54-42 | 6.0×10^{-8} | 61-66 | 2.0×10^{-8} |
| 47-60 | 3.0×10^{-8} | 51-18 | 7.0×10^{-8} |
| 60-60 | 2.0×10^{-8} | 65-50 | 1.0×10^{-8} |
| 63-90 | 5.0×10^{-8} | 47-35 | 1.0×10^{-8} |
| 59-80B | 2.1×10^{-7} | 45-20 | 3.0×10^{-8} |
| 43-89 | 5.0×10^{-8} | 38-43 | 3.0×10^{-8} |
| 34-88 | 2.0×10^{-8} | 28-41 | 3.0×10^{-8} |
| 25-80 | - | 55-50C | 5.0×10^{-8} |
| 35-70 | 5.6×10^{-7} | 49-57 | 4.0×10^{-8} |
| 55-70 | 3.0×10^{-8} | 42-42 | 3.0×10^{-8} |
| 49-79 | 2.0×10^{-8} | 48-71 | 4.0×10^{-8} |
| 39-79 | 8.0×10^{-8} | 51-63 | 3.0×10^{-8} |
| 35-78 | 6.0×10^{-8} | 71-30 | 4.0×10^{-8} |
| 32-77 | 2.0×10^{-7} | 32-72 | 4.0×10^{-8} |
| 36-61A | 1.2×10^{-7} | 32-70 | 3.8×10^{-7} |
| 34-39A | 8.9×10^{-6} | 38-70 | 3.5×10^{-7} |
| 45-69 | 5.0×10^{-8} | 35-66 | 5.0×10^{-8} |
| 45-42 | 5.0×10^{-8} | 31-65 | 4.0×10^{-8} |
| 50-30 | 2.0×10^{-8} | 51-75 | 2.0×10^{-8} |
| 25-70 | 4.0×10^{-8} | 50-84 | 1.0×10^{-8} |
| 55-89 | 1.0×10^{-8} | 11-45 | - |
| 71-52 | 3.0×10^{-8} | 63-25 | 6.0×10^{-8} |
| 70-68 | - | 77-36 | 1.0×10^{-8} |
| 41-62 | 3.0×10^{-8} | 62-43 | 2.0×10^{-8} |
| 50-42 | 1.0×10^{-8} | 8 6-E4B | 4.0×10^{-8} |
| 14-27 | 4.0×10^{-8} | 8 6-E4D | 2.0×10^{-8} |
| 72-88 | 7.0×10^{-8} | 8 6-E4E | 4.0×10^{-8} |
| 65-72 | 2.0×10^{-8} | 8 6-E4F | 2.0×10^{-8} |
| 54-57 | 5.0×10^{-8} | 8 6-E4G | 6.0×10^{-8} |
| | | 78-62 | 4.0×10^{-8} |

* Activity in these wells is in agreement with uranium analyses.

(Table I-A Cont.)

| <u>Well</u> | <u>Concentration</u> ($\mu\text{c/cc}$) | <u>Well</u> | <u>Concentration</u> ($\mu\text{c/cc}$) |
|--|--|-------------|--|
| <u>600 Area Wells</u> (prefixed by 699) | | | |
| 31-30 | 4.9×10^{-6} | 77-54 | - |
| 49-48 | - | 1-18 | 3.0×10^{-8} |
| 42-12 | - | 83-47 | 1.0×10^{-8} |
| 26-15 | 1.0×10^{-7} | 74-44 | 2.0×10^{-8} |
| 9E- 2 | 3.0×10^{-8} | 55-76 | 1.0×10^{-8} |
| 31-53B | 3.0×10^{-8} | 55-95 | 6.0×10^{-8} |
| 28-52 | 3.0×10^{-8} | 815-20 | 4.0×10^{-8} |
| 19-88 | 5.0×10^{-8} | 38-65 | 3.0×10^{-8} |
| 33-56 | 1.3×10^{-7} | 44-64 | 3.0×10^{-8} |
| 24-46 | 3.0×10^{-8} | 36-61B | 5.0×10^{-8} |
| 2-33 | 2.0×10^{-8} | 32-62 | 2.0×10^{-8} |
| 14-40 | 1.0×10^{-8} | 811-E12 | - |
| 19-58 | 3.0×10^{-8} | 8 3-E12 | 1.0×10^{-8} |
| 20-82 | 2.0×10^{-8} | 37-82A | 1.4×10^{-7} |
| 17-47 | 4.0×10^{-8} | 37-82B | 5.0×10^{-8} |
| 17-70 | 2.0×10^{-8} | 66-98 | 3.0×10^{-8} |
| 65-59 | 3.0×10^{-8} | 26- 8 | 2.0×10^{-8} |
| | | 57-83 | 1.6×10^{-7} |
| | | 22-38 | 4.0×10^{-8} |
| | | 15-15 | 3.0×10^{-8} |
| | | 69-45 | 6.0×10^{-8} |
| | | 67-51 | 8.0×10^{-8} |