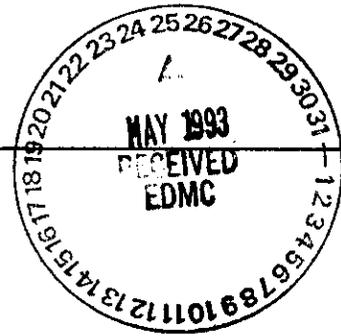


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7. Abstract

Wastewater streams from the 242-A Evaporator and the PUREX Plant must be treated to remove radionuclides and hazardous waste components prior to discharge to the environment. A proposed treatment facility for removal of these wastewater components includes an ion exchange/adsorption operation that will perform the final polishing step. Laboratory testing of adsorbents will be performed by the Plutonium Process Support Laboratory to select specific adsorbents for the ion exchange/adsorption system. The selection will be based on (1) the ability of the adsorbent to remove specific radionuclides and dissolved solids from the waste, (2) ease of regeneration of the adsorbent, (3) physical properties of the adsorbent, and (4) the loading capacity of the adsorbent for radionuclides and dissolved solids.

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TEST PLAN FOR SELECTING ION EXCHANGE/ADSORPTION MEDIA
FOR USE IN THE C-018H EFFLUENT TREATMENT FACILITY

G. S. Barney

1.0 INTRODUCTION

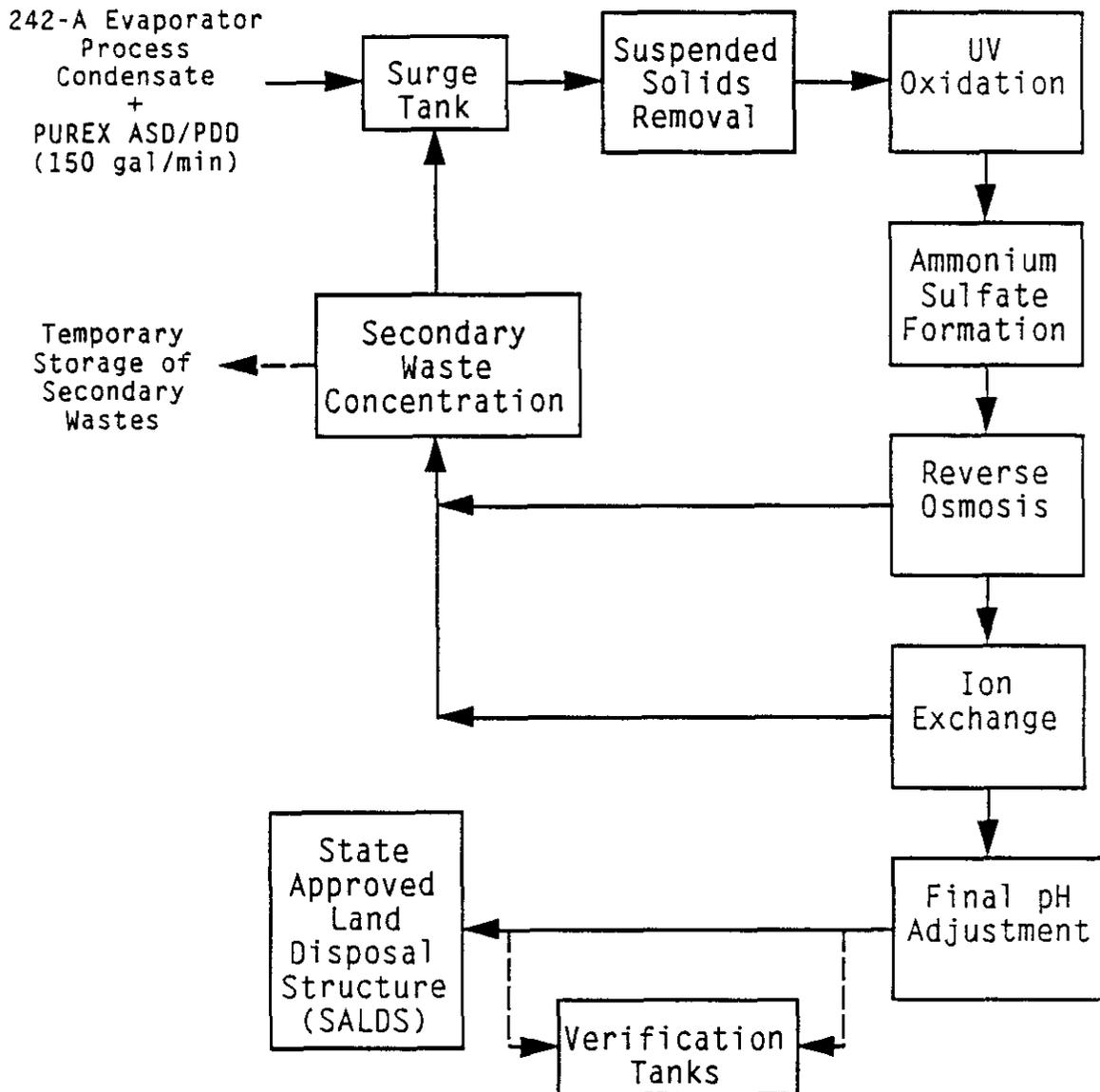
Past operation of chemical processing facilities at Hanford allowed discharge of large quantities of water containing low levels of radionuclides to shallow sediments below the ground surface. The favorable adsorption and filtration characteristics of these sandy sediments permitted most of the radionuclides to be retained in a sediment column above the water table. The U.S. Department of Energy has now implemented a policy that requires wastewater treatment and minimization of radioactive and hazardous waste discharge. Several projects have been initiated to provide facilities for treatment of major wastewater streams to remove radioactive and hazardous components from the wastewater.

Project C-018H will provide the facilities to treat and dispose of the 242-A Evaporator process condensate (PC), the Plutonium-Uranium Extraction (PUREX) Plant process condensate (PDD), and the PUREX Plant ammonia scrubber distillate (ASD). The functional design criteria for this project are presented in WHC-SD-C018-FDC-001 REV 1, "Functional Design Criteria for the 242-A Evaporator and PUREX Condensate Treatment Facility," (Flyckt, 1990).

The three waste streams are low-level wastes, as defined in DOE Order 5820.2A (DOE 1988). According to characterization data given in Flyckt, 1990, tritium is, by far, the most abundant radionuclide in each wastewater. In addition, small amounts of radioactive isotopes of plutonium, americium, uranium, cesium, strontium, ruthenium, iodine, promethium, europium, and tin have been measured in the wastewaters. Besides the radionuclides, inorganic components such as ammonia, potassium, silica, sulfate, carbonate, chloride, and nitrate have been observed in the wastewaters. Small amounts of organic compounds such as butyl alcohol, acetone, dodecane, tetradecane, tridecane, and tributyl phosphate are also present.

The overall proposed treatment system for the three waste streams consists of a single treatment train for the combined PUREX PDD/ASD and 242-A Evaporator process condensate streams (Figure 1). The maximum flow rate expected for the process is 150 gal/min (75 gal/min each for the 242-A Evaporator process condensate and PUREX PDD/ASD). The initial wastewater feed for the treatment system will be stored in the Liquid Effluent Retention Facility (Project W-105) and then will be transferred to staging tanks. Once this wastewater has been processed, wastewater will be fed directly to the treatment system from the 242-A Evaporator and PUREX. Suspended solids will be removed by filtration. The preferred organic removal step is an ultraviolet (UV) light mediated oxidation process (UV oxidation). The system will utilize hydrogen peroxide and/or ozone as the oxidant to promote the destruction of the organic impurities. Dissolved ammonia in the wastes will be converted to ammonium sulfate by adding sulfuric acid in-line to

Figure 1 - Proposed Treatment System (Project C-018)



achieve a pH of 4 to 6. Most of the dissolved solids will then be removed using a reverse osmosis (RO) unit. The reject from the RO unit will be concentrated to the maximum extent possible (preferably using a mechanical vapor recompression evaporator). The dissolved solids polishing step will consist of an ion exchange/adsorption system designed to assure that the treatment goals will be met for removal of radionuclides and dissolved solids. The ion exchange/adsorption system is the subject of this test plan. The final step in the treatment train is in-line adjustment of the pH to the 6 to 8 range. The treated effluent will then be routed to verification tanks for sampling prior to discharge. The tanks will be capable of holding treated effluent for 72 hours while analytical tests are performed for verification.

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The design of the ion exchange/adsorption system will incorporate a variety of adsorbents. Ion exchange/adsorption media will be selected based on (1) their ability to remove specific radionuclides and dissolved solids from the wastewaters (2) ease of regeneration of the media, (3) physical properties (strength, particle size, porosity, etc.), and (4) capacity for adsorption of radionuclides and dissolved solids. Potential media include strong acid/base ion exchange resins, weak acid/base resins, chelating resins, zeolites, ion-specific adsorbents, and activated carbon. All of the materials tested must be commercially available.

2.0 OBJECTIVE

The primary objective of these tests is to select adsorbents for the ion exchange/adsorption system that is part of the Project C-018H wastewater treatment facility. The requirements for this dissolved solids polishing system must be based on expected performance of the RO unit and on the treatment objectives. Several adsorbents may be required to remove specific radionuclides and dissolved solids. The adsorbents must be applied in a logical sequence to achieve optimum performance of the ion exchange/adsorption system. This sequence will be determined from laboratory adsorption parameters to be determined in these tests.

The tests will yield several types of adsorption parameters. Distribution coefficients (K_d 's) for radionuclides will be determined under a range of conditions (pH, wastewater composition, radionuclide concentration, and adsorbent type) expected in the ion exchange/adsorption system. These batch equilibrium tests will be used for screening potential adsorbents. Column testing will provide elution data that will be used to predict adsorption rates for dissolved solids, capacities, and regeneration efficiencies.

3.0 SCOPE

All tests will be performed on a laboratory bench-scale. Both batch equilibration tests and flow-through column tests will be performed. The batch tests will use several grams of adsorbent and less than 20 mls of wastewater solution. Several hundred of these batch tests will be completed to cover the required range of conditions of pH, wastewater composition, radionuclide concentration, and adsorbent type. Laboratory columns of adsorbents will range in bed volume from a few mls to about 30 mls. Several columns per laboratory adsorbent will be prepared. Volumes of wastewater to be pumped through these columns will be up to about one liter.

Only tracer levels of radionuclides will be used in the tests. The isotopes of radionuclides to be used as tracers in the wastewaters will be selected for their ability to be analyzed by liquid scintillation analysis.

A synthetic wastewater formulation will be used in all testing. This solution will be prepared from reagent grade chemicals and will have a composition near that expected for the feed to the ion exchange/adsorption system. This composition will be based on results of analyses of the actual wastewater streams.

Interfaces with the RO testing will be important since RO effluent will be the feed for the ion exchange/adsorption system. Exchange of information with laboratories performing the RO testing will be continued during these studies. Another important interface is with the Effluent Technology Unit which sets process goals for removal of various components of the wastewater.

4.0 DESCRIPTION OF TEST

4.1 Test Item

Adsorbents to be tested are chosen for their known effectiveness in removing specific radionuclides from wastewaters having a pH range of 4 to 7. It is expected that non-radioactive components of the waste streams will compete with radionuclides for adsorption sites on the adsorbents. They also will be present (in most cases) in much higher concentrations than the radionuclides. The use of selective adsorbents will greatly increase the capacity of the adsorbent and will thus reduce the volume of secondary waste. The adsorbents should be selective as possible for the individual radionuclides. Commercially available adsorbents for these radionuclides will be tested. The adsorbents to be tested and their probable applications are given in Table 1.

A mixture of strong acid cation exchanger and strong base anion exchanger (Amberlite IRN-150) will be tested initially to determine its effectiveness in removing major inorganic ions (mainly ammonium sulfate) and ionic radionuclides from the wastewaters. Prior work on removal of plutonium from Plutonium Finishing Plant wastewater (Barney, et al., 1989) and removal of ruthenium from aqueous radioactive wastes (Sato and Motoki, 1989), has shown that some species of radionuclides in near-neutral pH water are not extracted at all by ion exchangers. For this reason, several other adsorbents are proposed for testing in this study. Bone char has been shown to be much more effective in removing plutonium from PFP wastewaters than ion exchange resins (Barney, et al., 1989). Bone char might also be expected to remove americium and uranium by mechanisms similar to plutonium removal. Ruthenium is likely to exist as several species (cationic, neutral, and anionic) in the wastewater and may require conversion to cationic species by reduction with zinc-charcoal mixtures before adsorption on a cation resin will be effective (Sato and Motoki, 1989).

Americium and uranium may also be present in the wastewaters as non-ionic or neutral species that will not be adsorbed by ion exchange resins. At the pH range (4 to 7) expected in wastewaters after RO treatment, both U(VI) and Am(III) can exist as neutral hydroxyl or carbonate complexes (Allard, 1982). Adsorbents such as bone char or chelating resins may be required to remove these species.

TABLE 1
 ADSORBENTS TO BE TESTED FOR REMOVAL OF RADIONUCLIDES
 FROM WASTEWATERS

Adsorbent	Type	Manufacturer	Applicable Radionuclides
Bone Char	Activated carbon/ calcium phosphate adsorbent	Rhone-Poulenc Basic Chemicals Co.	Pu, Am, U
Duolite C-467	Selective calcium adsorbent with phosphonate sites	Rhom and Hass	Sr, Pu, Am
Duracil 10	Glass-based inorganic cation exchanger (Cs specific)	Duratek Corporation	Cs, Sr
Purolite NRW-37	A mixture of strongly acid cation and strongly basic anion exchangers 1:1 eq. (general purpose resin)	Purolite	Sr, Cs, Pu, Am,
Linde Ionsiv A-51	Synthetic zeolite cation exchanger	UOP	Cs, Sr
Linde Ionsive IE-95	Synthetic chabazite cation exchanger	UOP	Cs, Sr
Zinc-Charcoal mixture	Reductant/adsorbent for ruthenium removal	--	Ru

In addition to ion exchangers and other adsorbents, radionuclide-specific adsorbents will be tested. These have the advantage that they remove only those specific components that must be removed to meet process goals, rather than removing all components. This should allow use of smaller columns and result in less secondary waste from regeneration of adsorbents. These adsorbents include zeolites (Linde A-51, and Ionsive IE-95) and the selective adsorbents, Duracil 10, Duolite C-467, and Amberlite IRA-99.

The compositions of effluents to be treated are described in the functional design criteria document (WHC-SD-C018-FDC-001 REV 1). Concentrations of inorganic, organic, and radioactive components are given in this document for the PUREX Plant PDD and ASD streams and for the 242-A Evaporator process condensate. The concentrations of major inorganic components that must be used in preparing synthetic wastewaters for these tests are given in Table 2. Organic components are assumed to be destroyed in the UV oxidation step and will not be considered further. Radionuclide concentrations in the wastewaters are given in Table 3. These concentrations are compared with administrative control limits for discharges to the 200 Area liquid waste disposal facilities given in WHC-CM-7-5 (Environmental Compliance). This comparison shows that the radionuclides which must be removed in order to discharge the wastewater are (in approximate decreasing order of importance): $^{239,240}\text{Pu}$, ^{241}Am , ^{106}Ru , ^{137}Cs , ^{90}Sr , U (gross), and

TABLE 2

AVERAGE CONCENTRATIONS (PPB) OF NON-RADIOACTIVE
INORGANIC COMPONENTS IN THE WASTEWATERS^a

Chemical Components	PUREX PDD	PUREX ASD	242-A Evaporator PC	Treatment Target Values ^b
Ammonia + Ammonium	53	366,000	483,000	1,370
Potassium	508	--	5,950	--
Calcium	50	68	2,600	--
Magnesium	--	21	122	--
Sodium	12,900	279	3,600	--
Aluminum	--	--	1,295	50
Chromium	--	10.6	52	11
Sulfate	--	--	2,600	250,000
Carbonate	--	--	98,000	--
Nitrate	55,600	550	2,790	10,000 as N
Chloride	--	1,700	1,000	250,000
Sulfide	--	--	35,400	14,000

^aPUREX PDD and ASD data were taken from WHC-EP-0342, Addenda 12 and 14. The 242-A Evaporator PC data were compiled by A. P. Larrick (Internal Memo, 13331-89-491, to D. L. Flyckt).

^bTarget treatment values are from Flyckt, 1990.

129I. Tritium, of course, cannot be removed by any practical technology and will not be considered further.

The process flow diagram shows that the PUREX PDD and ASD streams are to be combined with the 242-A Evaporator process condensate before treatment. The combined waste streams will be acidified to a pH of 4 to 6 before the reverse osmosis separation. The acidification will be performed by adding sulfuric acid, thus yielding additional sulfate to the waste stream. The RO step will remove approximately 90 to 95% of the dissolved salts. Assuming (1) that RO removes 90% of all dissolved salts, (2) the amount of H₂SO₄ added is just enough to neutralize all the ammonia present, and (3) the average flow rates for the PUREX PDD, ASD and 242-A Evaporator process condensate streams are, respectively, 40, 35, and 75 gal/min, the composition of the combined waste stream to be processed by ion exchange is given in Table 4. A synthetic wastewater made to approximate this composition will be prepared for use in all the ion exchange experiments. Radioactive tracers will be added to the solution to measure the effectiveness of their removal by various adsorbents. Tracers such as ²³⁸Pu, ²⁴¹Am, ⁹⁰Sr, ¹³⁷Cs, and ¹⁰⁶Ru will be used in the tests.

TABLE 3

AVERAGE RADIONUCLIDE CONCENTRATIONS (pCi/L) IN THE WASTEWATERS^a

Radionuclide	PUREX PDD	PUREX ASD	242-A Evaporator PC	Treatment Target Values ^b
³ H	60,000,000	3,100,000	5,600,000	20,000
⁹⁰ Sr	500	9,500	5,200	8
¹⁰⁶ Ru	34,000	240,000	10,500	30
¹²⁹ I	560	53	--	1
¹³⁷ Cs	45,000	8,000	4,400	200
¹⁵⁵ Eu	--	--	1,400	4,000
¹⁴⁷ Pm	3,200	28,000	1,300	4,000
²³⁸ Pu	1,200	--	--	1.6
^{239,240} Pu	12,000	500	0.00037	1.2
²⁴¹ Pu	120,000	3,300	--	80
²⁴¹ Am	6,500	750	--	1.2
U (gross)	51	39	20	40

^aPUREX PDD and ASD data were taken from WHC-EP-0342, Addenda 12 and 14. The 242-A Evaporator PC data were compiled by A. P. Larrick (Internal Memo, 13331-89-491, to D. L. Flyckt).

^bTreatment target values are 1/25 of DCG (Derived Concentration Guides) in WHC-CM-7, Appendix A, Rev. 1, or from the FDC (Flyckt, 1990).

4.2 Test environment

The testing will be performed in radiochemical laboratories equipped with open-faced hoods for handling the solutions spiked with radioactive tracers. Non-radioactive solutions will be prepared in the cold lab (Room 191 of 234-5 Building) and portions of these solutions will be spiked with radioactive tracers in the hoods. The adsorption experiments with the spiked solutions will also be performed in these hoods. Samples generated from the testing will be sealed and counted using a liquid scintillation analyzer in Room 183.

Most of the work will be performed in the PPSL Laboratory. Solution preparation, spiking, adsorption experiments, and counting of the solutions containing alpha emitters (²³⁸Pu, ²⁴¹Am, and ²³⁴U) will be performed in Rooms 191, 187, and 183 of the PPSL Laboratory. Work with beta-gamma emitters will be done in either Room 180 of the PPSL (which has been previously approved for beta-gamma work) or in PCL hoods of the 222-S Laboratory.

TABLE 4

COMPOSITION OF THE WASTEWATER STREAM TO BE PROCESSED
BY ION EXCHANGE (CONCENTRATIONS IN PPB, pH = 4-7)

Chemical Component	242-A Evaporator PC + PUREX PDD +ASD Wastewater Mixture
Ammonium	32,692
Potassium	311
Calcium	133
Magnesium	6.6
Sodium	531
Aluminum	65
Chromium	3.1
Sulfate	87,275
Carbonate	--
Nitrate	1640
Chloride	447

4.3 Equipment and Facilities

At least two open-faced hoods in the PPSL must be available for preparing spiked solutions and performing the adsorption experiments. One hood approved for handling beta-gamma tracers must also be available. Space in the cold labs and in the counting room will also be used. Appropriate alpha and beta-gamma survey equipment must be available for contamination control. Applicable Radiation Work Permits for the laboratory rooms used in this work must be approved and followed.

Equipment required for these tests includes apparatus for batch equilibration, column tests and radioactive tracer analysis. The batch measurements will be performed using 20 ml polypropylene bottles with screw caps to contain the adsorbent-solution mixtures. These bottles will be shaken with a variable speed flat bed shaker. Chromatography columns (Spectrum Medical Industries, Inc.) will be used to contain the resin in the column tests. The resin bed dimensions can be adjusted with these columns. Precision metering pumps (Eldex Laboratories, Inc., model E-120-S) will be used to pump solutions through the columns at a known, constant rate. Effluents from the columns will be sampled automatically using a fraction collector (Haake Buchler Instruments, Inc., model LC 200) that will collect constant volume fractions. Radioactive tracer concentrations will be measured using liquid scintillation counting (Packard 1500 Tri-Carb liquid scintillation analyzer). The required laboratory equipment for these tests already exists in the PPSL.

The adsorbents to be tested are listed in Table 1.

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Tracer-level quantities of ²⁴¹Am, ²³⁸Pu, ⁹⁰Sr, and ¹³⁷Cs will be obtained from the Analytical Standards Laboratory. The ¹⁰⁶Ru and ²³⁴U will be purchased from a radiochemical supplier.

Synthetic wastewater will be prepared from reagent grade chemicals and distilled water. Wastewater will be prepared with a composition near that of the combined PUREX PDD and ASD wastewaters and 242-A Evaporator Process Condensate. This composition is based on the wastewaters characterized in the Functional Design Criteria document (SD-C018-FDC-001, Rev. 0).

4.4 Data

The important experimental conditions for batch equilibrium measurements of radionuclide distribution include tracer type, tracer concentration, wastewater composition, adsorbent type, and pH. In addition, if radionuclide elution is considered, eluant identity and concentration are important. For the column experiments, flow rate and bed volume are important experimental parameters, in addition to those given above. The ranges of experimental parameters for each type of measurement are given in Table 5.

TABLE 5
EXPERIMENTAL PARAMETERS AND RANGES

Measurement Type	Parameter	Range
Batch Equilibration (Distribution Coefficients)	Tracer Type	²³⁸ Pu, ²⁴¹ Am, ²³⁴ U, ⁹⁰ Sr, ¹³⁷ Cs, ¹⁰⁶ Ru
	Tracer Concentration	0.1 to 1.0 µCi/L
	Wastewater Composition	PDD + ASD + 242-A
	Adsorbent Type	See Table 1
	pH	4 to 7
Column Tests (Adsorption Rates, Capacity)	Above Parameters	Above Ranges
	Flow Rate	0 to 5 ml/min
	Bed Volume	1 to 20 mls

The experimental concentration ranges are based on estimates of wastewater composition which is the feed for the adsorption columns. Tracer concentrations, in most cases, will be higher than actually observed in the wastewaters so that their activities will be high enough to measure accurately.

The data to be obtained from these tests include equilibrium distribution coefficients and elution curves for adsorption of the radionuclides onto appropriate adsorbents. Values of these parameters will

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depend on the variables listed in Table 5. Ultimately, the data will be used to predict the performance of various adsorbents in removing radionuclides from wastewaters and to size the adsorbent beds. This information will allow Westinghouse Hanford Company to choose the best adsorbents for this application and to have confidence that the treated effluent will meet disposal limits given in the regulations.

4.5 Criteria/Constraints

The criterion for successful application of this testing to the wastewater treatment facility is the selection of adsorbents that remove radionuclides and hazardous components from the wastewater to levels that are acceptable for disposal. Failure to meet a target value will not necessarily disqualify a particular adsorbent for use in the treatment process. The overall performance of the adsorbents under expected conditions will be the most important criterion. Data generated in these tests will allow prediction of the performance of adsorbents in large-scale process application.

Some constraints on these tests are as follows:

- (1) Work with beta-gamma emitting radionuclides (^{90}Sr , ^{137}Cs , and ^{106}Ru) is restricted to a single open faced hood in room 180 of the PPSL laboratory which must be modified before using. A Radiation Work Permit for Room 180 must also be obtained before this work can be started. An alternative is to use hoods in the 222-S Laboratory, although specific hoods have not yet been identified.
- (2) For some radionuclides, tracer concentrations used in these tests will be much higher than in actual wastewaters. This is necessary so that the samples can be counted in a reasonable amount of time. Several concentrations will be used in the tests to allow extrapolation down to actual levels.
- (3) A synthetic wastewater composition prepared from laboratory chemicals must be used, rather than actual wastewater since the actual wastewater is not available.

5.0 EXPECTED RESULTS

The tests will show that several adsorbents can be applied to remove radionuclides and hazardous components from the wastewater. Based on previous work on removal of plutonium from the Plutonium Finishing Plant wastewaters and literature information on removal of other radionuclides from wastewaters, commercially-available adsorbents can be found that will fulfill the requirements of the ion exchange/adsorption system. Sizing the treatment columns for the large quantities of wastewaters to be processed will determine whether or not a given adsorbent is practical to use. The size of the columns will be estimated from expected wastewater flow rates, rates of adsorption and adsorption capacities of the media measured in these tests. One of the most important unknown factors in these tests is the effects of relatively large quantities of dissolved ammonium sulfate in the wastewaters. This salt, along

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with others present in the wastewater may compete with radionuclides for adsorption sites on the media and may reduce adsorption capacity.

6.0 TEST PROCEDURE

Procedures for measuring radionuclide distribution coefficients (K_d values), adsorption rates, and adsorption capacity are summarized in the following paragraphs. There are two general types of procedures to be used - batch equilibration measurements and column flow-through measurements.

In the batch equilibration measurements of radionuclide K_d values, a weighed amount of adsorbent (1 to 5 g) is equilibrated with a measured volume of solution (10 to 20 ml) containing known concentrations of tracer and inert components. The pH will be adjusted with either NH_4OH or H_2SO_4 and measured after equilibration. The time required for equilibration is determined by sampling the solution periodically and measuring the tracer concentration. When a constant tracer concentration is reached, equilibrium has been attained. The concentration of tracer in the solution after equilibration is used to calculate the amount of tracer adsorbed on the resin. A K_d value is then calculated using this data.

For the column experiments, commercially-available liquid chromatography columns will be filled with the adsorbent. Solutions containing known concentrations of radioactive tracer and inert components will be pumped through the columns at a constant, known flow rate. Samples of the effluents from the columns will be counted for tracer concentration. Breakthrough curves will be plotted to show tracer concentration in the effluent versus effluent volume. For adsorption rate experiments, the flow rate will be varied and the effect of flow rate on the tracer concentration in the effluent will be evaluated. Adsorbent capacities will be determined by measuring the volume passed through the column when the tracer is first observed in the effluent.

The size of the columns to be used will be determined by results of the batch equilibration measurements. Large distribution coefficients will require that smaller columns be used in order to reach the capacity of the adsorbent. The bed volume of the columns will range from about 2 to 30 mls. Other considerations in determining column size are height to diameter ratio (must be large enough to prevent channeling), and uniformity of distribution of the influent solution to the bed cross-sectional area.

The effects of pH, radionuclide concentrations, and concentrations of interfering ions will be determined in both the batch and column tests by changing their values over the specified range of these parameters and measuring the effects on adsorption.

In addition to measuring adsorption of radionuclides from the wastewater, adsorption of hazardous waste components such as ammonium ion and chromium(III) will be measured. The same test conditions will be used as for

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the radionuclide adsorption measurements, except that the analyses will include ammonia and sulfate determinations.

7.0 SAFETY

All standard laboratory safety measures will be observed. All radiation work procedures will be adhered to, as described in WH-CM-4-15, Volume 2, "Radiation Work Requirements and Permits Manual." The following specific permits will apply: Z-001 "Tours, Visual Inspections, General Facility Entry, Office Work and Cold Laboratory Work in Zone III," Z-014, "Routine Work Performed Inside Open Faced Hoods," and Z-043, "Routine Work, Tours, Inspections, Routine Surveillance Activities in Radiologically Controlled Areas."

Wastes containing ion exchange resins, inorganic adsorbents, synthetic wastewaters, and tracers (^{238}Pu , ^{241}Am , ^{234}U , ^{90}Sr , ^{137}Cs , ^{106}Ru) will be generated from these tests. The resins and inorganic adsorbents are not likely to be classified as hazardous wastes because of their relatively high flash point (165 °F), unreactiveness, and low toxicity. The organic resins will not contact any strong oxidizer and will not be an explosive hazard. They will, however, generally be contaminated with radioactive tracers. The aqueous waste solutions will be near neutral pH and radioactive and can be disposed of in the D-4 drain. PFP Environmental Compliance will be contacted before disposal of any of these wastes. Material Safety Data Sheets are available in the laboratory for all of the reagents that will be used.

8.0 QUALITY ASSURANCE

These tests are assigned Impact Level III, as per MRP 5.43. The quality assurance implementation is under the direction of the cognizant chemist. All procedures performed by the PPSL will be handled in accordance with Process Laboratories and Technology (PLT) Desk Instructions T001 A-01 450 F and T013 A-00 450 F. All work will be documented in laboratory notebooks according to PLT Desk Instruction T006 A-00 450 F.

All counting analyses will be performed according to procedures given by the manufacturer of the liquid scintillation analyzer. Standardization of this instrument against a ^{14}C standard is performed daily. Other chemical analyses will be performed by Analytical Services which maintains a Laboratory Measurement Control System (LMCS). The LMCS provides for analysis of standards and replicate analyses to assure quality control.

9.0 ORGANIZATION AND FUNCTION RESPONSIBILITIES

Organizational responsibilities are summarized in Table 6.

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11.0 REPORTS

In addition to this plan, letter reports will be issued as tasks are completed. A summary report will be issued November 29, 1991.

12.0 REFERENCES

1. Flyckt, D. L., "Functional Design Criteria for the 242-A Evaporator and PUREX Condensate Treatment Facility," SD-C018-FDC-001, Westinghouse Hanford Company, Richland, Washington, July 1990.
2. DOE, 1988, "Radioactive Waste Management - Guidance Document," DOE Order 5820.2A, U.S. Department of Energy, Washington, D.C.
3. WHC, 1988, "Environmental Compliance," WHC-CM-7-5, Westinghouse Hanford Company, Richland Washington.
4. Barney, G. S., A. E. Blackman, K. J. Lueck, and J. W. Green, "Evaluation of Adsorbents for Removal of Plutonium from a Low-Level Process Wastewater," WHC-SA-0533, Westinghouse Hanford Company, Richland, Washington, February 1989.
5. Robinson, S. M., et al., "Treatment of Radioactive Wastewaters by Chemical Precipitation and Ion Exchange," AICHE Symposium Series, 259, Adsorption and Ion Exchange, Vol. 83, 13-22, 1987.
6. Sato, T. and R. Motoki, "Chemical Species of Ruthenium in Radioactive Aqueous Waste and Decontamination Mechanism of Ruthenium with Zinc-Charcoal Mixed Column," Radiochemica Acta, 48, 101-113, 1989.
7. Allard, B., "Solubilities of Actinides in Neutral or Basic Solutions," in Actinides in Perspective, N. M. Edelstein, Editor, Pergamon Press, New York, NY, 553-580, 1982.

13.0 DATA SHEETS

Detailed, step by step test instructions will be prepared before any laboratory work is initiated. Data from these tests will be obtained in the form of computer printouts, instrument readings, and measurements. This data will be recorded in a laboratory notebook and in a computer spreadsheet for data analysis. Detailed test procedures will be included in the final report.

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