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7. Abstract

This treatability test program plan details testing required to support the C-018H Effluent Treatment Facility which will process the process condensates from the 242-A Evaporator and PUREX. This test program will provide data for C-018H Facility permitting activities, for the delisting petition preparation, and for design. Test data will be gathered through bench-scale, proof-of-concept tests, and pilot-scale tests using on-site facilities and vendor facilities. Testing will be performed with synthetic process condensate based on characterization of the 242-A Evaporator and PUREX process condensate streams and with actual process condensate which will be stored in the Liquid Effluent Retention Facility until C-018H Facility is completed.

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TREATABILITY TEST PROGRAM PLAN FOR C-018H PROJECT

EXECUTIVE SUMMARY

Westinghouse Hanford Company is planning to construct an effluent treatment facility under Project C-018H for processing condensates discharged from the 242-A Evaporator Facility and the PUREX Plant. This management-level program plan addresses the major treatability testing activities required to support process design, regulatory permitting of the effluent treatment facility and delisting of the wastewater stream. The treatability testing presented in this program plan is not considered treatability studies as defined by WAC 173-303-071(s). The scope of this treatability testing program goes beyond that defined for treatability studies in terms of volume and durations. This testing program will be performed under a Resource Conservation and Recovery Act (RCRA) permit.

The two key elements of the program plan strategy are process condensate testing and simulated process condensate testing. Process condensate testing will be performed on pilot-scale equipment in a renovated section of the Engineering and Environmental Demonstration Laboratory, building 1706-KE, at 100 K East Area. Limited testing will be performed at the Liquid Effluent Retention Facility (LERF) to facilitate large volumes of wastewater for filtration testing. The Design/Construct contractor for Project C-018H will provide Westinghouse Hanford Company technical support for pilot plant testing to remain up-to-date on test results.

Tests involving simulated process condensate will also be conducted until actual process condensate is available after the 242-A Evaporator restart. Testing to support detailed design of the effluent treatment facility is scheduled to be completed by the 30 percent review of the C-018H project, while support for delisting and permitting will continue into 1993.

The Design/Construct contractor will perform separate synthetic process condensate tests to validate the process design. The specific testing is not defined within this program plan (refer to the Design/Construct Specification) but must be completed by the 30 percent design review.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

TREATABILITY TEST PROGRAM PLAN FOR C-018H PROJECT

1.0 INTRODUCTION

Westinghouse Hanford Company (WHC) is planning to construct an Effluent Treatment Facility (ETF) under Project C-018H for treating process condensate discharged from the PUREX Plant and the 242-A Evaporator facility. The facility is scheduled to be operational in the latter part of 1994. At that time, the facility will also treat 242-A Evaporator process condensate stored in the Liquid Effluent Retention Facility (LERF). When all stored LERF wastewater has been treated, only process condensates received directly from the PUREX Plant and the 242-A Evaporator will be treated in the ETF. The ETF will be later modified to support the 200 Area Treatment Effluent Disposal System (TEDS), also known as Project W-049H.

This management-level program plan addresses activities associated with treatability testing required to support Project C-018H. The program plan will serve as the basis for preparing detailed testing plans which will support Project C-018H activities including: permitting activities, delisting petition activities, and facility design. Changes in the approach and/or schedule for these activities may necessitate changes in this program plan.

This plan is divided into seven sections and an appendix, including this introductory section (Section 1.0) which defines the purpose and objectives of the plan. Section 2.0 describes the approach to be used in conducting treatability testing. Section 3.0 defines the program organization and its function and responsibility. Section 4.0 presents rough order-of-magnitude costs for conducting the treatability testing. Section 5.0 contains a testing schedule that is consistent with the current schedule for Project C-018H. Section 6.0 contains Quality Assurance (QA) requirements and Section 7.0 identifies key references. The Appendix defines specific testing requirements for each unit operation that is part of the reference effluent treatment process.

1.1 Purpose

Treatability tests are required to provide information for designing the ETF, for obtaining the regulatory permits for its operation, and for preparing a delisting petition for the 242-A Evaporator process condensate waste stream. Treatability tests are necessary when innovative treatment technologies are employed, when treatment technologies are combined in non-standard configurations, and when wastes with unusual characteristics are to be treated. Each of these criteria applies to the C-018H Project.

The Environmental Protection Agency's (EPA) report, *Treatability Manual Volume III Technologies for Control/Removal of Pollutants*, (EPA 1980) documents the wide range of performances that have been achieved with different waste treatment technologies. The wide range of performances reported supports the need for treatability testing with actual Project C-018H process condensate and, where technically appropriate, with synthetic process condensate that closely simulates the actual process condensate.

The approach described in this program plan is based on four fundamental constraints:

1. The C-018H project will become operational late in 1994;

2. Treatability test data needed to support final design must be available by the 30 percent design review milestone;

3. The process flow diagram presented in the Functional Design Criteria (FDC) document will be successfully defended as the All Known, Available and Reasonable Treatment (AKART) Technology; and

4. The current waste characterization data are adequate for the purpose of defining treatability test needs.

These constraints define a treatability testing approach that includes a combination of proof-of-concept tests and design-parameter tests using simulated, as well as actual, waste. Proof-of-concept treatability tests are conducted to establish the technical viability of a candidate treatment technology. Design-parameter treatability tests are normally conducted at the pilot-scale level to provide necessary design information following successful proof-of-concept testing.

A key element of the approach is the renovation of an existing facility in which design-parameter testing using actual process condensate waste can be safely and efficiently conducted. Synthetic process condensate testing will also be conducted at Hanford, at equipment vendors' sites, and at the Design/ Construct contractor site.

Treatability tests with the actual process condensate do not conform to the WAC 173-303-071(s) definition of treatability studies. To fulfill the program purpose as stated requires testing in excess of the 250 kg of wastewater per day limit in the treatability study definition. This testing will be performed under a Resource Conservation and Recovery Act (RCRA) permit.

1.2 Objectives

The two major elements of the test plan are synthetic process condensate testing and process condensate testing. The primary objectives of simulated process condensate testing in this plan are to demonstrate proof-of-concept of the key unit treatment operations defined in the FDC and satisfy basic design needs. The primary objectives of process condensate testing are to satisfy remaining design needs and support the regulatory permitting and delisting petition activities.

Activities required to meet these objectives are identified below. These activities are described in greater detail in Section 2.0 and in the Appendix.

1.2.1 Simulated Process Condensate Testing

Key activities of simulated process condensate treatability testing are:

1. Procure test equipment (ultraviolet oxidation (UV), reverse osmosis (RO), pH adjustment, filtration, ion exchange (IX), and ancillary equipment) required to support simulated process condensate tests and subsequent process condensate tests. Equipment should be selected to be compatible in capacity with other equipment to be used in integrated tests. Required capacity to obtain representative design data for UV and RO systems is $\geq$ 5 gallons per minute.

2. Perform proof-of-concept (feasibility) tests to confirm the process flow diagram.

3. Conduct simulated process condensate tests with this equipment to establish design/sizing parameters and performance under the range of expected chemical loading conditions.

4. Conduct simulated process condensate reverse osmosis reject boil-down tests to establish the characteristics of the secondary waste.

1.2.2 Process Condensate Testing

Key activities of process condensate treatability testing are:

1. Renovate an existing facility for radioactive pilot plant testing and install equipment used in the simulated process condensate testing activity.

2. Prepare documentation and permit applications for the pilot plant which includes: RCRA permit, environmental assessment/ environmental checklist, Clean Air Act (CAA) permits and National Environmental Policy Act (NEPA) documentation.

3. Prepare documentation and obtain approvals to operate a radioactive pilot plant. (Likely documentation includes: RCRA facility plans, Safety Analysis Report (SAR), Radiation Work Procedures (RWPs), Standard Operating Procedures (SOPs), and a Operational Readiness Review (ORR).)

4. Conduct process condensate testing using actual waste accumulated in LERF. (Unit operations requiring process condensate testing include filtration, pH adjustment, UV, RO, and IX).

2.0 APPROACH

The treatability testing includes proof-of-concept testing and on-site pilot plant testing. Treatability testing will use both synthetic process condensate based on the characterization found in the FDC and actual process condensate from LERF. The Design/Construct contractor will also perform process design validation testing using synthetic process condensate.

Synthetic process condensate will be used for proof-of-concept testing. On-site testing will use synthetic process condensate only until actual process condensate is available after the restart of the 242-A Evaporator in late 1991. PUREX process condensate will not be available during this testing program since the PUREX plant is on standby status.

The treatability test program will evaluate the unit operations included in the ETF, as shown in Figure 1. The unit operations to be tested are filtration, ultraviolet oxidation, pH adjustment, reverse osmosis, ion exchange, and evaporator (mechanical vapor recompression (MVR) evaporation). The degassification unit, which is included in the ETF flow diagram, will not be included in pilot plant testing as the operation of the degassifier is understood. Modeling of the degassifier will be performed to predict the evolution of dissolved gases.

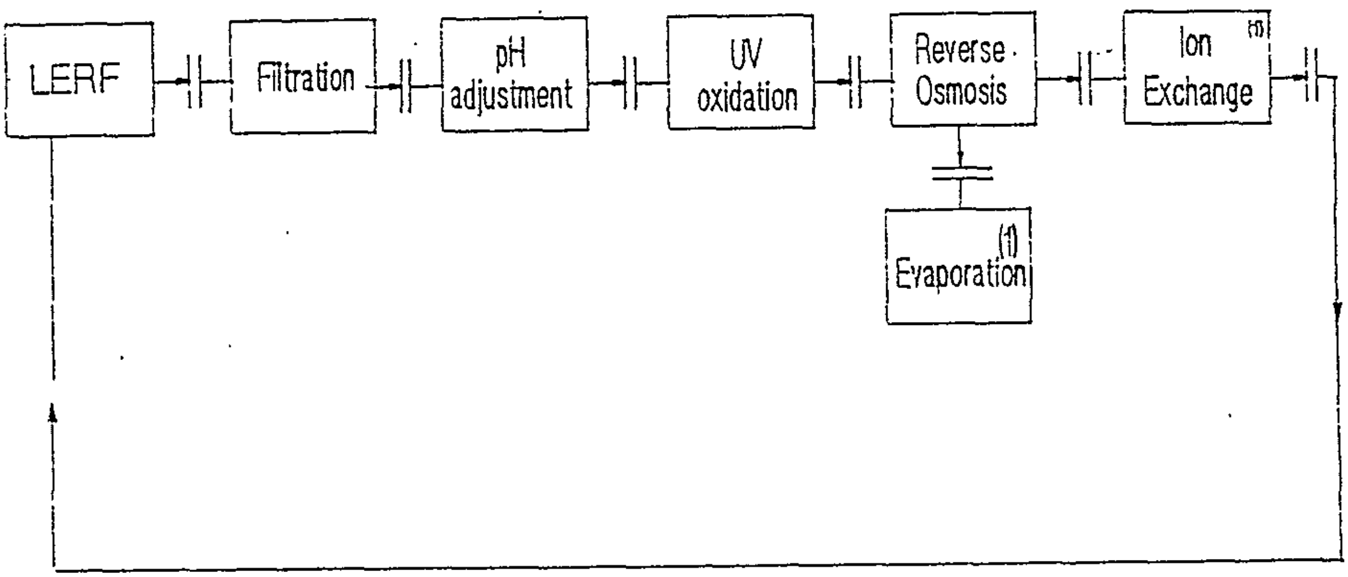
The pilot plant will be designed with each unit operation as a separate module and fabricated by an established manufacturer of full-scale processing equipment. This will allow the flexibility to test individual unit operations or a combination of unit operations and to vary the flow scheme, if desired.

The pilot plant equipment will be sized for 5 gpm with the exception of ion exchange and MVR. The ion exchange capacity testing will be performed on bench-scale. Concentration (MVR) may require only bench-scale testing using boil down tests since a MVR pilot plant is not feasible at this scale. The pH adjustment unit operation will require only limited testing to provide the necessary information to support design.

A test description of each unit operation is provided in the Appendix. A summary of the test matrix is shown in Table 1.

Testing of other unit operations than those listed above may be required as a result of this testing program to determine best available technology. Examples of specific unit operations which may be included: granular activated carbon (GAC), as an alternative (or in addition) to UV oxidation or if testing indicates GAC is required for off-gas treatment; and wiped film evaporation or freeze drying as alternatives to MVR.

Figure 1. Project C-018H Pilot Plant



(1) Unit operation to be performed only on a bench scale.

Table 1. Treatability Testing for Project C-018H

Unit Operation	Process Condensate Testing	Synthetic Process Condensate Testing
Filtration	X	
pH Adjustment	X	
UV Oxidation		X(2)
Degassification(1)		
Reverse Osmosis	X	X
Ion Exchange(3)	X	X
Evaporation(3)	X	X(2)
pH Adjustment with(4) UV Oxidation	X	X(2)
pH Adjustment with UV Oxidation and Reverse Osmosis		X
Filtration with pH Adjustment, UV Oxidation, and Reverse Osmosis	X	
Filtration with pH Adjustment, UV Oxidation, Reverse Osmosis, Ion Exchange, and Evaporation	X	

(1) additional study required to establish need for testing
(2) includes tests at vendors' facilities
(3) all testing performed on bench-scale
(4) all testing with more than one unit operation performed with semi-continuous operation

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The results of treatability tests must be adequate to support the regulatory permitting of the C-018H project, preparation of a delisting petition for the waste stream, and design of the C-018H project. Considerable interaction should be planned with the regulatory agencies, not only with the Washington State Department of Ecology (Ecology), but also with the Washington State Department of Health and the Tri-County Air Pollution Control Authority, for the purpose of structuring the tests to meet the requirements of the agencies, Design/Construct contractor, and WHC. Because the regulators may identify new requirements after reviewing the various stages of the work, it is likely that the plan and schedule for treatability testing will require modification.

2.1 Proof-of-Concept Testing

The purpose of the proof-of-concept testing is to demonstrate that the unit operations considered for the process flow diagram are appropriate and feasible for the process condensate feed streams. Proof-of-concept testing will use a synthetic process condensate formulation based on the 242-A Evaporator process condensate and the PUREX Process Distillate Discharge (PDD) and Ammonia Scrubber Distillate (ASD) stream specific report characterization data (WHC 1990) and the FDC.

The Design/Construct contractor will also perform proof-of-concept testing separate from this program. These tests will be conducted with synthetic process condensate and will support equipment sizing and material balance calculations to validate the process. All test plans generated by the Design/Construct contractor will be approved by WHC. All test reports prepared by the Design/Construct contractor will be completed by the 30-percent design review.

All WHC treatability tests conducted to date have involved separate RO and UV unit tests using a synthetic process condensate. The absence of actual waste is a significant concern because WHC, the regulatory agencies, and wastewater treatment equipment vendors strongly prefer treatability tests conducted using actual waste, particularly for new applications.

2.2 Pilot Plant Testing

The pilot plant testing requires the assembly of several wastewater treatment unit operations in a low-level radioactive environment. Most equipment vendors and commercial treatability testing laboratories have the capability to process only non-radioactive waste. Upon investigation, the U.S. Department of Energy (DOE) laboratories are either not equipped with the desired test equipment or have other near-term priorities. As a result, WHC is left with the need to install the necessary testing equipment at Hanford.

If the test equipment is leased and then used with radioactive process condensate wastewater, it will likely become contaminated with radioactivity and could not be released to the owner. Thus, a decision has been made to purchase and install the needed equipment in a suitable Hanford facility.

An additional advantage of purchasing the equipment is its potential applicability to the treatability test needs of other wastewater treatment projects (e.g., the 200 Area Treated Effluent Disposal Facility, Project W-049H and the 300 Area Treated Effluent Disposal Facility, Project L-045H).

The placement of the pilot plant focused on two alternatives; building a new facility at LERF or renovating an existing facility at 100 K East Area, building 1706-KE. The evaluation centered around requirements of Chapter 173-303 WAC; and of design, procurement, and construction of a new facility.

Evaluation of the alternatives concluded that the 1706-KE facility is the only viable option, because construction of a new facility at LERF would delay the pilot plant testing one year, which would threaten the Tri-Party Agreement milestone for C-018H startup. The decision was then made to renovate the existing facility at 1706-KE.

The approximate floor space required is 35 ft x 40 ft. The pilot plant facility would contain a process equipment room, a decontamination area, and appropriate HVAC and fire protection services. The facility currently contains laboratory space for limited analytical work and adequate electrical supply needs. Tanker trucks will transport liquid waste from LERF to the pilot plant facility and back to LEFT after treatability testing.

Limited pilot testing will be performed at LERF to evaluate several types of filtration apparatus. This will require only minimal staging and does not require a complete facility. The filters would receive water directly from LERF and discharge directly back to LERF. Double-lined pipe will be used for transferring to and from the filtration apparatus.

Filtration testing at LERF is necessary to minimize changes in the particulate characterization and reduce the settling that would occur with the transfer of process condensate to 1706-KE. With large volumes of process condensate required for long-term filter fouling tests, transportation of the process condensate to 1706-KE will be greatly reduced.

Dose calculations for a very conservative accident scenario involving the facility demonstrate that a low level of containment of radioactivity is required. This evaluation showed that potential exposures were well within established annual limits for workers and members of the public.

Providing a radioactive pilot plant facility for this project would be viewed favorably by the regulatory agencies because the pilot plant would provide high quality test results needed to support the permitting and delisting activities. In addition, because actual pilot plant test data would be available to the regulatory agencies, the permit for the full-scale facility would likely allow a lower, less-expensive level of process monitoring and control than would otherwise be required in the absence of empirical test data.

3.0 PROGRAM MANAGEMENT

This section describes which WHC functional groups are responsible and involved in this treatability program and what deliverables, in terms of documentation, will result from this program.

3.1 Program Organization

Within the Restoration and Remediation Division of WHC, the Effluent Treatment Program Office, a part of the Solid/Liquid Waste Remediation Department, has overall responsibility for the treatment of all wastewater effluent discharges from operations on site. (Project C-018H is one of the effluent construction projects managed by the Effluent Treatment Program Office.) The program office has developed a treatability testing program organization relying on a number of WHC organizations and is shown in Figure 2. The responsibilities of each organization is listed in Table 2.

The group primarily responsible for directing the treatability testing is Effluent Technology. The Chemical Engineering Laboratory has prime responsibility for conducting the treatability testing.

3.2 Program Documentation

The primary documentation from this treatability program will be the test plans and test reports. All test plans and test reports will be issued as WHC Supporting Documents (SD), externally cleared, (Impact Level III or greater). The following approvals will be required as a minimum: C-018H Program Manager; Effluent Technology; Quality Assurance; and Nuclear Safety.

The results obtained from executing a test plan will be assembled into a interim test report. The interim test reports will be compiled into treatability testing status reports which will coincide with C-018H Project 30-percent and 70-percent design reviews. A final report will be issued at the conclusion of this testing program. Other documentation required to perform this work includes: SAR, ORR, SOP, RWP, and RCRA permits. A CAA permit and NEPA documentation may also be required. The documentation will follow a structure as shown in Figure 3.

The Quality Assurance Project Plan (QAPP) will specify the quality requirements of the treatab'lity testing program. This QAPP will follow the requirements of the C-018H Project QA program plan.

Figure 2. Treatability Testing Program Organization

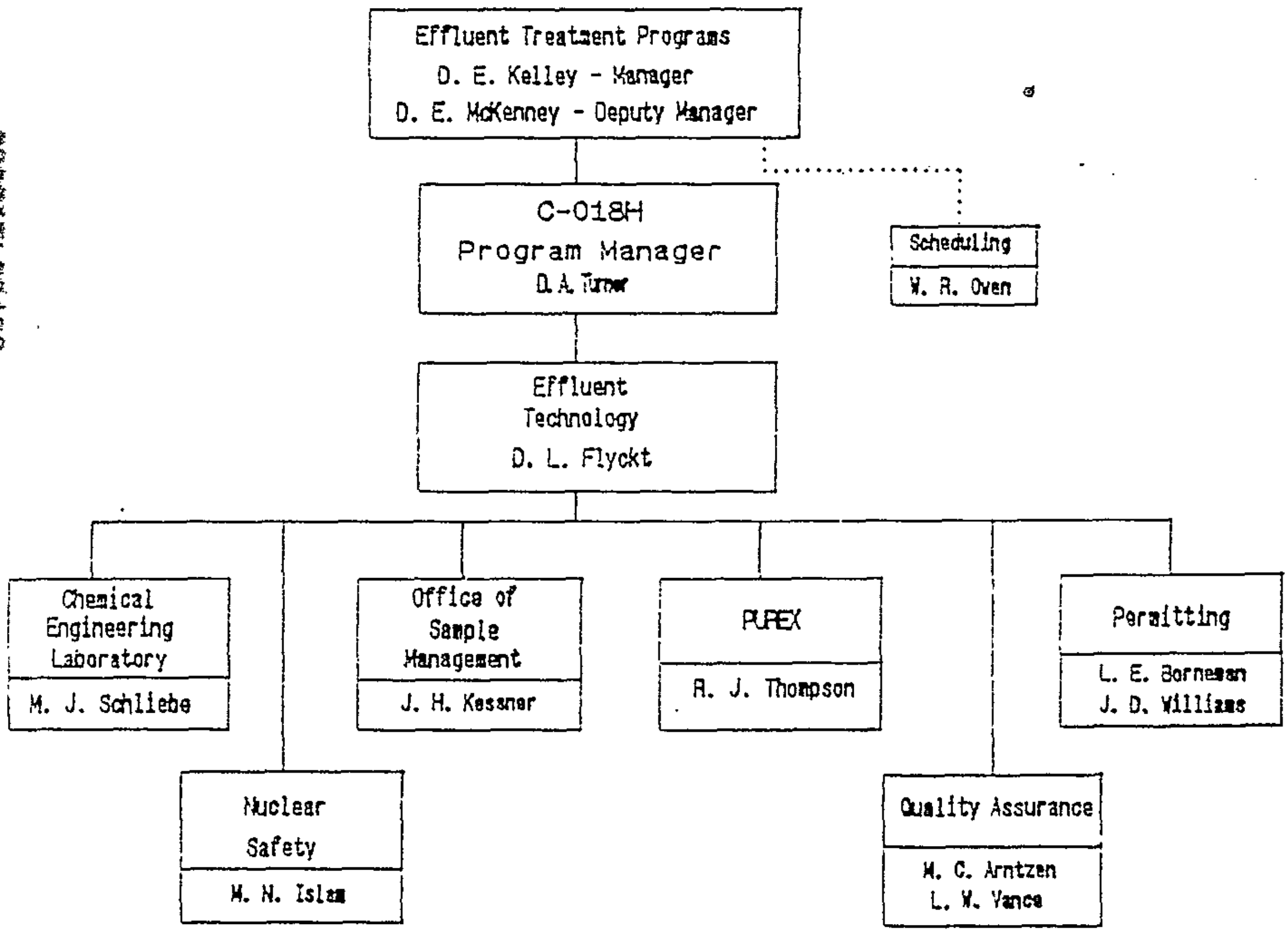
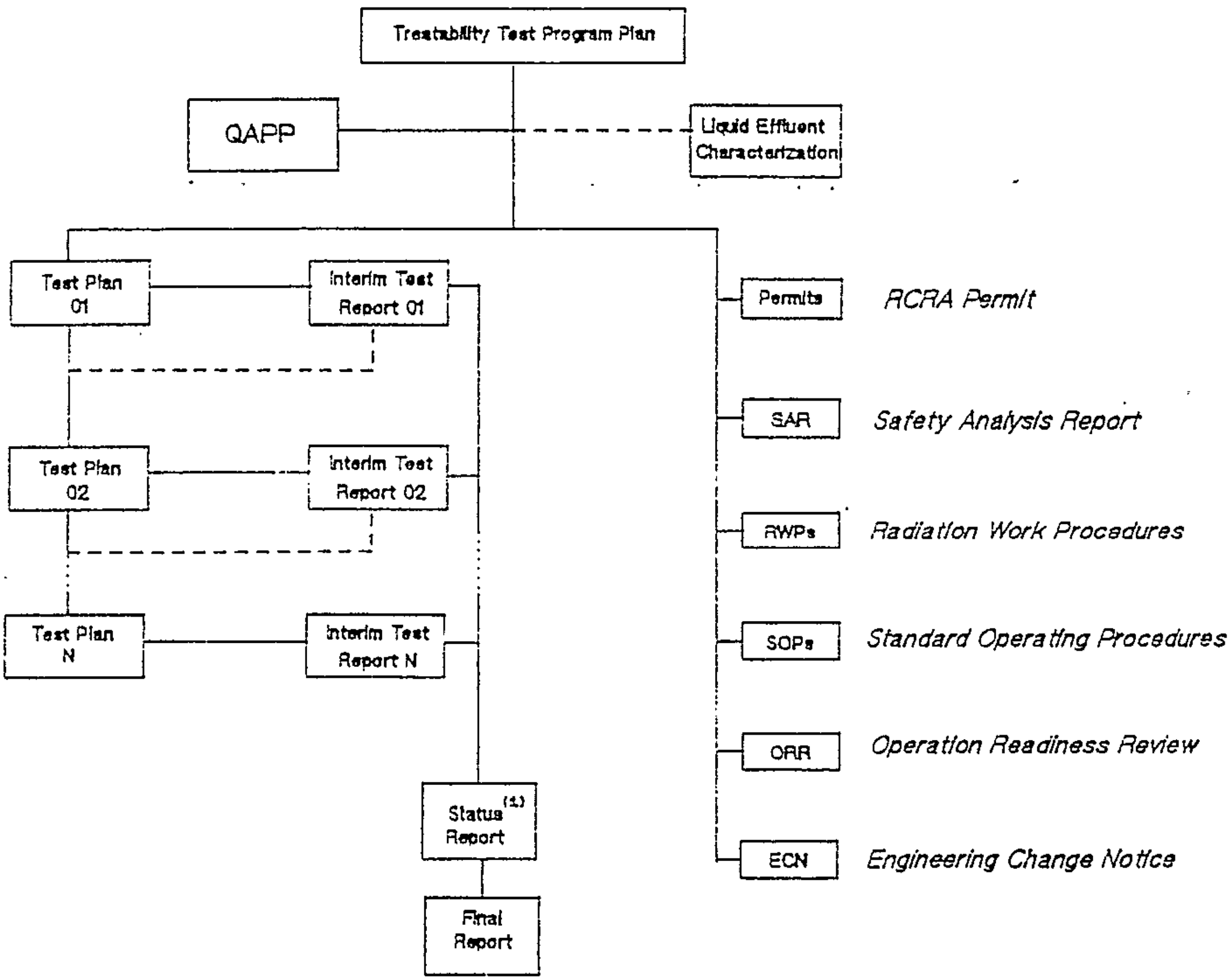


Table 2. Function Responsibilities

FUNCTION	RESPONSIBILITIES
Effluent Treatment	Responsible for oversight of effluent treatment and disposal.
C-018H Program Manager	Responsible for maintaining cost, schedule, and scope of the C-018H project.
Effluent Technology	Responsible for directing and managing the Pilot Plant testing activities for C-018H.
Chemical Engineering Laboratory	Responsible for performing the Pilot Plant testing in support of a proposed effluent treatment system.
Office of Sample Management	Responsible for the management of analytical samples taken during the effluent characterization, treatability testing program and treatment facility compliance program.
PUREX	Responsible for the interfaces of PUREX and this program to insure PUREX effluent treatment issues are included.
Permitting	Responsible for regulatory issues concerning this program. The issues include permitting of pilot plant facility, C-018 permitting and delisting support.
Quality Assurance	Responsible for oversight of activities to ensure compliance with Westinghouse Hanford and DOE quality control and documentation requirements. Responsible for ensuring quality data is generated from this program.
Safety	Responsible for all safety concerns in the safe operation of the pilot plant facility.
Scheduling	Responsible for preparation of all actions related to this treatability program, and coordination of testing with the effluent treatment facility.

Figure 3. Program Documentation



(1) Status Reports, compiled from interim reports, coincide with C-018H design review milestones.

4.0 COSTS

Rough order-of-magnitude costs over the three-year program are shown in Table 3. These costs are preliminary and will be refined following discussions with the regulatory agencies to define the scope of testing required to meet regulatory requirements.

Table 3. Treatability Testing Costs

Program Planning	$ 100K
Test Facility Engineering and Design	$ 100K
Test Facility Renovation	$ 300K
Safety and Regulatory Documentation	$ 300K
Treatability Testing	$ 800K
Laboratory Analysis	$ 800K
Documentation	$ 200K
Project C-018H Interface	$ 100K
Tanker Trucks	$ 125K
TOTAL	$2,825K

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5.0 SCHEDULE

A schedule for treatability testing is provided in Figure 4. The schedule supports the current Project C-018H schedule. Changes in the Project C-018H schedule will be assessed and appropriate modifications in the treatability test schedule will be made as required to maintain consistency. Lower-level schedules used to manage the treatability testing activities have been prepared.

Synthetic Processing Condensate Testing

Initial Feasibility Testing	2 Jan 90	31 Jan 91
Proof of Concept Testing	1 Oct 90	2 Mar 92

Process Condensate Testing

Pilot Plant Preparation	3 Jan 91	2 Mar 92
Pilot Plant Testing	2 Mar 92	6 Sep 93

Figure 4. Treatability Test Program Schedule

6.0 QUALITY ASSURANCE REQUIREMENTS

Basic QA policy for the U.S. Department of Energy-Richlad Operations Office (DOE-RL) and requirements for cost-effective QA programs and plans to be used by DOE-RL contractors are contained in DOE Order 5700.6B, *Quality Assurance* (DOE 1986). This Order requires each contractor to develop an overall QA program from which all DOE-sponsored programs and projects are implemented. In addition, a program or project specific QA plan is required to identify the specific requirements that are applicable to a particular program or project.

A QA project plan (QAPP) will be developed for this treatability test program using QAMS-005/80 the *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (EPA 1983). The QAPP will specify that test plans are required for all testing, operating procedures are required for all pilot plant equipment, and sampling and analytical procedures will comply with the *Test Methods for Evaluating Solid Wastes* SW-846 third edition (EPA 1986), and a log book for documenting tests. This QAPP will also use appropriate requirements from ASME NQA-1 (ASME 1989) regarding control of pilot plant equipment.

The test plan will be written in accordance to the QAPP and will include a QA section describing the specific QA requirements of each test. Examples of some specific requirements include calibration of instrumentation, a particular ASTM procedure, or a certain analytical procedure.

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APPENDIX

This appendix addresses the minimum treatability testing required for each unit operation included in the effluent treatment process.

Filtration

The purpose of filtration in the treatment process is to remove suspended solids that may coat UV lamps and plug RO membranes. Filtration treatability tests are necessary to determine how much of the suspended solids can be removed without incurring prohibitive maintenance costs for the filters in relation to maintenance costs for the UV and RO units. Candidate filter media should be tested under conditions recommended by the manufacturers using actual process condensate feed. Because of the relatively high volumes of waste required to test the performance of filters, the filters should be tested at the LERF site and in the radioactive pilot plant as part of treatability tests unit operations. Analyzed will be the filtered solids with attention to species having high removal requirements. This analysis would be used to determine if filtration can effectively reduce the load on downstream processes (i.e., RO and IX) before the pH adjustment step which could dissolve the solids.

UV Oxidation

The purpose of UV oxidation in the treatment process is to destroy organic contaminants. UV oxidation is the only unit operation in the process train that serves this purpose, although some of the higher molecular weight organics may be removed in RO. Preliminary feasibility tests have been conducted at vendor's facilities under WHC direction using synthetic process condensate. Results from these tests have shown the potential for this innovative technology to meet possible organic destruction objectives. Although the destruction efficiencies of three organics of concern (namely, dimethyl nitrosamine, phenol, and pyridine) were not measured in these tests, the high destruction efficiencies of the organics that were measured show promise for this technology.

Proving the efficacy of this technology to the regulatory agencies is critical because it is the technology on which a successful RCRA delisting petition will be based. If the technology cannot achieve destruction of listed organics to Land Disposal Restriction (LDR) levels, the treated wastewater cannot be disposed to the State Approved Land Disposal System (SALDS). More proof of the ability of UV oxidation to adequately destroy other organics of concern is needed. The regulatory agencies may also require that UV oxidation achieve destruction or removal of organics to levels achievable by EPA's Best Demonstrated Available Treatment (BDAT) technologies for these organics (i.e., steam stripping and biodegradation).

One of the organics of concern that has been tentatively identified in the 242-A process condensate, dimethyl nitrosamine, (N-nitros dimethylamine) potentially requires a very high level of removal due to the existence of a very low water quality standard. The level of destruction (decontamination factor) required for this organic could be as high as 30,000, assuming the standard applies in this case. This level of destruction is equivalent to the level achievable in a well-run incinerator. It is unknown if any practicable wastewater treatment process can achieve this level of performance.

Additional testing and analysis may be necessary in an effort to reduce the burden dimethyl nitrosamine potentially places on UV oxidation. These tests and analyses should include additional process condensate analyses that may show that the single analytical detection observed to-date was a spurious reading and, therefore, can be discounted. If dimethyl nitrosamine cannot be ignored, establishment of a dilution/attenuation factor will reduce the load. Testing of below-surface biodegradation may support the use of a higher dilution/attenuation factor than would otherwise be acceptable to the agencies. Such testing would warrant consideration if treatability testing shows inadequate destruction.

In addition to the need to destroy organics to support delisting of treated wastewater, the listed contaminants should also be destroyed to the level required to allow for the land disposal of the concentrated salts RO concentrate and IX regenerate). Unless this destruction is achieved, the salt fraction may require further treatment, e.g., by incineration, which is EPA's BDAT for solvent-containing non-wastewater wastes. Ecology could also apply soil standards developed under the Model Toxics Control Act in establishing disposal limits for the concentrate salt waste forms. See the section titled <u>Mechanical Vapor Recompression Evaporation</u> for further recommendations on organic destruction testing.

To perform the needed UV oxidation treatability tests, a skid-mounted, pilot-scale UV oxidation system with sufficient capability to control key operating parameters, e.g., power, residence time, and oxidant addition, will be procured. The system should be designed and manufactured by a qualified vendor, but it should not include proprietary features so as to avoid complicating the procurement process for the full-scale system. The system will be sized so that scale-up of test results can be determined with confidence. The system will be initially installed and set up for testing with synthetic process condensate. Tests conducted using synthetic process condensate will focus on establishing operating parameters to reduce all organic contaminants of concern to levels that would permit land disposal of the treated wastewater.

Testing with actual waste will be conducted to produce the data necessary to demonstrate the technology as AKART, to achieve delisting, and to support design. Because of the critical nature of this testing, high QA standards on sample collection, management, analysis, and validation should be employed. An agreement on QA requirements will be reached with the agencies before pilot plant testing is initiated to assure that the test results will be acceptable.

pH Adjustment

The purpose of pH adjustment in the treatment process is to remove part of the carbonate content of the waste through the evolution of carbon dioxide and to adjust the chemistry of the waste to enhance removal of ammonia (in the form of ammonium sulfate) by RO. Titration tests with sulfuric acid will be conducted in a suitable laboratory using actual waste to establish the required sensitivity of the acid addition system in achieving the pH target. Only limited testing is required. The pH will be adjusted for various tests to determine the effect to downstream unit operations.

Reverse Osmosis

The purpose of reverse osmosis in the treatment process is to reduce the load on the energy-intensive MVR evaporation process and the ion exchange operation. Preliminary feasibility testing has been conducted by WHC using simulated waste and a very small RO unit. However, this small RO unit is not conducive for scale up to a full-scale unit. A skid-mounted, pilot-scale unit will be procured and installed in the pilot plant facility.

There are several tests that will be conducted to demonstrate the likely performance level of the full-scale RO unit. Because several stages of RO are likely to be used, knowledge of the water/salt removal efficiency of each stage is important to establish the required capacity of the MVR evaporation unit. An overall system that rejects 10% of the water will require an MVR unit that has twice the capacity of an RO system that rejects 5% of the water.

Testing under simulated waste conditions will be conducted to establish appropriate operating conditions and the number of stages that are practicable in this application. Recycle testing may be important to establish insight into the degradation rate of the RO membrane material. Periodic make-up of lost volatile organics and other materials that may sorb onto the RO membrane or otherwise be lost is important in such testing, as is measurement of organic reject levels.

Testing with actual process condensate will focus on assessing rates of plugging RO membranes, membrane cleaning methods, and determination of rates of membrane sorption of high gamma energy emitters. The latter information will be used to plan and design membrane maintenance methods, which may require special techniques because of potentially high dose rates. Process condensate testing should use UV oxidation-treated and filtered wastewater as feed to the extent practicable.

Ion Exchange

The purpose of ion exchange in the treatment process is to remove additional dissolved inorganic anions and cations so as to meet final water quality discharge limits (i.e., the limits allowed in the permit). It would appear from an evaluation of potentially required decontamination factors that

RO alone would be unlikely to remove cations to levels that would ensure meeting groundwater standards; thus, cation exchange requires testing. The need for anion exchange is less certain than for cation exchange, especially if it can be shown that sulfide is adequately removable by filtration and/or convertible to sulfate by pH adjustment and UV oxidation.

Initial testing of ion exchange should be based on a simulated worst-case RO permeate concentration and may use radioactive spike solutions to simulate the radionuclides. Small-scale column tests, evaluating several types of ion exchange resins, will be conducted to establish breakthrough points of various species. After the UV oxidation and RO units are installed in the radioactive pilot plant facility, the treated wastewaters should be collected and passed through small-scale ion exchange columns to establish chemical and radionuclide breakthrough points. The ability to regenerate the resins should also be determined. The small-scale tests should be adequate to design ion exchange regeneration systems.

Evaporation (Mechanical Vapor Recompression Evaporation)

The purpose of MVR evaporation is to concentrate the salt fraction (RO rejects) so as to reduce the load on any downstream stabilization or solidification process. MVR evaporators are not routinely used to perform concentration of ammonium sulfate solutions; the usual choice is a multiple effect evaporator. The MVR should perform in an acceptable manner so long as a high level of salt concentration is not the objective of the process treatment. At the higher salt concentrations, scaling and compressor problems have been experienced. Concentrating the waste to the high salt concentration levels required for crystallization will probably increase these and other types of maintenance problems. Several factors should be investigated during evaporator treatability test planning. These factors include: the excess steam in the 200 East Area; trade-offs involving amortized capital costs; operating costs including steam costs; maintenance costs; and complexity of MVR and alternate evaporators.

Even if vendors of evaporators are confident they can design an effective evaporator based on current knowledge of the wastewater composition, a simple boil-down test should be conducted using a simulated worst-case, post-UV oxidation/RO salt stream. The purpose of the test is to determine if sufficient evaporation of residual listed solvents (if any remain after UV oxidation) in the salt stream occurs so that the dried or solidified salt waste form will not exceed LDR limits for land disposal. Samples should be collected in this test at a level of concentration somewhat before crystallization commences and also after the solution has been evaporated to dryness.

Calculations to determine the potential Toxic Characteristic Leaching Procedure (TCLP) extract composition should be performed and the results compared to TCLP limits. If the dried salt can be shown not to contain listed solvent compounds and not to exceed LDR and TCLP limits, the waste can be land disposed without further treatment.