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HEPA FILTER LEACHING CONCEPT VALIDATION TRIALS AT THE IDAHO CHEMICAL PROCESSING PLANT

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ABSTRACT

The enclosed report documents six New Waste Calcining Facility (NWCF) HEPA filter leaching trials conducted at the Idaho Chemical Processing Plant using a filter leaching system to validate the filter leaching treatment concept. The test results show that a modified filter leaching system will be able to successfully remove both hazardous and radiological constituents to RCRA disposal levels. Based on the success of the filter leach trials, the existing leaching system will be modified to provide a safe, simple, effective, and operationally flexible filter leaching system.

SUMMARY

Six New Waste Calcining Facility (NWCF) spent HEPA filters were leached using the existing filter leaching system to validate the HEPA filter leaching treatment concept developed at the Idaho Chemical Processing Plant (ICPP). The leaching system includes three leach cycles in 1-3M nitric acid at $176^{\circ}\text{F} \pm 15^{\circ}\text{F}$ for 40 minutes per cycle, followed by two water rinse cycles at ambient temperature for 15 minutes per cycle. During the leaching process, minor operational problems were experienced. (Modifications to correct these problems are expected to start in early 1995.)

Post-leach filter media sampling results for all six NWCF spent filters show that both hazardous and radiological constituents levels were reduced and that the filters can be disposed of as low-level radiological waste.

The liquid waste volume generated during the filter leaching trials using the existing system averaged 678 gallons for each filter. After the existing system is modified, the liquid waste volume generation will be reduced by approximately 225 gallons per filter. In addition, the modified leaching system will be designed to leach all filter sizes including Waste Calcining Facility (WCF), Special Power Excursion Reactor Test (SPERT), Fluorinel Dissolution Process (FDP), and NWCF spent filters.

Chemical analysis of the leachate and rinsate samples from cell drain hold tank VES-NCD-123 revealed that chloride concentration in the liquid waste was higher for filters #2 and #5 and did not meet the Process Equipment Waste (PEW) evaporator acceptance criteria. Liquid waste analysis of the leachate and rinsate for filters #1, 3, 4, and 6 met PEW evaporator acceptance criteria. It is suggested that the leachate and rinsate solution of VES-NCD-123 be mixed with similar waste to reduce chloride concentration for disposal to the PEW evaporator. Assuming the composite samples of leachate and rinsate will meet the PEW evaporator acceptance criteria, it is estimated that only 15 gallons of waste solution from the PEW evaporator bottoms per treated filter will go to the tank farm during leaching in the modified system.

The average leaching time is approximately ten hours for each large filter. With no anticipated delays, and considering equipment downtime and intermittent operation of the leach system (assuming 50% downtime), it is estimated that eight large filters could be leached per month in the modified leaching system.

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ACRONYMS

CMA	Crane Maintenance Area
FDP	Fluorinel Dissolution Process
HEPA	High Efficiency Particulate Air
Hg	Mercury
HFLS	HEPA Filter Leach System
ICPP	Idaho Chemical Processing Plant
INEL	Idaho National Engineering Laboratory
NWCF	New Waste Calcining Facility
PTS	Pneumatic Transport System
PEW	Process Equipment Waste
RWMC	Radioactive Waste Management Complex
RAL	Remote Analytical Laboratory
RCT	Radiological Control Technician
RCRA	Resource Conservation and Recovery Act
SPERT	Special Power Excursion Reactor Test
SVOC	Semi-Volatile Organic Compound
TC	Toxic Characteristic
TRU	Transuranic
TCLP	Toxic Characteristics Leaching Procedure
VOC	Volatile Organic Compound
WCF	Waste Calcining Facility
β	Beta radiation
γ	Gamma radiation

HEPA FILTER LEACHING CONCEPT VALIDATION TRIALS AT THE IDAHO CHEMICAL PROCESSING PLANT

1.0 INTRODUCTION

This report describes the nitric acid leaching of six spent New Waste Calcining Facility (NWCF) high efficiency particulate air (HEPA) filters to validate the modified filter leaching concept developed at the Idaho Chemical Processing Plant¹ (ICPP) within the Idaho National Engineering Laboratory (INEL). HEPA filters are used to remove radioactive and hazardous contaminants. Contaminated HEPA filters are generated in the final stages of the calciner off-gas cleanup system and in similar off-gas clean up systems throughout the INEL.

A cross-section view of a typical HEPA filter is presented in Figure 1. An optical photomicrograph of the HEPA filter media is shown in Figure 2. The corrugated filter media is a mixture of fire resistant glass fibers, special acid-resistant material (Kevlar/Nomax), and a chemical binder. The corrugated media is folded back and forth and sealed on the edges of the metal housing with high temperature resistant silicone. The typical filter housing is made of 14 gauge 300 series austenitic stainless steel. Most filters have a plastic mesh on the top and a stainless steel screen on the bottom to ensure the filter media remains intact.

Contaminated spent HEPA filters are transuranic mixed waste. Untreated HEPA filters could be disposed of at the Waste Isolation Pilot Plant (WIPP) facility as transuranic mixed waste, but the limited storage space and high disposal costs make alternate disposal methods highly desirable. Disposal at the Radioactive Waste Management Complex (RWMC) at the INEL would be more cost effective. However, RWMC cannot accept contaminated filters unless transuranic, radioactive, and hazardous contaminants are below regulatory limits. Nitric acid leaching is regarded as an effective tool to remove these contaminants.

The purpose of the HEPA Filter Leaching System (HFLS) is to reduce transuranic and radioactive contaminant levels in the spent HEPA filters to allow disposal as low-level radioactive waste at the RWMC. The existing filter leach

Figure 1. Typical HEPA filter.

Magification X 200

Magificaton X 100

Figure 2. Photomicrograph of the HEPA filter media
(Courtesy of Dr. S. V. Raman, Waste Form Development Group).

system was built and installed in mid-1988 in the filter handling cell in the decontamination area of the NWCF (see Figures 3 and 4). The Resource Conservation and Recovery Act (RCRA), 40 CFR parts 260 through 270, requires removal of hazardous materials from solid waste prior to disposal as non-hazardous low-level radioactive waste. Hazardous materials limits are specified in the Toxic Characteristic Leaching Procedure (TCLP) and are indicated in Table 1 below:

Table 1. Maximum TCLP limits.

Toxic Metal	Concentration (ppm)
Arsenic	5
Barium	100
Cadmium	1
Chromium	5
Lead	5
Mercury	0.2
Selenium	1
Silver	5

Initial testing of the HFLS indicated that leaching would reduce transuranic elements as well, as most hazardous contaminants to regulatory disposal limits but would not consistently remove mercury and cadmium to acceptable levels. Moreover, severe operational problems were experienced during the initial leaching trials¹. Filter media was partially destroyed and pieces of the filter media plugged the vessel drain and clung to the interior of the leach vessel. A testing effort was initiated to optimize leaching process parameters so that RCRA disposal limits could be met and the operational problems experienced during the previous trial could be eliminated².

The ICPP designed, built, and tested a HFLS mock-up in the pilot plant area of the CPP-637 high bay. The leaching system was designed to perform testing on Fluorinel Dissolution Process (FDP) filters which measure 8 inches x 8 inches x 6 inches. These filters were contaminated with hazardous constituents but were not radioactive.

Figure 3. Decontamination area plan view.

Figure 4. Existing filter handling cell.

This developmental work identified process parameters that allowed satisfactory leaching of filters to meet RCRA disposal criteria. The test results also indicated that the original method of leaching filters should be modified. The filters should be placed face down in the leaching vessel, (stainless steel screen side up) and only one filter should be leached at a time. The filter media should be breached prior to leaching, to aid in the leaching process. Recirculation of the nitric acid is not necessary during leaching, but air sparging might be necessary to promote agitation. The nitric acid molarity should be in the range of 1-3M. The leach solution temperature should be approximately 176°F during start-up of the leach operation. It was also recommended that five leach cycles and two rinse cycles be used. These test results and recommendations were confirmed by leaching NWCF hot filters using the existing leach facility with the modified operating parameters. This report describes the validation trials which were conducted in the existing leaching facility at NWCF.

2.0 CONCEPT VALIDATION TRIALS

HEPA filter leaching tests were conducted in the existing filter leaching system to validate the modified HEPA filter leaching treatment concept. Six spent radioactive NWCF HEPA filters were leached. After treatment in the existing HFLS, representative filter media samples were collected and transported to the Remote Analytical Laboratory (RAL) for analysis.

The purpose of the analysis was to show that treated filters were not characteristically and radiologically hazardous and to obtain data on any organic residuals. The analysis tested TCLP metal and selected volatile organic levels. The organics that were analyzed correspond to waste codes that are not "soluble to at least 5% by weight in the water solution or 5% by weight in the emulsion, as applicable" (57FR 37230, August 18, 1992). The results of these tests indicated that the extent of contamination by these organics was extremely small, and the HEPA filter was no longer considered hazardous and could be disposed of as low-level radioactive waste. The results will be submitted to the State of Idaho for a regulatory determination. A regulatory determination for this treatment methodology is supported by a new regulatory provision to exclude low-hazard debris from subtitle C regulations under those circumstances. [40 CFR 261.3(f)(2), 57 FR 37264].

During the filter leach treatment validation trial, the following process parameters were selected by the Operations Department after reviewing the HEPA filter leach system technical base report¹. Leaching of filters included three leach cycles in 1-3M nitric acid at 176°F ± 15°F for 40 minutes per cycle, followed by two water rinses at ambient temperature for 15 minutes per cycle. The acid and water volume should just submerge the HEPA filter during leaching and rinsing cycles with an air sparge rate of 12 to 30 scfm to promote agitation. No circulation of acid or water was required. The filters were air dried at 425°F for 12 to 18 hours.

3.0 LEACHING SYSTEM DESCRIPTION

The previous leaching trials² conducted at the filter handling cell produced severe filter media disintegration during leaching. The disintegrated, loose filter media caused severe plugging of the leach vessel drain line. It was decided that during this leaching trial, each filter would be placed in a disposable basket which completely encompassed the filter to preclude vessel drain plugging during leaching. The top and bottom of the basket was constructed of 14 mesh stainless steel screens with 0.053 inch openings to retain the loose filter media. Appendix B shows the detailed design of the leach basket along with the support frame.

The existing filter leaching system is shown in Figure 5 and consists of a leaching vessel, two work tables, and associated piping and instrumentation. The leach vessel and work tables are located in the filter handling cell. Piping lines pass through the cell wall to utility service lines in the clean operating corridor. Remote handling capabilities are available within the cell via a pair of master-slave manipulators located on either side of the window, an overhead crane, and an electro-mechanical PaR with a robotic arm.

The filter leaching vessel (VES-NCD-155) is fabricated from 304L stainless steel and has a capacity of 175 gallons with a normal working volume of 110 gallons. The outside dimensions of the vessel are approximately 43 inches x 43 inches x 60 inches high. The interior of the vessel measures 30 inches x 30 inches x 45 inches deep. The bottom 8 inches of the vessel cannot be used for leaching because of piping interferences. The floor of the leaching vessel is sloped to the vessel drain, which is then piped through a screen basket into a

Filter Leaching System

Figure 5. Existing filter leaching system.

cell drain via the cell drain trench. There are pipes into the lower section of the vessel to allow it to be filled with nitric acid or water, sparged with steam or air, or dried with heated air. Other connections into the lower sections of the vessel include three air lifts, a sample port, level/density port, and a thermowell. The top portion of the vessel includes piping connections for venting, overflow, and level indications. A second thermowell is also located at the top of the vessel. The leaching vessel has a removable lid which fits tightly on the vessel so that a slight vacuum is maintained in the vessel by the ventilation system during leaching, rinsing, and drying cycles.

The sampling station is located next to the filter leaching vessel and is designed for pulling liquid samples from the leach vessel. Process samples (water rinse #2) are taken from the sampling station and hand-carried to the Remote Analytical Laboratory (RAL) under Radiological Control Technician (RCT) escort. Liquid wastes are collected in cell drain hold tank VES-NCD-123 where RCRA samples are taken remotely and sent to the RAL for analysis via the pneumatic transfer system (PTS).

The filter handling table is located behind the leaching vessel and is directly under the filter handling cell hatch cover. The dimensions are 10.75 feet x 5 feet x 5.5 feet high. The table is constructed of stainless steel with an open grating working surface. It serves as the primary work surface for filter handling operations.

4.0 OPERATION OF EXISTING SYSTEM

This section describes how the existing leach system is operated to leach spent radioactive filters.

A contaminated filter is transferred into the filter handling cell through the PaR parking area and shielding doors using the filter handling tool and decon cell crane. The filter is then placed inside the top half of the leaching basket so that the stainless screen side is facing upward. The open leach basket is placed on the filter handling table. The filter is then mechanically breached using a breaching tool to make holes in the filter media for effective leaching and rinsing operations. The lid of the basket is then closed and locked using

the cell crane, PaR, or manipulator. The leach basket and filter are then placed on the basket support inside leaching vessel VES-NCD-155.

1-3M nitric acid is made up in VES-NCD-127 where it is heated to $110^{\circ}\text{F} \pm 15^{\circ}\text{F}$. The volume of the acid per leach cycle is estimated to be approximately 140 gallons which is enough to submerge the HEPA filter. The leaching operation begins when the acid solution is transferred to the leach vessel and heated by steam to $176^{\circ} \pm 15^{\circ}\text{F}$ keeping the vessel lid closed. Air sparging at 12 scfm is initiated immediately. The filter is leached for 40 minutes. The leachate waste solution is then drained to VES-NCD-123. Second and third leach cycles follow the first leach cycle.

After completion of the three leach cycles, two water rinses are conducted at ambient temperature for 15 minutes each. The volume of water per rinse cycle is approximately 130 gallons. The last rinsate sample is collected from the leach vessel sample port and the rinsate is drained to VES-NCD-123.

After transferring all leachate and rinsate to VES-NCD-123, liquid composite samples are collected from VES-NCD-123 for RCRA characterization through dedicated sampling station SAM-NCC-620 and sent to the RAL via the PTS for analyzing TC Metals, VOC/SVOC, Hg, TRU, and acidity.

After completion of the leaching and rinsing cycles, the filter is dried in the leaching vessel. The drying operation is performed by forcing air through an air heater to raise the air temperature to 425°F . The air is then forced into the bottom of the vessel, through the filter, and out to the vent at the top of the leach vessel. The drying air temperature is controlled by a thermocouple downstream of the air heater. Two additional thermocouples monitor the air temperature at the leaching vessel air inlet and the leaching vessel vent outlet. Drying time is 12 to 18 hours.

After the filter is dried, the leaching basket containing the leached filter is removed from the leaching vessel by the cell crane and placed on the filter handling table for media sampling. The basket is rotated upside down with the in-cell remotely operated equipment, so that the fiber glass screen is upward. The lid of the leach basket is then opened for media sampling.

5.0 LEACHING OF NWCF SPENT FILTERS

This section describes the nitric acid leaching trials of six NWCF spent filters using the existing filter leaching facility and employing the leaching process parameters described in the section 3.0. The details of the six pre-leached NWCF filters are described in Appendix A, Table A-4.

In the course of the trials, it was observed that the average time of filter transportation from the PaR parking area to the filter handling cell was approximately 45 minutes. Breaching time was approximately 15 minutes. During filter breaching, the sharp spikes of the breaching tool did not fully penetrate inside the filter media as designed. Additional forces by the PaR were necessary for full penetration of the sharp spike into the filter media.

Prior to the start up of the leaching trials, VES-NCD-123 was flushed with 2000 gallons of water to clean out as many contaminants as possible. RCRA samples from the heel of VES-NCD-123 were collected and sent to the RAL via the PTS to analyze for TC Metals, Hg, VOC/SVOC, TRU, and acidity.

The molarity of the nitric acid used in the leaching trials is presented in Table 2 below:

Table 2. Nitric acid molarity for filter leach.

Filter ID	Molarity
NWT-1	1.5
NWT-2	1.38
NWT-3	1.5
NWT-4	1.6
NWT-5	2.0
NWT-6	1.75

At the conclusion of the leaching and rinsing cycles, the leachate and rinsate was drained to VES-NCD-123. The filters were then dried for 12-18 hours inside the leach vessel. Appendix A, Tables A-6 through A-11, fully describe the process parameters for each of the six filters.

RCRA samples for the leachate and rinsate were taken remotely from VES-NCD-123 through SAM-NCC-620 and sent to the RAL via the PTS. It is to be noted that a total of 517 liquid sample bottles of 15 ml-glass were sent to the RAL for analysis for this entire test.

Post-leach filter media was too loose and brittle for core sampling. (See Appendix A, Table A-5.) Samples were placed in two 8 oz glass bottles using the master-slave manipulators. The average radiation level in the sample bottles for all six filters was below 100 mr/hr-(β/γ). The sample bottles, along with trip blanks, were transported by hand to the RAL for RCRA analysis of TC Metals, Hg, acidity, Gamma scan, TRU, VOC, and SVOC.

At the conclusion of the trials, two leached filters, along with the leach basket, were placed within a wooden box which measured 6.1 inches x 31.5 inches x 16.5 inches inside the decon cell. Two of the wooden boxes were sized to fit inside a standard waste box (4 ft x 4 ft x 8 ft) for removal to waste staging building CPP-1617 prior to transport to RWMC.

5.1 Leaching of Filter #1

The filter was transported from the PaR parking area to the filter handling cell and positioned inside the leach basket. The maximum radiation level was measured to be 19.6 R/hr(γ). The condition of the filter media along with the housing appeared to be normal. Calcine particles were noticed on the fiber glass screen side of the filter. After breaching, the filter, along with the leach basket, was placed inside leach vessel VES-NCD-155 for leaching. After completion of leaching, the rinsate (2nd cycle) was sampled from VES-NCD-155. Average acid heatup time in VES-NCD-155 was 58 minutes. Both leach cycles were completed without any difficulties. The air sparge rate was 12-30 scfm. During the acid heatup for the third cycle, the low pressure steam valve (LS-155-1) handle was broken. After the handle had been repaired, all remaining leach and rinse cycles were completed. The average leachate/rinsate drain time from VES-NCD-155 to VES-NCD-123 was approximately 36 minutes. The rinsate sample (2nd cycle) radiation level was 4 mR/hr(β/γ) and was hand-carried to the RAL under RCT escort. RCRA samples from VES-NCD-123 were sent to the RAL via the PTS.

The leached filter was dried inside the leach vessel for 16 hours. After the completion of the drying cycle, the leach basket was pulled out from the leach vessel and placed over the filter handling table. The basket was rotated upside down so that the fiber glass screen side was in the upward position and the basket lid was open. The filter media and fiber glass screen were intact. The filter media was brittle and loose. The sample tool was unable to collect a cored sample due to the brittle condition of the filter media. The filter media samples were collected by grab sampling in random locations and packed inside two 8 oz glass bottles (>20 gm each bottle) using the master-slave manipulator. The radiation level of the media sample bottles was 50 mR/hr(β/γ). The sample bottles and trip blank (>30 gm) were hand-carried to the RAL under RCT escort.

5.2 Leaching of Filter #2

The second filter was transferred to the filter handling cell from the PaR parking area. The filter condition was not good. The filter media was disintegrated and the filter housing was separated from the filter media. The fiber glass screen was found torn. The radiation level was measured to be 5 R/hr(γ). The filter media was breached and placed inside VES-NCD-155 for leaching.

After the completion of the first leach cycle, the leachate could not be drained from leach vessel VES-NCD-155 to VES-NCD-123 due to plugging of the drain line by the disintegrated filter pulp which came out of the leach basket. A temporary blow back line was connected to the drain line and the plugged drain line was cleared using low pressure nitrogen gas. All leach and rinse cycles were completed without any problems. The average nitric acid heatup time was 44 minutes and the vessel drain time following the leach/rinse cycle was 46 minutes (excluding leach #1 drain time). During leaching and rinsing, disintegration of the filter media occurred, which probably resulted due to the poor condition of the filter media. Some of the filter media came out of the leach basket in slurry form. The radiation level in the second rinsate sample was 5 mR/hr(β/γ). It was hand-carried to the RAL under RCT escort. RCRA samples for the leachate and rinsate were collected and sent to the RAL via the PTS. The filter was dried in the leach vessel for 16 hours. The leach basket was pulled out from the leach vessel and placed upside down on the filter handling table.

The lid of the basket was opened for media sampling. Severe disintegration of the media samples was evident. Most of the disintegrated filter media (99%) stayed inside the leach basket. Media samples were taken in two 8 oz glass bottles (60 mR/hr(β/γ)) and hand-carried to the RAL under RCT escort.

5.3 Leaching of Filter #3

This spent filter was used in the last campaign (H3) of NWCF. The pre-leach radiation level was 85 R/hr(γ) and it was in very good condition. The filter was transported to the filter handling cell from the PaR parking area for leaching. The acid heatup rate was 39 minutes. The average vessel drain time was 29 minutes. The filter was breached and leached without any problems. The radiation level for the second rinse sample was 5 mR/hr(β/γ). The filter was dried for 16 hours. The media sample 35 mR/hr(β/γ) was collected and hand-carried to the RAL along with the media trip blank and rinsate sample under RCT escort. The RCRA samples for the leachate and rinsate were collected from VES-NCD-123 and sent to the RAL via the PTS.

5.4 Leaching of Filter #4

This spent filter was also used in the last campaign (H3) of NWCF. It was received in very good condition with a radiation level at 90 R/hr(γ). The filter was breached and leached without any problems. The average acid heatup time for each leach cycle was 36 minutes. The average vessel drain time was 29 minutes. The filter was dried for 18 hours. The leach basket was opened for media sampling. It was noticed that the stainless steel screen of the basket was separated from the basket frame on which the screen was riveted. Also, the latch of the basket lock was dissolved during leaching. It was observed that the rivets in the leach baskets were mistakenly made of aluminum alloys. Leach baskets #5 and #6 were reworked to replace aluminum rivets with stainless steel materials. After collecting media samples in glass bottles, the filter was put inside a wooden waste box (placed in the cell) with the help of the filter handling tool.

The radiation level of the filter media sample was 30 mR/hr(β/γ) and that of the second rinsate sample was below 5 mR/hr(β/γ). All samples were

hand-carried to the RAL under RCT escort. The RCRA samples for leachate/rinsate were pulled from VES-NCC-123 remotely and sent to the RAL via the PTS.

5.5 Leaching of Filter #5

This filter was received in good condition from the PaR parking area. It also was used in the last (H3) NWCF campaign. The maximum radiation level was 120 R/hr(γ) in pre-leach condition. The filter was leached with the stainless steel screen side down. The average acid heatup time was 48 minutes for each leach cycle. During vessel draining for both second and third leach cycles, drainline strainer plugging was experienced and it resulted in a longer drain time of 62 minutes for the second leach and 40 minutes for the third leach cycle. The average vessel drain time was 41 minutes. The filter was dried for 16 hours in the leach vessel. After drying, the leach basket was pulled out and placed over the filter handling table. The lid of the basket was opened for sampling. It was observed that the fiber glass screen was completely destroyed. Severe disintegration of the filter media had also occurred. The filter media was collapsed; especially in the mid-section of the filter. It is to be noted that this filter was leached with the stainless steel screen side down. During leaching, coupled with air sparging, the fiber glass screen at the top of the HEPA filter could not sustain the hydrodynamic pressure of the leaching solution, which resulted in the failure of the fiber glass screen of the filter. Some of the filter media (2%) was dispersed into the leach/rinse solution as a slurry mass and plugged the vessel drain strainer during the second and third leach cycle. The media samples were taken in two glass bottles 80 mR/hr(β/γ) and hand-carried to the RAL under RCT escort with the second rinsate sample 5 mR/hr(β/γ). The RCRA samples for leachate and rinsate were collected from VES-NCD-123 and sent to the RAL via the PTS.

5.6 Leaching of Filter #6

The maximum radiation level of this filter was measured to be 18 R/hr(γ) in pre-leach condition. The filter condition was good and it was breached and leached without any problem. The average acid heatup time was 38 minutes for each leach cycle. The average vessel drain time was 42 minutes. The filter was dried for 16 hours. It was noticed that the latch of the basketlock dissolved completely. Media samples 90 mR/hr(β/γ) were collected and hand-carried to the

RAL along with the second rinse sample $<5 \text{ mR/hr}(\beta/\gamma)$ under RCT escort. RCRA samples for leachate and rinsate were collected from VES-NCD-123 and sent to the RAL via the PTS.

6.0 RESULTS

The six NWCF spent HEPA filters were successfully leached in the existing leach facility. During the leaching process, some operational problems were experienced which are not insurmountable. These problems will be corrected during the modification of the existing leaching system which is expected to commence in early 1995.

Post-leach media sample analysis results were below regulatory levels for the toxic characteristics (40 CFR 261.24). The TRU and non-TRU radiological characteristics of the leached filter media sample met RWMC disposal criteria for low-level radioactive waste. The volatile/semi-volatile organic constituents were analyzed but the results of the analysis were not accepted due to the expiration of holding times per regulatory requirements. All six filters were resampled for volatile and semi-volatile organic compounds analysis. The results of the analysis showed that the extent of contamination by those organics was extremely small and the HEPA filters can be disposed of as low-level radioactive waste. The results of the testing are being submitted to the State of Idaho for a regulatory determination which is made possible pursuant to a regulatory provision to exclude low-hazard debris from RCRA requirements [40 CFR 261.3(f)(2)]. After treatment in the HFLS, the leachate and rinsate will be considered hazardous waste and will be sampled for characterization purposes. Detailed chemical analysis of the media samples and composite samples of leachate and rinsates for all six filters is presented in Appendix A, Tables A-16 through A-25.

Two leached filters along with the leach baskets were placed in a wooden waste box. Two of the wooden waste boxes containing filters #1, 2, 3, and 4 were placed in a standard waste box. The radiological level (β/γ) was measured to be 120 mR at contact and 10 mR at a 3 foot distance. The other standard waste box contained only one wooden box (filters #5 and 6 along with the leach baskets) and the radiation level (β/γ) was reported to be 50 mR at contact and 15 mR at a

3 foot distance. Both standard wooden waste boxes containing the leached filters met RWMC disposal criteria for shipment.

7.0 DISCUSSION

All six HEPA filters were leached under similar conditions except filter #5 which was leached upside down with the fiber glass screen side up. The pre-leach and post-leach filter conditions are described in Appendix A, Tables A-4 and A-5. Post-leach media sample analyses revealed that all six filters treated in the HFLS were below regulatory levels for the toxic characteristic. (See Table 1).

TRU and non-TRU radiological analysis showed that the leached filters met INEL low-level radioactive waste acceptance criteria (DOE/ID-10112, Rev. 5). The volatile organics were analyzed per 57FR37230, August 18, 1993. All media sample analyses will be submitted to the State of Idaho. Filter leach test results have shown that the extent of organic contamination is extremely small and will conform to "debris treatment" so that the leached filters can be disposed as low-level non-hazardous waste (40 CFR 268). All chemical and radiological analysis is presented in Appendix A, Tables A-16 through A-25.

During leaching and rinsing of the filters, it was evidenced that small disintegrated filter particles in pulp form were coming out of the leach basket. The phenomenon was observed to the greatest extent during the leaching of filters #2 and #5. Filter #2 was received in a disintegrated form and filter media was separated from the stainless steel housing. During the leaching of this filter, the VES-NCD-155 drainline became clogged by escaping filter pulp from the leach basket after the first leach cycle. The clogged drainline was cleared by connecting a temporary air blow down line in the drainline. Filter #5 was leached in the upside down (fiber glass screen side up) position. Test results showed that leaching efficiency was as good as that of the other filters. It appeared that filter orientation did not have any affect on leaching efficiency. However, destruction of the fiber glass screen and severe filter media disintegration were evidenced during the leaching of filter #5. The fiber glass screen could not sustain the air sparged liquid pressure during the leaching/rinsing cycles and tore apart. Most (98%) of the disintegrated filter media was contained in the leach basket. Some of the filter pulp came out of the

leach basket and clogged the leach vessel drain strainer resulting in longer vessel drain time.

During filter leach operations #1 through #6, filter particulates in the form of pulp were evidenced during the leaching and rinsing cycles and they came out of the leach basket. The use of smaller screen mesh in the leach basket may not be a viable solution to preclude escaping of filter pieces out of the leach basket. The filter pieces may clog the leach basket screen and affect leaching efficiency. It is suggested to install a permanent blow back system in the vessel drainline of the modified leaching system to clean the clogged drainline. During leaching of filter #4, the latch in the locking mechanism of the basket was completely dissolved. The stainless steel screen mesh became separated from the basket frame due to the dissolution of the aluminum rivets by the nitric acid. During leaching of filter #6, the latch of the basket locking mechanism was also dissolved which probably resulted from incompatible materials.

In the modified leaching system design, there is no provision for a blow down mechanism in the leach vessel drainline. Moreover, the drainline is designed in such a manner that post-leach disintegrated solid filter media will be drained out along with the leachate and rinsate to VES-NCD-123. This is unacceptable; therefore, incorporation of a permanent blow back mechanism in the vessel drainline and redesign of the vessel drain system are essential to preclude clogging of the leach vessel drainline and also to avoid the transfer of disintegrated filter media into VES-NCD-123.

The waste volume produced in the filter leaching trials is shown in Appendix A, Table A-12. The waste volume of leachate and rinsate generated during the leaching of each filter was 678 gallons in the existing filter leach system. As mentioned in section 3.0, the piping occupies the bottom 8 inches of the existing leaching vessel. Therefore, the existing leaching system is generating 45 gallons of unnecessary waste per leach/rinse cycle. As a result, 225 gallons of liquid waste generation will be minimized per filter leached in the modified leaching system (see section 8).

The leachate and rinsate waste generated during the course of the leaching trials was transferred to the PEW evaporator except during filter #2 leach, where the liquid waste was transferred to VES-NCC-119 due to high chloride content.

That process waste was sent to the PEW evaporator after being combined with a lower chloride waste solution in VES-NCC-119. The composite sample analysis of leachate and rinsate is shown in Appendix A, Table A-13.

The process analysis results of the leachate and rinsate for filters #1, 3, 4, and 6 met the PEW evaporator acceptance criteria for disposal. The leachate and rinsate analysis of filters #2 and #5 showed higher chloride content which did not conform to the PEW evaporator acceptance criteria. The other constituents (F^- , SO_4^{--} , and Hg^{++}) in the leachate and rinsate solution of all six filters were well below the PEW evaporator acceptance limit. It is suggested that the leachate and rinsate solution be mixed with another similar waste prior to disposal to the PEW evaporator to minimize chloride content. It had been expected that the leachate and rinsate waste solution would go to the tank farm, but it was transferred to the PEW evaporator which resulted in a substantial savings in tank farm volume.

Assuming the composite samples of the leachate and rinsate will meet PEW acceptance criteria, a total of 453 gallons of waste volume would be produced per filter leach in the modified filter leach system and transferred to the PEW evaporator. Due to lower molarity of the acid solution used in the filter leaching operation, a 30.1 reduction ratio in the PEW evaporator is assumed. Thus, 15 gallons of waste solution from the PEW evaporator bottom will go to the tank farm per filter leach under the modified filter leach system.

The average leaching time in the existing process included filter handling from the PaR parking area, breaching, leaching, and rinsing activities. It is estimated that 10 hours total leaching time will be required to leach a spent NWCF filter without anticipating any delays. Appendix A, Table A-14 presents a comprehensive breakdown of filter handling and leaching time requirements.

8.0 MODIFICATION OF PRESENT SYSTEM

The majority of facility modifications are within the filter handling cell and would not require additional penetrations in the wall between the filter handling cell and the clean operating corridor. Figure 6 shows a sketch of the proposed modifications which include removal of the existing leaching vessel; replacement with a new leaching vessel; modifications to the filter handling

Figure 6. Modified filter leaching system plan view.

table so that rinsed filters can be partially drip dried; removal of the existing sampling station and filter basket table; and installation of a separate filter drying vessel.

The existing leaching vessel has performed all functions required for filter leaching, but there are mitigating factors which support a replacement. The existing vessel produces 45 gallons of unnecessary liquid waste per filter leach because eight inches of the leaching vessel bottom is occupied by piping. In addition, the height of the existing leaching vessel obstructs the operator's view of almost half of the filter handling table which adversely affects the operability of the system. Finally, the leaching vessel is designed to accommodate filters up to 24 inches x 24 inches x 12 inches high. There are at least ten filters at the ICPP which measure 30 inches x 24 inches x 12 inches, and more of the same size at SPERT. The existing vessel cannot be used for the leaching of those filters. The new filter leaching vessel is designed to leach all filters sizes (one filter at a time for large filters, and four filters at a time for small filters). The total number of spent HEPA filters stored at the ICPP is presented in Table 3 below:

Table 3. Number of spent HEPA filters currently at the ICPP.

Source	Radiation Level	Inventory	Filter Dimensions
Fluorinel Dissolution Process (FDP)	20-30 R 20-30 R	129 (DOG) ¹ 2-4 (COG) ²	8" x 8" x 6" 8" x 8" x 6"
New Waste Calcining Facility (NWCF)	>50 R	113	2' x 2' x 1'
Radioactive Waste Management Complex (RWMC)	>50 R	34	2' x 2' x 1'
Atmospheric Protection System/Vessel Off-Gas (APS/VOG)	>10 R	9	2' x 2' x 1'
Atmospheric Protection System/Cell Off-Gas (APS/COG)	>5 R	100	2' x 2' x 1'
Waste Calcining Facility (WCF)	>25 R	10-12	28" x 24" x 8"

¹ Dissolver Off-Gas

² Cell Off-Gas

The modified leaching system is designed to minimize the volume of leaching and rinsing solution requirements by eliminating much of the wasted volume at the bottom of the leach vessel. Stainless steel filler blocks could also be used to displace volume when leaching all but the largest filters. The modified leaching vessel would be shorter than the existing vessel by approximately one foot which would provide better operator visibility of the leach vessel interior and the filter handling table. A schematic of the modified leaching system is shown in Figure 7.

The proposed leaching system modification does not include a vessel blow down mechanism and the vessel drainline goes directly to the cell drain trench. The present validation test of the six NWCF HEPA filters experienced both vessel drainline and strainer plugging by filter media. This phenomena suggests that a permanent blow down mechanism in the vessel drainline, coupled with a drain pan with strainer (like the existing system), should be considered to prevent drainline clogging and transfer of disintegrated filter media to VES-NCD-123.

9.0 FILTER THROUGHPUT

Several factors will significantly affect the HEPA filter leaching throughput rate including drying time, manpower availability, sampling requirements, sample analysis turnaround, equipment failure rate, and releaching of filters. It is difficult to quantify the filter throughput for the HEPA filter leaching system. The following approach makes a reasonable estimate of filter throughput. A batch of four large filters (or sixteen small filters) could be processed in a batch mode through the modified leaching system in five working days with two shifts in operation. (See Appendix A, Table A-15.) Time estimates for each step are based on the experience obtained in the leaching test. (See Appendix A, Table A-14.) It is assumed all four filters would be leached without any interruptions and all leachate and rinsate would be transferred to VES-NCD-123. The estimated volume of leachate and rinsate would be 1812 gallons which could then be sampled for disposal. The waste volume might need to be added to another waste stream to lower the chloride content to meet the PEW evaporator acceptance criteria.

A processing rate of four filters per week would equate to a monthly throughput rate of seventeen large filters per month. The above monthly

Figure 7. Modified filter leaching system flow chart.

throughput value assumes full-time operation of the system and does not consider lost time to equipment breakdown, repair, or other related constraints. Considering equipment downtime and intermittent operation of the leach system (50% downtime) it is estimated eight large filters could be leached per month.

10.0 CONCLUSIONS

After completion of leaching of all the six hot filters, the following results were derived:

- Six NWCF HEPA filters were leached successfully without any major problems using the existing leaching system.
- Most (>98%) of the loose post-leach filter media stayed inside the leach basket.
- During leaching, disintegrated filter media in the form of "pulp" was evidenced in the leaching solution. It had escaped from the leach basket and plugged the vessel drainline during the leaching of filters #2 and #5.
- Media sample analysis revealed that the filter leach concept (with modified process parameters) met both RCRA and radiological criteria for disposal as low-level waste.
- Filter orientation does not have any affect on leaching to remove hazardous and radiological particulates; however, severe media disintegration was evidenced due to the destruction of the fiber glass screen of the HEPA filters.
- The breaching tool did not perform effectively.

11.0 RECOMMENDATIONS

Leaching activities of the six hot filters determined that the following steps should be taken for the success of the HEPA filter leaching process:

- Installation of a blow down mechanism and a drain pan with strainer is highly recommended to minimize restricted drainlines and undissolved solids (filter media) in VES-NCD-123.
- The material compatibility of the latch in the locking system of the leaching basket must be ensured.
- It is desirable to collect post-leach media samples employing batch sampling techniques because core sampling is impractical.
- The filter should be leached stainless steel screen side up to prevent severe filter media disintegration.
- The need for breaching filters should be evaluated.
- The breaching tool should be redesigned and rebuilt for easy penetration inside the filter media during mechanical breaching.
- A sampling station outside the leach vessel should be added.

12.0 REFERENCES

1. G. W. Hogg Letter (HOGG-23-92) to L. F. Ermold, "HEPA Filter Leach Technical Bases and Operating Recommendation"
2. Thornton H. Waite, Design and Installation of a Radioactive Filter Leaching System at the Idaho Chemical Processing Plant. Proceedings, 36th Conference on Remote System Technology, 1988, Volume 2.

APPENDIX A

FILTER LEACH TRIALS DATA

Table 4. Pre-leach filter condition.

Filter No.	Filter ID	Media Condition	Housing Condition	Screens Condition	Maximum Radiation Level (r)	Remarks
NWT-1	Not available	Good	Good	Good	20 R/hr	Large particles of calcine noticed (blue tint color)
NWT-2	Not available	Fair	Warped	Fiberglass screen damaged	5 R/hr	No evidence of calcine material over the filter media
NWT-3	8-27-93 #2 pre-filter	Good	Good	Good	85 R/hr	Large particles of calcine noticed (blue tint color)
NWT-4	8-27-93 #2 middle filter	Good	Good	Good	90 R/hr	No evidence of calcine material over the filter media
NWT-5	5-27-93 #4 pre-filter	Good	Good	Good	120 R/hr	No evidence of calcine material over the filter media.
NWT-6	7-15-93 #3 middle filter	Good	Good	Good	18 R/hr	No evidence of calcine material over the filter media.

Filters #3 and #4 were in-service from 8-27-93 to 9-15-93.

Filter #5 was in-service from 5-27-93 to 6-27-93.

Filter #6 was in-service from 7-15-93 to 8-21-93.

Table 5. Post-leach filter drying parameters, filter media conditions and sampling.

	Filter #1	Filter #2	Filter #3	Filter #4	Filter #5	Filter #6	Remarks
Filter ID	NWT-1	NWT-2	NWT-3	NWT-4	NWT-5	NWT-6	Grab samples were taken on all filters due to media deterioration.
Drying Air Temp ('F)	420	420	420	420	420	420	
Air Flow Rate (scfm)	50	50	50	50	50	50	
Drying Time (hrs)	16	17	13	12	12	12	
Media Condition	Loose and brittle	Loose and extremely brittle (10% of loose filter in the basket)	Loose and brittle	Loose and brittle	Media blown apart. Extremely loose and brittle	Loose and brittle	Most of the loose media was contained in the basket.
Location of Samples	Random	Random	Random	Random	Random	Random	
Weight of the Sample	>40 gm	>40 gm	>40 gm	>40 gm	>40 gm	>40 gm	
Sample Radiation Level (β/γ)	50 mR/hr	60 mR/hr	35 mR/hr	80 mR/hr	90 mR/hr	90 mR/hr	
Weight of trip blank	>20 gm	>20 gm	>20 gm	>20 gm	>20 gm	>20 gm	

Table 6. HEPA filter leach/rinse cycles (Filter ID - NWT#1).

	Leach #1	Leach #2	Leach #3	Rinse #1	Rinse #2	Remarks
Approximate Acid/Water Volume in VES-NCD-155 (gallons)	143	143	143	138	138	
Acid heating time (min)	45	50	80*			* Acid heating was stopped due to breakage of LS-155-2 valve handle. After the repair of the valve handle, acid heating resumed. Acid heat up time was longer because the acid in the leach vessel had cooled down.
Acid Solution temp °F during leaching	182-188	180-190	186-190			
Leaching time (min)	40	40	40			
Water temperature °F during rinsing				85-89	74-78	
Rinse time (min)				15	15	
Sparge rate (scfm)	12-30	12-30	12-30	12-30	12-30	
Vessel drain time (min)	49	37	32	25	38	

Table 7. HEPA filter leach/rinse cycles (Filter ID - NWT#2).

	Leach #1	Leach #2	Leach #3	Rinse #1	Rinse #2	Remarks
Approximate Acid/Water Volume in VES-NCD-155 (gallons)	146.6	146.6	146.6	126.5	126.5	
Acid heating time (min)	50	40	43			
Acid Solution temp °F during leaching	174-190	170-190	172-190			
Leaching time (min)	40	40	40			
Water temp °F during rinsing				84	74-75	
Rinse time (min)				15	15	
Sparge rate (scfm)	12	12	12	12	12	
Vessel drain time (min)	600*	50	43	42	47	* Vessel drain line clogged.

Table 8. HEPA filter leach/rinse cycles (Filter ID - NWT#3).

	Leach #1	Leach #2	Leach #3	Rinse #1	Rinse #2	Remarks
Approximate Acid/Water Volume in VES-NCD-155 (gallons)	138	138	138	139	139	
Acid heating time (min)	45	34	37			
Acid Solution temp °F during leaching	167-191	170-190	168-191			
Leaching time (min)	40	40	40			
Water temp °F during rinsing				82-90	76-80	
Rinse time (min)				15	15	
Sparge rate (scfm)	12-30	12-30	12-30	12-30	12-30	
Vessel drain time (min)	26	30	30	32	27	

Table 9. HEPA filter leach/rinse cycles (Filter ID - NWT#4).

	Leach #1	Leach #2	Leach #3	Rinse #1	Rinse #2	Remarks
Approximate Acid/Water Volume in VES-NCD-155 (gallons)	133	133	133	118.5	118.5	
Acid heating time (min)	40	32	37			
Acid Solution temp °F during leaching	167-191	170-191	168-191			
Leaching time (min)	40	40	40			
Water temp °F during rinsing				82-90	76-80	
Rinse time (min)				15	15	
Sparge rate (scfm)	12-30	12-30	12-30	12-30	12-30	
Vessel drain time (min)	26	30	30	32	27	

Table 10. HEPA filter leach/rinse cycles (Filter ID - NWT#5).

	Leach #1	Leach #2	Leach #3	Rinse #1	Rinse #2	Remarks
Approximate Acid/Water Volume in VES-NCD-155 (gallons)	138	138	138	139.5	139.5	
Acid heating time (min)	40	66	40			
Acid Solution temp °F during leaching	174-191	170-191	169-191			
Leaching time (min)	40	40	40			
Water temp °F during rinsing				91-94	88-94	
Rinse time (min)				15	15	
Spurge rate (scfm)	12-30	12-30	12-30	12	12	
Vessel drain time (min)	37	62*	40*	35	30	* Drain pan strainer got plugged.

Table 11. HEPA filter leach/rinse cycles (Filter ID - NWT#6).

	Leach #1	Leach #2	Leach #3	Rinse #1	Rinse #2	Remarks
Approximate Acid/Water Volume in VES-NCD-155 (gallons)	139	139	139	112.5	112.5	
Acid heating time (min)	40	35	40			
Acid Solution temp °F during leaching	166-191	172-191	166-191			
Leaching time (min)	40	40	40			
Water temp °F during rinsing				88-89	76-77	
Rinse time (min)				15	15	
Sparge rate (scfm)	12-30	12-30	12-30	12-30	12-30	
Vessel drain time	45	42	45	40	36	

Table 12. Acid/water volume consumed and waste volume generated during filter leach.

Filter	#1	#2	#3	#4	#5	#6	Average
Acid Volume (gallons)	430	440	414	400	414	419	419.5
Water Volume (gallons)	276	253	279	237	279	225	258
Waste Volume (gallons)	706	693	693	637	693	644	677.5
Projected Acid Volume in Modified System (gallons)	295	305	279	265	279	284	284.5
Projected Water Volume in Modified System (gallons)	186	163	189	147	189	135	168
Projected Waste Volume Generation in Modified System (gallons)	481	468	468	412	468	419	452.6

Table 13. Analysis of leachate and rinsate from VES-NCD-123.

Constituents	PEW Evaporator Acceptance Limit	Filter #1	Filter #2	Filter #3	Filter #4	Filter #5	Filter #6
Cl ⁻ (ppm)	50	40	195	30	30	144	33.1
Fl ⁻ (ppm)	200	25.6	25.64	25.6	70	79	25.6
SO ₄ ⁼⁼ (ppm)	100	60	56.9	71.5	76.7	75.1	108
Hg ⁺⁺ (ppm)	80	4.64	5.09	4.38	2.98	7.79	3.73
Undissolved Solids (g/liter)	50	6.6	1.43	2.6	3.28		

NOTE: After leaching filter #6, leachate in VES-NCD-123 was diluted before transferring from VES-NCD-123 to the PEW evaporator.

Table 14. Filter handling and leaching time.

Activity	Time (min)
1. Transfer filter from PaR parking area to filter handling cell	45
2. Position filter into the leach basket	10
3. Breach filter	15
4. Position the leach basket with the filter inside the leach vessel	10
Total time for filter handling	80
5. Acid transfer and heat up in VES-NCD-155	45
6. Leach cycle	40
7. Drain time	40
Total leach time	$125 \times 3 = 375$
8. Rinse time	15
9. Drain time	40
Total rinse time	$55 \times 2 = 110$

Total leach time = $80 + 375 + 110 = 565$ minutes (approx. 10 hours)

Table 15. Activity schedule for batch throughput.

	Monday	Tuesday	Wednesday	Thursday	Friday
Shift I	<ul style="list-style-type: none"> • Transfer four large filters into the filter handling cell. • Breach filter #1 putting it in the leach basket. • Start leaching filter #1. • Breach other filters. 	<ul style="list-style-type: none"> • Start leaching of filter #2. • Move filter #1 from drying vessel. 	<ul style="list-style-type: none"> • Start leaching of filter #3. • Move filter #2 from drying vessel. 	<ul style="list-style-type: none"> • Start leaching of filter #4. • Move filter #3 from drying vessel. 	<ul style="list-style-type: none"> • Take process sample from VES-NCD-123 for disposal. • Move filter #4 from drying vessel.
Shift II	<ul style="list-style-type: none"> • Complete leaching of filter #1. • Complete breaching of the other filters and put them in leach baskets. • Start drying of filter #1. 	<ul style="list-style-type: none"> • Complete leaching of filter #2. • Start drying of filter #2. 	<ul style="list-style-type: none"> • Complete leaching of filter #3. • Start drying of filter #3. 	<ul style="list-style-type: none"> • Complete leaching of filter #4. • Start drying of filter #4. 	<ul style="list-style-type: none"> • Start moving filters into the cell for leaching. • Clean up cell and prepare for next week's leaching.
Shift III	• Dry overnight.	• Dry overnight.	• Dry overnight.	• Dry overnight.	

Table 16. TRU results on HEPA filter media.

Filter	Log #	Gross Alpha nCi/g
1	022110	3.6
2	022512	1.2
3	030418	0.8
4	031125	1.4
5	03169	0.6
6	032822	0.4

Table 17. Six HFLS filter media samples analyzed for RCRA metals in 1994.

Constituent	Regulatory Limit	Filter #1 94-022110 (mg/l)	Filter #2 94-022512 (mg/l)	Filter #3 94-030418 (mg/l)	Filter #4 94-031125 (mg/l)	Filter #5 94-03169 (mg/l)	Filter #6 94-032822 (mg/l)
Arsenic	5 mg/l	<0.170	<0.681	<0.671	<0.170	<0.170	<0.170
Barium	100 mg/l	0.240	3.62	<0.865	<0.219	0.48	<0.219
Cadmium	1 mg/l	<0.216	<0.866	<0.853	<0.216	<0.216	<0.216
Chromium	5 mg/l	<0.208	<0.833	<0.820	<0.208	<0.208	<0.208
Lead	5 mg/l	<0.143	<0.575	<0.566	<0.143	<0.143	<0.143
Mercury	0.2 mg/l	<0.0402	<0.0402	0.018	0.016	0.092	0.012
Selenium	1 mg/l	<0.149	<0.599	<0.590	<0.149	<0.149	<0.149
Silver	5 mg/l	<0.194	<0.777	<0.765	<0.194	<0.194	<0.194

This table provides the analytical results for each RCRA TC Metal analyzed for in the filter media samples. Detection limits will vary based on the size of the sample dilution.

These analyzes were performed at ICPP laboratories.

Table 18. Six HFLS filter rinsate samples analyzed in 1994 for RCRA metals.

Constituent	Regulatory Limit	Baseline 94-012010 ppm	#1 Rinse 94-022012 ppm	#2 Rinse 94-022512 ppm	#3 Rinse 94-030418 ppm	#4 Rinse 94-0031125 ppm	#5 Rinse 94-03169 ppm	#6 Rinse 94-032619 ppm
Arsenic	5 ppm	<3.55	<0.170	<0.170	<0.681	<0.679	<0.679	<0.681
Barium	100 ppm	<4.03	0.33	2.25	<0.878	1.56	2.34	1.19
Cadmium	1 ppm	<0.539	1.91	1.55	<0.865	20.04	21.58	10.17
Chromium	5 ppm	<4.09	1.63	1.38	13.29	1.20	1.23	0.84
Lead	5 ppm	<4.39	0.28	0.19	<0.575	<0.573	<0.573	<0.575
Mercury	0.2 ppm	<0.001	1.50	3.45	7.85	4.30	9.10	12.00
Nickel	139 ppm	<5.34	0.78	0.75	<0.809	<0.807	<0.807	<0.809
Selenium	1 ppm	<0.550	<0.149	<0.149	2.07	<0.597	<0.597	<0.599
Silver	5 ppm	<1.56	<0.194	<0.777	1.22	<0.775	<0.777	<0.777

This table provides the associated analytical results for each of the RCRA TC Metals analyzed for in the filter rinsate. Detection limits will vary based on the size of the sample dilution.

These analyzes were performed at ICPP laboratories.

In all tables, "rinse" means a composite sample of leachate and rinsate from vessel VES-NCD-123.

Table 19. HFLS 1994 six filter media samples ran for total analysis by GC/MS.

Constituent	CAS Number	Regulatory Limit	Filter #1 94-022110 (ng/ml)	Filter #2 94-022512 (ng/ml)	Filter #3 94-030418 (ng/ml)	Filter #4 94-031125 (ng/ml)	Filter #5 94-03169 (ng/ml)	Filter #6 94-032822 (ng/ml)
Chloromethane	74-87-3	U045 33,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Vinyl Chloride	75-01-4	U043 33,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Bromomethane	74-83-9	U029 15,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
1,1-Dichloroethene	75-35-4	U078 33,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Acetone	67-64-1	F003 180,000 ng/ml U002 180,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Carbon Disulfide*	75-15	F005 N/A	87	45J & 720	<50	<50	<50 & <48	<50 & <49
Methylene Chloride*	75-08-2	F002 33,000 ng/ml U080 33,000 ng/ml	<52	<50 & <49	<50	97*	130* & 140*	130* & 100*
trans-1,2-Dichloroethene	156-80-5	U079 33,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
1,1-Dichloroethane	75-34-3	U078 7,200 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
cis-1,2-Dichloroethene		N/A	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Methyl Ethyl Ketone (2-Butanone)	78-93-3	F005 38,000 ng/ml U159 38,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Chloroform*	67-66-3	U044 5800 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
1,1,1-Trichloroethane*	71-55-6	F002 5800 ng/ml U228 5800 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Carbon Tetrachloride*	56-23-5	U211 5800 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Benzene*	71-43-2	F005 3700 ng/ml U019 38,000 ng/ml	<52	<50 & <49	520	<50	<50 & <48	<50 & <49
1,2-Dichloroethane	107-06-2	U077 7,200 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Trichloroethane*	78-01-8	F002 5800 ng/ml U228 5800 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
1,2-Dichloropropane	78-87-5	U083 18,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Bromodichloromethane	75-27-4	N/A	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
cis-1,3-Dichloropropene	10061-01-5	U084 18,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Methyl Isobutyl Ketone (4-Methyl-2-Pentanone)	108-10-1	F003 33,000 ng/ml U161 33,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Toluene	108-88-3	F005 28,000 ng/ml U220 28,000 ng/ml	<52	<50 & <49	870	<50	<50 & <48	<50 & <49

Table 19 (continued).

Constituent	CAS Number	Regulatory Limit	Filter #1 94-022110 (ng/ml)	Filter #2 94-022512 (ng/ml)	Filter #3 94-030418 (ng/ml)	Filter #4 94-031126 (ng/ml)	Filter #5 94-03169 (ng/ml)	Filter #6 94-032822 (ng/ml)
trans-1,3-Dichloropropene	10061-02-6	U084 18,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
1,1,2-Trichloroethane*	78-00-6	F002 7800 ng/ml U227 5800 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Tetrachloroethene*	127-18-4	F002 5800 ng/ml U210 5800 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
2-Hexanone		N/A	<52	<50 & <49	X	<50	<50 & <48	<50 & <49
Dibromochloromethane		N/A	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Chlorobenzene	108-90-7	F002 5700 ng/ml U037 5700 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
Ethylbenzene	100-41-4	F003 8,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
m-Xylene & p-Xylene	1330-20-7	F003 28,000 ng/ml U239 28,000 ng/ml	<52	<50 & <49	107	<50	<50 & <48	<50 & <49
o-Xylene	1330-20-7	F003 28,000 ng/ml U239 28,000 ng/ml	<52	<50 & <49	285	<50	<50 & <48	<50 & <49
Styrene		N/A	<52	<50 & <49	285	<50	<50 & <48	<50 & <49
Bromoform	75-25-2	U225 15,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49
1,1,2,2-Tetrachloroethane	79-34-6	U209 42,000 ng/ml	<52	<50 & <49	<50	<50	<50 & <48	<50 & <49

* Insoluble organics identified in the HFLS Waste Analysis Plan (WAP) that require regulatory determination.

** Shown because they are CLP calibrated analytes.

J - Indicates an estimated value for an analyte which is detected and identified, but the level is below the minimum reporting limit.

X - Identification of this analyte is not possible due to severe matrix interferences.

a - Concentration around 100 ng/ml can be considered laboratory contamination.

These analyses were performed at ICPP laboratories

Table 20. HFLS 1994 initial six filter media samples extracted by ZHE and analyzed by GC/MS.

Constituent	CAS Number	Regulatory Limit	Filter #1 94-022010 (ng/ml)	Filter #2 94-022512 (ng/ml)	Filter #3 94-030418 (ng/ml)	Filter #4 94-031125 (ng/ml)	Filter #5 94-03189 (ng/ml)	Filter #6 94-032822 (ng/ml)
Chloromethane	74-87-3	U045 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
Vinyl Chloride	75-01-4	D043 200 ng/ml U043 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
Bromomethane	74-83-9	U029 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
1,1-Dichloroethene	75-35-4	D029 700 ng/ml U078 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
Acetone	67-64-1	U002 N/A	< 20	11 & 11	130	< 10	230E	not needed
Carbon Disulfide*	75-15	F005 4800 ng/ml P022 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
Methylene Chloride*	75-09-2	F002 N/A U080 N/A	< 20	< 10 & < 10	< 10	18X	19X	not needed
trans-1,2-Dichloroethene	156-60-5	U079 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
1,1-Dichloroethane	75-34-3	U078 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
cis-1,2-Dichloroethene		U079 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
Methyl Ethyl Ketone (2-Butanone)	78-93-3	D036 200,000 ng/ml U169 N/A	120	120 & 120	110	80	78	not needed
Chloroform*	67-68-3	D022 8000 ng/ml U044 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
1,1,1-Trichloroethane*	71-55-6	F002 N/A U226 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
Carbon Tetrachloride*	56-23-5	D019 500 ng/ml U211 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
Benzene*	71-43-2	D018 500 ng/ml F005 N/A U019 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
1,2-Dichloroethane	107-08-2	D028 500 ng/ml U077 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
Trichloroethene*	79-01-8	D040 500 ng/ml F002 N/A U228 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
1,2-Dichloropropane	78-87-5	U083 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
Bromodichloromethane	75-27-4	N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed
cis-1,3-Dichloropropene	10061-01-5	U084 N/A	< 20	< 10 & < 10	< 10	< 10	< 10	not needed

Table 20 (continued).

Constituent	CAS Number	Regulatory Limit	Filter #1 94-022010 (ng/ml)	Filter #2 94-022512 (ng/ml)	Filter #3 94-030418 (ng/ml)	Filter #4 94-031125 (ng/ml)	Filter #5 94-03189 (ng/ml)	Filter #6 94-032822 (ng/ml)
Methyl Isobutyl Ketone (4-Methyl-2-Pentanone)	108-10-1	F003 N/A U181 N/A	<20	<10 & <10	<10	<10	<10	not needed
Toluene	108-88-3	F005 N/A U220 N/A	<20	<10 & <10	<10	<10	<10	not needed
trans-1,3-Dichloropropane	10081-02-8	U084 N/A	<20	<10 & <10	<10	<10	<10	not needed
1,1,2-Trichloroethane*	79-00-5	F002 N/A U227 N/A	<20	<10 & <10	<10	<10	<10	not needed
Tetrachloroethane*	127-18-4	D039 700 ng/ml F002 N/A U210 N/A	<20	<10 & <10	<10	<10	<10	not needed
2-Hexanone		N/A	<20	<10 & <10	<10	<10	<10	not needed
Dibromochloromethane		N/A	<20	<10 & <10	<10	<10	<10	not needed
Chlorobenzene	108-90-7	D021 100,000 ng/ml F002 N/A U037 N/A	<20	<10 & <10	<10	<10	<10	not needed
Ethylbenzene	100-41-4	F003 N/A	<20	<10 & <10	<10	<10	<10	not needed
m-Xylene & p-Xylene	1330-20-7	F003 N/A U239 N/A	<20	<10 & <10	<10	<10	<10	not needed
o-Xylene	1330-20-7	F003 N/A U239 N/A	<20	<10 & <10	<10	<10	<10	not needed
Styrene		N/A	<20	<10 & <10	<10	<10	<10	not needed
Bromoform	75-25-2	U225 N/A	<20	<10 & <10	<10	<10	<10	not needed
1,1,2,2-Tetrachloroethane	79-34-6	U209 N/A	<20	<10 & <10	<10	<10	<10	not needed

* Insoluble organics identified in the HFLS Waste Analysis Plan (WAP) that require regulatory determination.

X - Concentrations around 20 ng/ml may be considered laboratory contamination.

E - Indicates an estimated value for an analyte which is detected but the level is above the maximum reporting limit.

These analyses were performed at ICPP laboratories

Table 21. HFLS 1994 filter media samples repulled and ran for total analysis by GC/MS.

Constituent	CAS Number	Regulatory Limit	Filter #1 84-072715 (ng/ml)	Filter #2 84-072717 (ng/ml)
Chloromethane	74-87-3	U045 33,000 ng/ml	<10	<10 & <10
Vinyl Chloride	75-01-4	U043 33,000 ng/ml	<10	<10 & <10
Bromomethane	74-83-9	U029 15,000 ng/ml	<10	<10 & <10
1,1-Dichloroethane	75-35-4	U078 33,000 ng/ml	<10	<10 & <10
Acetone	67-64-1	F003 180,000 ng/ml U002 180,000 ng/ml	<10	11 & <10
Carbon Disulfide*	75-15	F005 N/A	<10	<10 & <10
Methylene Chloride*	75-09-2	F002 33,000 ng/ml U080 33,000 ng/ml	<10	<10 & <10
trans-1,2-Dichloroethane	156-80-5	U079 33,000 ng/ml	<10	<10 & <10
1,1-Dichloroethane	75-34-3	U076 7,200 ng/ml	<10	<10 & <10
cis-1,2-Dichloroethane		N/A	<10	<10 & <10
Methyl Ethyl Ketone (2-Butanone)	78-93-3	F005 36,000 ng/ml U159 36,000 ng/ml	<10	<10 & <10
Chloroform*	67-68-3	U044 5600 ng/ml	<10	<10 & <10
1,1,1-Trichloroethane*	71-55-6	F002 5600 ng/ml U228 5600 ng/ml	<10	<10 & <10
Carbon Tetrachloride*	56-23-5	U211 5600 ng/ml	<10	<10 & <10
Benzene*	71-43-2	F005 3700 ng/ml U019 36,000 ng/ml	<10	<10 & <10
1,2-Dichloroethane	107-08-2	U077 7,200 ng/ml	<10	<10 & <10
Trichloroethane*	78-01-6	F002 5600 ng/ml U228 5600 ng/ml	<10	<10 & <10
1,2-Dichloropropane	78-87-5	U083 18,000 ng/ml	<10	<10 & <10
Bromodichloromethane	75-27-4	N/A	<10	<10 & <10
cis-1,3-Dichloropropane	10061-01-5	U084 18,000 ng/ml	<10	<10 & <10
Methyl Isobutyl Ketone (4-Methyl-2-Pentanone)	108-10-1	F003 33,000 ng/ml U161 33,000 ng/ml	<10	<10 & <10

Table 21 (continued).

Constituent	CAS Number	Regulatory Limit	Filter #1 94-072715 (ng/ml)	Filter #2 94-072717 (ng/ml)
Toluene	108-88-3	F005 28,000 ng/ml U220 28,000 ng/ml	<10	<10 & <10
trans-1,3-Dichloropropene	10061-02-8	U084 18,000 ng/ml	<10	<10 & <10
1,1,2-Trichloroethane*	79-00-5	F002 7800 ng/ml U227 5800 ng/ml	<10	<10 & <10
Tetrachloroethane*	127-18-4	F002 5800 ng/ml U210 5800 ng/ml	<10	<10 & <10
2-Hexanone		N/A	7.4 J	9.3 J & <10
Dibromochloromethane		N/A	<10	<10 & <10
Chlorobenzene	108-90-7	F002 5700 ng/ml U037 5700 ng/ml	<10	<10 & <10
Ethylbenzene	100-41-4	F003 8,000 ng/ml	<10	<10 & <10
m-Xylene & p-Xylene	1330-20-7	F003 28,000 ng/ml U239 28,000 ng/ml	<10	<10 & <10
o-Xylene	1330-20-7	F003 28,000 ng/ml U239 28,000 ng/ml	<10	<10 & <10
Styrene		N/A	<10	<10 & <10
Bromoform	75-25-2	U225 15,000 ng/ml	<10	<10 & <10
1,1,2,2-Tetrachloroethane	79-34-6	U209 42,000 ng/ml	<10	<10 & <10

* Insoluble organics identified in the HFLS Waste Analysis Plan (WAP) that require regulatory determination.

J - Indicates an estimated value for an analyte which is detected and identified, but the level is below the minimum reporting limit.

Table 22. Six HFLS filter leachate/rinsate samples analyzed in 1994 for RCRA volatile organic carbons.

Constituent	CAS Number	Regulatory Limit	Baseline Rinse 94-01	#1 Rinse 94-022012 ppb	#2 Rinse 94-02259 ppb	#3 Rinse 94-030415 ppb	Duplicate #3 Rinse 94-030415 ppb	#4 Rinse 94-031121 ppb	Duplicate #4 Rinse 94-031121 ppb	#5 Rinse 94-03167 ppb	#6 Rinse 94-032819 ppb
Chloromethane	74-87-3	U045 190 ppb D043 200 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	75-01-4	U043 270 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromomethane	74-83-9	U029 110 ppb D029 700 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene	75-35-4	U078 25 ppb F003 280 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Acetone	67-64-1	U002 280 ppb	<10	136	47	<10	<10	33	16	<10	<10
Carbon Disulfide*	75-15	F005 14 ppb P022 14 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Methylene Chloride*	75-09-2	F002 89 ppb U080 89 ppb	<10	<10	<10	<10	<10	<10	11	<10	19
trans-1,2-Dichloroethene	156-60-5	U079 54 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	75-34-3	U076 59 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene	150-60-5	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10
Methyl Ethyl Ketone (2-Butanone)	78-93-3	D035 200,000 ppb F005 280 ppb U159 280 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloroform*	67-66-3	D022 6000 ppb U044 46 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,1-Trichloroethane*	71-55-6	F002 54 ppb U226 54 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Carbon Tetrachloride*	56-23-5	D019 500 ppb F002 57 ppb U211 57 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzene*	71-43-2	D018 500 ppb F005 70 ppb U019 140 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichloroethane	107-06-2	D028 500 ppb U077 210 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Trichloroethene*	79-01-6	D040 500 ppb F002 54 ppb U228 54 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichloropropane	78-67-5	U083 850 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromodichloromethane	75-27-4	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10
cis-1,3-Dichloropropene	10061-01-5	U084 36 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Methyl-2-Pentanone	108-10-1	F003 140 ppb U161 140 ppb	<10	18	17	13	13	11	11	13	11
Toluene	108-88-3	F005 80 ppb U220 80 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10

Table 22 (continued).

Constituent	CAS Number	Regulatory Limit	Baseline Rinse 94-01	#1 Rinse 94-022012 ppb	#2 Rinse 94-02259 ppb	#3 Rinse 94-030415 ppb	Duplicate #3 Rinse 94-030415 ppb	#4 Rinse 94-031121 ppb	Duplicate #4 Rinse 94-031121 ppb	#5 Rinse 94-03167 ppb	#6 Rinse 94-032819 ppb
trans-1,3-Dichloropropene	10061-02-6	U084 36 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane*	79-00-5	F002 30 ppb U227 54 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tetrachloroethene*	127-18-4	D039 700 ppb F002 56 ppb U210 56 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Hexanone	591-78-6	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dibromochloromethane	124-48-1	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chlorobenzene	108-90-7	F002 57 ppb D021 100,000 ppb U037 57 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Ethylbenzene	100-41-4	F003 57 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
m-Xylene & p-Xylene	1330-20-7	F003 320 ppb U239 320 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
o-Xylene	1330-20-7	F003 320 ppb U239 320 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
Styrene	100-42-5	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromoform	75-25-2	U225 630 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2,2-Tetrachloroethane	79-34-6	U209 57 ppb	<10	<10	<10	<10	<10	<10	<10	<10	<10

* Insoluble organics identified in the HFLS Waste Analysis Plan (WAP) as requiring a regulatory determination.

In all tables, "rinse" means a composite sample of leachate and rinsate from vessel VES-NCD-123.

Table 23. Six HFLS filter media samples analyzed for RCRA semi-volatile organic carbons in 1994.

Constituent	CAS Number	Regulatory Limit	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6
		ppb	94-072715	94-072717	94-072714	94-072713	94-072712	94-072711
			ppb	ppb	ppb	ppb	ppb	ppb
n-Nitrosodimethylamine	62-75-9	P082 NA	<10	<10	<10	<10	<10	<10
Phenol	108-95-2	U188 6200	<10	<10	<10	<10	<10	<10
bis(2-Chloroethyl) Ether	111-44-4	U025 7200	<10	<10	<10	<10	<10	<10
2-Chlorophenol	95-57-8	U048 5700	<10	<10	<10	<10	<10	<10
1,3-Dichlorobenzene	541-73-1	U071 6200	<10	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	106-46-7	U072 6200	<10	<10	<10	<10	<10	<10
1,2-Dichlorobenzene	95-50-1	U070 6200 D027 7500	<10	<10	<10	<10	<10	<10
2-Methylphenol	95-48-7	U052 5600 D023 200000	<10	<10	<10	<10	<10	<10
2,2'Oxybis(1-Chloropropane)		NA	<10	<10	<10	<10	<10	<10
n-Nitroso-di-n-propylamine	621-64-7	U111 14000	<10	<10	<10	<10	<10	<10
3 & 4 methylphenol	108-39-4 106-44-5	U052 3200 D024 200000 D025 200000	<10	<10	<10	<10	<10	<10
Hexachloroethane	67-72-1	U131 28000 D034 3000	<10	<10	<10	<10	<10	<10
Nitrobenzene	98-95-3	U169 14000 D036 2000	<10	<10	<10	<10	<10	<10
Isophorone		NA	<10	<10	<10	<10	<10	<10
2-Nitrophenol	88-75-5	NA	<10	<10	<10	<10	<10	<10
2,4-Dimethylphenol	105-67-9	U101 14000	<10	<10	<10	<10	<10	<10
bis(2-chloroethoxy)methane	111-91-1	NA	<10	<10	<10	<10	<10	<10
2,4-Dichlorophenol	120-83-2	U081 14000	<10	<10	<10	<10	<10	<10
1,2,4-Trichlorobenzene	120-82-1	NA	<10	<10	<10	<10	<10	<10
Naphthalene	91-20-3	U165 3100	<10	<10	<10	<10	<10	<10
4-Chloroaniline	106-47-8	P024 16000 U128 28000	<10	<10	<10	<10	<10	<10
Hexachlorobutadiene	87-68-3	D033 500	<10	<10	<10	<10	<10	<10
4-Chloro-3-Methylphenol	59-50-7	NA	<10	<10	<10	<10	<10	<10
2-Methylnaphthalene	91-57-6	NA	<10	<10	<10	<10	<10	<10
Hexachlorocyclopentadiene	77-47-4	U130 3600	<10	<10	<10	<10	<10	<10
2,4,5-Trichlorophenol	95-95-4	D041 400000	<10	<10	<10	<10	<10	<10
2,4,6-Trichlorophenol	88-06-2	D042 2000	<10	<10	<10	<10	<10	<10
2-Chloronaphthalene	91-58-7	U047 5600	<10	<10	<10	<10	<10	<10
2-Nitroaniline	88-74-4	NA	<10	<10	<10	<10	<10	<10
Dimethyl phthalate	131-11-3	U102 28000	<10	<10	<10	<10	<10	<10
2,6-Dinitrotoluene	606-20-2	U106 28000	<10	<10	<10	<10	<10	<10
Acenaphthylene	208-96-8	NA	<10	<10	<10	<10	<10	<10
3-Nitroaniline	99-09-2	NA	<10	<10	<10	<10	<10	<10

Table 23 (continued).

Constituent	CAS Number	Regulatory Limit	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6
		ppb	94-072715	94-072717	94-072714	94-072713	94-072712	94-072711
			ppb	ppb	ppb	ppb	ppb	ppb
Acenaphthene	83-32-8	NA	<10	<10	<10	<10	<10	<10
2,4-Dinitrophenol	51-28-5	P048 160000	<10	<10	<10	<10	<10	<10
4-Nitrophenol	100-02-7	U170 29000	<10	13	15 U	34	93	12
Dibenzofuran	132-64-98	NA	<10	<10	<10	<10	<10	<10
2,4-Dinitrotoluene	121-14-2	U105 140000 D030 130	<10	<10	<10	<10	<10	<10
Diethyl phthalate	84-66-2	U088 28000	<10	<10	<10	<10	<10	<10
Fluorene	206-44-0	NA	<10	<10	<10	<10	<10	<10
4-Chlorophenylphenyl Ether	7005-72-3	NA	<10	<10	<10	<10	<10	<10
4-Nitroaniline	100-01-6	P077 28000	<10	<10	<10	<10	<10	<10
4,6 Dinitro-2-Methylphenol		NA	<10	<10	<10	<10	<10	<10
n-Nitroso-Diphenyl Amine	156-10-5	NA	<10	<10	<10	<10	<10	<10
Azobenzene	103-33-3	NA	<10	<10	<10	<10	<10	<10
4-Bromophenylphenyl Ether	101-55-3	U030 15000	<10	<10	<10	<10	<10	<10
Hexachlorobenzene	118-74-1	U127 28000	<10	<10	<10	<10	<10	<10
Pentachlorophenol	87-86-5	D037 100000	<10	<10	<10	<10	<10	<10
Phenanthrene	85-01-8	NA	<10	<10	<10	<10	<10	<10
Anthracene	120-12-7	NA	<10	<10	<10	<10	<10	<10
Carbazole	86-74-8	NA	<10	<10	<10	<10	<10	<10
Dibutyl phthalate	84-74-2	U069 28000	<10	<10	<10	<10	<10	<10
Fluoranthene	206-44-0	U120 8200	<10	<10	<10	<10	<10	<10
Pyrene	129-00-0	NA	<10	<10	<10	<10	<10	<10
Butylbenzyl phthalate	85-68-7	NA	<10	<10	<10	<10	<10	<10
Chrysene	218-01-9	U050 8200	<10	<10	<10	<10	<10	<10
Benz[a]anthracene	56-55-3	U018 8200	<10	<10	<10	<10	<10	<10
3,3'-Dichlorobenzidine	91-94-1	U073 NA	<10	<10	<10	<10	<10	<10
bis(2-Ethylhexyl)Phthalate	117-81-7	U028 28000	<10	<10	34*	10	27	26
Diethylphthalate	117-84-0	U107 28000	<10	<10	<10	<10	<10	<10
Benzo[b]fluoranthene	205-99-2	NA	<10	<10	<10	<10	<10	<10
Benzo[k]fluoranthene	207-08-9	NA	<10	<10	<10	<10	<10	<10
Benzo[a]pyrene	50-32-8	U022 8200	<10	<10	<10	<10	<10	<10
Indeno[1,2,3-cd]pyrene	193-39-5	U137 8200	<10	<10	<10	<10	<10	<10
Dibenzo[ah]anthracene	53-70-3	U063 8200	<10	<10	<10	<10	<10	<10
Benzo[ghi]perylene	191-24-2	NA	<10	<10	<10	<10	<10	<10

* Phthalates are commonly used to increase the strength and chemical inertness of plastics; and therefore are laboratory and sample contaminants.
U indicates analyte fails mass spectral confirmation.

These analyses were performed at ICPP laboratories.

Table 24. Six HFLS filter leachate/rinsate samples analyzed in 1994 for RCRA semi-volatile organic carbons.

Constituent	CAS Number	Regulatory	Limit	#1 Rinse	#2 Rinse	#3 Rinse	#4 Rinse	#5 Rinse	#6 Rinse
n-Nitrosodimethylamine	67-75-9	ppb	ppb	<10	<10	<10	<10	<10	<10
Aniline	62-53-3	ppb	ppb	<10	<10	<10	<10	<10	<10
Phenol	108-95-2	ppb	ppb	<10	<10	<10	<10	<10	<10
bis(2-Chloroethyl) Ether	111-44-4	ppb	ppb	<10	<10	<10	<10	<10	<10
2-Chlorophenol	95-57-8	ppb	ppb	<10	<10	<10	<10	<10	<10
1,3-Dichlorobenzene	541-73-1	ppb	ppb	<10	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	106-46-7	ppb	ppb	<10	<10	<10	<10	<10	<10
1,2-Dichlorobenzene	95-50-1	ppb	ppb	<10	<10	<10	<10	<10	<10
o-Cresol	95-48-7	ppb	ppb	<10	<10	<10	<10	<10	<10
m-Cresol	108-38-4	ppb	ppb	<10	<10	<10	<10	<10	<10
p-Cresol	106-44-5	ppb	ppb	<10	<10	<10	<10	<10	<10
n-Nitroso-di-n-propylamine	621-64-7	ppb	ppb	<10	<10	<10	<10	<10	<10
bis(2-Chloroisopropyl) Ether	108-60-1	ppb	ppb	<10	<10	<10	<10	<10	<10
Hexachlorocyclopentadiene	67-72-1	ppb	ppb	<10	<10	<10	<10	<10	<10
Hexachlorobenzene	98-95-3	ppb	ppb	<10	<10	<10	<10	<10	<10
3,5,5-Triethylcyclohex-2-ene	111-91-1	ppb	ppb	<10	<10	<10	<10	<10	<10
2-Nitrophenol	88-75-5	ppb	ppb	<10	<10	<10	<10	<10	<10
2,4-Dimethylphenol	105-67-9	ppb	ppb	<10	<10	<10	<10	<10	<10
2,4-Dichlorophenol	120-83-2	ppb	ppb	<10	<10	<10	<10	<10	<10
1,2,4-Trichlorobenzene	120-82-1	ppb	ppb	<10	<10	<10	<10	<10	<10
Naphthalene	91-20-3	ppb	ppb	<10	<10	<10	<10	<10	<10
4-Chloronitrobenzene	106-47-8	ppb	ppb	<10	<10	<10	<10	<10	<10
Hexachlorobutadiene	67-68-3	ppb	ppb	<10	<10	<10	<10	<10	<10
4-Chloro-3-Methylphenol	58-60-7	ppb	ppb	<10	<10	<10	<10	<10	<10
2-Methylphenol	91-57-8	ppb	ppb	<10	<10	<10	<10	<10	<10
Hexachlorocyclopentadiene	77-47-4	ppb	ppb	<10	<10	<10	<10	<10	<10
2,4,5-Trichlorophenol	88-95-4	ppb	ppb	<10	<10	<10	<10	<10	<10
2,4,6-Trichlorophenol	88-06-2	ppb	ppb	<10	<10	<10	<10	<10	<10
2-Chloronaphthalene	91-58-7	ppb	ppb	<10	<10	<10	<10	<10	<10
o-Nitroaniline	68-74-4	ppb	ppb	<10	<10	<10	<10	<10	<10
Dimethylphthalate	131-11-3	ppb	ppb	<10	<10	<10	<10	<10	<10
2,6-Dimethylbenzene	606-20-2	ppb	ppb	<10	<10	<10	<10	<10	<10
Acenaphthylene	208-68-8	ppb	ppb	<10	<10	<10	<10	<10	<10

In all tables, "rinse" means a composite sample of leachate and rinsate from vessel VES-NCD-123.

Table 24 (continued).

Constituent	CAS Number	Regulatory Limit ppb	#1 Rinse 94-022012 Duplicate	#1 Rinse 94-022012 Duplicate	#2 Rinse 94-02259 Duplicate	#2 Rinse 94-02259 Duplicate	#3 Rinse 94-030415 Duplicate	#3 Rinse 94-030415 Duplicate	#4 Rinse 94-031122 Duplicate	#4 Rinse 94-031122 Duplicate	#5 Rinse 94-03167 Duplicate	#5 Rinse 94-03167 Duplicate	#6 Rinse 94-032819 Duplicate
3-Nitroaniline	99-09-2	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthene	83-32-9	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dinitrophenol	51-28-5	P048 120	96Y	11U	16Y	<10	20	26	17	39Y	<10	23U	21U
4-Nitrophenol	100-02-7	U170 120	22U	29U	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dibenzofuran	132-64-98	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dinitrotoluene	121-14-2	D030 130 U105 320	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Diethylphthalate	84-68-2	U088 200	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fluorene	206-44-0	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Chlorophenylphenyl Ether	7005-72-3	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Nitroaniline	100-01-6	P077 28	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
n-Nitroso-Diphenyl Amine	158-10-5	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Azobenzene	103-33-3	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2-Methyl-4,6-Dinitrophenol	505-71-5	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Bromophenylphenyl Ether	101-55-3	U030 55	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorobenzene	118-74-1	D032 130 U127 55	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Pentachlorophenol	87-86-5	D037 100000	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Carbazole	88-74-8	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Phenanthrene	85-01-8	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Anthracene	120-12-7	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dibutylphthalate	84-74-2	U069 57	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Butylbenzylphthalate	85-68-7	NA	<10	<10	13*	<10	<10	<10	13*	<10	<10	<10	<10
Fluoranthene	206-44-0	U120 68	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Pyrene	129-00-0	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
3,3'-Dichlorobenzidine	81-84-1	U073	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benz[a]anthracene	56-56-3	U018 59	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chrysene	218-01-9	U050 59	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
bis(2-Ethylhexyl)Phthalate	117-81-7	U028 280	160U*	<10	168*	148*	<10	52*	40*	78*	48Y	23Y	18Y
Dioctylphthalate	117-84-0	NA	<10	<10	<10	<10	109*	<10	<10	<10	<10	<10	<10
Benzobifluoranthene	205-99-2	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzokifluoranthene	207-08-9	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzofluoranthene	50-32-8	U022 61	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Indeno[1,2,3-cd]pyrene	193-39-5	U137 5.5	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dibenz[ah]anthracene	53-70-3	U063 55	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzofluoranthene	191-24-2	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Table 25. HEPA filter leaching system (HFLS) initial six filter last process rinse sample.

Constituent	Regulatory Limit	Filter #1 94-022010 (mg/l)	Filter #2 94-022511 (mg/l)	Filter #3 94-030417 (mg/l)	Filter #4 94-031124 (mg/l)	Filter #5 94-031611 (mg/l)	Filter #6 94-032821 (mg/l)
Arsenic	5 mg/l	<0.170	<0.121	<0.671	<0.679	not completed	<0.681
Barium	100 mg/l	<0.219	<0.156	<0.865	<0.879	not completed	<0.878
Cadmium	1 mg/l	<0.216	<1.19	<0.853	<0.863	not completed	0.902
Chromium	5 mg/l	0.212	<1.48	<0.820	<0.831	not completed	2.61
Lead	5 mg/l	<0.143	<1.02	<0.566	<0.573	not completed	<0.575
Mercury	0.2 mg/l	<0.0002	<0.2	0.026	0.46	0.46	0.36
Selenium	1 mg/l	<0.149	<0.826	<0.590	<0.597	not completed	<0.599
Silver	5 mg/l	<0.194	<1.38	<0.765	<0.775	not completed	<0.777

Preliminary (4/4/94)

APPENDIX B
DESIGN OF LEACH BASKET AND SUPPORT FRAME

Figure B-1. Sketch of assembled basket.

Figure B-2. Sketch of basket bail.

Figure B-3. Plan view of basket top assembly
(screen and bail omitted for clarity).

Figure B-4. Plan view of base assembly (screen omitted for clarity).

Figure B-5. Isometric sketch of folded sheet metal box.

Figure B-6. 3-D Isometric view of base assembly
(screen omitted for clarity).

Figure B-7. Side view of basket support assembly (bail omitted for clarity).

Figure B-8. Top view of basket support assembly.

Figure B-9. Section view through side of basket support (bail omitted).

Figure B-10. Detail of top frame of basket support.

Figure B-11. Detail of bottom frame of basket support.

Figure B-12. Sketch of bail assembly for basket support.