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Pollution Prevention Opportunity Assessment for the Neutron Generator Production Facility

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Prepared by
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Pollution Prevention Opportunity Assessment for the Neutron Generator Production Facility

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Abstract

This Pollution Prevention Opportunity Assessment was conducted for the Neutron Generator Production Facility (NGPF) between February and September 2001. The primary purpose of this PPOA was to provide recommendations for possible waste reduction measures of NGPF's Hazardous and Low-Level Radioactive waste streams. This report contains a summary of the information collected and analyses performed with recommended options for implementation. The Sandia National Laboratories/New Mexico Pollution Prevention Group will work with the NGPF to implement these options.

Acknowledgements

The author thanks Max Saad, Sherron Hirdman, Jack Mizner, John Norwalk, Robert Welberry, Donald Malbrough, Ruth Bargman-Romero, Tamara Deming, Daniel Kettleborough, MaryAnn Olascoaga, James Browning and Gilbert Theroux for their participation in the inter-disciplinary team that was responsible for evaluating processes, identifying the sources of the facility's waste streams, and generating the pollution prevention (P2) opportunities called out in this report.

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Executive Summary

The Neutron Generator Production Facility (NGPF) is one of the most advanced facilities of its type in the United States. The NGPF is a non-reactor, non-nuclear facility whose primary purpose is to build neutron generators to meet the nation's deterrence strategy. The NGPF is currently Sandia National Laboratories/New Mexico's (SNL/NM's) largest generator of low-level radioactive waste (LLW) and one of the largest generators of Resource Conservation and Recovery Act (RCRA) regulated hazardous waste. This Pollution Prevention Opportunity Assessment (PPOA) was conducted on the NGPF to provide recommendations for possible waste reduction measures for hazardous and LLW waste streams. The PPOA team consisted of waste management, pollution prevention and facility managers, engineers, and operations personnel. This inter-disciplinary team was responsible for evaluating processes and waste streams, and generating the pollution prevention (P2) opportunities identified in this report.

The largest waste streams for the facility are spent alcohol, spent mixed acids, and personal protective equipment (PPE). These waste streams were targeted for reduction. The PPOA team evaluated the waste stream data and ten potential waste reduction ideas. The ideas were then evaluated based on effectiveness, feasibility, and cost. The ideas were categorized using a P.I.C.K (Possible-Implement-Challenge-Kill) Chart and seven opportunities were selected for further evaluation. The seven P2 opportunities described below are recommended for implementation. These opportunities showed annual cost savings with quick payback periods, and would prove to be effective in reducing hazardous and low-level waste.

Opportunity 1: Alcohol Recycle: Re-distill and/or filter alcohol for reuse either within NGPF or externally

Opportunity 2: Lean Thinking: Integrate Green into NGPF's Lean Thinking Quality Program

Opportunity 3: Elementary Neutralization: Segregate chemicals from different processes for neutralization and Profile as a solid waste capable of disposal through the sanitary sewer system.

Opportunity 4: Chemical Substitution: Evaluate chemical substitution options for solvents, Mold release, and other chemical changes that would not affect the product specifications

Opportunity 5: Radiation Protection Protocol: Develop a Procedure for the characterization of non-radioactive waste leaving the Tritium Envelope.

Opportunity 6: Recycle non-Radioactive PPE: Set up a contract for PPE recycle from non-Radiological areas.

Opportunity 7: Permanent PPE: Purchase shoes for all areas that require booties.

Acronyms

DI	De-Ionized
FY	Fiscal Year
LLW	Low Level Waste
NGPF	Neutron Generator Production Facility
P2	Pollution Prevention
P.I.C.K Chart	Possible Implement Challenge Kill Chart
PPE	Personnel Protective Equipment
PPOA	Pollution Prevention Opportunity Assessment
RMWMF	Radioactive and Mixed Waste Management Facility
RCRA	Resource Conservation and Recovery Act
ROI	Return on Investment
SNL/NM	Sandia National Laboratories/New Mexico

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Introduction

Sandia National Laboratories/New Mexico (SNL/NM) conducts pollution prevention opportunity assessments (PPOAs) for line organizations to evaluate waste-generating processes and identify cost-effective methods to reduce waste. The completed PPOA then is presented to the line organization for implementation.
The goal of a PPOA is to:

- Reduce waste volumes and toxicity
- Implement a system of tracking and reporting environmental improvements
- Reduce the line organization's operational costs

This PPOA was conducted for the Neutron Generator Production Facility (NGPF) between February and September 2001. The primary purpose of this PPOA was to provide recommendations for possible waste reduction measures of NGPF's Hazardous and Low-Level Radioactive waste streams. The process used to perform this PPOA is out lined in Figure 1. This report contains a summary of the information collected and analyses performed with recommended options for implementation. The SNL/NM Pollution Prevention (P2) Group (3124) will work with the NGPF to implement these options.

The PPOA team consisted of waste management, P2, facility managers, engineers and operations personnel. This inter-disciplinary team was responsible evaluating processes and waste streams, and generating the pollution prevention (P2) opportunities identified in Section 5.0 of this report. Information was collected through extensive interviews with facility personnel, site visits, and evaluation of waste disposal and purchasing databases. Waste disposal and purchasing data was collected for all of fiscal year 2000 and the first three quarters of fiscal year 2001. The data was used to establish a baseline and to estimate future waste disposal with the anticipated increase in production. The identification of these opportunities was determined through a multi-stage process occurring over a 3 month time period. This process consisted of brainstorming ideas, screening ideas using a Lean Thinking tool, the P.I.C.K. chart, and conducting technical and cost analyses on the screened options.

The PPOA process for the NGPF was broad in scope extending over all of the production processes. This broad scope was selected because this is the first PPOA preformed at the facility since the neutron generator and tube production processes moved from the Pinellas Plant, Florida to SNL/NM. The results of this PPOA are documented in this report.

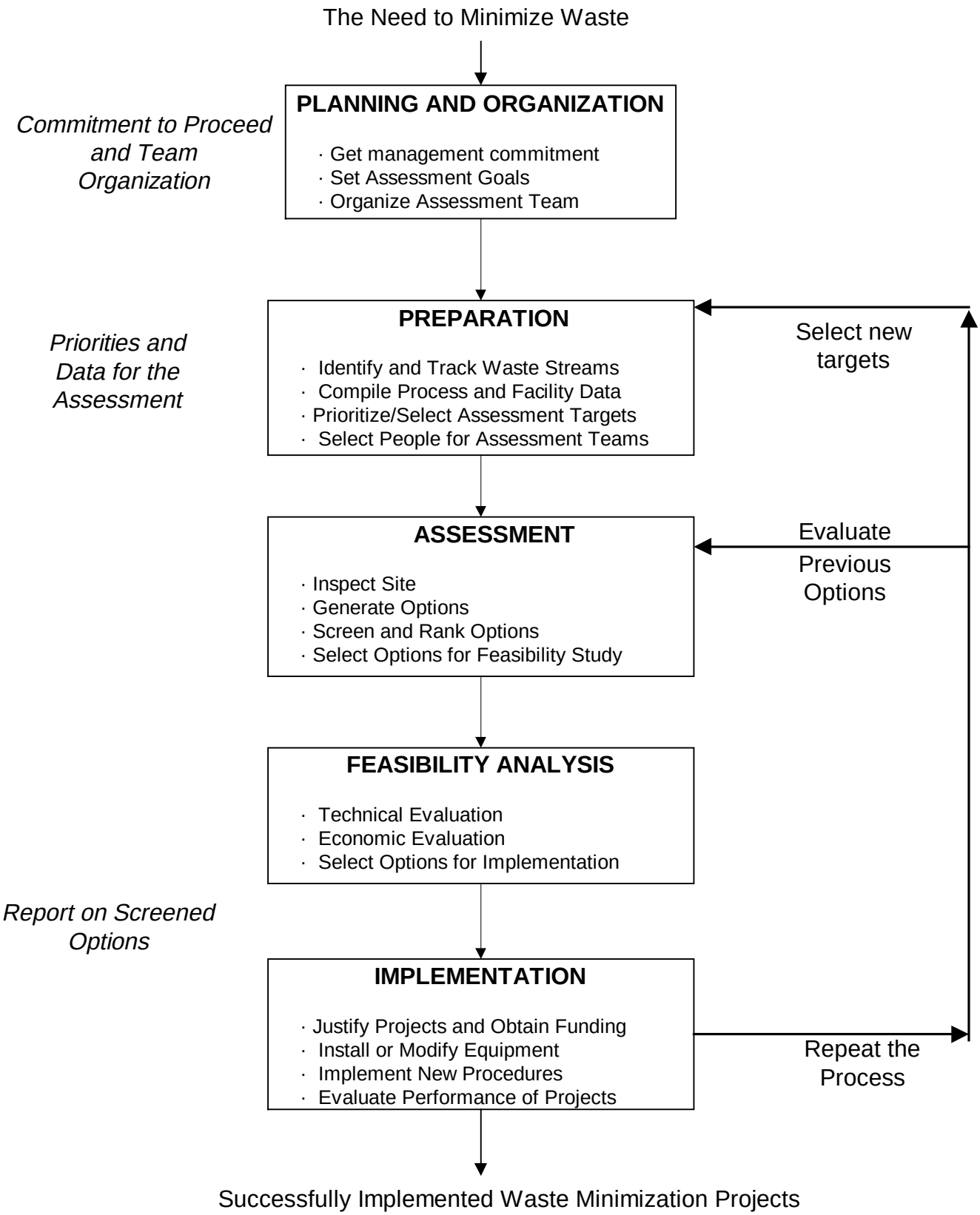

Figure 1. Pollution Prevention Opportunity Assessment Process

Facility Description

NPGF is one of the most advanced production facilities of its type in the United States. The NPGF consists of buildings 870, 857, and 905 at Sandia National Laboratories/New Mexico. The mission of the NGPF is to build neutron generators to meet the nation's deterrence strategy and to deliver a quality product on time. Neutron Generators are miniature particle accelerators. Neutron Generators consist of approximately 100 piece parts that are electrically and mechanically assembled. A completed generator takes more than 6 months to assemble. The NGPF produces approximately 1500 generators per year. There are five phases in the production process of a neutron generator. Each phase has multiple processes. Figure 2 is a process map of the production of a neutron generator with the major processes associated with each phase.

The NGPF is a non-reactor, non-nuclear facility comprised of 100,000 square feet. The NGPF limits all radiological work to the Tritium Envelope, a radiologically controlled area within building 870. Tube Assembly occurs within the Tritium Envelope. The purpose of the Tritium Envelope is to limit the possibility of tritium contamination throughout the facility. The Tritium Envelope has self-contained water and air emissions capture systems to prevent tritium releases to the environment.

Neutron generators have unique production complexities due to stringent performance requirements, complex physics and processes, and the need for extensive prototyping and testing. Changes to the production process undergo a rigorous review and approval process.

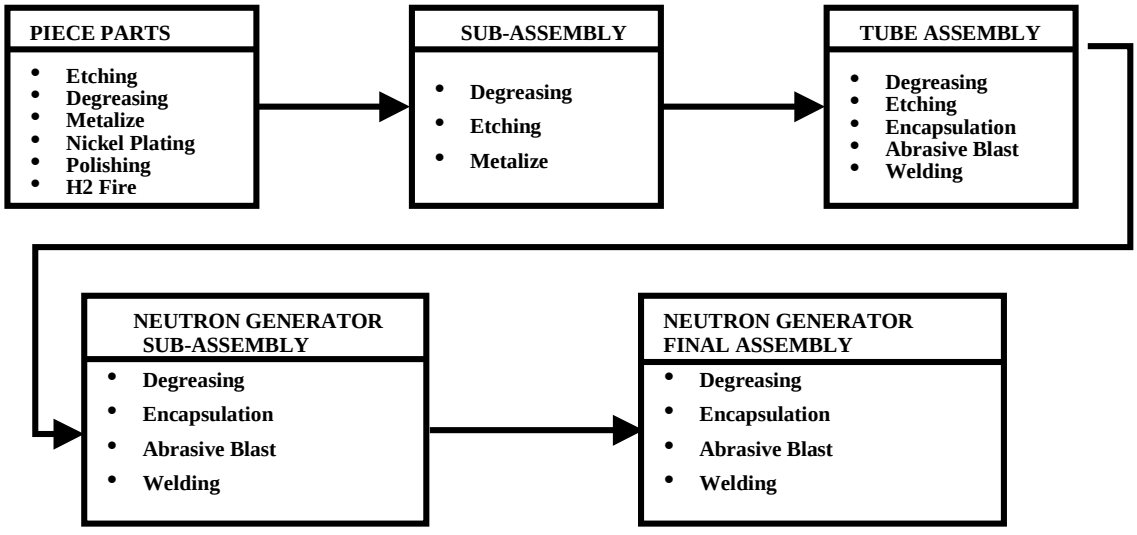

Figure 2. Neutron Generator Production Flow Diagram

Waste Streams

The operation and maintenance activities at the NGPF demands are diverse and generate a large number of waste streams. Total waste generated in fiscal year 2000 (FY00) for hazardous waste (RCRA), solid waste, mixed waste and low-level waste (LLW) is shown in Table 1. NGPF produces approximately 10% of all of SNL/NM's RCRA regulated waste and 60% of the LLW.

Hazardous Waste	1135 kg
Solid Waste	1148 kg
Mixed Waste	5 ft3
Low Level Waste	963 ft3

Table 1. NGPF Waste Generation for Fiscal Year 2000

During fiscal year 2001 (FY01) NGPF has been increasing (ramping up) it's production to full capacity. This ramp up has caused an increase in their routine LLW and hazardous waste. Figures 3 and 4 show the increased generation of LLW and Hazardous, respectively by quarter for FY01. LLW production in FY00 was largely affected by the removal of several HEPA filters, which is considered a non-routine waste source.

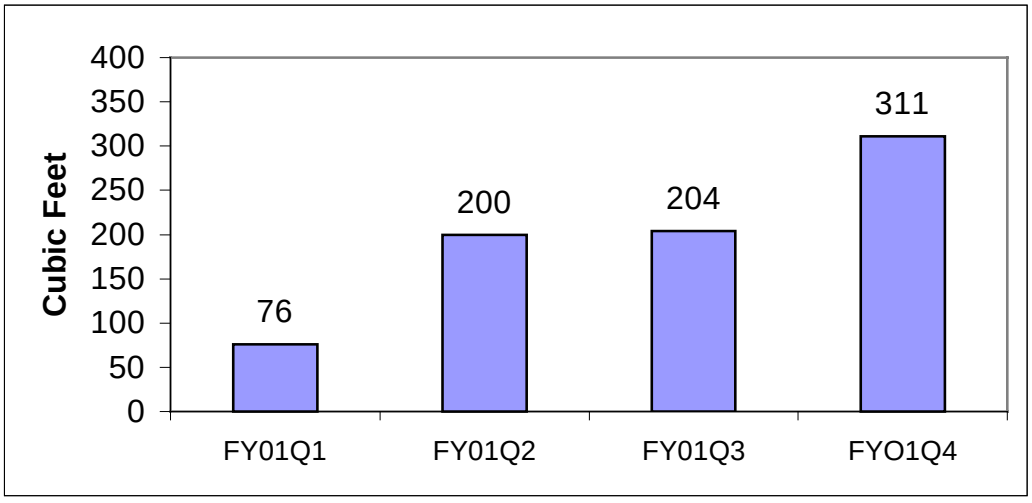

Figure 3. LLW and Mixed Waste Disposal for NGPF During FY01

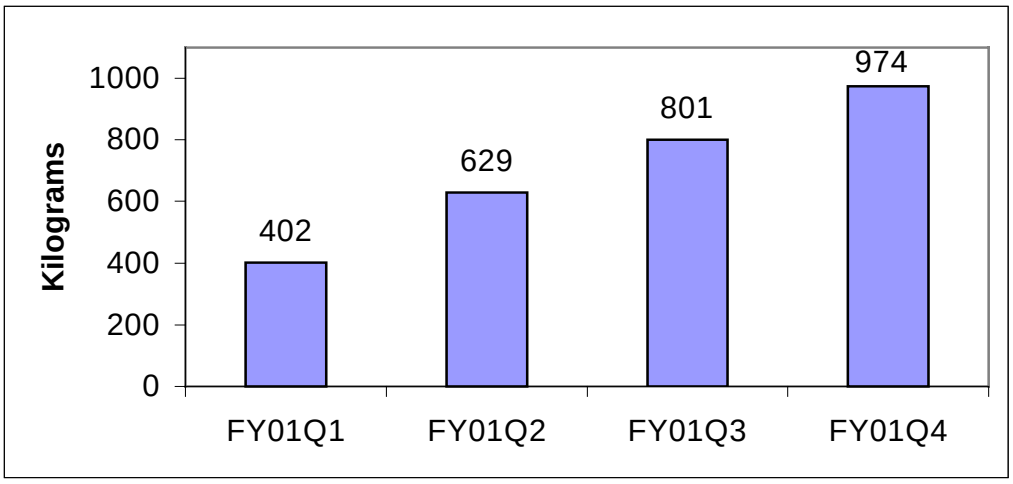

Figure 4. Hazardous Waste Disposal for NGPF during FY01

The primary waste streams of the NGPF are hazardous solvents, mixed acids, and plating solutions, and both low-level and solid waste laboratory trash consisting mainly of personnel protective equipment (PPE) including lab coats, gloves and booties. Figure 5 is a flow diagram of the production process identifying the products used and waste streams associated with each process.

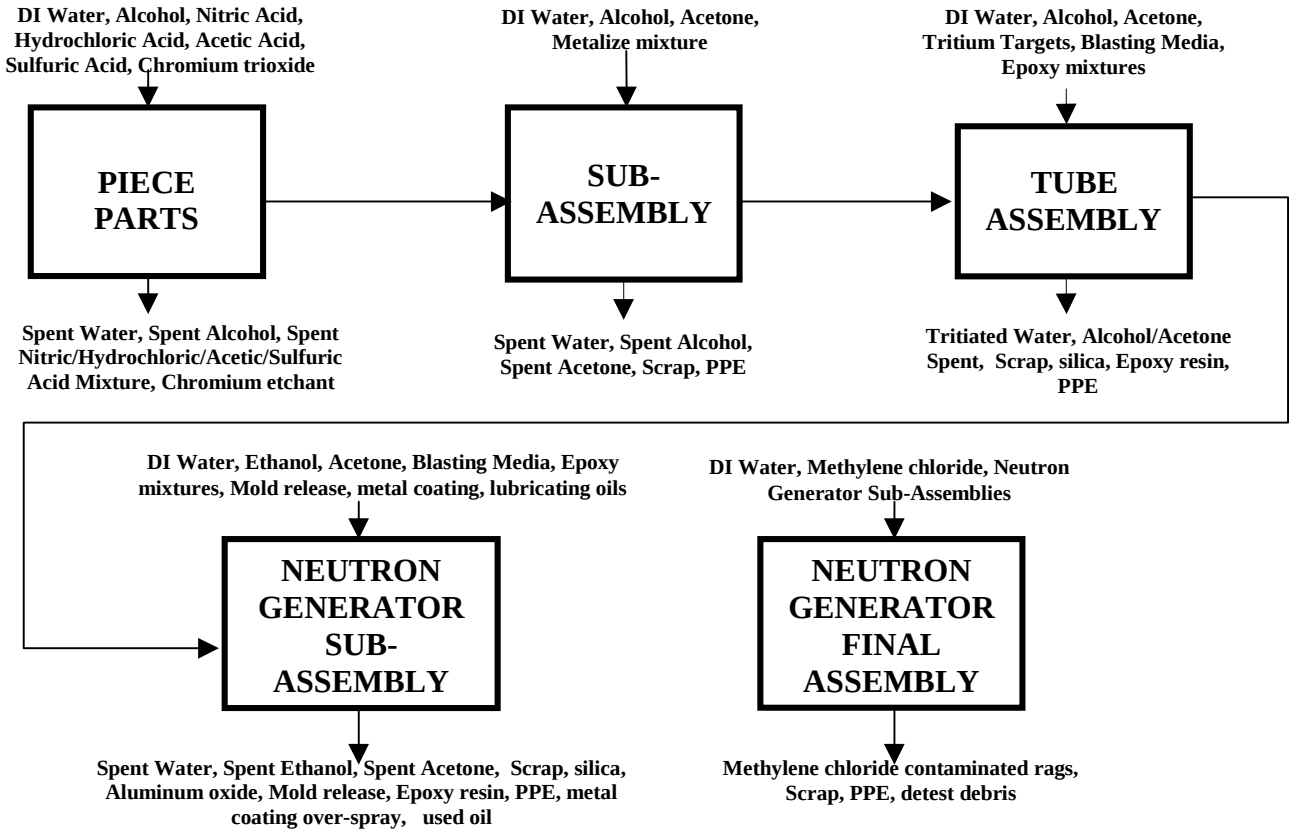

Figure 5. NGPF Flow Diagram with Major Waste Streams

Hazardous Waste Streams

The NGPF produces approximately 40 different hazardous waste streams. The largest hazardous waste streams are shown in Figure 6. The largest waste stream for the facility is spent alcohol. Alcohol is used through out the facility as a solvent, degreaser and cleaner. The remaining hazardous waste streams are comprised of other solvents and acids. The solvents and acids are mainly used for degreasing and etching respectively.

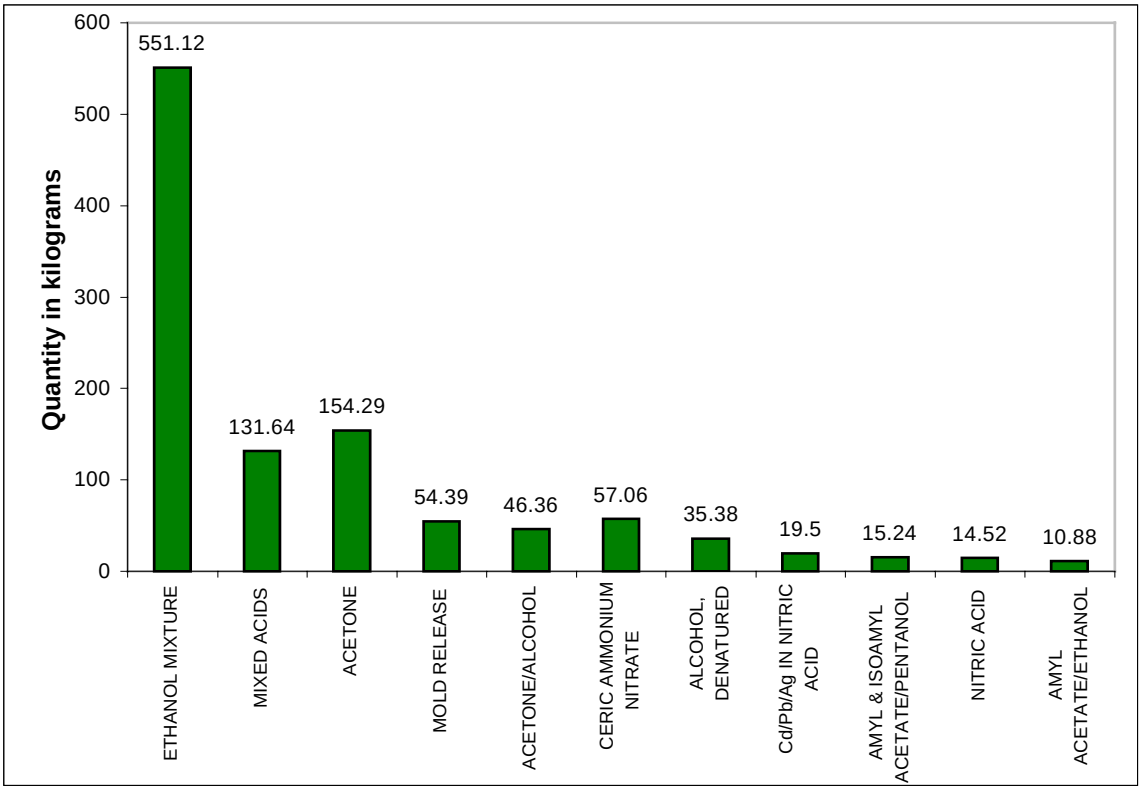

Figure 6. Top RCRA-Regulated Wastestreams for 14400 in FY00

Solid Waste Streams

The NGPF produces approximately 35 different non-RCRA chemical solid waste streams. The largest solid waste streams are shown in Figure 7. Only waste streams requiring a disposal request that are entered in the Oracle Environmental System are reported. SNL/NM does not currently have a separate mechanism for tracking individual solid waste streams disposed to the dumpster.

Alumina or aluminum oxide is the largest solid waste stream. Alumina is used in abrasive blasting. Alumina was profiled in FY01 and is now disposed in the solid waste dumpster stream. Waste streams not currently tracked by the facility include glass, plastic, cardboard, and aluminum.

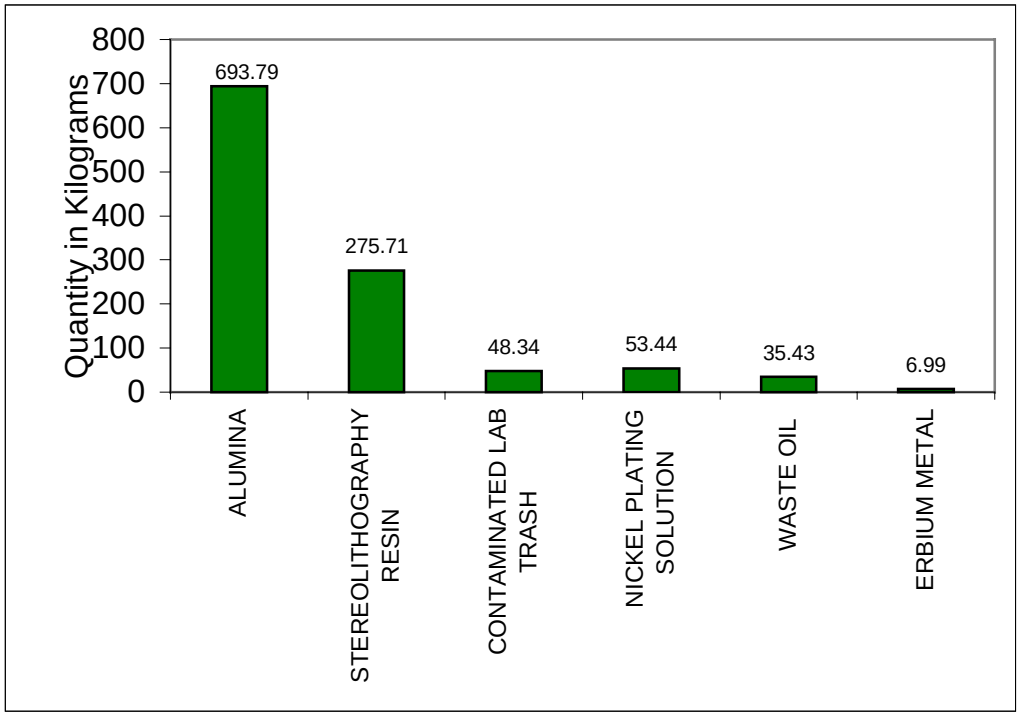

Figure 7. Top Non-RCRA Chemical Wastestreams for 14400 in FY00

Low Level and Mixed Radioactive Waste

All low level and mixed waste is produced in the Tritium Envelope. Current facility procedures require that all material from this area is disposed as either low level or mixed, depending on the presence of a hazardous constituent. Figures 8 and 9 show the distribution of the different waste types.

Compactable, solid waste from routine operations is disposable PPE including suits, lab coats, gloves, booties and skullcaps. A large portion of this waste stream is Tyvek™ material. Non-compactable, solid waste from routine operations consists largely of scrap metal, computer parts, glass, plastic, and filters. Non-compactable, liquid waste from routine operations is tritiated water and target waste. This waste stream is solidified at the Radioactive and Mixed Waste Management Facility (RMWMF) and sent off-site for disposal. Non-compactable waste from non-routine operations consists of vacuum pumps, HEPA filters, scrap metal, glass, and plastic generated from clean out and demolition projects. This waste stream is generated during a spill or other event that is not part of the facilities normal operation, and varies from year to year. The change out of HEPA filters, for instance, was the major component of this waste stream in FY00.

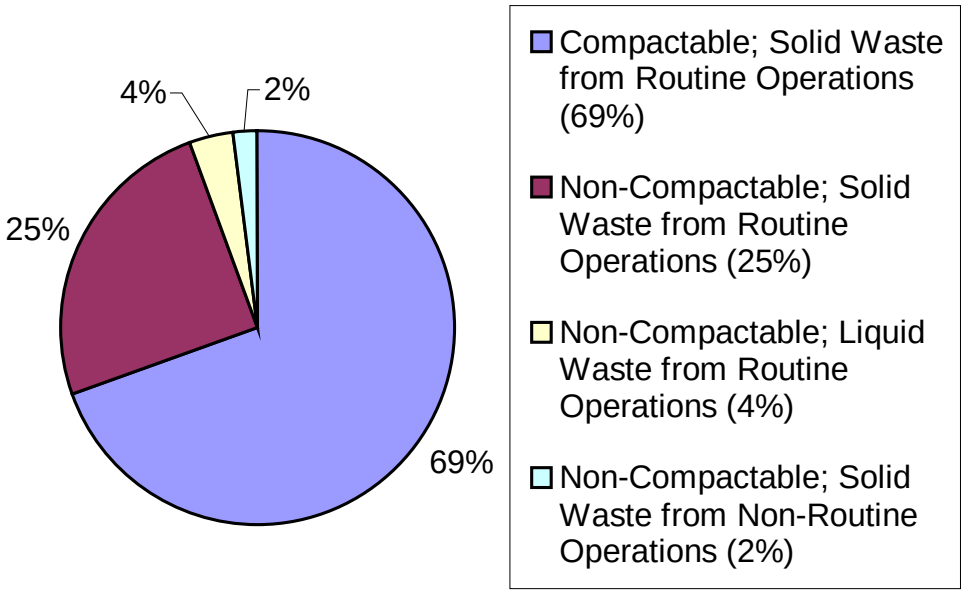

Figure 8. Distribution of Low Level Waste Types

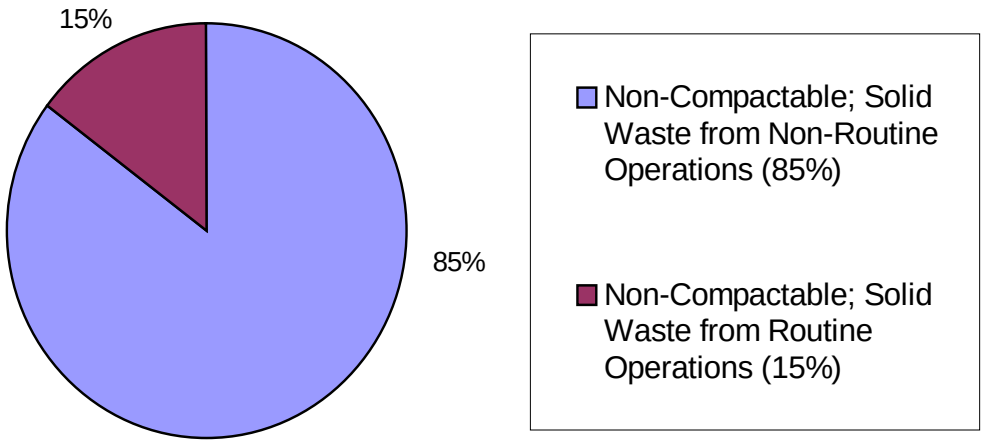

Figure 9. Distribution of Mixed Waste Types

Current Activities

Waste Profiling

Over the last couple of years, the SNL/NM Legal and the Regulatory Compliance Departments have allowed organizations like the NGPF to "profile" certain waste streams as non-hazardous that were previously managed as hazardous. This profiling process allows wastes to be removed from the RCRA regulatory requirements and be disposed as solid waste. The profiling process requires that facility waste management personnel prove that the waste stream does not meet either the characteristic or listed criteria of a hazardous waste.

Several waste streams have been profiled. This reclassification process reduced the amount of hazardous waste generated at the NGPF by almost 30%, and saved over $40,000 a year in disposal costs. Profiled waste streams included:

- ✓ Rags and wipes contaminated with solvents. This facility was generating over 55-gallons a week of dry solvent contaminated wipes. An evaluation of each generator's processes was reviewed along with a basic training session on the regulatory guidelines for the disposal of these rags.
- ✓ Oily contaminated material. Daily, weekly and monthly preventative maintenance programs generate large amounts of this waste stream.
- ✓ Wastewater, consisting of 15% soap, 20% ethanol and 75% DI water solution. About 20 gallons a week of waste water, previously regulated, is discharged to the sanitary sewer.

Waste Compactor

Waste Management crews are presently working to install a compactor for low-level tritium contaminated compactable material. This compactor was purchased last year to reduce crew's time for the handling, packaging and documentation of each bag of PPE, and to reduce the total waste volume. Presently, the NGFP generates about ten bags a week of this waste stream. This compactor has the capabilities to compact seven bags of PPE into one metal 55-gallon drum. This drum will then be certified by an onsite inspector and could be shipped directly to the disposal site. This will not reduce the amount of PPE presently being used, but will allow for better space management at the disposal sites. A Return on Investment (ROI) calculation on the implementation of this equipment is included in Attachment 2.

Pollution Prevention Opportunities

After evaluating the waste stream data, the team participated in a brainstorming session to develop a list of potential waste reduction ideas. The ideas identified for evaluation are summarized below:

Idea 1: Alcohol Reduction: Find an alternate use for spent alcohol, possibly as a fuel.

Idea 2: Alcohol Recycle: Re-distill and/or filter alcohol for reuse either within Neutron Generator Facility or externally

Idea 3: Lean Thinking: Integrate Green into NGPF's Lean Thinking Quality Program

Idea 4: Elementary Neutralization: Segregate high and low pH chemicals from different processes and neutralize to remove the hazardous characteristic. Profile the neutralized wastes for disposal in the sanitary sewer system.

Idea 5: Chemical Substitution: Evaluate chemical substitution options that would decrease the health and environmental impact of NGPF's solvents, mold release, and acids. Chemicals that are not required in the production specifications would be evaluated first and alternatives generated through the NGPF's current Lean Thinking initiative.

Idea 6: Launder PPE: Purchase in-house equipment to wash and reuse PPE from radioactive areas.

Idea 7: Radiation Protection Protocol: Develop a procedure for the characterization of non-radioactive waste leaving the tritium envelope.

Idea 8: Reuse PPE in non-Radioactive areas: Reuse labcoats that are not damaged during use and document the quantity of waste reduced from reuse.

Idea 9: Recycle non-Radioactive PPE: Set up a contract to recycle PPE from non-Radioactive areas.

Idea 10: Permanent PPE: Purchase reusable shoes or shoe covers for all areas that require booties.

The P2 ideas were further evaluated by the PPOA team based on effectiveness, feasibility, and cost. The ideas were categorized using the P.I.C.K (Possible-Implement-Challenge-Kill) Chart in Attachment 1. The

P.I.C.K Chart is a tool used by the facility to rank ideas for implementation. Opportunities 2, 3, 4, 5, 7, 9, and 10 were selected for additional investigation, and a technical and economic analysis was performed. Each of these opportunities is discussed below. The detailed results of these analyses can be found in Attachment 2. Each of these seven opportunities are recommended for implementation. They show annual cost savings with quick payback periods, and significant reductions in hazardous and low-level waste.

Opportunity 1: Alcohol Recycle

Opportunity 1 proposes to treat the spent alcohol through distillation and/or filtration for reuse either within NGPF or externally. Treatment would be preformed in the less than 90-day storage area located in building 870. The alcohol would be treated to meet the requirements in specification SS704556-0001: 3A Formula Alcohol. Treated alcohol could then be used internally within NGPF or externally. Currently NGPF is the largest user of alcohol on-site so reuse within the facility is preferred, but other onsite users that could benefit from the recycled alcohol include 14100 and 1800. This opportunity would greatly reduce NGPF's largest waste stream with the possibility of complete elimination. Costs incurred could include analysis, equipment, installation, if sent offsite shipping, and personnel. This measure would decrease disposal cost and possibly the cost of purchasing virgin alcohol. The Return on Investment (ROI) is 173% and the Life Cycle Cost Savings is $266,549. Information on possible equipment vendors is included in Attachment 3.

Opportunity 2: Lean Thinking

Currently NGPF is continuously improving their efficiency through the Sigma Six Quality program. Continuous improvement for quality and environment can complement each other through a shared program that broadens the definition of "waste" to include physical waste as well as process time waste. Opportunity 2 recommends the integration of Clean into NGPF's Lean Thinking Quality Program by utilizing SNL/NM's pollution prevention (P2) support staff in Lean Efforts. There is no cost associated with utilizing the P2 support staff. The Clean & Lean effort could decrease disposal of single use solvent mixtures, continue to look at waste streams and profile all non-RCRA streams as solid waste, track reductions for profiled solid waste streams, and decrease unnecessary PPE changes. An ROI or Life Cycle Cost Savings was not calculated for this opportunity because the cost and waste reduction effectiveness would be variable depending on the reduction measures identified.

Opportunity 3: Elementary Neutralization

Waste Management crews are starting to investigate the savings potential of performing elementary neutralization in some of the plating operations. Opportunity 3 would include segregation of the chemicals from different processes for neutralization and profiling the neutralized waste streams as a solid waste for disposal in the sanitary sewer system. Although this opportunity would not reduce the total quantity of waste produced at the facility it would reduce the toxicity of the waste stream. Opportunity 3 has the potential to reduce hazardous plating bath wastes by 30%. An ROI or Life Cycle Cost Savings was not calculated for this opportunity due to the necessity of specific waste streams being identified for neutralization.

Opportunity 4: Chemical Substitution

Opportunity 4 proposes chemical substitution options for solvents, mold release, and other chemical changes that would not affect the product specifications. A full evaluation of all chemical substitutes is beyond the scope of this PPOA. Therefore, the evaluation process will be incorporated as part of the Lean and Clean effort. This will be an on going process where particular chemicals will be identified and evaluated for substitution options. This could include the further use of d-limonene or Brulin 815GD as non-hazardous solvents. An ROI or Life Cycle Cost Savings was not calculated for this opportunity because the cost and waste reduction effectiveness is variable depending on the substitution options identified.

Opportunity 5: Radiation Protection Protocol

Opportunity 5 recommends the development of a procedure for the characterization of non-radioactive waste leaving the Tritium Envelope. Currently all waste removed from the tritium envelope is considered either LLW or Mixed. This opportunity recommends an in depth Health Physics evaluation of the current protocol and a determination of whether characterization protocol could be developed. Although this opportunity would not reduce the total waste generated, it would reduce the volume of LLW and Mixed Waste sent for disposal. Further study will need to be preformed before an ROI or Life Cycle Cost Savings calculation can be preformed.

Opportunity 6: Recycle non-Radioactive PPE

Opportunity 6 recommends recycling Tyvek™ PPE from non-radiological areas. The Tyvek™ PPE would be segregated from the non-Tyvek™ at the exit point of all non-radiological controlled areas. The segregated Tyvek™ would be boxed in cardboard shipping containers with pre-addressed labels provided by the vendor. The vendor pays shipping and donates $0.10 per lab coat and $0.25 per coverall to a local charity in SNL/NM's name. This opportunity reduces the amount of solid waste PPE generated at the facility by 75% and supports SNL/NM's public outreach program. The ROI is 255% and the Life Cycle Cost Savings is $4,517. Attachment 4 contains specific vendor information.

Opportunity 7: Permanent PPE

Opportunity 7 recommends the purchase of reusable shoes or shoe covers for all areas that require booties. Shoes would be purchased for all individuals that enter the controlled areas on a regular basis. The shoes would remain in the areas in racks designed for storage of the shoes. The shoes would be donned and doffed per the appropriate control procedures. This opportunity reduces both the solid and low-level waste disposal by 12.5%. The ROI for this opportunity is 227% and the Life Cycle Cost Savings is $44,851.

Conclusion

The NGPF has an ongoing commitment to pollution prevention by applying source reduction, using less toxic materials, and by recycling and reusing materials. As a result of this PPOA seven opportunities have been identified for implementation. The seven opportunities are:

Opportunity 1: Alcohol Recycle: Re-distill and/or filter alcohol for reuse either within Neutron Generator Facility or externally

Opportunity 2: Lean Thinking: Integrate Clean into NGPF's Lean Thinking Quality Program

Opportunity 3: Elementary Neutralization: Segregate chemicals from different processes for neutralization and Profile as a solid waste capable of disposal through the sanitary sewer system.

Opportunity 4: Chemical Substitution: Evaluate chemical substitution options for solvents, Mold release, and other chemical changes that would not affect the product specifications

Opportunity 5: Radiation Protection Protocol: Develop a Procedure for the characterization of non-radioactive waste leaving the Tritium Envelope.

Opportunity 6: Recycle non-Radioactive PPE: Set up a contract for PPE recycle from non-Radiological areas.

Opportunity 7: Permanent PPE: Purchase shoes for all areas that require booties.

These opportunities show annual cost savings with quick payback periods, and significant reductions in the generation of hazardous and low-level waste.

Attachment 1
P.I.C.K Chart

Description: FY01 PPOA of the Neutron Generator Facility

	Big Pay-	Small Pay-
EASY	**Implement** • Recycled Tyvek • Use Compactor • Profile Solid Waste Streams	**Challenge** • Lean Thinking • Further Process Review • Chemical Substitutions that would not affect drawings

HARD	**Possible**
	• Neutralization
	• External Reuse of Ethanol
	  •As a Fuel
	  •Industrial Use
	• Internal Reuse of Ethanol
	• Change Rad Release Limits
	• Develop Methodology to Characterize LLW
		Kill
		• Reuse PPE
		• Launderable PPE
		• Chemical Substitution that would affect drawings

• Permanent PPE: shoes in Rad and non-Rad areas

Attachment 2
Cost Analysis

Recycling of Spent Ethanol and Methanol Mixture

Worksheet 1: Operating and Maintenance Annual Recurring Costs

Expense Cost Items	Before (B) Annual Costs	After (A) Annual Costs
Equipment		
Purchased Raw Materials and Supplies		
Process Operation Costs:		
Utility Costs		
Labor Costs		
Routine Maintenance Costs for Processes		
Process Costs		
Material and Supply Costs	$14,180	$3,545
Subtotal	**$14,180**	**$3,545**
PPE and Related Health/Safety/Supply Costs		
Waste Management Costs:		
Waste Container costs		
Treatment/Storage/Disposal Costs	$27,500	$6,875
Inspection/Compliance Costs		
Subtotal	**$27,500**	**$6,875**
Recycling – Material Collection/Separation/Preparation Costs:		
Material and Supply Costs		
Operations and Maintenance Labor Costs		
Vendor Costs for Recycling		
Subtotal	**$0**	**$0**
Administrative/Other Costs		
Total Annual Cost:	**$41,680**	**$10,420**

Recycling of Spent Ethanol and Methanol Mixture

Worksheet 2: Itemized Project Funding Requirements (One-Time) Implementation Costs)

Category	Cost $
INITIAL CAPITAL INVESTMENT	
Design	
Purchase	$16,000
Installation	$1,000
Other Capital Investment (explain)	
Subtotal: Capital Investment = (C)	**$17,000**
INSTALLATION OPERATING EXPENSES	
Planning/Procedure Development	
Training	
Miscellaneous Supplies	
Startup/Testing	
Readiness Reviews/Management	
Assessment/Administrative Costs	
Other Capital Investment (explain)	
Subtotal: Installation Operating Expenses = (E)	**$0**
All company adders (G&A/PHMC Fee, MPR, GFS, Overhead, taxes, etc.)	
Total Project Funding Requirements = (C + E)	**$17,000**

Useful Project Life (L) (Years)= 10	Time To Implement (Months)= 6
Estimated Project Termination/Disassembly Cost (if applicable) (D) =	
RETURN ON INVESTMENT CALCULATION	
ROI =([(B – A) – [(C + E + D)/L]]/(C + E + D) x 100)=	**173.88%**

O&M Annual Recurring Costs		Project Funding Requirements	
Annual Costs, Before (B) =	$41,680	Capital Investment (C) =	$17,000
Annual Costs, After (A) =	$10,420	Installation Op Expenses (E) =	$0
Net Annual Savings (B – A) =	$31,260	Total Project Funds (C + E) =	$17,000

Recycling of Spent Ethanol and Methanol Mixture

Worksheet 3: Estimate Basis

INITIAL CAPITAL INVESTMENT

Equipment and Installation costs are based on an average cost estimated by potential distillation system distributors

INSTALLATION AND STARTUP

TRADITIONAL (BASEINE) TECHNOLOGY/METHOD

Material costs are based on estimate given by Cynthia Tenorio that 14400 purchases approximately 1000 gallons of denatured ethanol ($13,280) and 100 gallons of methanol ($900). Waste management costs are based on the FY00 and FY01 disposal information for ethanol and methanol mixtures approximately 550kg per year at a rate of $50 per kilogram.

NEW TECHNOLOGY/METHOD

After costs were estimated based on the system being able to recycle and reuse 75% of the mixture thereby reducing the waste disposed by 75% as well.

COST SAVINGS/COST AVOIDANCE/RISK REDUCTION

Cost savings are based on reduction of virgin product purchasing and reduction in the quantity of waste disposed.

Project Title
Recycling of Spent Ethanol and Methanol Mixture

Implementation Cost ($)	17,000					**Year Initiated**	2001						
Project Life (years)	10												
Annual Expenditures													
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Sum	Present Value in 2001
Base Case:													
annual cost	41,680	41,680	41,680	41,680	41,680	41,680	41,680	41,680	41,680	41,680	41,680	458,480	$378,065
													$0
													$0
													$0
Total Base Case	**41,680**	**41,680**	**41,680**	**41,680**	**41,680**	**41,680**	**41,680**	**41,680**	**41,680**	**41,680**	**41,680**	**458,480**	**$378,065**
Average annual cost =				**$41,680**								**Net Present Value in 2001, Base Case**	**$378,065**
P2 Project:													
implementation cost	17,000											17,000	$17,000
annual cost	10,420	10,420	10,420	10,420	10,420	10,420	10,420	10,420	10,420	10,420	10,420	114,620	$94,516
Decommissioning Cost											-		$0
													$0
Total P2 Project	**27,420**	**10,420**	**10,420**	**10,420**	**10,420**	**10,420**	**10,420**	**10,420**	**10,420**	**10,420**	**10,420**	**131,620**	**$111,516**
												Net Present Value in 2000, P2 Project	**$111,516**

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) =	**$266,549**
Life Cycle Cost Savings per $ Invested =	**1568%**

Real Discount Rate 4.1%

Recycling of Solid Waste Tyvek PPE

Worksheet 1: Operating and Maintenance Annual Recurring Costs

Expense Cost Items	Before (B) Annual Costs	After (A) Annual Costs
Equipment		
Purchased Raw Materials and Supplies		
Process Operation Costs:		
Utility Costs		
Labor Costs		
Routine Maintenance Costs for Processes		
Process Costs		
Other		
Subtotal	**$0**	**$0**
PPE and Related Health/Safety/Supply Costs	$3,600.00	$3,600.00
Waste Management Costs:		
Waste Container costs		
Treatment/Storage/Disposal Costs	$693	$173
Inspection/Compliance Costs		
Subtotal	**$693**	**$173**
Recycling – Material Collection/Separation/Preparation Costs:		
Material and Supply Costs		
Operations and Maintenance Labor Costs		
Vendor Costs for Recycling		
Subtotal	**$0**	**$0**
Administrative/Other Costs		
Total Annual Cost:	**$4,293**	**$3,773**

Recycling of Solid Waste Tyvek PPE

Worksheet 2: Itemized Project Funding Requirements (One-Time) Implementation Costs)

Category	Cost $
INITIAL CAPITAL INVESTMENT	
Design	
Purchase: Extra trash cans	$200
Installation	
Other Capital Investment (explain)	
Subtotal: Capital Investment = (C)	**$200**
INSTALLATION OPERATING EXPENSES	
Planning/Procedure Development	
Training	
Miscellaneous Supplies	
Startup/Testing	
Readiness Reviews/Management	
Assessment/Administrative Costs	
Other Capital Investment (explain)	
Subtotal: Installation Operating Expenses = (E)	**$0**
All company adders (G&A/PHMC Fee, MPR, GFS, Overhead, taxes, etc.)	
Total Project Funding Requirements = (C + E)	**$200**

Useful Project Life (L) (Years)= 20	Time To Implement (Months)= 1
Estimated Project Termination/Disassembly Cost (if applicable) (D) =	
RETURN ON INVESTMENT CALCULATION	
ROI = (B – A) – [(C + E + D)/L] x 100 =	**255.00%**

O&M Annual Recurring Costs		Project Funding Requirements	
Annual Costs, Before (B) =	$4,293	Capital Investment (C) =	$200
Annual Costs, After (A) =	$3,773	Installation Op Expenses (E) =	$0
Net Annual Savings (B – A) =	$520	Total Project Funds (C + E) =	$200

Recycling of Solid Waste Tyvek PPE
Worksheet 3: Estimate Basis

GENERAL

Tyvek PPE would be sent to an off-site recycler. The recycler would pay shipping and would donate $.10/labcoat and $.25/coverall to a local charity in SNL/NM's name.

INITIAL CAPITAL INVESTMENT

Extra trash cans to separate Tyvek material from non-Tyvek material will be purchased through JIT. Approximate cost per trash can is $20.

INSTALLATION AND STARTUP

TRADITIONAL (BASEINE) TECHNOLOGY/METHOD

Previously all PPE from non-rad areas was disposed of as solid waste.

NEW TECHNOLOGY/METHOD

All Tyvek material would be sent off-site to a recycler. The After waste disposal costs are based on a 75% reduction in volume.

COST SAVINGS/COST AVOIDANCE/RISK REDUCTION

Cost savings would be based on a 75% reduction in solid waste disposed at $13/cubic yard (the average unit cost that SNL/NM pays to use the KAFB Landfill.

Project Title: Recycling of Solid Waste Tyvek PPE

Implementation Cost ($)	200					**Year Initiated**	2001						
Project Life (years)	20												
Annual Expenditures													
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Sum	Present Value in 2001
Base Case:													
annual cost	4,293	4,293	4,293	4,293	4,293	4,293	4,293	4,293	4,293	4,293	4,293	47,227	$38,943
													$0
													$0
													$0
Total Base Case	**4,293**	**4,293**	**4,293**	**4,293**	**4,293**	**4,293**	**4,293**	**4,293**	**4,293**	**4,293**	**4,293**	**47,227**	**$38,943**
Average annual cost =				**$4,293**						**Net Present Value in 2001, Base Case**			**$38,943**
P2 Project:													
implementation cost	200											200	$200
annual cost	3,773	3,773	3,773	3,773	3,773	3,773	3,773	3,773	3,773	3,773	3,773	41,507	$34,227
Decommissioning Cost											-		$0
													$0
Total P2 Project	**3,973**	**3,773**	**3,773**	**3,773**	**3,773**	**3,773**	**3,773**	**3,773**	**3,773**	**3,773**	**3,773**	**41,707**	**$34,427**
										Net Present Value in 2000, P2 Project			**$34,427**

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) =	**$4,517**
Life Cycle Cost Savings per $ Invested =	**2258%**

Real Discount Rate 4.1%

Purchase of Permanent PPE (shoes)

Worksheet 1: Operating and Maintenance Annual Recurring Costs

Expense Cost Items	Before (B) Annual Costs	After (A) Annual Costs
Equipment		
Purchased Raw Materials and Supplies		
Process Operation Costs:		
Utility Costs		
Labor Costs		
Routine Maintenance Costs for Processes		
Process Costs		
Other		
Subtotal	**$0**	**$0**
PPE and Related Health/Safety/Supply Costs	$3,600	$0
Waste Management Costs:		
Waste Container costs		
Treatment/Storage/Disposal Costs	$1,527	$0
Inspection/Compliance Costs		
Subtotal	**$5,127**	**$0**
Recycling – Material Collection/Separation/Preparation Costs:		
Material and Supply Costs		
Operations and Maintenance Labor Costs		
Vendor Costs for Recycling		
Subtotal	**$0**	**$0**
Administrative/Other Costs		
Total Annual Cost:	**$5,127**	**$0**

Purchase of Permanent PPE (shoes)

Worksheet 2: Itemized Project Funding Requirements (One-Time) Implementation Costs)

Category	Cost $
INITIAL CAPITAL INVESTMENT	
Design	
Purchase: permanent PPE (shoes)	$630
Installation	
Other Capital Investment (explain)	
Subtotal: Capital Investment = (C)	**$630**
INSTALLATION OPERATING EXPENSES	
Planning/Procedure Development	
Training	
Miscellaneous Supplies	
Startup/Testing	
Readiness Reviews/Management Assessment/Administrative Costs	
Other Capital Investment (explain)	
Subtotal: Installation Operating Expenses = (E)	**$0**
All company adders (G&A/PHMC Fee, MPR, GFS, Overhead, taxes, etc.)	
Total Project Funding Requirements = (C + E)	**$630**

Useful Project Life (L) (Years)=	10	Time To Implement (Months)=	1
Estimated Project Termination/Disassembly Cost (if applicable) (D) =			$1,527

RETURN ON INVESTMENT CALCULATION	
ROI = (B – A) – [(C + E + D)/L] x 100 =	**227.71%**

O&M Annual Recurring Costs		Project Funding Requirements	
Annual Costs, Before (B) =	$5,127	Capital Investment (C) =	$630
Annual Costs, After (A) =	$0	Installation Op Expenses (E) =	$0
Net Annual Savings (B – A) =	$5,127	Total Project Funds (C + E) =	$630

Purchase of Permanent PPE (shoes)
Worksheet 3: Estimate Basis

INITIAL CAPITAL INVESTMENT

PPE shoes would be purchased by the facility to replace the current disposable booties that are being used. Approximate cost per pair of shoes is $3.15 and it is assumed that approximately 200 pairs will be purchased.

INSTALLATION AND STARTUP

TRADITIONAL (BASEINE) TECHNOLOGY/METHOD

Approximately 100 pairs of booties per month are purchased at $3 per pair. Currently all booties are being disposed of as waste. Booties from non-rad areas are disposed of as solid waste at a rate of $13/cubic yard. Approximately 12.5% of the solid waste PPE stream is booties with a total waste stream quantity of 40 cubic feet per month. Booties from rad areas are disposed of as LLW at a rate of $30/cubic foot. Approximately 12.5% of the LLW PPE stream is booties with a total waste stream quantity of 32 cubic feet per month.

NEW TECHNOLOGY/METHOD

Permanent PPE shoes would eliminate the purchase and disposal of booties on an annual basis. Shoes at the end of the project life would be disposed of in accordance with waste management procedures.

COST SAVINGS/COST AVOIDANCE/RISK REDUCTION

Cost savings are based on the elimination of annual purchase and disposal of booties.

Project Title: Purchase of Permanent PPE (shoes)

Implementation Cost ($)	630					**Year Initiated**	2001						
Project Life (years)	10												
Annual Expenditures													
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Sum	Present Value in 2001
Base Case:													
annual cost	5,127	5,127	5,127	5,127	5,127	5,127	5,127	5,127	5,127	5,127	5,127	56,393	$46,502
													$0
													$0
													$0
Total Base Case	**5,127**	**5,127**	**5,127**	**5,127**	**5,127**	**5,127**	**5,127**	**5,127**	**5,127**	**5,127**	**5,127**	**56,393**	**$46,502**
Average annual cost =				**$5,127**							**Net Present Value in 2001, Base Case**		**$46,502**
P2 Project:													
implementation cost	630											630	$630
annual cost	-	-	-	-	-	-	-	-	-	-	-		$0
Decommissioning Cost											1,527	1,527	$1,467
													$0
Total P2 Project	**630**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1,527**	**2,157**	**$2,097**
											Net Present Value in 2000, P2 Project		**$1,651**

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) =	**$44,851**
Life Cycle Cost Savings per $ Invested =	**7119%**

Real Discount Rate	4.1%

Use of Compactor to Reduce the Volume Disposed of LLW PPE

Worksheet 1: Operating and Maintenance Annual Recurring Costs

Expense Cost Items	Before (B) Annual Costs	After (A) Annual Costs
Equipment		
Purchased Raw Materials and Supplies		
Process Operation Costs:		
Utility Costs		
Labor Costs		
Routine Maintenance Costs for Processes		
Process Costs		
Other		
Subtotal	**$0**	**$0**
PPE and Related Health/Safety/Supply Costs		
Waste Management Costs:		
Waste Container costs		
Treatment/Storage/Disposal Costs	$11,520	$3,840
Inspection/Compliance Costs		
Subtotal	**$11,520**	**$3,840**
Recycling – Material Collection/Separation/Preparation Costs:		
Material and Supply Costs		
Operations and Maintenance Labor Costs		
Vendor Costs for Recycling		
Subtotal	**$0**	**$0**
Administrative/Other Costs		
Total Annual Cost:	**$11,520**	**$3,840**

Use of Compactor to Reduce the Volume Disposed of LLW PPE

Worksheet 2: Itemized Project Funding Requirements (One-Time Implementation Costs)

Category	Cost $
INITIAL CAPITAL INVESTMENT	
Design	
Purchase	
Installation	
Other Capital Investment (explain)	
Subtotal: Capital Investment = (C)	**$0**
INSTALLATION OPERATING EXPENSES	
Planning/Procedure Development	
Training	
Miscellaneous Supplies	
Startup/Testing	
Readiness Reviews/Management	
Assessment/Administrative Costs	
Other Capital Investment (explain)	
Subtotal: Installation Operating Expenses = (E)	**$0**
All company adders (G&A/PHMC Fee, MPR, GFS, Overhead, taxes, etc.)	
Total Project Funding Requirements = (C + E)	**$0**

Useful Project Life (L) (Years)=	10	Time To Implement (Months)=	6
Estimated Project Termination/Disassembly Cost (if applicable) (D) =			$10,000
RETURN ON INVESTMENT CALCULATION			
ROI = (B – A) – [(C + E + D)/L] x 100 =		**66.80%**	

O&M Annual Recurring Costs		Project Funding Requirements	
Annual Costs, Before (B) =	$11,520	Capital Investment (C) =	$0
Annual Costs, After (A) =	$3,840	Installation Op Expenses (E) =	$0
Net Annual Savings (B – A) =	$7,680	Total Project Funds (C + E) =	$0

Use of Compactor to Reduce the Volume Disposed of LLW PPE
Worksheet 3: Estimate Basis

GENERAL

Neutron Generator has purchased a compactor to reduce the volume of their Low Level Waste. This cost assessment does not account for equipment already purchased only the cost savings of the use of the compactor and the eventual cost of the disposal of the compactor.

INITIAL CAPITAL INVESTMENT

Compactor has already been purchased so there is no further capital investment anticipated.

INSTALLATION AND STARTUP

Future costs related to the startup of the compactor are already accounted for in the employment of full time waste management personnel.

TRADITIONAL (BASEINE) TECHNOLOGY/METHOD

Currently LLW PPE is not being compacted. The charge for disposal of LLW is approximately $30 per cubic foot with an average of 32 cubic feet per month being disposed.

NEW TECHNOLOGY/METHOD

Compaction of PPE will reduce the current volume by approximately 66%. The charge to dispose of the PPE will remain at $30 per cubic foot

COST SAVINGS/COST AVOIDANCE/RISK REDUCTION

Cost savings are based on the reduction in volume of disposed LLW PPE due to compaction. Cost savings do not account for the reduction in volume due to the purchase of permanent PPE.

Project Title: Use of Compactor to Reduce the Volume Disposed of LLW PPE

Implementation Cost ($)	-					**Year Initiated**	2001						
Project Life (years)	10												
Annual Expenditures													
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Sum	Present Value in 2001
Base Case:													
annual cost	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	126,720	$104,494
													$0
													$0
													$0
Total Base Case	**11,520**	**11,520**	**11,520**	**11,520**	**11,520**	**11,520**	**11,520**	**11,520**	**11,520**	**11,520**	**11,520**	**126,720**	**$104,494**
Average annual cost =				**$11,520**							**Net Present Value in 2001, Base Case**		**$104,494**
P2 Project:													
implementation cost	-												$0
annual cost	3,840	3,840	3,840	3,840	3,840	3,840	3,840	3,840	3,840	3,840	3,840	42,240	$34,831
Decommissioning Cost											10,000	10,000	$9,606
													$0
Total P2 Project	**3,840**	**3,840**	**3,840**	**3,840**	**3,840**	**3,840**	**3,840**	**3,840**	**3,840**	**3,840**	**13,840**	**52,240**	**$44,438**
										Net Present Value in 2000, P2 Project			**$41,522**

Results Summary:

Life Cycle Savings (NPV Base Case - NPV P2 Project) =	**$62,972**
Life Cycle Cost Savings per $ Invested =	**N/A**

Real Discount Rate 4.1%

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Attachment 3
Vendor Information

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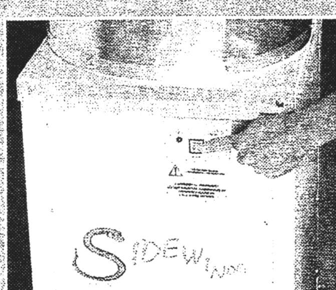
SIDEWINDER

MODEL M-2
SOLVENT RECOVERY SYSTEM

HASSLE FREE

LOAD...

LATCH...



PUSH...

Single Button Operation!

You're Done.

You'll have crystal clean solvent when the machine automatically turns off. Use the same solvents over and over for pennies.

UL LISTED 20CK

Recycling - it's about savings

Recycling Of Hazardous Wastes Benefits All

People Buy or Lease a Sidewinder Model M-2 for Four Reasons:

- To save money on solvent purchases.
- To save money on waste disposal costs.
- To conform with regulations and avoid potential costly fines.
- To do their part to save the planet.

Hazardous Waste

All used solvents, thinners and reducers are hazardous wastes. There are only two legal ways to dispose of these hazardous wastes:

1. For less than 100 kilograms of waste per month, obtain an EPA identification number as a small quantity generator and pay a registered transporter to haul the waste to an approved recycling facility or other type of approved facility...or
2. Recycle the used solvent on site for future reuse.

Hazardous waste generators have a "cradle to grave" responsibility for safe disposal of hazardous wastes. Federal law says the generator is responsible for the waste he creates, regardless of who hauls it away or where it is stored. His name is on the barrel and if it is spilled or otherwise causes pollution, he is responsible for the cleanup. Forever!

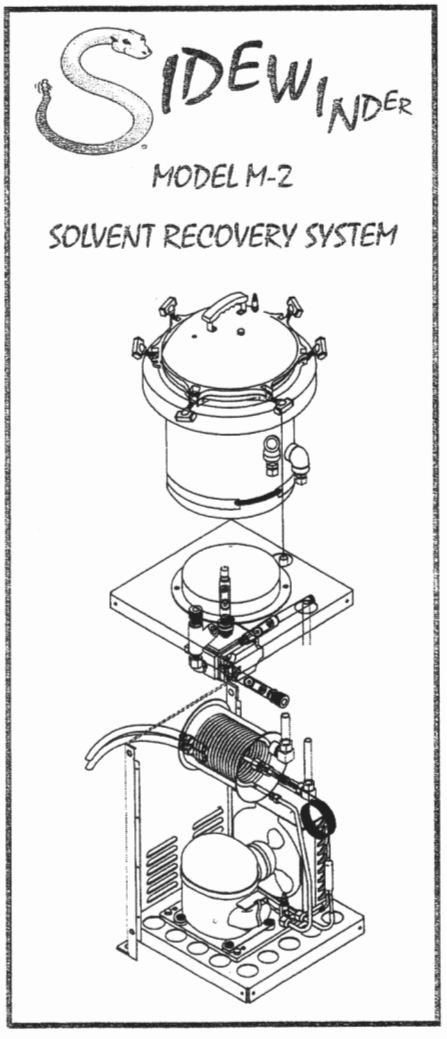
Of course to dispose of hazardous wastes in any unlawful way is just foolhardy and a good way to risk heavy cleanup costs, stiff fines and possible jail time.

The Sidewinder Concept

The Sidewinder Model M-2 is manufactured by Persyst Enterprises, Inc. in Las Vegas, Nevada. The market we satisfy is the 5 to 70 gallon per week solvent (thinners, etc.) user that must meet EPA requirements for waste minimization. General user classifications are:

1. Commercial paint and finish contractors.
2. Industrial and government paint, finish and coatings users.
3. Automotive paint and finish users.

Recycling and waste minimization is one of the few areas where national environmental goals, industries economic interests and public health and safety issues clearly coincide. For waste generators, the benefits include reduced costs, liabilities, and regulatory burdens associated with hazardous waste management. For the general public, waste minimization pays off in our improved environment.



Our nation has interests in minimizing the overall amounts of hazardous waste being transported on our highways and stored at hazardous waste sites. The EPA tailors rules and regulations to encourage on site recycling and reuse.

The Sidewinder Model M-2 reduces the volume of hazardous materials on site and all but eliminates the need to transport liquid hazardous waste on our streets and highways.

The Sidewinder Method

The Sidewinder Model M-2 is a small batch distiller, it processes 5 gallons or less per batch. A standard 5 gallon metal bucket of waste is placed in the chamber. Waste solvents are vaporized and re-condensed, making the solvent reusable. The vapors expand in the chamber, displacing air. The vapors, being heavier than air, then fall through a refrigerated heat exchanger, condense and gravity flow out into the clean solvent receiving vessel. The waste stays behind in the cooking bucket within the chamber.

The vaporizing chamber is built to pressure cooker specifications. Although the unit operates at atmospheric pressure a safety pressure relief valve is installed in the lid. Metal to metal machined surfaces seal the chamber and its' lid, which is held fast during processing with 6 bakelite wing nut assemblies.

The vapor tubes and the outlet tubes are of TFE Teflon®. The evaporator (condensing chamber) is stainless steel. The lightweight aluminum stand is provided with floor mount capabilities. The Sidewinder Model M-2 is covered by a one year limited warranty.

The use of a refrigeration condensing system instead of a forced air or water cooled system is a more resourceful choice, especially where water conservation is important. Additionally, special plumbing, water treatment and freezing weather considerations are unnecessary. Water condensing systems can use water at about 3 gallons a minute or about 180 gallons of water per 1 gallon of recycled solvent. Forced air condensing systems, simply are not efficient in warmer climates.

The Sidewinder Model M-2 is for use in commercial and industrial applications only by trained personnel. Strict

adherence to cautious handling of hazardous materials must be maintained always. For location, wiring, and operating instructions, refer to the owners manual.

Pitfalls to Avoid

As with most products, there are some pitfalls to avoid. Only knowledgeable persons should be allowed to operate the Sidewinder Model M-2.

- Never process unidentified compounds.
- Avoid the processing of wastes containing acids.
- Do not process wastes containing Nitrocellulose or Cellulose Nitrate (found in many lacquers and inks) or other reactive materials under any circumstance.
- Know what you are processing and check material safety data sheets for the waste contaminants as well as for the solvent to be recycled for compatibility before processing.

Electrical

Because of the small batch size, the rate of processing, air movement through the condensing unit and the heavier than air qualities of the vapors produced, under normal operating conditions, the minimum concentration of gases or vapors necessary to define Class I, Division 1 area are not present.

The Sidewinder Model M-2 has been investigated for use in normal, non-hazardous locations and Listed by Underwriters Laboratories Inc. as compliant with UL 2208 Standard for Solvent Distillation Units.

The process is continuously monitored by an electronic logic printed circuit board. Automatic shut down is commenced in the unlikely event of an over heat situation. These safeguards not only shut off the unit, but disable it until a service representative can evaluate the problem and help with repairs.

The 1997 Uniform Fire Code, Volume 1, 10th Edition, Article 79 section 7903.4, states:

7903.41 General. Solvent distillation units used to recycle Class I, II or III-A liquids having a distillation chamber capacity of 60 gallons (227.1 L) or less shall be listed, labeled and installed in accordance with Table 7903.4 and nationally recognized standards. See Article 90, standard u.1.17.

ARTICLE 90 - STANDARDS

u.1. UNDERWRITERS LABORATORIES INC.
333 Pfingsten Road, Northbrook, IL 60062
UL STANDARDS

u.1.17. UL 2208 Standard for Solvent Distillation Units

FEATURES:

- ***UL Listed***
  Sidewinder Model M-2 is the first UL Listed Solvent Recycler in the world.
- ***Meets UL 2208***
  UL 2208, Standard for Solvent Distillation Units is the US National Standard. Sidewinder Model M-2 is certified by UL to meet the requirements of UL 2208.

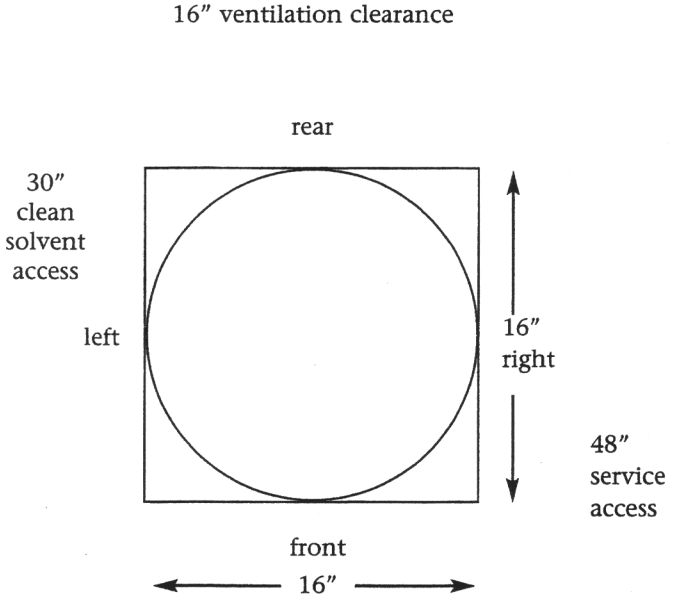
  1997 Uniform Fire Code™ requires that a Solvent Recycler be listed by a nationally recognized third party testing agency and that it be certified by the testing agency to meet the requirements of UL 2208 Standard for Solvent Distillation Units.
- ***Complies With UL 2208 For Use in Ordinary Non-Hazardous Locations***
  According to the Standard and Codes, a Solvent Distillation Unit complies for use in non-hazardous areas or it doesn't and must be put in either an Class I, Division 2 or Class I, Division 1 hazardous location. The Sidewinder Model M-2 complies for use in non-hazardous locations.
- ***Hassle Free***
  It couldn't be more simple. Load the unit with dirty solvent, 5 gallon bucket and all. Replace the lid. Press the button.
- ***Single Button Operation***
  What more can we say?
- ***Reliable***
  Follow the simple maintenance routine, for years of trouble free operation. We have many units in the field beginning their tenth year.
- ***Efficient Refrigeration Condensed***
  We're the **only one** we know of that uses refrigeration to condense. The alternatives are: forced air - not totally efficient in warm climates or water cooled - wastes lots of water, messy and special consideration must be given to plumbing, water storage, water treatment and waste water disposal.
- ***Ozone Safe HFC-134a Refrigerant***
  Big Brother made us do it, but it turned out for the best. We are able to get a larger horsepower unit to fit the same R-12 frame and it is more efficient than the old method.
- ***Self Monitoring***
  Sidewinder regulates temperature, engages condensing system, over sees built in safety failsafes, initiates cool down and shuts off. All automatic.
- ***Auto Shutdown***
  You go about your business... Sidewinder knows when to shut off even if you've given it your worst case mess. Solvents only, please - no water or water base.
- ***Processing Bags Optional***
  We personally like the convenience of Sidewinder processing bags but they are optional.
- ***110-120 volts***
  Easy to find a home, no special 220-240 volt wiring.
- ***No Water Hookups***
  This goes back to Hassle Free. Water cooled units - waste lots of water, are messy and special consideration must be given to plumbing, water storage, water treatment and waste water disposal.
- ***Micro Control Logic***
  This time tested, rugged circuitry makes the operation simple.
- ***Safety Failsafes & Shutdowns***
  If something is unusual the control simply shuts it down.
- ***Made in USA***
  It's where we live, work, and play.
- ***Full 1 Year Limited Warranty***

Distributed by:

This unit has been investigated for use in normal, non-hazardous locations and Listed by Underwriters Laboratories Inc. in compliance with UL 2208 Standard for Solvent Distillation Units.

Width	16 inches
Depth	16 inches
Height	44 inches
Net weight	95 lbs.
Voltage	110/120VAC
Current	11 amps
Heater	1050 watts
Condensing system	refrigeration
Evap temp rate	low
Refrigerant	ozone safe HFC-134a 0.16kg
Evap temp range	0°F to +15°F
Cap tube	96″ x .042″ ID
Operating pressure	atmosphere
Warmup time	approx. 90 min.
Capacity	5 US gallons
Electronics	micro-linear logic
Safety limits	heating vessel evaporator
UL Listed	UL Standard 2208

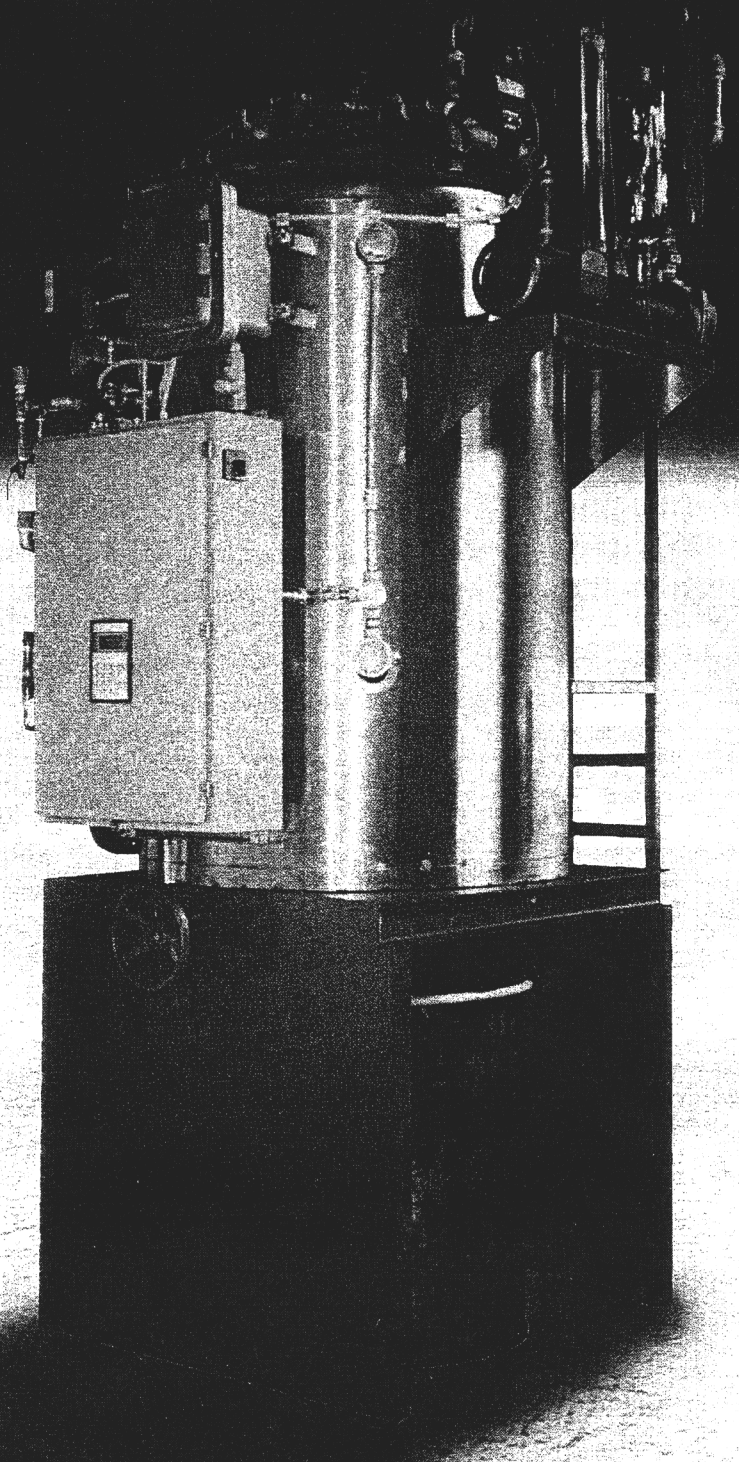
Required clearances



Locate in a level, well ventilated, under cover area. Out of grinding, welding and smoking area.

Manufactured by: Persyst Enterprises, Inc., 4695 Melvin Street, Las Vegas, Nevada 89115
Phone (702) 362-9432 • Fax: (702) 362-9440 • Email: persyst@worldnet.att.net • Website: www.solvent-recycler.com

AUTOMATIC SOLVENT DISTILLATION SYSTEMS



REDUCE COSTS AND LIABILITIES....
....RECYCLE SOLVENTS ON SITE

SRS Industrial Engineering, Inc.

AUTOMATIC SOLVENT DISTILLATION SYSTEMS....

Automatic solvent distillation systems greatly reduce the costs and liabilities often associated with waste disposal or outside recycling services. Automated systems are designed to safely and economically recycle a wide range of solvents with minimal intervention from the operator.

SYSTEM FEATURES

SRS Industrial Engineering, Inc. offers a complete range of state-of-the-art systems for the most demanding applications. Standard system configurations can recycle up to 150 GPH of solvents with boiling points of up to 500 degrees F.

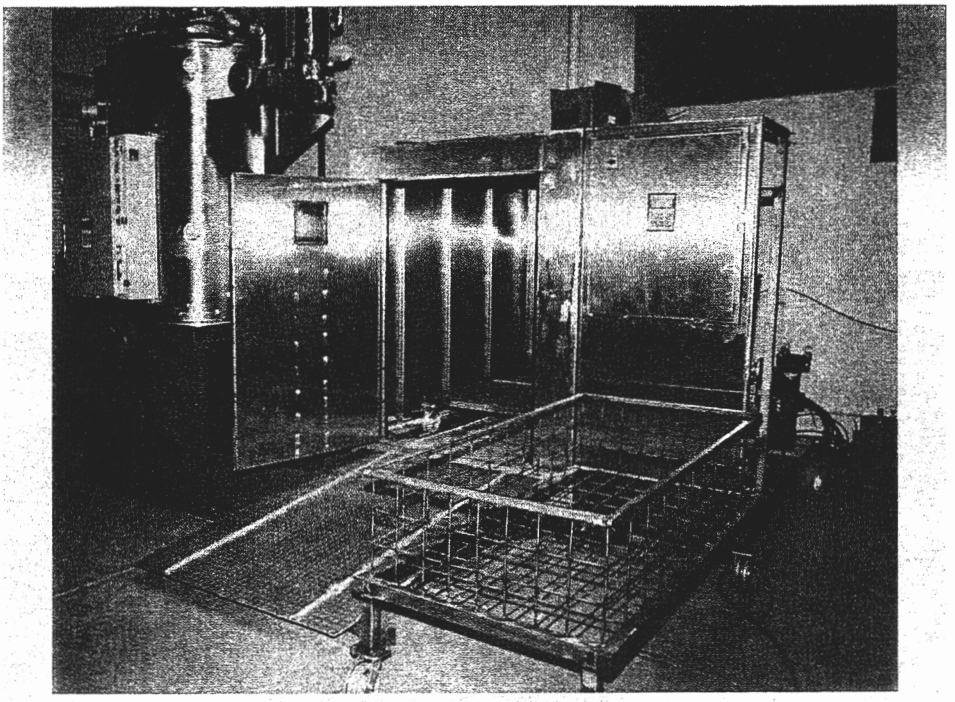
Self adjusting scrapers, unique waste receptacle designs and a variety of heat sources are combined to offer a system optimal for the user's application. The vapor condensate is collected in a clean solvent tank with the use of a high efficiency 316 stainless steel water cooled condenser.

System performance is further enhanced through the use of optional features including vacuum, auto fill and auto cool. The vacuum system includes a liquid ring vacuum pump and decant reservoir, and is fitted with a secondary condenser to virtually eliminate VOC emissions.

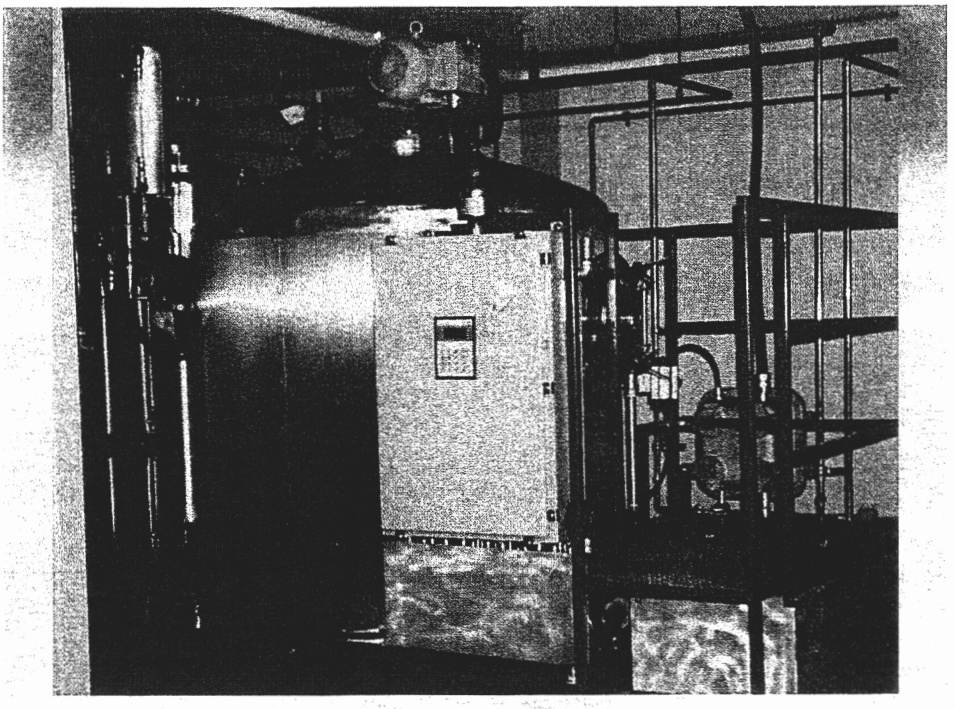
All systems feature programmable logic controllers (PLC) which monitor and control all phases of the distillation process for optimal throughput, solvent purity and operator safety.

PRINCIPLE OF OPERATION

An easy set up menu is used by the operator to input the process parameters into the PLC, which then automatically operates the system. The PLC monitors a series of relays and sensors to verify the discharge valve position, liquid levels and flows before starting the recycling process. Precision RTD's in the hot oil system, the sludge and the vapor space are continuously monitored, to ensure that the process temperature is always operating within the preset range. Process status and fault condition are clearly displayed on the controller panel. The system automatically shuts off in the event of a fault condition or at the end of the cycle.



This SRS MW-200 automatic drum and pail washer system uses an SRV-60 automatic distillation system to recover the solvent in a closed loop configuration for a coating facility application.



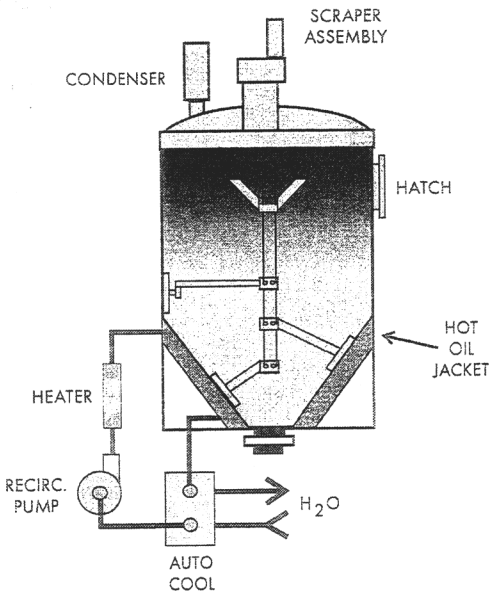
This SRS-150 distillation system was configured to be mounted under a low mezzanine in a pharmaceutical manufacturing facility.

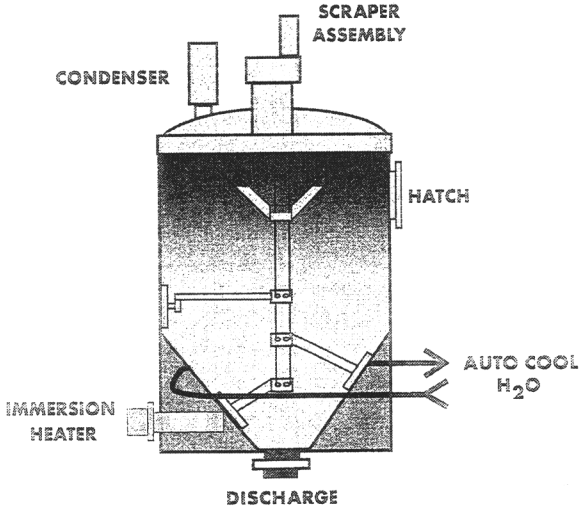
SYSTEM CONFIGURATIONS....

SRS Series

The SRS Series offers optimal performance in most applications. This design incorporates a unique self adjusting scraper assembly which agitates the solvent for even heat distribution, and keeps the inside surfaces of the distillation chamber free of sludge build-up for maximum heat transfer from the hot oil media. Scrapers also assist in discharging the sludge from a bottom mounted 6" discharge valve.

The hot oil media is recirculated through a jacket surrounding the distillation chamber to ensure the most even heat distribution over the entire heat transfer area. This eliminates hot spots for maximum efficiency. A recirculating hot oil media also offers a faster heat up and cooling cycle to maximize the effective throughput of your distillation system. Either steam or electric heaters can be used.





SRH Series

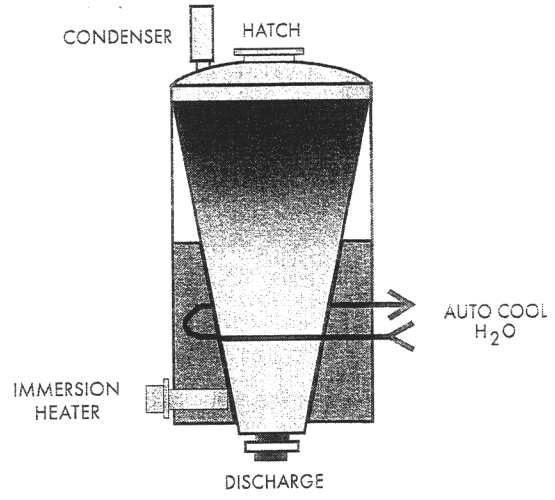
The SRH Series incorporates the self adjusting scraper assembly of the SRS Series for the same performance reasons.

The hot oil media consists of a large volume chamber surrounding the distillation chamber, and is heated via two electric immersion heaters or optional steam coils. Because of the relatively large volume of oil involved, this simple and trouble free design minimizes hot spots and results in a very efficient distillation process. An optional auto cool system is achieved by circulating cooling water through coils in the oil bath.

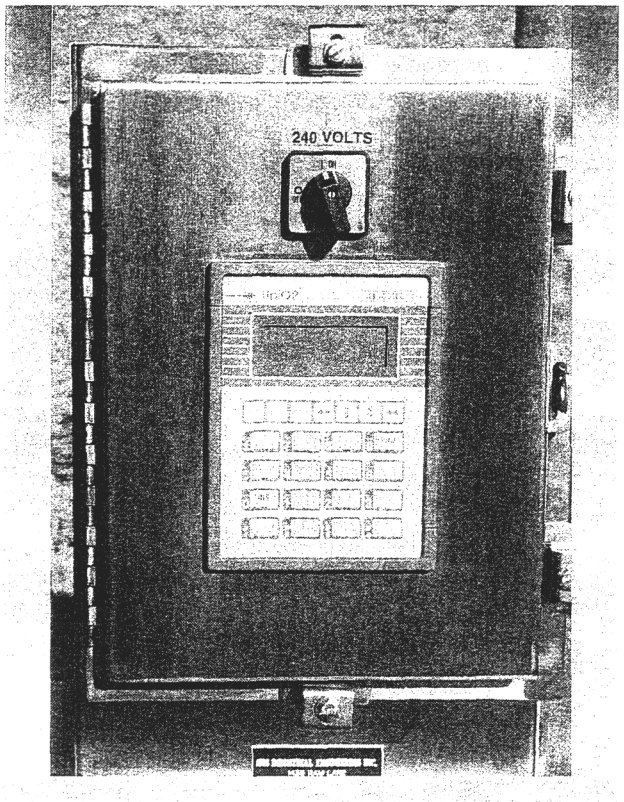
SRV Series

The SRV Series offers the simplest and highest performance system design in its price range. This design incorporates a unique steep walled conical distillation chamber, which is surrounded by a large volume oil bath heated with electric immersion heaters or optional steam coils. This design provides excellent heat transfer characteristics because of the large surface area in contact with the solvent and the oil media.

In most applications, the steep walls keep the inside surfaces of the distillation chamber free of sludge build-up for maximum heat transfer from the hot oil media, and assists in discharging the sludge from a bottom mounted 6" discharge valve.



SYSTEM OPERATION....



AUTOMATIC CONTROLS

SRS automatic solvent distillation systems are equipped with a programmable logic controller (PLC) housed in a NEMA 4X enclosure. All distillation decisions are controlled by the PLC with minimal operator intervention to ensure the most efficient and safe operation possible. The operator selects the desired process setting following a comprehensive computer prompted set up procedure, and has full control of all parameters for each portion of the cycle.

The PLC monitors a series of relays and sensors to verify proper liquid levels, flows, temperatures and discharge valve position before starting the cycle. Any fault condition is diagnosed and clear status messages are displayed on the controller panel to ensure operator safety and ease of operation. The system automatically shuts off in the event of a fault condition or at the end of the cycle.

For optimum safety, an operator can only specify operating parameters within a predetermined range. The system will not accept any value out of this range. These range values can only be changed through a security pass code. Sludge, oil, solvent and vapor space temperatures are very important factors in any distillation process. These are controlled very accurately through the use of high precision sensors and proven logic programming of the PLC, making SRS distillation systems ideal for demanding applications including those containing nitro cellulose.

SAFETY FEATURES

SRS automatic distillation systems are designed to be used in hazardous areas where all precautions are taken to prevent any risk of accidents due to explosions, corrosion and operator errors. The following are some of the design features which address safety.

- Optional Class I, Division I electrical motors and controls
- The control panel is contained within a NEMA 4X enclosure, with purge capabilities offered as an option.
- In very hazardous areas, optional NEMA 7 enclosures are offered to house local ON-OFF controls, with the main control panel located in a remote non-hazardous area.
- Stainless steel and corrosion resistant materials are used throughout the system.
- The PLC monitors all applicable parameters to ensure safe and uninterrupted operation of the system throughout the cycle. Such parameters include:
  - Interlock sensor to ensure the discharge valve is closed before the fill operation is started.
  - High precision RTD temperature sensors in the heating oil, solvent, sludge and vapor space are continuously monitored and controlled for optimal results and safety.
  - Liquid proving switches on feed pumps monitor flow. The system will shut down if the cooling water supply is inoperative to prevent accidental VOC discharge.
  - Current overload interlocks on all motors
  - High/low level sensors to ensure proper fluid levels throughout the system
- Operating conditions are detected by the controller, and clear status messages are displayed on the console.
- The controller executes a safe and complete shut down on fault conditions.

SYSTEM SPECIFICATIONS....

	SRS Series				SRH Series		SRV Series	
MODEL	**SRS-55**	**SRS-90**	**SRS-150**	**SRS-250**	**SRH-55**	**SRH-90**	**SRV-60**	**SRV-150**
LOAD CAPACITY	55 USG	90 USG	150 USG	250 USG	55 USG	90 USG	60 USG	150 USG
DISTILLATION RATE (1)	35-60 GPH	50-80 GPH	75-110 GPH	100-150 GPH	30-50 GPH	40-70 GPH	30-60 GPH	50-110 GPH
KILOWATT RATING	30 KW	45 KW	70 KW	90 KW	40 KW	60 KW	30/36 KW	80 KW
HEAT UP TIME	30 MIN	30 MIN	45 MIN	60 MIN	45 MIN	60 MIN	45 MIN	60 MIN
COOLING WATER	70 GPH	100 GPH	135 GPH	180 GPH	70 GPH	100 GPH	70 GPH	135 GPH
WEIGHT	4200 LBS	5400 LBS	6800 LBS	8600 LBS	4200 LBS	5400 LBS	3700 LBS	5800 LBS
FOOTPRINT	L86" W58"	L98" W62"	L104" W68"	L110" W74"	L86" W58"	L98" W62"	L60" W60"	L75" W68"
HEIGHT	H148"	H148"	H158"	H168"	H148"	H148"	H130"	H156"
HEATING MEDIA	HOT RECIRCULATING OIL THROUGH A HEATING JACKET				IMMERSION ELECTRIC HEATERS IN HIGH VOLUME OIL BATH			
STEAM	OPTIONAL HEAT EXHANGER IN RECIRCULATING OIL LOOP				OPTIONAL STEAM COILS THROUGH HIGH VOLUME OIL BATH			
AUTO SCRAPER	STANDARD - SELF ADJUSTING SCRAPER BLADES FOR MAINTENANCE FREE OPERATION						N/A	N/A
VACUUM	AVAILABLE ON ALL SYSTEMS - LIQUID RING VACUUM PUMP WITH MECHANICAL SEAL							
AUTO FEED	AVAILABLE ON ALL SYSTEMS - CAN USE EITHER A PUMP OR VACUUM FEED							
AUTO COOL	AVAILABLE ON ALL SYSTEMS							
SLUDGE DISCHARGE	STANDARD - 6 INCH VALVE AT CONE BOTTOM FOR SAFE AND EASY DISCHARGE INTO A DRUM OR OTHER CONTAINER							
CONTROL PANEL	100% MICROPROCESSOR (PLC) CONTROLLED. MESSAGE DISPLAY WITH OPERATOR CONTROL KEYPAD							

(1) DISTILLATION RATE IS DEPENDENT ON THE SOLIDS CONTENT AND THE HEAT OF VAPORIZATION OF THE SOLVENT

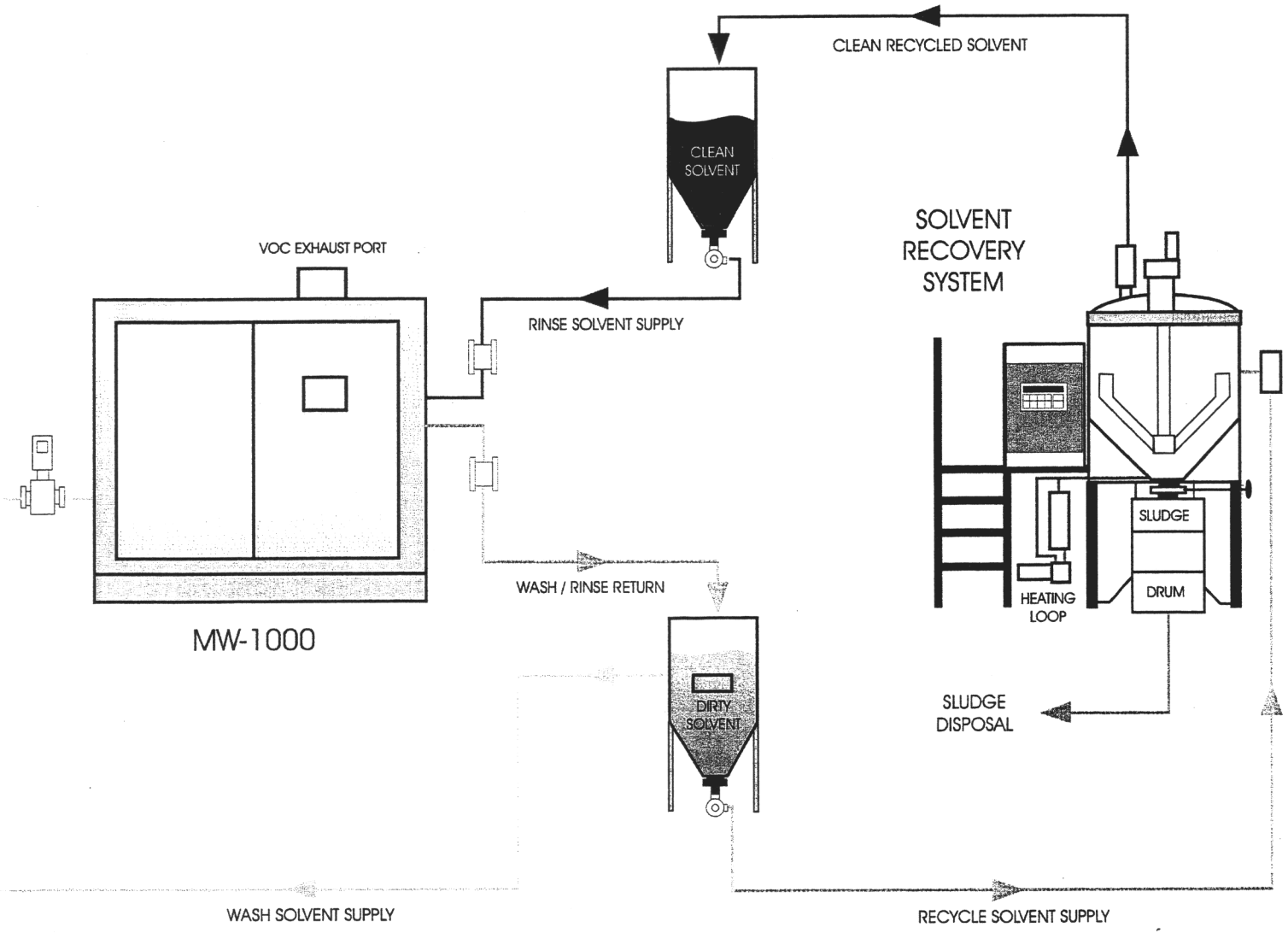
STANDARD FEATURES

- 304 stainless steel vessel
- Programmable Logic Controller (PLC) in a NEMA 4X enclosure
- Full function digital display with clear status and fault messages
- Interlocking safety devices on all required parameters for maximum operator safety.
- Explosion resistant designs and components
- 5 psi pressure relief valve in vessel
- Program watchdog timer to prevent overfilling
- RTD in vapor space, sludge and thermal oil
- 6" sludge discharge valve
- Elevated stand for easy discharge into a drum
- Inspection hatch and platform
- 316 Stainless steel condenser
- Ready for single point utility connections
- Auto cycle timer

OPTIONS

- NEMA 4X purge panel with auto shut down or
- Remotely located operator panel and local "ON-OFF" controls in a NEMA 7 enclosure (for Class I, Division I, Group D areas)
- External tanks for clean and dirty solvent with level controls.
- Pumps, valves and controls to client's holding tanks
- Vacuum system with secondary condenser for maximum VOC control
- Auto fill systems using a pump or the vacuum system and level controls
- Auto cool systems
- Nitro cellulose package
- Turn key systems including automatic tank and drum wash systems
- Custom systems

CLOSED LOOP SYSTEMS....



REDUCE COSTS...HEALTH AND SAFETY RISKS...VOC EMISSIONS

Fully automated closed loop systems are used to wash tote tanks, mixing vessels drums and a wide variety of small containers and parts, and recycle the solvent on-site. The distillation system is equipped with an auto fill feature, and along with the automatic wash system, monitor the liquid levels in the solvent tanks to ensure a constant material balance throughout the cycle. Reduced labor, disposal costs and solvent usage have allowed these systems to pay for themselves in 6 to 12 months, while assisting in complying with OSHA and air emission requirements.

SRS Industrial Engineering, Inc.

SRS Engineering Corp.

550 Industrial Way, Unit C
Fallbrook, CA 92028

Ph. (760) 728-1790
Fax (760) 728-3151
Internet: www.srsindustrial.com
E-Mail: marketing@srsindustrial.com

QUOTATION

From:	**B/R Instrument Corporation** 9119 Centreville Rd. Easton, MD 21601 Tel: 410-820-8800 Fax: 410-820-8141	Quote No.:	8380
		Date:	19-Sep-01
		Terms	Net 30
To:	**Stacy Richardson** **Sandia National Laboratory** **Pollution Prevention** **Albuquerque, NM 87185-1050**	Prices quoted are F.O.B.	Easton, MD
		Delivery:	4/6 Weeks ARO

We are pleased to quote as follows:

Part No.	Description	Price
B/R 9600	**High Purity Solvent Recycling System, Spinning Band, Automatic, 22 Liter**	
SB A 22	21mm bore x 90cm tall, fractional, adiabatic, spinning band distillation column, 50 theoretical plates with all borosilicate glass and teflon components. M690 microprocessor with hand held keyboard. Teflon spinning band with DC drive motor. 22 liter pot flask with heating mantle and lab jack. Enclosure cabinet with door, automatic water on/off with pressure regulator, sensor shutdown and 18' of PVC tubing and clamps. **System is Listed to UL 3101-1 and CAN/CSA C22.2 No. 1010.1-92**	$14,450.00
	OPTIONAL ACCESSORIES:	
7725A	Automatic two way valve. Collects two distillation cuts without operator intervention.	$834.00
HP-19R	High Purity 19 liter glass receiver with fume guard	$645.00
BATH-33	Recirculating Refrigeration Bath	$2,950.00

INSTALLATION BY B/R FACTORY TRAINED REPRESENTATIVE $975 (OPTIONAL)

FOR COMPLETE DESCRIPTION PLEASE REFER TO PRODUCT BROCHURE
SHIPPING CHARGES ARE PREPAID AND ADDED TO THE INVOICE

THIS QUOTATION IS VALID FOR SIXTY (60) DAYS UNLESS OTHERWISE STATED
THE WARRANTY INFORMATION FOLLOWING IS A PART OF THIS QUOTE

Dear B/R Instrument Customer,
Thank you very much for your interest in B/R Instrument's products.
Review the quotation and following after sales information. Please call us should you require additional assistance.

Signed: _____
B/R Instrument Corporation 9119 Centreville Rd Easton MD 21601

QUOTATION

From:	**B/R Instrument Corporation** 9119 Centreville Rd. Easton, MD 21601 Tel: 410-820-8800 Fax: 410-820-8141	Quote No.:	8381
		Date:	19-Sep-01
		Terms	Net 30
To:	**Stacy Richardson** **Sandia National Laboratory** **Pollution Prevention** **Albuquerque, NM 87185-1050**	Prices quoted are F.O.B.	Easton, MD
		Delivery:	4/6 Weeks ARO

We are pleased to quote as follows:

Part No.	Description	Price
B/R 9600	**High Purity Solvent Recycling System, Spinning Band, Automatic, 50 Liter**	
SB A 50	21mm bore x 90cm tall, fractional, adiabatic, spinning band distillation column, 50 theoretical plates with all borosilicate glass and teflon components. M690 microprocessor with hand held keyboard. Teflon spinning band with DC drive motor. 50 liter pot flask with heating mantle. Open frame mounting rack for column and M690. Plexiglass safety shield. Automatic water on/off with pressure regulator, sensor shutdown and 18' of PVC tubing and clamps.	$17,450.00
	OPTIONAL ACCESSORIES:	
7725A	Automatic two way valve. Collects two distillation cuts without operator intervention.	$834.00
HP-19R	High Purity 19 liter glass receiver with fume guard	$645.00
BATH-33	Recirculating Refrigeration Bath	$2,950.00

INSTALLATION BY B/R FACTORY TRAINED REPRESENTATIVE $975 (OPTIONAL)

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Signed: _____
B/R Instrument Corporation 9119 Centreville Rd Easton MD 21601

QUOTATION

SHIPPING

B/R Instrument ships all units via air freight, FOB Easton, MD. This assures you of quick, dependable shipments and minimizes the chance of damage. Please consult B/R regarding estimated shipping charges when you place your order.

WARRANTIES

The products listed on this quotation are sold "as is." Seller specifically excludes all warranties of merchantability and fitness. However, if the warranty registration form shipped with the product is completed in its entirety and returned to B/R Instrument Corp. within thirty days (30) from shipment, the Seller warrants for the period indicated below that the products are free of defects in workmanship and free of defects in such materials as are wholly manufactured by B/R Instrument Corp. Such materials which are not wholly manufactured by B/R Instrument Corp. are not covered by this warranty, but may be covered under warranty from the original manufacturer. In the event of a breach of warranty, Buyer shall have the rights set forth in the "remedies" section of this agreement. The warranty, if any, is non-transferable.

Service costs incurred during the warranty period cover labor and parts. Travel expenses and shipping charges are paid by the customer.

Equipment and parts returned to B/R Instrument are subject to a 15% restocking fee.

WARRANTY PERIOD

If payment for the product is made with in ten (10) days from the mailing of the invoice the warranty is eighteen (18) months from the date of shipment. If payment for the product is made within thirty (30) days from the mailing of the invoice, the warranty period is twelve (12) months from the date of shipment. If payment for the product is made after thirty (30) days, but before sixty (60) days from the mailing of the invoice, the warranty period is six (6) months from the date of shipment. Otherwise the warranty period is ninety (90) days.

INDEMNITY

Buyer indemnifies and holds Seller harmless from any and all claims by Buyer or third parties for damages arising from the use of the products. Damages specifically include, but are not limited to, bodily and economic injuries to people and property damage. Indemnity shall extend to attorney fees, litigation expenses, interest on funds expended and court costs. Indemnity reimbursement to Seller shall occur whether or not suit is actually filed. Buyer understands that use of the products involves some danger of damage to persons and property which is minimized by continuous careful monitoring of the products while in use. Sale to Buyer is with the understanding that Buyer will read and follow all instructions provided with the products.

REMEDIES

The sole and exclusive remedy which is available in the event of Seller's breach of this agreement, including breach of warranty, is return of the product, at Buyer's cost, and refund of the purchase price by Seller. Seller reserves the right to repair or replace non-conforming goods or parts instead of accepting return of the product and refunding the purchase price. Accordingly, any consequential, incidental, or other damages arising from breach by Seller are expressly, and by agreement, excluded.

APPLICATION NOTE # 29

THE RECOVERY OF ISOPROPANOL

PROBLEM: To recover Isopropanol from a waste material containing 64 % Isopropanol and 36 % aqueous buffer from an HPLC procedure.

EXPERIMENTAL PROCEDURE: Distillation of the mixture was accomplished on a 9400 distillation unit. The following conditions were employed:

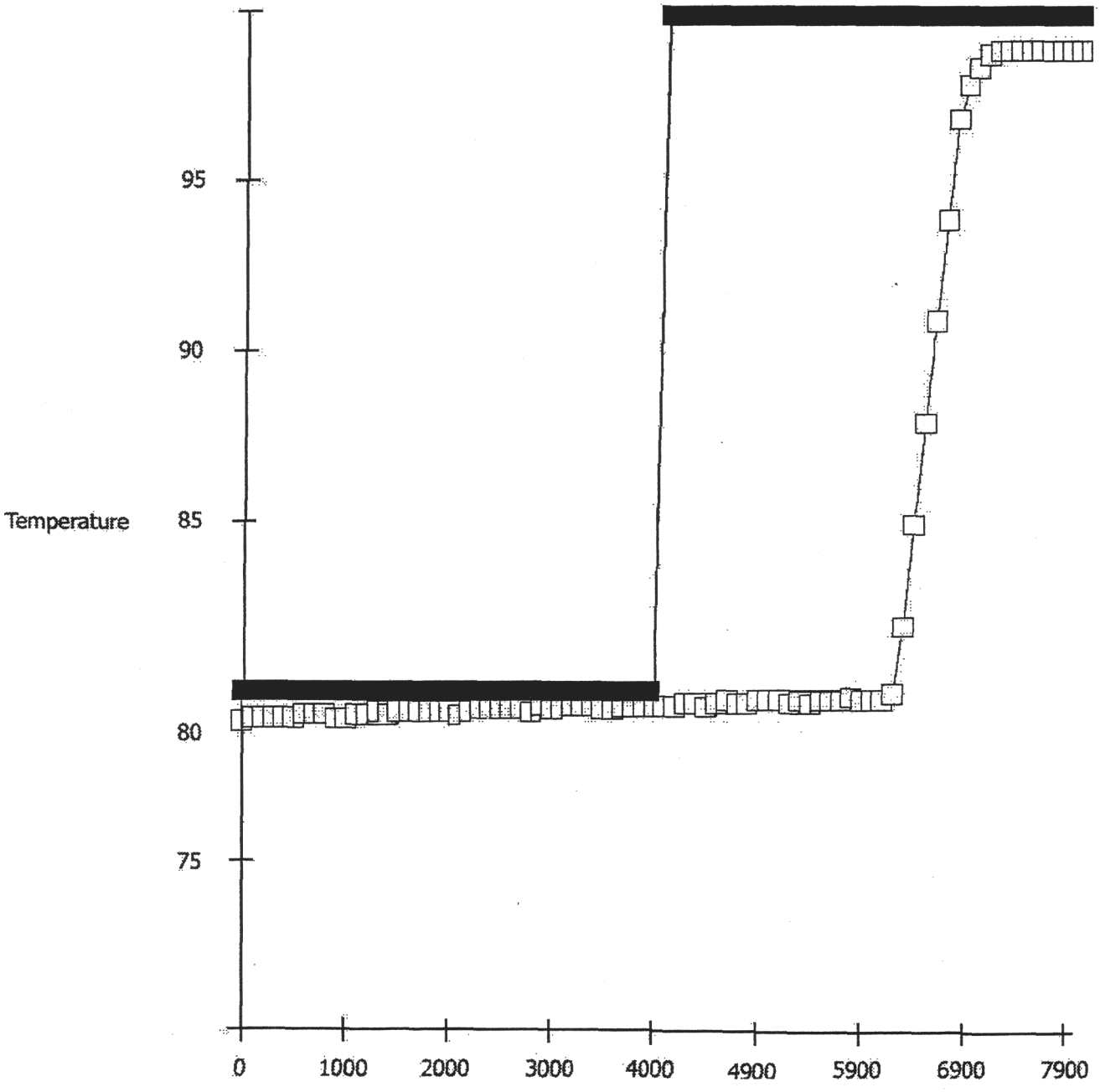
POT CHARGE	: 8000 mL
EQUILIBRATION	: 1 Hour
BOILUP RATE	: Steady Stream
REFLUX RATIO	: 5:1
THROUGHPUT	: 600 mL/Hour
BAND SPEED	: 2200 rpm

Each fraction was analyzed by GC analysis on a HP-5890 Gas Chromatograph using a thermal conductivity (TC) detector. Calibration curves were prepared in order to determine % Water in each fraction.

RESULTS: The distillation curve is presented on the next page. The first fraction (the first 10 mL was discarded) had a boiling range of 79.1 to 79.8 ^{o}C and was the 87.1:12.9 Isopropanol/Water azeotrope. No further analysis was performed.

B/R Instrument Corporation
9119 Centreville Rd. Easton MD 21601 USA
www.brinstrument.com, brsales@brinstrument.com
Phone: 410.820.8800 Fax: 410.820.8141

Distillation of Isopropanol/Water Waste
87:13 Azeotrope Recovered



Application Note 29
B/R Instrument Corp., www.brinstrument.com

B/R Instrument Corp.

RECYCLE HPLC GRADE METHANOL FROM A USED SOLVENT

PROBLEM: Recycle an HPLC grade Methanol from a used solvent. The solvent is derived from an HPLC mobile phase that has the composition 90% Methanol/10% Buffer. This solvent is used in an HPLC analysis of Salicylate drugs (Salicylic Acid, Sulfathiazole, Naproxen, and Thiosalicylic Acid).

EXPERIMENTAL PROCEDURE: Distillation is carried out without any pretreatment utilizing the distillation conditions described below. Two cuts are taken and distillation is complete after almost 95% of the pot charge is recycled.

POT CHARGE	: 5000 mL	
CUT # 1	: 50 mL	B.P. 62 - 64°
CUT # 2	: 4500 mL	B.P. 64 - 64.5°
POT RESIDUE	: 450 mL	

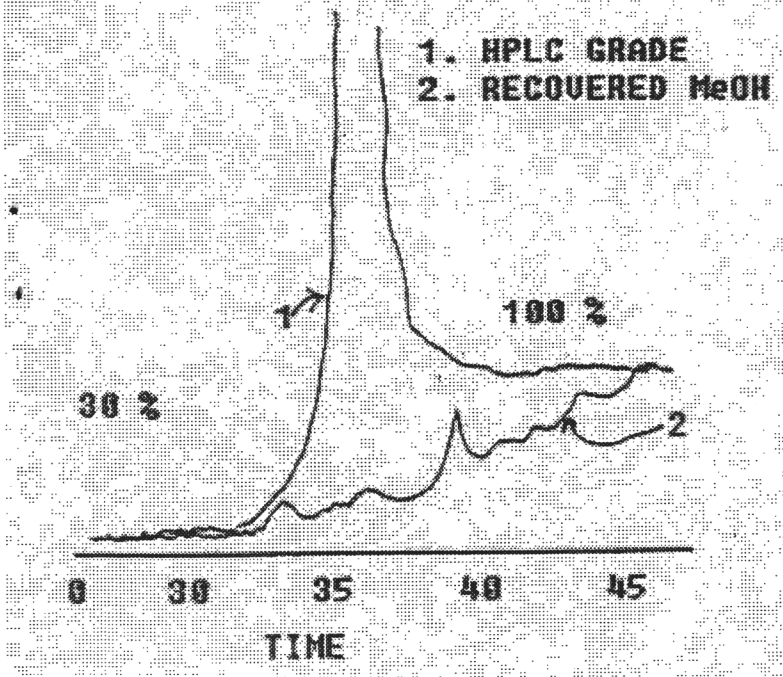
All distillations are carried out automatically in a **B/R Instrument 9400 High Purity Solvent Recycling System.** The system includes a 30 theoretical plate spinning band column and microprocessor controller. Conditions for the distillation are:

THROUGHPUT	: 450 mL/hr
REFLUX RATIO	: 5:1
EQUILIBRATION	: 2 hours

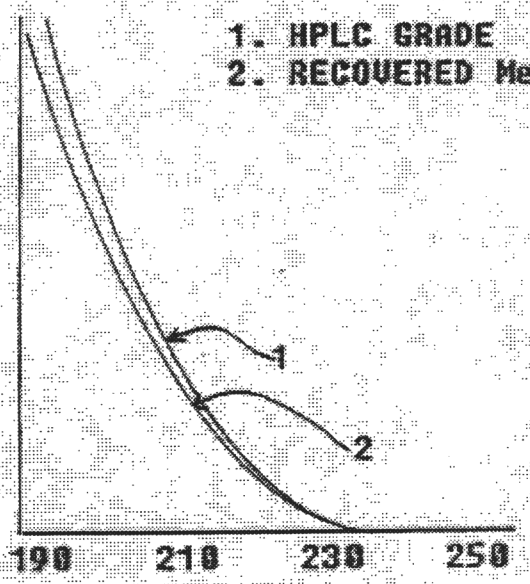
RESULTS: A comparison of the heart cut (Cut # 2) with HPLC grade is given below. Spectral data are found on the reverse side of this sheet. In this distillation, 94 % of the pot charge is recycled as the pure solvent. This material has a purity equal to or better than a commercial HPLC grade. The percentage of water in the distillate is dependent upon the amount present in the original waste. In this case, a material containing 1 % water is obtained from a waste with a 10 % original water content. In other experiments, we have found that as much as 5 % water will be obtained in the distilled material(from an initial 50:50 waste). If a strictly anhydrous solvent is required, the distillate should be dried with anydrous Sodium or Magnesium Sulfate and filtered before use.

	HPLC GRADE METHANOL	RECOVERED METHANOL
Boiling Point	64 - 64.5°	64 - 64.5°
Refractive Index	1.3311	1.3308
WATER (Karl Fischer)	0.074%	1.1%
GLC Purity	99.9%	99.9%

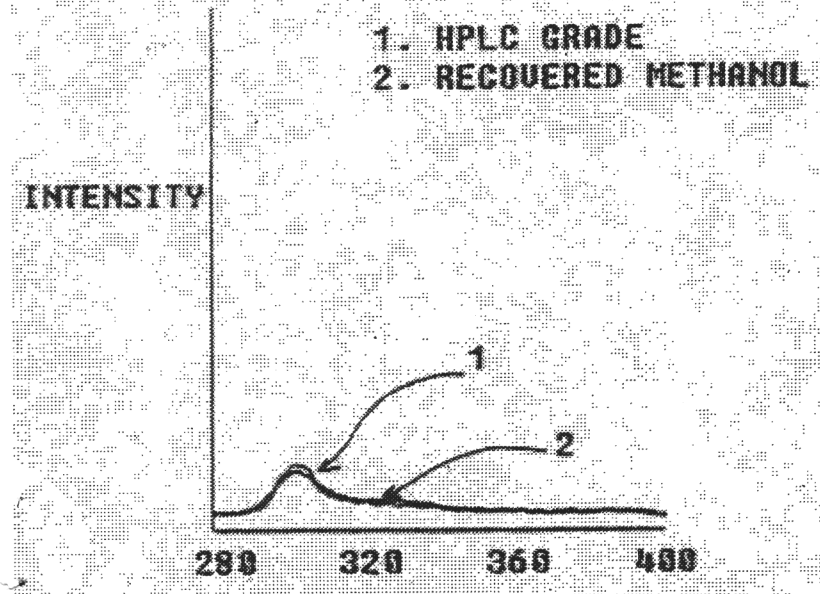
B/R Instrument Corp. 9119 Centreville Rd. Easton, MD USA
Tel: 410.820.8800 Fax: 410.820.8141 Email: brintl@brinstrument.com



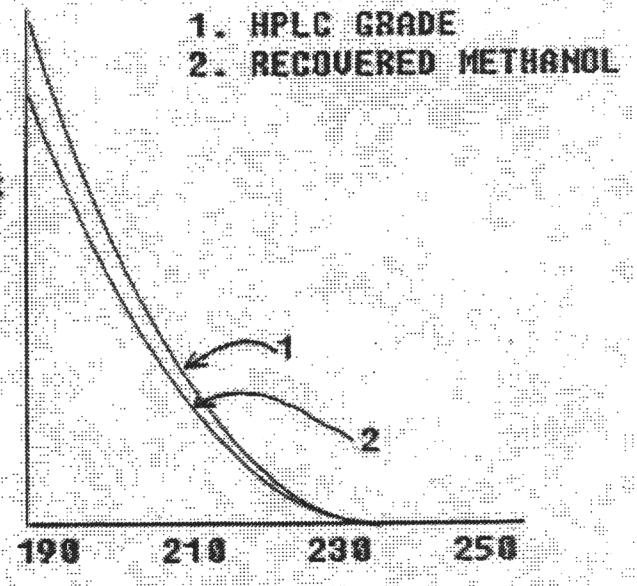
DYNAMIC HPLC STUDY: 30 % MeOH at 3 mL/min STEP GRADIENT TO 100 %



UV SPECTRA (10 FOLD PRECONCENTRATE)



FLUORESCENCE SPECTRA (267 nm EXCITATION)



UV SPECTRA (NEAT SOLVENT)

OhioEPA

Office of Pollution Prevention

January 1998
Number 9

Onsite Solvent Recycling Equipment

The generation of solvent wastes contributes to air and water pollution and hazardous waste generation. It is one of Ohio's most common environmental problems. Pollution Prevention for industrial solvents should be practiced whenever

Reducing solvent wastes is currently one of the most important elements of pollution prevention (P2) programs nationwide. Solvent use is a major contributor to air and water pollution, and is a leading source of hazardous waste. Chlorinated solvents are a major contributor to ozone depletion. The Clean Air Act Amendments of 1990 mandate a reduction in the amounts of solvents released into the atmosphere. As a result the costs of complying with the Clean Air Act have risen accordingly. Generators of solvent wastes can profit by reducing the costs associated with waste disposal. Reducing solvent use also reduces the cost of purchasing virgin solvents as well as reducing storage and management costs.

When implementing a pollution prevention program aimed at reducing solvent wastes, the first alternative should be to reduce or eliminate the use of solvents at the source, (source reduction). Source reduction reduces the release of wastes and pollutants, and the costs associated with those releases. The second option is to recycle or reuse the wastes in an environmentally sound manner. Disposal of solvent wastes, even when they are used as fuel, is not considered pollution prevention, and would not be considered part of a pollution prevention program.

Businesses may be able to eliminate their solvent wastes by finding an aqueous or semi-aqueous cleaner to replace the solvent. The Ohio EPA Office of Pollution Prevention provides over a dozen documents and fact sheets on solvent substitution, alternatives to ozone depleting solvents and on aqueous degreasing and parts cleaning. Please contact the Ohio EPA Office of Pollution Prevention for more information.

If solvents cannot be eliminated from the process, the second option, is to recycle or reuse the wastes that are generated in an environmentally sound manner (waste minimization). Businesses can recover spent solvents though the use of an outside recycler, or recycle sol-

This paper contains 100% post-consumer recycled fiber and was printed using soy-based inks

Office of Pollution Prevention, Ohio Environmental Protection Agency
P.O. Box 1049, Columbus, Ohio, 43216-1049, (614) 644-3469

vents on-site using their own equipment, as discussed in this fact sheet. Before a company purchases any solvent recycling equipment it needs to consider possible limitations. These limitations include:

- The cost of purchasing and maintaining recycling equipment
- The cost of training and staffing equipment operators
- Will the amount of spent solvent recycled justify the costs of recycling?
- Potential fire and/or explosion hazard
- Is the final product of the recycling process usable in the original process?
- Regulatory considerations for air emissions and bottoms disposal

Before investing in a recycling process, it is important for a company to investigate whether its spent solvents are recyclable. Some industrial solvents are blends of two or more pure solvents and additives. Recycling could alter the solvent's composition and usefulness. 1,1,1-trichloroethane, for example, can break down during distillation and become acidic. By-products of the industrial process may also prevent recycling. Stabilizers and/or other additives may be required in order to make the recycled product usable. Suspended solids affect the efficiency of the recycling apparatus and limit which types of recycling units can be used.

Before purchasing a recycling system, ask the equipment supplier to recycle samples of the spent solvent. Analysis of the distillation product will demonstrate the effectiveness of the recycling still and help determine what is required to make the recycled solvent usable. It will also help to determine the characteristics of the still bottoms waste.

Explosion or fire hazard conditions can be created when some materials are distilled. Some printing and painting process wastes for example, contain nitrocellulose which can pose a fire or explosion hazard if not distilled under strict conditions. Consult with the manufacturer to see if the still comes equipped with a "nitrocellulose" or other explosion proof package.

The quality of the distilled product of the recycling process needs to be considered as some recycled solvents may not be usable for their original purpose. Alternative uses generally can be found. It may not be necessary to recycle a solvent to 100 percent purity for an intended purpose. Additives may be necessary for a solvent to be safe and effective for an industrial process. If not usable for its original purpose, the final product could be used in another process or sold to another company through a waste exchange program .

Solvent Still Types

There are three general solvent still types: simple distillation units, fractional distillation units, and thin film evaporators. The most common method is simple distillation. During simple distillation, solvent wastes are heated, driving off the solvent in vapor form. The vapor is reverted back to liquid form in the condenser and collected. The still bottoms, or waste remaining in the bottom of the still is then collected and disposed. Simple distillation units are run in batches.

The second type of unit, fractional stills, produce a higher purity of recycled product. A fractional still may separate an industrial solvent blend into its pure constituents. Fractional distillation units are generally more expensive to operate and are generally better suited to larger volumes. Fractional distillation units are also usually batch units.

The third type, thin film evaporators, distill by running a thin film of dirty solvent down a heated cylindrical vessel where it is vaporized. The vapors are collected and condensed back into liquid form for reuse. Thin film evaporators are generally

suited for use in high volume, continuous processes. Thin film evaporation requires the dirty solvent to have a low suspended solids content to work well.

Still Operating Considerations

Wastes should be segregated whenever possible. If two wastes containing two solvents are distilled, a simple still may produce a solvent blend of the two solvents. This blend may not be usable for the original purposes of the individual solvents. When pure solvent is the goal, it is best not to mix wastes containing different solvents.

If the suspended solids content is high, additional equipment may be necessary. This equipment is necessary to facilitate distillation in addition to cleaning. As the still bottoms becomes more and more concentrated, the solids can insulate the solvent and slow the distillation process. Some "total recovery systems" use microwave units or other technologies that can drive the solvent out of the solids once the ratio of solvent to solids is too low to be distilled normally.

The ease of cleaning should be considered when choosing a still. Still liners facilitate cleaning the still and in disposing the still bottom wastes. Still cleaning can make up a significant portion of still operating costs. In cases where suspended solid content is higher, additional equipment and/or considerations may be necessary .

Solvents with very high boiling points may require reduced pressures to be distilled, a vacuum can be used to reduce the distillation pressure. The risk of fire hazards or explosions that are possible in some stills, can be reduced with the use of a vacuum unit.

Stills come in a wide range of sizes and specifications. Batch stills can range in size from two to over 55 gallons. They distill their capacity in a six to eight hour work shift. Continuous flowing stills range in distillation capacity and can distill as much as 500 gallons per hour. Smaller stills can run on electricity while larger stills may require a steam connection. The condenser may be cooled by circulating air, water or a chemical coolant or refrigerant. A water hook-up is necessary for water cooled stills.

During distillation of spent solvents, water can mix with the solvent resulting in an acidic mixture that is corrosive to the still. Stainless steel and Teflon fittings and gaskets which are corrosion resistant, last longer than other materials under these conditions.

Safety Consideration

Safety features also need to be reviewed before choosing a still. Safety features which are available include explosion proof electrical compartments and automatic shutdown features. Investigate if the still shuts down automatically after a batch is finished, if there is a coolant failure, when the boiling chambers temperature exceeds a threshold setting, and if the water/coolant temperature in the condenser goes above a certain threshold temperature.

Some other safety considerations: Electrical components should be explosion proof and made with Underwriter Lab approved components. The pot should have a pressure relief valve. Some stills come equipped with an automatic shut-off feature that senses when all of the solvent has been distilled.

Safety regulations must also be met when instaling a new solvent recycling system. OSHA requirements for ventilation and employee safety should be considered. Local fire regulations need also to be considered. Finally, notify your insurance carrier to ensure that the installation of the equipment does not affect your coverage.

Onsite Solvent Recycling Equipment

Recycling Costs

Several factors should be considered when reviewing the cost efficiency of a still. These factors include the amount of solvent used by the business, the cost of new solvent, the cost of still bottom or other waste disposal, usefulness of recycled solvent, the operating cost of the still, and the payback period. Electricity, labor requirements, and still liners should also be included in the operating costs.

Regulatory Considerations for Solvent Recycling Stills and Still Waste

It is important to note that "waste" that is recycled or sold to another compay is not subject to hazardous waste regulations. Reducing the use of virgin solvents, could give a business the regulatory advantage of falling below the Superfund Amendment and Reauthorization Act (SARA) reporting requirements (SARA 311, 312, 313 reporting). Hazardous solvent wastes sent off site for recycling or disposal must be reported under SARA 313 toxic release requirements. Solvent wastes which are recycled ***onsite*** do not have to be reported, except for that portion of the solvent which is released in the form of air emissions.

Another important consideration are the air emissions of the still and/or the recycling process. Air emissions from a distillation process are regulated in two forms: Fugitive emissions and point source emissions. Fugitive air emissions are leaks in the unit, or emissions from the recycling process, opening the unit, filling the unit, cleaning the unit etc. Point source air emissions would be emissions via a ventilation stack. The design of most modern stills should limit the amount of solvent which is released into the air in vapor form during operation. A business should investigate the emissions of a particular still since improper design or maintenence could result in emissions which would require an air emissions permit. Depending on the geographic region in which the company is located and the air emissions of a particular model and/or process, the distillation unit might require a permit to install, or permit to operate an air emissions source under title V of the Clean Air Act. For more information please contact the Ohio EPA Division of Air Pollution Control.

Still bottoms are considered hazardous when a listed hazardous waste solvent is distilled or if they meet hazardous waste characteristics as defined by the Federal Resource Conservation and Recovery Act and by the Ohio Administrative Code (OAC).

Microwave still bottoms recyclers and other "Total Recovery" systems can significantly reduce solvent content of still bottoms in some cases. If the solvent is the only hazardous component in the waste and enough solvent is removed from the still bottoms they may no longer meet the characteristics of hazardous waste. However, when a **listed** hazardous waste is distilled the still bottoms are *always* a listed hazardous waste. For more information on hazardous waste rules, please contact the Ohio EPA Division of Hazardous Waste Management.

The Ohio EPA Office of Pollution Prevention Document. *Legal Considerations for On-Site Solvent Recycling*, gives a more comprehensive explanation of air, water, and hazardous waste disposal considerations for recycling solvents on-site.

Sources:

USEPA. 1990. *Guides to Pollution Prevention: Selected Hospital Waste Streams*. EPA/625/7-90/009.

USEPA. 1996. *Partners for the Environment - Green Chemistry Challenge*. http://es.inel.gov/partners/chemstry/chemstry.html

*Vendors:	Products:
All American Recovery Systems, Inc. P.O. Box 1089 Huffman, TX 77336 (800)367-5773	Distillation units ranging in size from 5 gal. batch units to 100 gal., both batch and continuous units.
Alpha Laval, Inc. 955 Mearns Rd. Warminister, PA 18974-2884 (215)443-4000	Centrifuges, oil purifiers
Artisan Industries, Inc. 73 Pond Street Waltham, MA 02254-9193 (617)893-6800	Continuous and batch stills, rotary stills, thin film evaporators, mobil solvent recovery systems.
Better Engineering Mfg., Inc. 7101 Belair Rd. Baltimore, MD 21206 (410)931-0000	Aqueous and solvent-free cleaning equipment for cleaning and degreasing parts and machinery
Binks Corp. (div. of NovaPro) 6909 Engle Rd. Bldg. 2 Cleveland, Ohio 44130 (216)891-8181	Small batch distillation units (2.5 gal. and 7.5 gal.)
Black Rhino Recycling Corporation P.O. Box 18044 Pittsburgh, PA 15122 (412) 460-0160	Recycling systems to reclaim solvents, lubricants, coolants, regridgerants, hydraulic oil, and oily water.
B/R Instrument Corp. 9119 Centerville Rd. Easton, MD 21601 (301)820-8800 (800)922-9206	Batch stills, formalin recycling equipment, high purity solvent reclaimation systems.
Branson Ultrasonic 41 Eagle Rd. Danbury, CT 06813 (203)796-0392	Solvent-free cleaning and degreasing equipment, batch stills
Buffalo Technologies 750 East Ferry Street Buffalo, NY (716)895-2100	Tubular evaporators, water evaporators, drum driers and flakers

* For the most current version of this list, please contact the Office of Pollution Prevention or view our Web site.

Onsite Solvent Recycling Equipment

Vendors:	Products:
Chemical Management Technology, Inc. 3035 Bravo Ct. Orange Park, FL 32065 (800)749-1008	Continuous and batch stills
Detrex Corp. P.O. Box 5111 Southfield, MI 48086 (810)358-5800	Continuous and batch stills, custom equipment.
Doumar Solvent Recovery Systems, Inc. P.O. Box 740953 Orange City, FL 32774 (904)774-1311	Automatic Stills, Vacuum Stills, and Integrated solvent wash/recycling systems
Finish Thompson 921 Greengarden Rd. Erie, PA 16501-1591 (814)455-4478	Antifreeze recycling equipment and pumps for special fluids
Finishing Equipment, Inc. 3640 Kennebec Dr. Eagan MN, 55122 (612)452-1860	Batch and continuous distillation units Super-Heated Vapor Degreasers Total-Recovery distillation systems
Gardner Machinery Co. P.O. Box 33818 Charlotte, NC 38233 (704)372-3890	Vacuum distillation units, environmental "leak-proof" pumps for corrosives
Hoffman / Clarkson, Inc. P.O. Box 548 East Syracuse, NY 13057-0548 (800)258-8008	Continuous and batch stills, vacuum stills
Interel Corp. 2600 S. Parker Rd. Suite 261 Aurora, CO 80014 (303)721-8071	Amine removal, foundry core and catalyst equipment
LCI Corp. 2407 Worthington Dr. Suite 101 Naperville, IL 60565 (630)305-8693	Membrane filters, other filter

Vendors:	Products:
Lanair Corp. 4109 Capital Circle Janesville, WI 53546 USA (800) 753-1601	1-8 gallon explosion proof batch still (SR 80-XP
Lenan Corp. 4109 Capital Cir. Janesville, WI 53546 (800) 753-1601	Batch stills
National Fluid Separators 827 Hanley Industrial Ct. St. Louis, MO 63144 (314)968-2838	Oil and water separators, large and small, and asphalt equipment cleaning systems
PBR Industries 143 Cortland St. Lyndenhurst, NY 11757 (800)842-1630	Explosion proof batch stills ranging in size from 2 to 40 gal., vacuum stills and agitator stills.
Phaudler Co. P.O. Box 23600 1000 West Avenue Rochester, NY 14692-3600 (716)235-1000	Wiped film evaporators
Pope Scientific, Inc. N.90 W.14337 P.O. Box 495 Commerce Drive Menomonee Falls, WI 53051	Spinning-band evaporators, molecular/vacuum stills
Processall, Inc. 10596 Springfield Pike Cincinnati, OH 45215 (513)771-2266	Vacuum stills, Regrind recycling systems (wood, plastic, etc.)
Progressive Recovery, Inc. P.O. Box 126 700 Industrial Drive Dupo, IL 62239 (618) 286-5000	Pot scrape-side equipment Microwave "Total recovery systems"

Onsite Solvent Recycling Equipment

Distributors:

PuraStil 900 N. Westwood Toledo, OH (419)536-7384	Parts washer / recovery systems Continuous loop systems High-boiling solvent stills
D.W. Renzmann GmbH 6557 Monzingen/Nahe West Germany 0-6751-5011	Batch, continuous, vacuum stills
TransSolv 1740 Stebbins Drive Houston, Texas 77043 (800) 673-6914	Batch or Continual Feed Portable Systems
SRS Industrial Engineering 6101 Ball Rd. Cypress, CA 90630 (714)827-1977	Produces a wide variety of distillation units
Unique Industries 2155 Verdugo Blvd. #133 Montrose, CA 91020 (818)249-5620	Tank, Tote, Drum, Pail, & Parts Washers & Washing Systems. Solvent Distillation, Recycling, Recovery Systems.
UIC Incorporated P.O. Box 863 Joliet, IL 60434 (800)342-5842	Equipment for modifying existing stills and vapor degreasers, Continuous no-residue-hold-up evaporators
Westport Environmental Systems P.O. Box 217 Westport, MA 02790-0217 (800)343-9411	Batch, continuous, and vaccuum stills carbon absorption, vapor-phase recovery

Distributors:

G.H. Diers Co. P.O. Boc 43198 Cincinnati, OH 45243 (513)791-1188	Coolant, oil, vacuum stills, oil and water sseparators, Distributor for Westport Environmental Systems, Inc.
Distil Kleen 22 Hudson Place Hoboken, NJ 07030-5512 (201)217-0505	Distributor for D.W. Renzman
Erie Industrial Supply 931 Greengarden Blvd. Erie, PA 16512 (814)452-3231 (800)999-0452	Representing Finish Thompson, Inc.
Flanagan Associates, Inc. 10999 Reed Hartman Hwy. Suite 139 Cincinnati, OH 45242 (800)852-5820	Distributor for Artisan Industries, D.W. Renzmann, FlexCon, and drum / bulk bag equipment
Giangarlo Scientific Company, Inc. 162 Steuben St. Pittsburg, PA 15220 (412)922-8850	Distributor for Pope Scientific, Inc.
Hydro-Tek Inc. 8501 W. 191st St. Unit #45 Mokena, IL 60448-8708 1-800-526-4955 708-479-0001	Distributor for D.B. Mills. and other manufacturers of Recycling and Resource Recovery Systems including stills, membrane filtration. and other filtration.

This is the 16th in a series of documents Ohio EPA has prepared on pollution prevention. For more information, call the Office of Pollution Prevention at (614) 644-3469.

The Office of Pollution Prevention was created to encourage multi-media pollution prevention activities within the state of Ohio, including source reduction and environmentally sound recycling practices. The Office analyzes, develops, and publicizes information and data related to pollution prevention. Additionally, the Office increases awareness of pollution prevention opportunities through education, outreach, and technical assistance programs directed toward business, government, and the public.

Office of Pollution Prevention WWW address: www.epa.state.oh.us/opp

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Attachment 4
Vendor Information

GRS
A Division of MPE, Inc.

GARMENT RECOVERY SYSTEMS™

445 Junction Avenue Schererville, Indiana 46375
(219) 865-3322 • FAX (219) 865-0132

September 27, 2001

Stacy Richardson
Sandia National Lab
P.O. Box 5800
ALBUQUERQUE, NM 87185-0100

Dear Stacy:

This letter answers some commonly asked questions about our Tyvek® Recycling Program. The intent is to help Sandia National Lab begin recycling disposable garments instead of discarding them into the solid waste stream. Although we have certain guidelines, GRS will tailor the program to accommodate the specific needs of Sandia National Lab.

Why should we recycle our Tyvek?

As our country's landfills reach capacity, states and local communities are finding it increasingly difficult to dispose of solid waste. Tyvek® is 100% polyethylene and does not decompose in landfills; however, it can be diverted from the solid waste stream, recycled by GRS and, at the same time, generate financial support to the local shelter for abused women & children.

What is the best reason to recycle our Tyvek?

Recycling your Tyvek® is good. Turning your Tyvek® waste into dollars to help make a difference in your community is even better.

Every recycled Tyvek® garment provides much needed financial support to Shelters for Abused Women and Children in your community. The National Coalition Against Domestic Violence has agreed to assist in identifying the shelter closest to you facility. GRS will contribute $.25 for each coverall and $.10 for each lab coat in the name of Sandia National Lab to that shelter. If it is your preference to support a different cause, please let us know which charitable concern you would like to designate.

GRS will send a quarterly statement indicating the number of garments sent and accepted for recycling and reflect the contribution made on behalf of Sandia National Lab to the shelter in your area. In addition, you will receive acknowledgement from the shelter's Executive Director thanking your company for its support by participating in this unique recycling program.

Who is Garment Recovery Systems?

Garment Recovery Systems (GRS) was established in 1987 for the sole purpose of recycling disposable garments. GRS recycles Tyvek® for over 350 companies from the U.S., Canada, Mexico, and Puerto Rico. A partial list of companies currently recycling their Tyvek® with GRS follows this letter. Detailed references are available upon request.

GRS
A Division of MPE, Inc.

GARMENT RECOVERY SYSTEMS ™

445 Junction Avenue Schererville, Indiana 46375
(219) 865-3322 • FAX (219) 865-0132

Do you have to buy garments from GRS in order to recycle them?

Absolutely not! GRS recycles garments that Sandia National Lab buys from its current Vendor.

What type of garments does GRS accept?

GRS accepts Tyvek® coveralls, lab coats, hoods, boot covers, shoe covers, pants, and sleeves. As long as the bulk of the garments are Tyvek®, you can include other types of disposable garments so you do not have to sort or separate out other materials. Your employees do not have to think about what goes in the recycling bin and what does not. If the garment is disposable and non-hazardous, it can be thrown in the bin labeled "TYVEK® RECYCLING".

Does GRS accept torn garments?

There is no need to inspect your garments before discarding them. If garments are slightly torn or have holes, we can usually repair them. Please remind the people wearing coveralls not to tear them off but instead unzip and step out of them. There is no problem if the garments come to us inside out but we do not to put shredded garments through our process. Please do not shred, tear off, or write on your garments.

Do we need to sort or count garments?

There is no need to count, sort, or inspect the garments before shipping them to GRS. The garments are sorted and counted by GRS. Sandia National Lab will receive a statement detailing how many garments were recycled each quarter.

What about hazardous garments?

GRS is not a registered hazardous waste site. GRS accepts garments that are currently being disposed of as general waste. All garments considered hazardous by the EPA or the Department of Transportation must still be disposed of as hazardous waste by a licensed hazardous waste hauler per federal and state regulations. GRS accepts autoclaved garments that are no longer considered hazardous. The only exception is garments that have been exposed to HIV or HBV, neither is acceptable even after autoclaving.

Will GRS provide us recycling reports?

In addition to the quarterly statements, GRS can provide feedback detailing pounds of Tyvek® and pounds of packing materials such as corrugated boxes and pallets which are also recycled.

What is the best way for us to collect garments?

GRS
A Division of MPE, Inc.

GARMENT RECOVERY SYSTEMS ™

445 Junction Avenue Schererville, Indiana 46375
(219) 865-3322 • FAX (219) 865-0132

GRS provides Tyvek® recycling labels to assist in the collection of the used disposable garments. These labels are to be placed on the collection containers in the degowning areas. When the containers are full, remove the trash liners of used garments and prepare them for shipping to Garment Recovery Systems. Since the garments compact quite nicely, it is helpful to poke holes in the plastic bags to allow air to escape and increase the number of garments per shipment. Please save up as much as possible before shipping. Sending one large shipment is far more cost effective than a series of smaller shipments. GRS recycles all wood pallets and cardboard boxes and encourages the reuse of your used boxes.

How do we ship the garments?

GRS will provide the dispatch number for our trucking company so you can ship collect. Please save at least one pallet load or approximately 200 pounds before shipping. Please send as many pallets per shipment in order to help keep our shipping costs down. The Bill of Lading should reflect the product description number 196200 and be sent class 70. We will be happy to provide a sample bill of lading for your convenience.

Mark each shipment with YOUR COMPANY NAME AND ADDRESS and ship to:

Garment Recovery Systems, 445 Junction Avenue, Schererville, IN. 46375

GRS provides a supply of pre-addressed labels so your shipping department will not have to bother with the inconvenience of labeling each shipment. It is helpful to have your return address on each pallet load.

What if we can not save enough to ship via common carrier?

If you cannot save enough for a pallet load, you can send your box(s) via UPS Ground.

We look forward to working with you to keep Tyvek® out of the landfill and help Sandia National Lab reduce solid waste. Please call me if you need more information or have any questions about our recycling program.

Sincerely,

Garment Recovery Systems

Beverly Pettis

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Distribution:

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MS 0871 John Norwalk, 14403

MS 1050 Albert Villareal, 3124

MS 0873 Ruth Bargman-Romero, 14404

MS 0873 Tamara Deming, 14404

MS 0869 Robert Welberry, 14402

MS 0871 Dan Kettleborough, 14405

MS 0873 Moses Jones, 14404

MS 0856 Gilbert Theroux, 14409

MS 0856 Ruben Muniz, 14408

MS 0873 Donald Malbrough, 14404

MS 0873 James Williams, 14404

MS 0856 Mary-Ann Olascoaga, 14408

MS 1050 Jack Mizner, 3124

MS 0872 Lorraine Sena-Rondeau, 14409

MS 9018 Central Technical Files, 8945-1

2 MS 0899 Technical Library, 9616

MS 0612 Review and Approval Desk, 9612
For DOE/OSTI