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SAND2002-0550
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Printed March 2002

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.

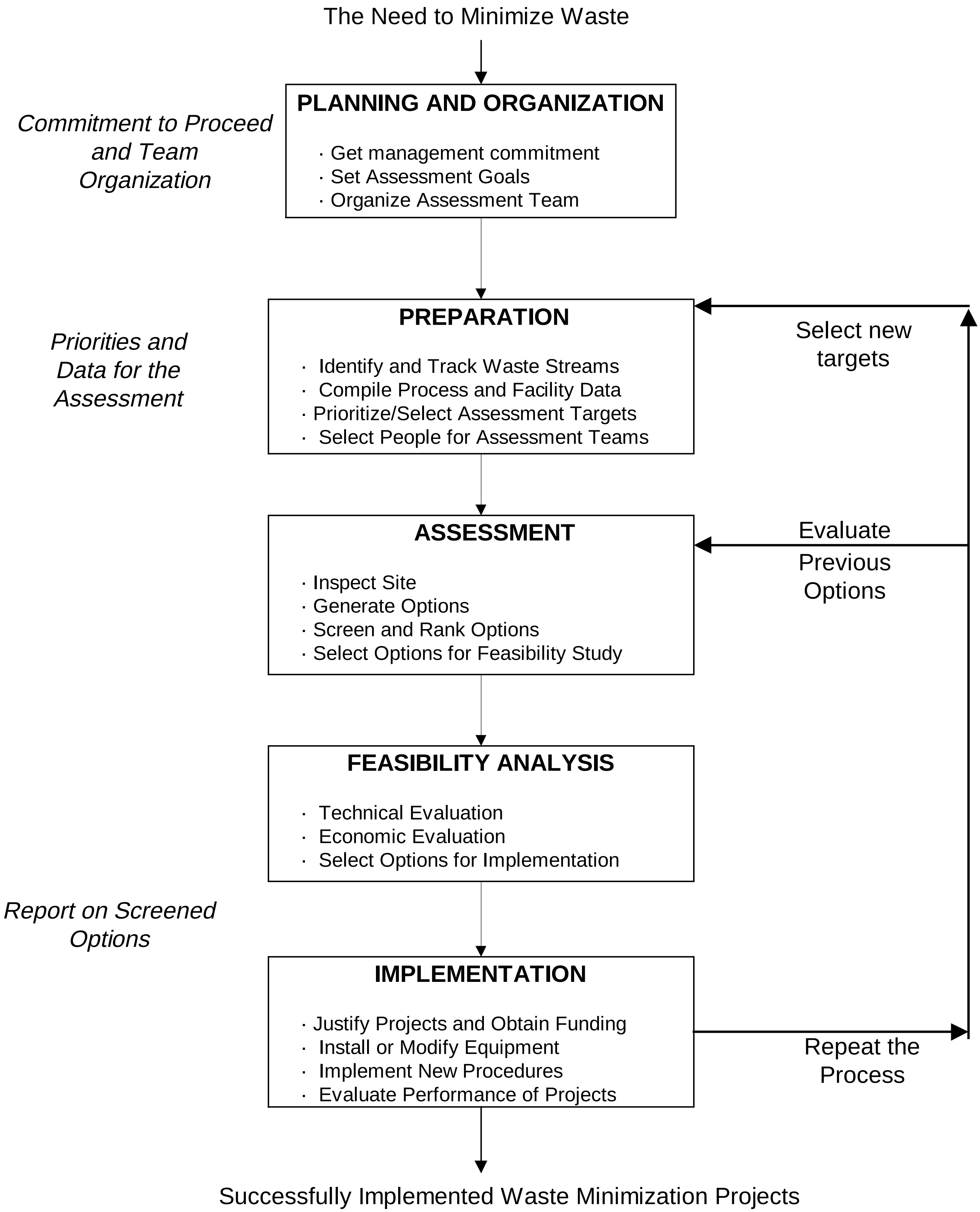

Figure 1. Pollution Prevention Opportunity Assessment Process

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.

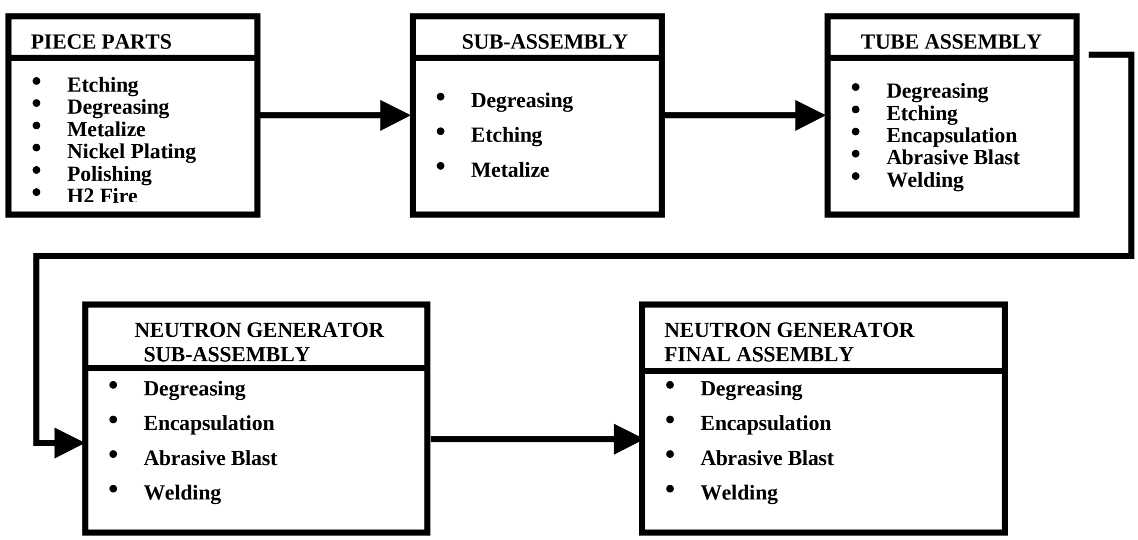

Figure 2. Neutron Generator Production Flow Diagram

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.

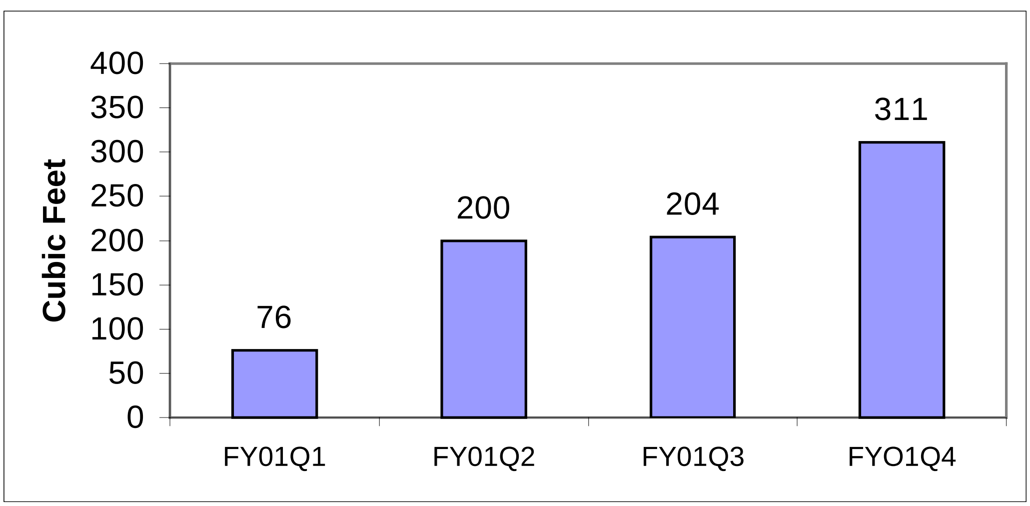

Figure 3. LLW and Mixed Waste Disposal for NGPF During FY01

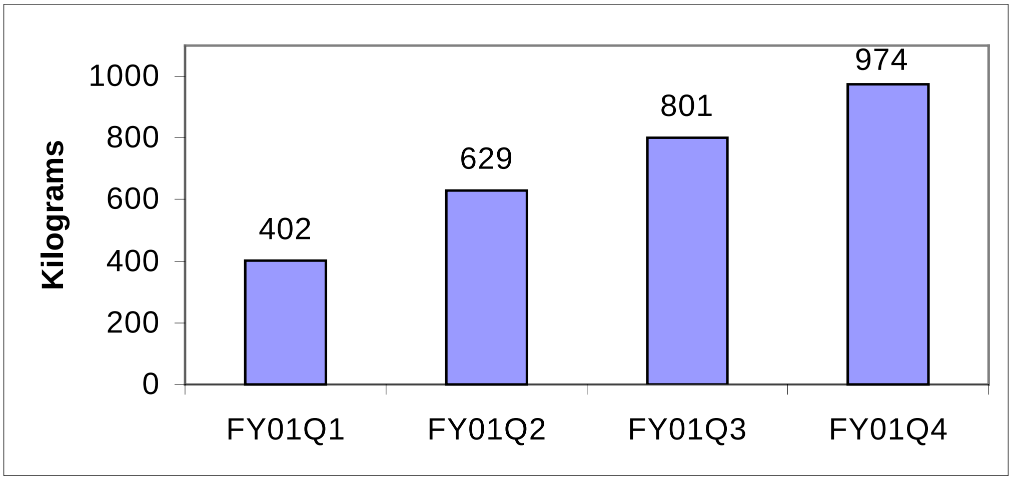

Figure 4. Hazardous Waste Disposal for NGPF during FY01

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.

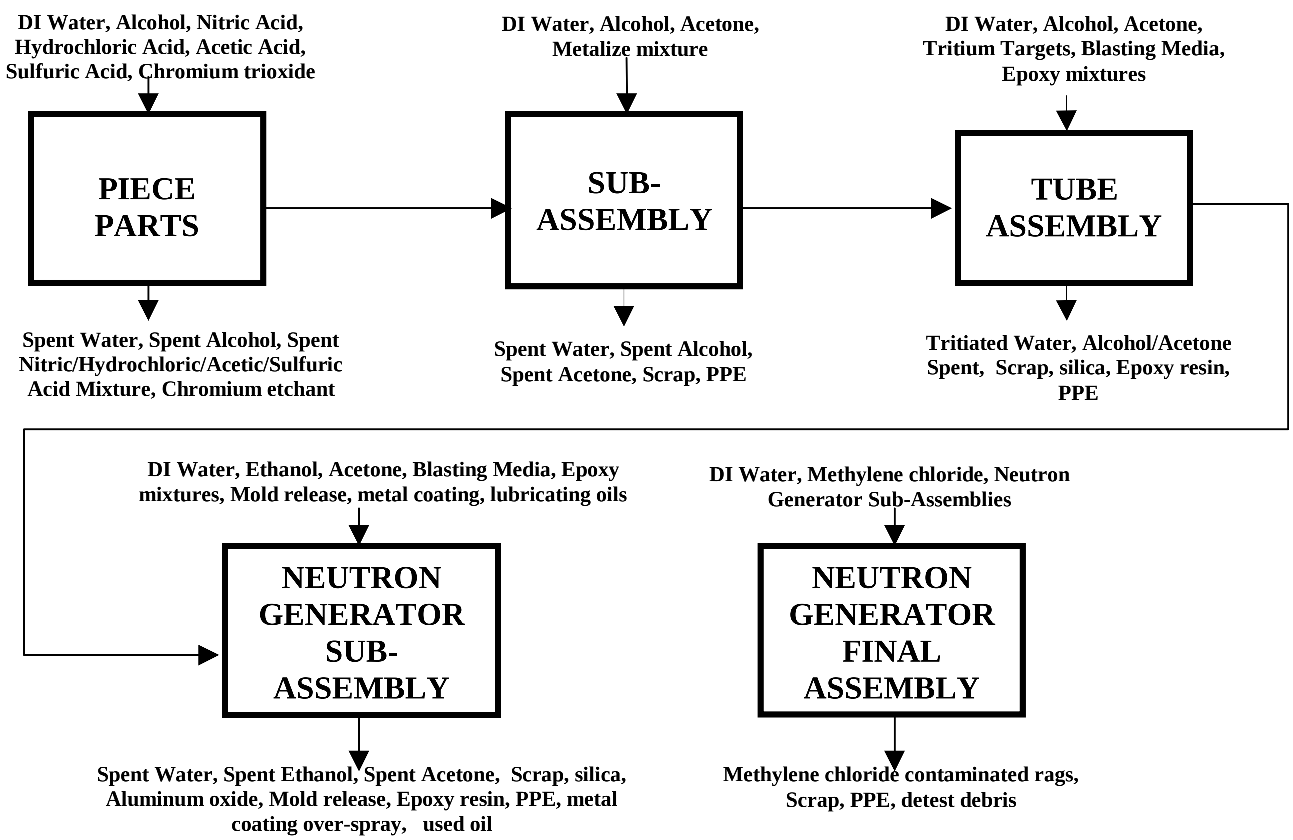

Figure 5. NGPF Flow Diagram with Major Waste Streams

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.

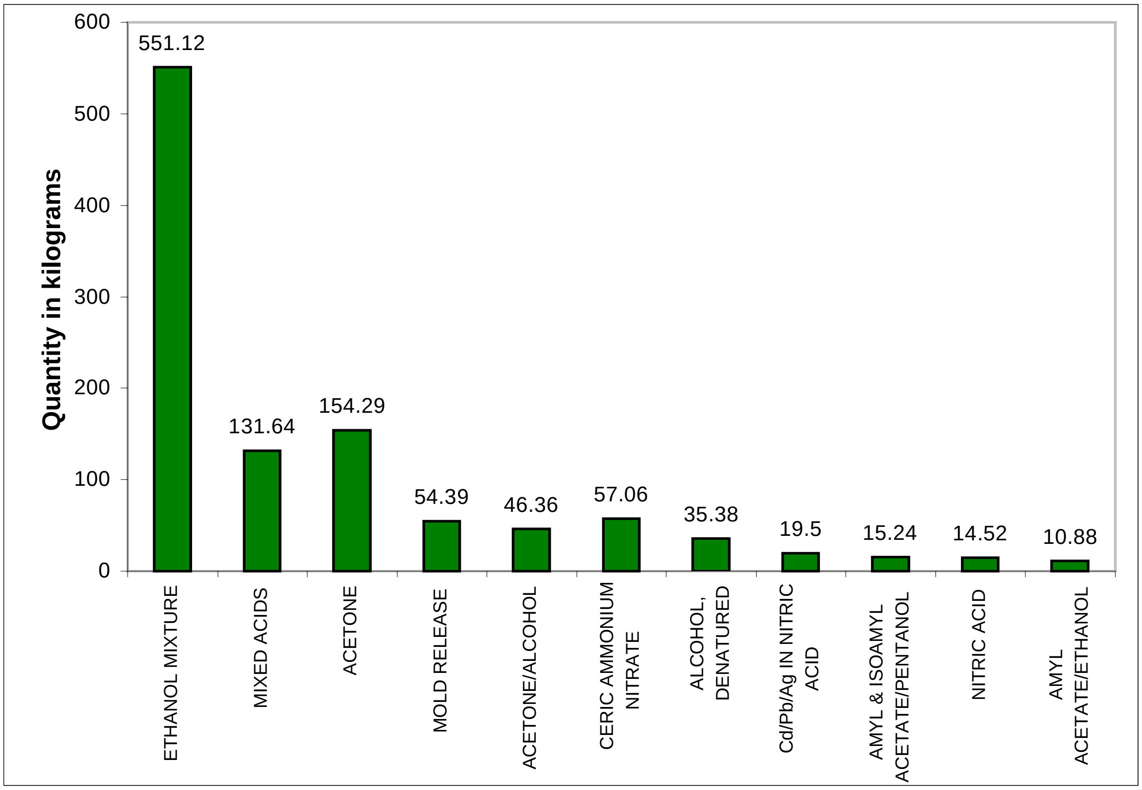

Figure 6. Top RCRA-Regulated Wastestreams for 14400 in FY00

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.

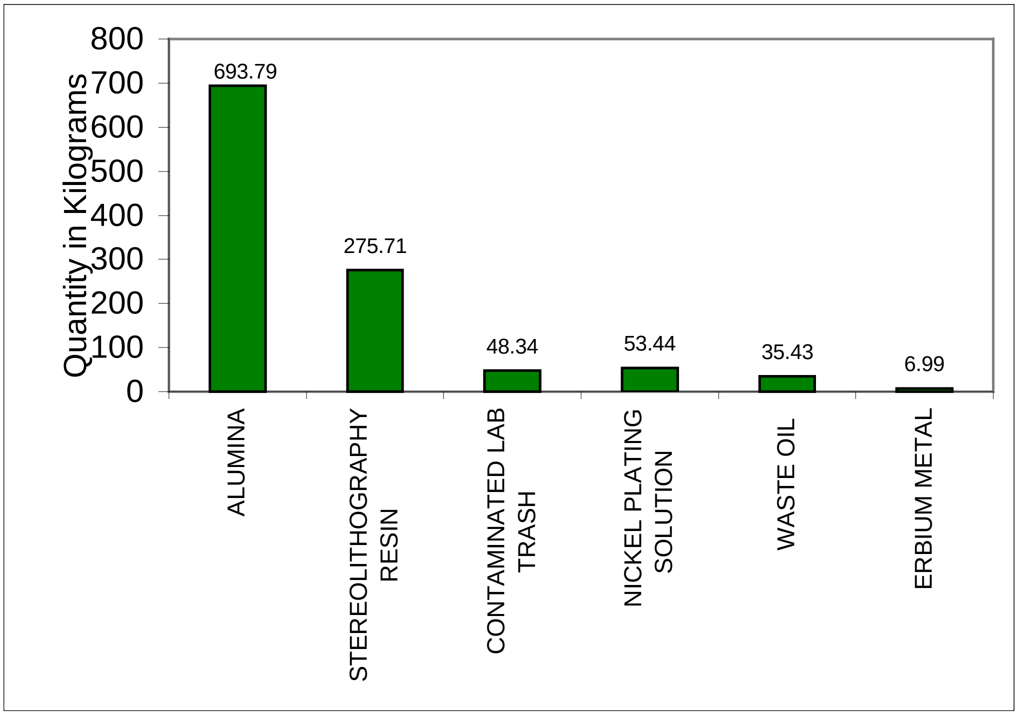

Figure 7. Top Non-RCRA Chemical Wastestreams for 14400 in FY00

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.

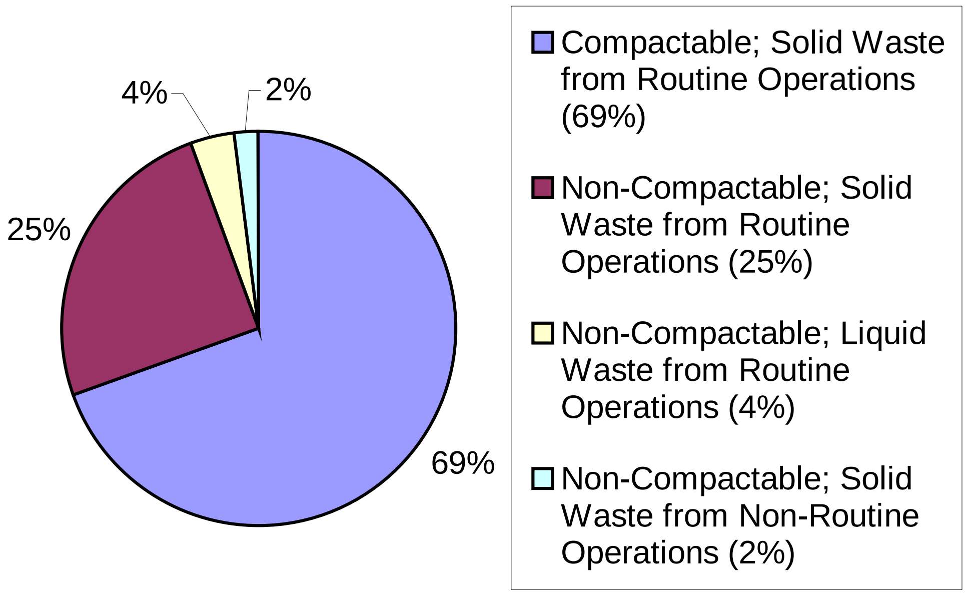

Figure 8. Distribution of Low Level Waste Types

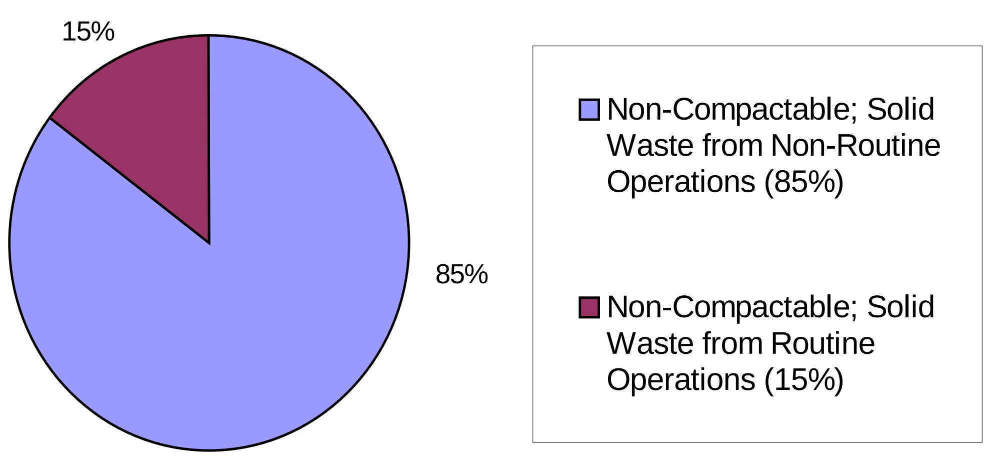

Figure 9. Distribution of Mixed Waste Types

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

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**

<u>Results Summary:</u>

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 4
Vendor Information

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