REMOVAL AND CONTAINMENT OF LEAD-BASED PAINT VIA NEEDLE SCALERS

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NOTICE

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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of materials that, if improperly dealt with, can threaten both public health and the environment. The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. These laws direct the EPA to perform research to define our environmental problems, measure the impacts, and search for solutions.

The Risk Reduction Engineering Laboratory is responsible for planning, implementing, and managing research, development, and demonstration programs to provide an authoritative, defensible engineering basis in support of the policies, programs, and regulations of the EPA with respect to drinking water, wastewater, pesticides, toxic substances, solid and hazardous wastes, Superfund-related activities, and pollution prevention. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

This report describes the results of a technical and economic evaluation of the comparison between conventional abrasive blasting and a dustless needlegun system for removing lead-based paint from steel structures. The objective of the study was to substantiate the reduction of hazardous waste generation and airborne lead-containing dusts from the paint removal operations through the use of the dustless needlegun system and to comparatively analyze the economics associated with its substitution for conventional abrasive blasting.

E. Timothy Oppelt, Director
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ABSTRACT

This report describes a comparative technical and economic evaluation of using a dustless needlegun system versus a conventional abrasive grit blasting system in the removal of lead-based paint from steel structures. The objective of the study was to comparatively analyze the operational and logistical aspects of using dustless needleguns for lead-based paint removal as they relate to hazardous waste generation, worker health and safety and associated economic factors.

The dustless needlegun system demonstrated its ability to produce a substantial reduction (97.5%) in the generation of hazardous waste when compared to conventional abrasive blasting. Also demonstrated was the ability to substantially reduce (up to 99%) the airborne concentrations of respirable dusts and lead-containing particulates generated during paint removal operations.

Labor costs were decidedly higher (approximately 300%) for the dustless needlegun system primarily due to slower production rates which would necessitate more operating personnel. These costs are substantially mitigated by the reduction of costs associated with expendable abrasive blast material and hazardous waste disposal.

Conventional abrasive blasting proved to be decidedly superior in the quality of surface preparation, based upon prescribed contract specifications.

The dustless needlegun system is shown to be economically competitive with conventional abrasive blasting when considering the reduced requirements for containment, hazardous waste disposal and worker protection.

This report was submitted in partial fulfillment of contract number CR-816762 by the Erie County Department of Environment and Planning, under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period from July 1992 through August 1993. Field and analytical work was completed as of March 1993.

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NOTE: **Appendix D** has been deleted from this report. Copies are available from Paul Randall or James E. Stadelmaier.

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ACKNOWLEDGEMENT

The USEPA, Erie County and Recra Environmental, Inc. acknowledges the New York State Thruway Authority (NYSTA) and Pentek, Inc. for its assistance and cooperation during this evaluation.

The NYSTA Buffalo Division Department of Maintenance Engineering, Civil Engineer I Environmental Specialist, Gary Hart, provided the evaluation sites and historical information. The NYSTA Department of Administrative Services Bureau of Occupational Safety and Health Services Senior Industrial Hygienist, Carol Butt, performed the worksite air sampling. Mr. Brad Fuller of Pentek, Inc. provided the operators and equipment for testing. Commercial Painting Co., Inc., Niagara Falls, New York, performed the abrasive blasting. The final report was reviewed by Dr. Ralph Rumer of the New York Center for Hazardous Waste Management, Mr. George Moore of the USEPA Toxics Control Branch, and Mr. Bernard Appleman of the Steel Structures Painting Council.

SECTION 1
INTRODUCTION

PROGRAM OVERVIEW

This is a final report for the third of five innovative waste minimization technology evaluations which are being conducted under the cooperative agreement program between the United States Environmental Protection Agency (EPA) and Erie County, New York entitled "Waste Reduction Innovative Technology Evaluation" (WRITE) Program, Contract No. CR-816762-02-0. The project entailed the technical and economic assessment of a dustless, mechanical lead-based paint removal system as compared to conventional abrasive blasting on a steel bridge. The program was completed in conformance with work plans and quality assurance project plans previously submitted and approved by the EPA.

The project was completed under the terms of the Erie County/WRITE Program as a joint effort by the New York State Thruway Authority; Pentek, Inc., Coraopolis, PA; Erie County Environmental Compliance Services, Buffalo, NY; Recra Environmental, Inc., Amherst, NY; and the EPA Office of Research and Development, Cincinnati, OH.

PROJECT PURPOSE

The purpose of this project was to evaluate an alternative to the current practices of abrasive blasting using expendable media for removing lead-based paint from bridges and other structures with respect to any reduction in the generation of waste or in worker exposure to hazardous materials. Furthermore, it was to evaluate the economic and logistical aspects of replacing current practices with such an alternative.

INDUSTRIAL PARTICIPANTS

The industrial participants for this program were the New York State Thruway Authority (NYSTA) and Pentek, Inc.

The NYSTA is responsible for the operation and maintenance of the New York State Thruway system. The Buffalo District of the NYSTA, with offices located at 3901 Genesee Street in Cheektowaga, New York, 14225 (716-631-9017) is responsible for the westernmost part of New York. A significant portion of the maintenance requirements for the Thruway deals with the upkeep of elevated portions of the roadway including bridge painting. The Buffalo District had scheduled for 1992, the commercial abrasive blast cleaning and repainting of 33 bridges in Western New York. This work encompasses approximately 8,644 lineal feet of bridge span requiring the cleaning and repainting of 5,832 tons of structural steel.

Pentek, Inc., with offices located at 1026 Fourth Avenue, Coraopolis, Pennsylvania, 15108 (412-262-0725), has been manufacturing dustless surface preparation equipment for use by nuclear facilities and hazardous waste cleanup/remediation contractors since 1985. The equipment was developed in the early 1980's for the removal of radioactive surface contamination during the Three Mile Island Unit 2 remediation efforts. The benefit derived from the containment of the contamination enhanced the applicability of the technology for other surface contamination removal projects including PCBs and lead-based paint.

BACKGROUND.

In order to achieve sufficient metal surface preparation to insure proper coating and adherence of newly applied paint, the NYSTA has relied upon a commercial blasting procedure as defined in the Steel Structures Painting Council Specification SSPC-SP 6. This procedure is a common standard for paint removal for bridges and other similar structures. The procedure is proficient at achieving the necessary surface cleanliness and profile for the subsequent coating operation.

Although the use of standard blast cleaning technologies are proficient in the removal of paint and rust and surface preparation prior to repainting, there are disadvantages to its use:

1. Blast technologies present a problem with respect to containment of the blast media and removed paint. Blasting technologies tend to pulverize the paint and the blast media resulting in the generation of a significant amount of airborne lead-contaminated particulates which are difficult to contain. Contract specifications usually dictate the requirements for varying levels of containment of the blast residues, which can range from simple curtains or barriers to sophisticated containment structures which include additional controls such as negative pressure or water curtains. Increasing regulatory attention toward reducing the amount of lead in the environment, fueled by increasing public concern and an aging infrastructure, will tend to force contractors to utilize the more sophisticated forms of particulate containment. This containment, while minimizing environmental contamination, will tend to result in more hazardous localized environments for workers, and substantially higher costs for lead-based paint removal operations.
2. A high potential for worker exposure to lead requires the use of extensive personal protective equipment to meet the new OSHA standards which were published as an Interim Final Rule in the Federal Register on May 4, 1993. The new standard requires lead paint removal contractors to institute worker protection practices when airborne lead concentrations reach an action level of 30ug/m^3 of air when expressed as an 8 hour time-weighted average (8 hour TWA). Worker protection practices include medical monitoring and surveillance, employee training, respiratory protection with higher protection factors, disposable protective clothing, upgraded personal hygiene facilities, and more efficient engineering controls. These worker protection practice requirements become more pronounced when complete environmental containment structures are specified. The enhanced worker protection requirements all serve to increase the cost for lead paint removal operations.

3. Blast technologies using expendable media generate an excessive amount of waste material in the form of lead-based paint chips mixed with substantial volumes of spent abrasive blast grit which require disposal as a hazardous waste. Additionally, depending upon the concentration of lead in the waste abrasive blast mixture, additional treatment or stabilization of the waste may be required to meet land ban disposal restrictions (LDR).

Since 1986, the NYSTA has been aware of the potential adverse environmental and health effects of lead-based chips contained in sandblasting debris generated during routine bridge maintenance. A policy of specifications was developed by the NYSTA for the containment of blast cleaning debris generated by paint removal operations. The 1986 directives were focused on the handling and disposal of the waste material. In addition, it was during 1986 that the NYSTA stopped using lead-based coatings on steel structures.

The 1986 directives stipulate the use of blast cleaning methods which, as best as possible, contain the lead contaminated debris for disposal as hazardous waste. Provisions contained in standard NYSTA specifications call for comprehensive coverage of potentially impacted surface areas, daily cleaning or vacuuming of contaminated surfaces and placement of residues in clean, resealable, watertight 55 gallon steel drums. Containment, however, becomes even more difficult where the bridge spans a continuously used right-of-way such as railroad or water crossing.

A potential solution to the difficulties encountered with the utilization of blast cleaning technologies for lead paint removal would include a blastless paint removal system which had the capability to contain paint residues as they are removed from the structure surface. One such technology available for evaluation under the WRITE Program is the Pentek dustless needlegun system.

OBJECTIVES

It is the intent of this WRITE Program evaluation to comparatively analyze the technical and economic advantages of employing Pentek's dustless surface preparation system for the containment and reduction of hazardous waste relative to conventional abrasive blasting paint removal technologies.

The objectives of the dustless paint removal and surface preparation system evaluation are as follows:

- To determine the economics associated with removing lead-based paint from steel structures using Pentek's dustless needlegun system relative to conventional abrasive blasting paint removal.
- To quantify the potential reduction in the generation of hazardous waste through the utilization of a blastless paint removal technology.
- To compare the ability of the Pentek System to contain dust and particulates for the protection of the environment and minimization of worker exposure.

SECTION 2
TECHNOLOGY DESCRIPTION

PAINT REMOVAL SYSTEMS

There exists a variety of paint removal systems, most of which represent a variation of the traditional sand blast methods. Most recently, blast paint removal utilizing recycled blast media, such as steel shot or plastic beads, have been used. Other blast media used for specialized applications include baking soda and pelletized dry ice. High pressure water has been used both independently and in conjunction with an abrasive blast media. Manual and powered hand tools, along with chemical paint removal, are still utilized in areas inaccessible by other means.

The disadvantage to some of these methods is that the residue generated as a result of the paint removal is increased by the introduction of a blast media or water, magnifying the waste disposal problem. In addition, these methods do not address the concerns with respect to environmental and worker exposure.

Mechanical Power Tool Paint Removal

Power tools, such as rotary grinders and wire brushes and orbital, belt, and vibrating sanders, have been utilized for years to remove paints and coatings from both interior and exterior structures. The mechanism behind this process is primarily that of abrasive cutting action followed by mechanical displacement of the paint by a rotating or reciprocating tool member at the point of operation. The efficiencies of paint and coating removal are a function of the relative hardness of the coatings to be removed as compared to the abrasive impact of the power tool and the forces exerted by the operator and/or by the power tool itself, in addition to the tool's accessibility to different structure configurations.

Pentek's Dustless Needlegun Scaler System

The Pentek System is a form of power tool cleaning which combines material removal and containment. Pentek Inc. manufactures three models of surface preparation tools as follows:

1. "MOOSE®" - for scabbling and scarifying of large horizontal concrete surfaces.
2. "SQUIRREL III®" - for scabbling and scarifying smaller horizontal concrete surfaces including corners and wall/floor joints.
3. "CORNER-CUTTER®" - hand-held needlegun for surface preparation in tight spots and/or vertical and inverted horizontal steel or concrete surfaces.

Material removal is accomplished through the actions of pneumatically operated reciprocating cutting bits or steel needles which scarify and pulverize the paint or coating. This cutting action does not adversely impact the structural integrity of steel substrates. The surfaces of concrete substrates, on the other hand, can be removed in controlled layers of between 1/16 and 1/4-inch thick. Containment of the removed material is accomplished first by utilizing an adjustable shroud located at the tool's point of operation to localize containment, and second, to transport the contained materials via vacuum to an attached VAC-PAC® containment vessel (DOT 17-H drum). The vacuum head of the containment drum (VAC-PAC® system) is equipped with High-Efficiency Particulate Air (HEPA) filters which serve to prevent the escape of airborne dusts at the containment vessel. Based on field experiences, Pentek claims to provide immediate capture of 100% of airborne dusts and 99.5% of solid debris at the surface.

The Pentek System utilized in this evaluation is comprised of the following components:

1. CORNER-CUTTER® needlegun - This hand-held, pneumatic, piston-driven power tool uses multiple 2mm diameter hardened steel needles which strike the surface 3500 times per minute, independently conforming and adjusting to surface irregularities, to scarify and pulverize the paint or coating and produce a surface profile required by SSPC-SP 11. These specifications are depicted in Appendix A. As many as three CORNER-CUTTER® units can be supported by a single vacuum system (see VAC-PAC®, Item 3 below). Each CORNER-CUTTER® consumes 5 scfm of 90 psig compressed air and is capable of a production rate of 20-30 sq. ft. per hour on flat surfaces and 30-60 linear feet per hour on edges and corners.

2. ADJUSTABLE CONTAINMENT SHROUD - This component, which is attached to the CORNER-CUTTER®, provides containment of the dislodged material at the point of operation. Interchangeable end shrouds on the tool conform to the work surface, flat inside/outside corners, and custom contours to direct the vacuum flow and provide effective localized containment.

3. VAC-PAC® HEPA VACUUM/DRUMMING SYSTEM - This vacuum system provides negative pressure at the CORNER-CUTTER® containment shroud, which serves to complement the localized containment shroud's effectiveness by minimizing fugitive dust emissions from the paint removal point of operation. The VAC-PAC® system may be operated remotely at distances of up to 100 feet from three (3) simultaneously operating CORNER-CUTTER® tools without compromising air flow or process containment. The VAC-PAC® is equipped with self-cleaning first stage filters in order to maintain continuity of rated flow. Self-cleaning is accomplished by blowing back high pressure pulses of air which restores the filter to near-original efficiency while depositing the dislodged particulates into the waste collection drum. First stage filtration efficiency is 95% at 1 micron. A second stage high efficiency particulate air filter has an efficiency of 99.9% at 0.3 micron. Recommended filter service intervals are once per year for average usage.

The design of the VAC-PAC® incorporates a controlled-seal drum fill system that allows an operator to fill, seal, remove and replace the waste drum under controlled vacuum conditions. This feature serves to positively control waste and dust and minimize the production of fugitive dust emissions during waste drum changes. The system is equipped with a bin level indicator which informs the operator both visually and audibly that the waste drum requires changing.

Vacuum units can be either pneumatically or electrically driven. Specifications for the various systems are presented in Table 1:

Table 1. Specifications for Air-Powered and Electric Powered Systems

	AIR-POWERED		ELECTRIC-POWERED		
	Model 6	Model 9D	Model 10	Model 11	Model 12
Rated Vacuum Flow (scfm) [Note 1]	150	225	250	325	550
Rated Static Lift (in W.G.)[1]	100	100	93	102	102
Air Consumption @ 85 psig (scfm)	70	105	N/A	N/A	N/A
Rated Motor HP	N/A	N/A	5	7.5	15
Primary Roughing Filter Cartridges	2	3	2	2	3
Secondary HEPA Filters	2 @ 8" dia.	3 @ 8" dia.	1 @ 12"x24"	1 @ 12"x24"	1 @ 12"x24"
Overall Dimensions: LxWxH (inches)	48x28x72	48x28x72	48x28x72	48x28x84	48x28x84
Standard Waste Drum Size (gallons)	21/52/55	21/52/55	21	21	21
Approximate Weight (pounds)	650	750	950	1100	1250

[1] Inches of vacuum measured by water gauge.

Condensed operating procedures for the CORNER-CUTTER® and VAC-PAC® systems are included in Appendix B. The CORNER-CUTTER® is schematically shown in Figure 1.

Conventional Abrasive Blasting

In this method, compressed air is used to propel expendable abrasive particles against the surface to be cleaned, to produce a surface profile required by SSPC-SP 6. These specifications are provided in Appendix A. The spent abrasive and paint debris are manually collected for disposal, usually as hazardous waste. A conventional abrasive blasting operation is schematically shown in Figure 2.

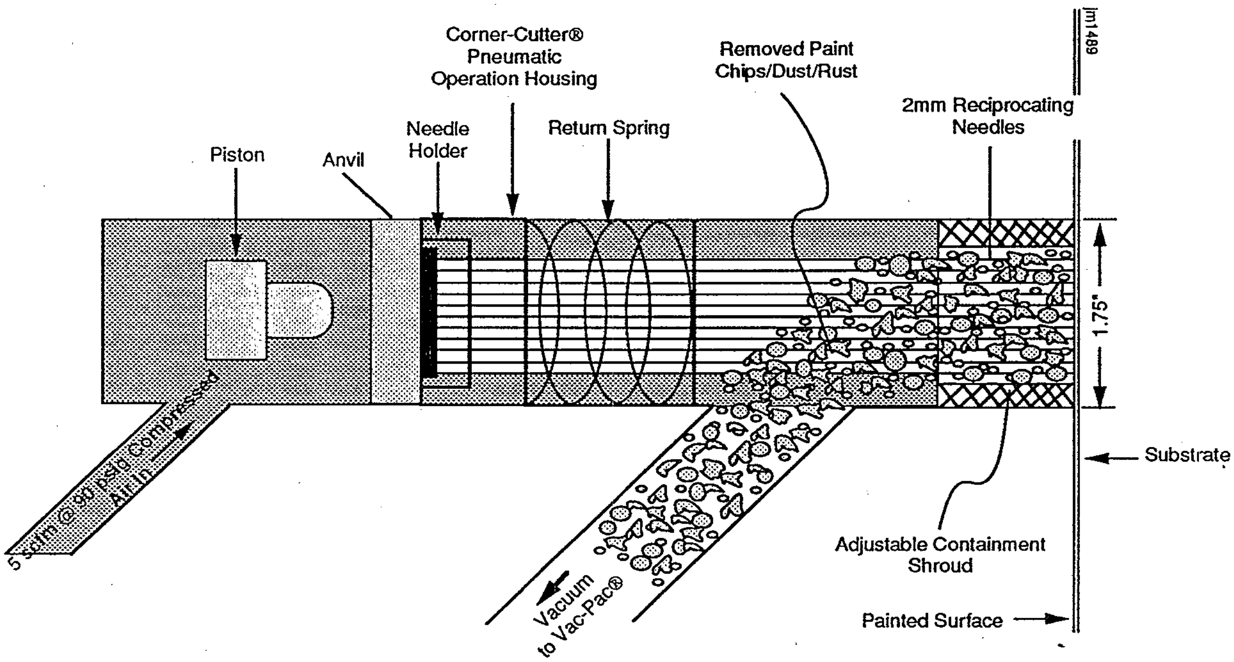

Figure 1. Pentek CORNER-CUTTER® Schematic Diagram

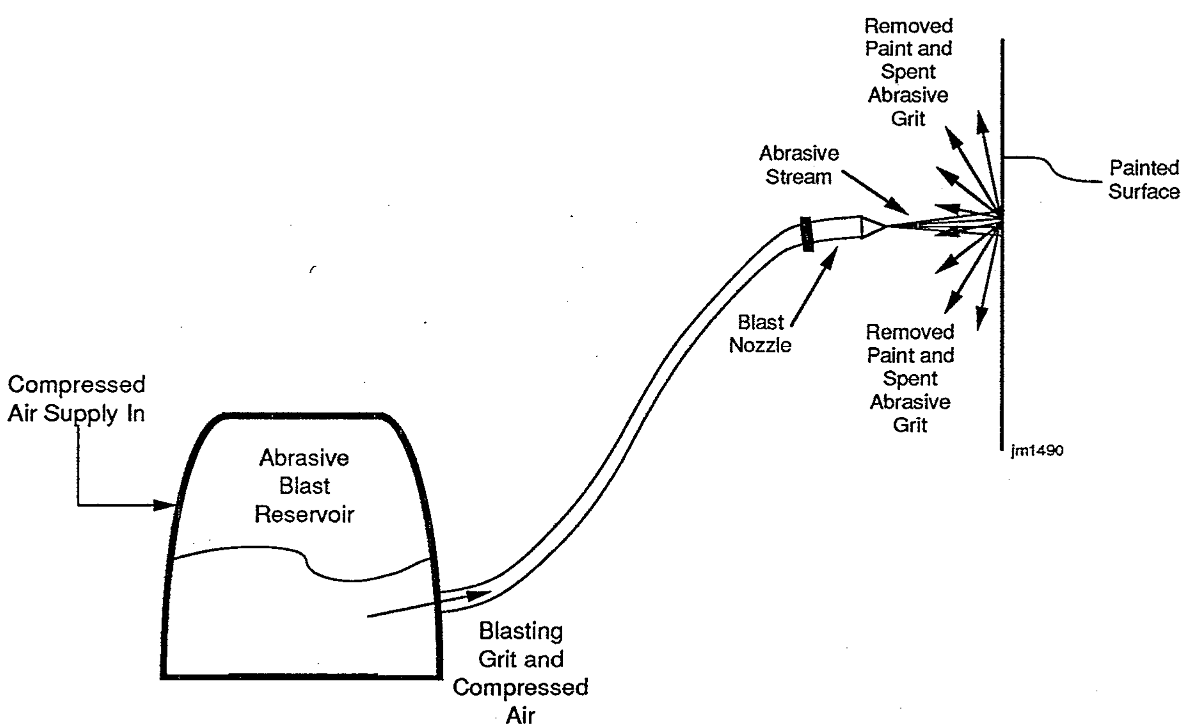

Figure 2. Abrasive Blasting Process Schematic Diagram

SECTION 3
METHODOLOGY

Both paint removal technologies were evaluated on New York State Thruway Authority (NYSTA) bridges located on Interstate 90 in Western New York, and as such receive essentially identical exposure to weathering and traffic flow. The abrasive blasting evaluation was performed on NYSTA Bridge #10 on October 7 and 8, 1992. The Pentek evaluation was performed at NYSTA Bridge #1 on October 13, 1992. The evaluations consisted of observations of work practices, equipment and labor requirements, time required for various task completion as well as physical measurements of background, and work-in-progress airborne dust and lead concentrations during the paint removal operations. Waste materials from both processes were collected and analyzed for lead concentrations. Interviews were conducted with NYSTA, Pentek, Inc., and paint removal contractor personnel in order to obtain background information and historical data relative to the evaluations.

BACKGROUND AND HISTORICAL DATA

Conventional Abrasive Blasting

NYSTA Bridge #10 is of rolled beam design and is comprised of approximately 151 tons of steel and 14,946 sq. ft. of surface area by NYSTA calculations. The paint thicknesses on this bridge were estimated to range from 10 mils (.254 mm or 0.01 inches) to 13 mils (.330 mm or 0.013 inches), based upon NYSTA upon field measurements. Previous testing by NYSTA had determined the presence of lead-based paints as the primer and finish coatings.

Historically, surface preparation of similar NYSTA bridges using conventional abrasive blasting methods with expendable media to SSPC-SP 6 specifications has generated an average of 0.15-0.20 tons of waste per ton of steel consisting of spent abrasive, paint and miscellaneous dirt, rust and mill scale. Theoretically, this would equate to 22.7-30.2 tons of waste generated by conventional abrasive blasting operations at this structure. This waste has been characteristically hazardous due to its leachable lead content.

Pentek Dustless Needlegun System

NYSTA Bridge #1 also of rolled beam design, is comprised of approximately 315 tons of steel and approximately 25,000 sq ft of surface area. The paint thickness on this bridge was again estimated by the NYSTA to range from 10-13 mils. As with Bridge #10, previous testing by NYSTA had determined the presence of lead-based paints.

Historically, paint removal from similar substructures would generate paint waste at a rate of 1 ounce per sq. ft. of area cleaned. This waste has been characteristically hazardous due to its leachable lead content.

Paint

Based upon information provided by the NYSTA, the following represents specifications for the lead-based paint on the structures evaluated. These are estimated averages based upon paint specification sheets and are used in subsequent calculations and comparisons:

Table 2. Paint Specifications

lbs/gallon (liquid)	14.3 lb/gallon
% solids (non-volatile)	62.2%
lbs/gallon (solids)	8.9 lb/gallon
density	66.3 lb/cu. ft.
% Pb in solids (average)	20%

Abrasive Blast Media

The abrasive blast media utilized in this evaluation consisted of Ebony Grit 20, non-silica abrasive provided to the contractor by Barmin, Inc., of Waterdown, Ontario, Canada. The abrasive was certified to be lead-free based upon technical data sheets provided by the supplier. The bulk density is 128 lbs/cu. ft. as per technical data sheets, provided by the NYSTA.

Table 3 lists the typical chemical analysis of the blast media.

Table 3. Typical Chemical Analysis of the Blast Media

Silica (as Iron Silica)	32.6%
Silica (Crystalline)	0.1%
Iron Oxide (Fe_2O^32+FeO)	54.0%
Alumina (Al_2O_3)	4.7%
Lime (CaO)	2.3%
Magnesia (MgO)	1.3%
Alkalies (Na_2O+K_2O)	1.5%
Copper (Cu)	0.8%
Zinc (Zn)	2.8%
	100.1%

PROCEDURES - CONVENTIONAL ABRASIVE BLASTING

In order to minimize the potential for cross-contamination and to satisfy bridge painting schedules and other logistical concerns, these comparative evaluations were conducted on two separate bridges. It was felt that this would not compromise the quality of the data obtained due to the similarity of structures and the paint coatings used on each.

The conventional abrasive blasting evaluation was performed on October 7 and 8, 1992. Day 1 was dedicated to obtaining background information regarding the process and to observe and record both clean-up activities from the prior day's work and set-up activities for work to be performed. Day 1 was also used to perform background air monitoring of lead-in-air concentration to be used as a baseline for both technology evaluations. Day 2 activities consisted of observing work procedures, conducting personal and area air monitoring and recording appropriate measurements to assess productivity and waste generation.

Employee and supervisor interviews were conducted to develop information relative to time and labor requirements for daily cleanup and job site mobilization and demobilization activities. This information was integrated with job site observations to calculate estimates of man hours required and their associated costs.

Set-up/Mobilization

Job set-up and mobilization required seven workers for 1.5 hours each and consisted mainly of establishing traffic control, positioning equipment and installing hanging enclosure tarps and ground cover tarps. Equipment used consisted of two 7-ton capacity abrasive blast reservoir pots with compressors, two truck-mounted mobile platforms and several straight body and pick-up trucks for hauling equipment and transporting personnel. The work enclosures, which are contractually required by the NYSTA consisted of canvas tarpaulins which were suspended from cables attached to the bridge structure so as to form a three-sided enclosure, the closed sides facing traffic during abrasive blasting operations. The tarpaulins extended from the underside of the bridge structure to the ground cover tarps placed below. The suspended tarps were fastened at the grommeted edges with clips to minimize sailing due to winds or passing traffic.

Abrasive Blasting Operations

Abrasive blasting operations conducted on October 8, 1992 were performed simultaneously on the interior eastbound and westbound lanes. Two operators with abrasive blasting nozzles were utilized per section, which consisted of six 32 inch x 12 inch flange I-beams placed 20 feet on center with connecting 13 inch steel channel bracing and mechanical fastening with nuts and bolts. The beam undersides are elevated approximately 15 feet above the center median and road surfaces, which necessitated the use of a mobile elevated work platform for access by the abrasive blast nozzle operators. Only the operations on the westbound section of the Thruway bridge were considered for the purposes of this evaluation. The operations conducted concentrated on the 30 foot length of I-beam extending from the center of the westbound lane to the support column located in the median, in addition to all connecting braces and supports. A total of approximately 1180 sq. ft. of surface was completed during the 4-hour evaluation. The blasting grit vessels and compressors were located approximately 150 feet from the work zone. Grit usage, based on past experiences, was estimated to be 4-7 tons per day of average production per vessel, based upon 1/2 ton/hour of grit usage per nozzle operator. This usage was expected to produce specification surface preparation at a rate of 120 sq. ft. per hour per operator.

Prior to commencement of the evaluation phase, the two nozzle operators performing work on the westbound section were each fitted with two air sampling pumps (SKC low volume) which were calibrated to provide a flow rate of 1.5-1.7 liters of air per minute using an SKC digital calibrator. The media for collection of total and respirable dusts emitted during the blasting process consisted of Millipore 37mm, 0.8μ MCEF Matched-Weight Cassettes with cyclone separators for respirable dust collection. The nozzle operators were dressed in standard work clothes with cloth coveralls and were equipped with air supplied, type CE abrasive blasting helmets. Work progressed continuously from 9:45 am to 1:45 pm with three short (5 minute) breaks taken for the purpose of changing air monitoring cassettes. The operation was very noisy, however, sound pressure levels were not evaluated. Hearing protection was available, but was not utilized by all workers.

During the abrasive blasting operation, it was very apparent that the tarpaulins installed to enclose the operation were less than 100% efficient in containing the abrasive blast grit and paint removal residues. Visible plumes of dust were noted escaping from the enclosure and depositing along the Thruway and elevated sections of roadway and median areas. Light winds were noted to be from the East Northeast at 1-5 mph and were not considered to be a factor in this evaluation. The weather was clear and 65°.

Clean-up

The clean-up activities observed were performed at the termination of abrasive blasting activities on October 7, 1992, one day prior to the abrasive blasting operation evaluation. The clean-up activities were described by NYSTA and the contractors to be typical and consisted of manually dry sweeping spent abrasive and paint residues, progressively elevating ground tarps to consolidate wastes and then manually shoveling the collected materials into openhead 55 gallon steel drums. The section cleaned was approximately 40 feet x 100 feet with a 3:1 sloped earthen embankment from the road surface to the bridge and bearing supports. The slope served to facilitate the consolidation of spent abrasive and paint, as much of the material was swept via gravity to the collection points. Manpower consisted of six laborers and clean-up of this section took 1.5 hours. The clean-up operation was noted to be very dusty. Laborers wore only standard work clothes. Paper dust masks (non-toxic variety) were available, but noted to be used by only one worker.

Additional clean-up was also required of the roadway above which had received overspray or deposits of fugitive dusts. The material was dry swept and shoveled to drums.

PROCEDURES - PENTEK DUSTLESS NEEDLEGUN SYSTEM

The Pentek System evaluation was performed on October 13, 1992 at NYSTA Bridge #1, which was not scheduled for paint removal and repainting until the spring of 1993. Evaluation activities consisted of observing and documenting mobilization, paint removal, and clean-up and demobilization activities, as well as performing personal and area air monitoring and making necessary measurements to assess productivity and waste generation.

Set-up/Mobilization

Job set-up and mobilization required four workers for 0.5 hours each and consisted primarily of positioning equipment. Equipment used consisted of one pick-up truck which carried the VAC-PAC® system and CORNER-CUTTER® units and hauled a trailer with an air compressor. There were no containment enclosures or ground cover tarpaulins used.

Pentek Dustless Needlegun Paint Removal Operations

The Pentek System was evaluated above the upper section of the sloped embankment on Bridge #1 so as to eliminate the necessity of using elevated working platforms and thus simplify later cost comparisons. Three operators each with a CORNER-CUTTER® unit were employed for paint removal at the evaluation area which consisted of four 34 inch x 12 inch flange I-beams with connecting 13 inch steel channel bracing and connecting hardware. A total of approximately 119 sq. ft. of surface was completed during the 3 hour, 15 minute evaluation period, however, Pentek, Inc. reported that this is most likely a depressed number due to several factors including, but not limited to, the inexperience of operators and their unfamiliarity with SSPC-SP 11 requirements. Pentek, Inc. management stated that this production number should be closer to 260 sq. ft. based upon previous experience.

Prior to commencement of the evaluation, two of the three CORNER-CUTTER® operators were fitted with two air sampling pumps each, with appropriate media for collection of total and respirable dusts emitted during the paint removal operations. The CORNER-CUTTER® operators were dressed in Tyvek suits and were equipped with full-face, negative pressure air-purifying respirators with high-efficiency particulate cartridges. Work progressed continuously from 8:30 am to 12:30 pm with three work breaks totalling 45 minutes.

During the Pentek System paint removal operations, there were no visible emissions of dust or paint residues. The operation was very noisy, however, sound pressure levels were not evaluated and operators were utilizing hearing protection. The CORNER-CUTTER® units removed the finish paint coat layers with little difficulty, however, the orange primer required considerably more effort and time, which served to further depress the square foot production area expected by Pentek, Inc. personnel.

Clean-up

Upon completion of paint removal operations, it was apparent that nearly all paint residues had been effectively contained and collected by the Pentek System. Some minor residues consisting of large paint chips and rust were easily collected using the vacuum hose attached to the CORNER-CUTTER®. Clean-up operations then consisted of wiping down, disassembly and storage of equipment which required four workers for 0.5 hour. This operation would normally only be conducted after job completion and not on a daily or shift-by-shift basis.

SAMPLING AND ANALYSIS PLAN

Sampling and analysis for this evaluation was conducted in accordance with the approved Quality Assurance Project Plan (QAPjP).

Air sampling consisted of pre-work samples taken at Bridge #1 on October 7, 1992, to establish a baseline of background airborne dust and lead in air, and work-in-progress samples of operator breathing zones and work areas for both the abrasive blasting and Pentek System operations. All air sampling was conducted over a 4-hour period coinciding with the technology evaluations. Air samples were collected on 37mm, 0.8μ matched-weight, mixed cellulose ester fiber (MCEF) filter cassettes. This type of filter media was chosen so as to allow both dust and lead analyses to be performed on the same cassette, thus minimizing the amount of sampling equipment and the number of samples required for this evaluation. Digestion procedures were evaluated using an SRM (NIST 1579). The first procedure, from NIOSH 7082, resulted in a 65.2% recovery. The second procedure, a modified version of NIOSH 7082 as described in the NTIS publication "Standard Operating Procedures for Lead in Paint by Hotplate - Microwave - Based Acid Digestions and Atomic Absorption or Inductively Coupled Plasma Emission Spectrometry", resulted in a recovery of 121%. The second procedure was utilized for this evaluation. Samples were analyzed for the following:

Table 4. Air Analysis Methods

Parameter	Method
Total Dust	NIOSH 0500
Lead in Total Dust	NIOSH 7082
Respirable Dust	NIOSH 0600
Lead in Respirable Dust	NIOSH 7082

Waste samples were collected from both operations by compositing grab samples and were analyzed as follows:

Table 5. Waste Analysis Methods

Parameter	Digestion Method	Method
Total Lead	Modified NIOSH 7082	SW-846 7420
TCLP Lead	3010	SW-846 7420

The following Table 6 summarizes the type and location of samples:

Table 6. Type and Location of Samples

	Number of Analyses Performed Sample Points*									
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**Total**
Total Nuisance Dust										
Non-QC (primary)	2	1	1	2	1	1	2	0	0	10[1]
Field blank[2]	2	1	1	2	1	1	2	0	0	10
									Total	20
Total Lead in Total Nuisance Dust										
Non-QC (primary)	2	1	1	2	1	1	2	0	0	10[1]
Field blank[2]	2	1	1	2	1	1	2	0	0	10
Matrix spike	1	1	0	1	1	0	1	0	0	5
									Total	25
Total Respirable Dust										
Non-QC (primary)	2	1	1	2	1	1	2	0	0	10
Field blank[2]	2	1	1	2	1	1	2	0	0	10
									Total	20
Total Lead in Respirable Dust										
Non-QC (primary)	2	1	1	2	1	1	2	0	0	10
Field blank[2]	2	1	1	2	1	1	2	0	0	10
Matrix spike	1	1	0	1	1	0	1	0	0	5
									Total	25
TCLP Lead in Waste										
Non-QC (primary)	0	0	0	0	0	0	0	1	1	2
Matrix spike	0	0	0	0	0	0	0	1	1	2
Matrix spike duplicate	0	0	0	0	0	0	0	1	1	2
									Total	6
Total Lead in Waste										
Non-QC (primary)	0	0	0	0	0	0	0	1	1	2
Matrix spike	0	0	0	0	0	0	0	1	1	2
									Total	4
Miscellaneous										
Independent check[3]	0	0	0	0	0	0	0	0	0	1
(Lead in paint SRM)									Total	1

* Sample Points:

a. Background
b. Abrasive blasting operator #1
c. Abrasive blasting operator #2
d. Abrasive blasting area
e. Pentek operator #1
f. Pentek operator #2
g. Pentek area
h. Abrasive blasting waste drums
i. Pentek waste drums

1 Each sample consists of 3, 37mm matched weight 0.8 micron MCEF filter cassettes. Samples to be taken in consecutive 80-minute sequences with a maximum air volume throughput of 133 liters/cassette. The analysis results are additive for both total dust and lead in total dust.

2 Field blanks for air monitoring are included at the rate of one blank per sample set for a total of 10 field blanks. Each blank is to be analyzed for dusts and total lead.

3 The independent check standard will consist of a Standard Reference Material (SRM) for lead based paint. The SRM was used to determine the adequacy of digestion procedures used in lead analysis and also for performing necessary matrix spikes.

Work area samples for the abrasive blasting operations were obtained within the tarpaulin work enclosure approximately 25 feet distant from the points of operations. No evaluations were performed outside the work enclosure. Work area samples for the Pentek operations were conducted approximately 25 feet distant from the point of operations, but were more vulnerable to changing air currents due to Thruway traffic.

Waste quantities generated by the abrasive blasting operations were determined by examining Line 11 of the New York State Hazardous Waste Manifests from Bridge #10 and extrapolating data based upon total surface areas of the bridge versus total surface area of paint removal

Waste quantity generated by the Pentek operations was determined by performing net and tare drum weights of the VAC-PAC® system collection drum. This figure could then be extrapolated to total quantity for an entire structure based upon surface area of paint removal during the evaluation.

Surface areas cleaned were calculated based on direct measurement with a standard 25 foot carpenter's tape measure.

SECTION 4
RESULTS AND DISCUSSION

PERFORMANCE AND PRODUCT QUALITY

The contract specifications for the bridges evaluated called for SSPC-SP6 (commercial blast) to remove all visible paint from two-thirds of the bridge surface area prior to repainting. This specification was augmented by NYSTA's requirement for all paint to be removed. This additional requirement was included in order to minimize the potential for lead releases and exposures during future maintenance operations. The abrasive blasting operation was able to meet or surpass this level of surface preparation for all areas of the structure.

The Pentek system, by definition, cannot meet SSPC-SP6 specifications as it is not an abrasive blasting technology. As evaluated according to the contract surface preparation specifications, the Pentek System demonstrated a less efficient removal of paint, especially the orange primer coat, and was also less effective while performing around irregular surfaces such as nut and bolt heads and in inaccessible corners. The NYSTA bridge inspectors indicated that a post-blast would be required for the Pentek-cleaned sections in order to meet contract specifications.

Historical information provided by Pentek indicates the post-blast operation necessary to achieve the desired surface quality would typically require consumption of about 1 lb. of abrasive/sq ft of surface area. Pentek reported that spent abrasives would typically be classified as non-hazardous, however, this would need to be determined on a case-by-case basis.

The Pentek System demonstrated superiority in its potential to minimize the generation of hazardous waste (see Table 14).

ENVIRONMENTAL, HEALTH AND SAFETY

The results of the air sampling performed before and during the evaluations is presented in Table 7. Air sampling was performed for four hour periods on two abrasive blast operators and two Pentek CORNER-CUTTER® operators in addition to work areas proximate to the paint removal activities. There was no sampling performed on support labor or during mobilization, demobilization or cleanup operations, and no area samples were obtained from outside the abrasive blasting containment area.

As can be seen from the abrasive blasting sampling data, OSHA Permissible Exposure Limits (PELs) were exceeded for total dust, respirable dust and total airborne lead on three samples and respirable lead on two of four samples based upon eight hour time-weighted averages (TWA). This is assuming that no other dust or lead exposures are encountered for the remainder of the work day. If exposures were to stay constant for the entire work period, PELs would have been exceeded by all samples based upon levels encountered in the four hour sampling period. Nonetheless, even extrapolating eight hour TWA values from the four hour sampling period, all sampling results obtained for the abrasive blasting operation are above the OSHA action level for lead of 30 μ/m^3 or 0.03 mg/m^3 of air. This value is irrespective of personal protective or respiratory protective equipment used.

The Pentek air sampling results exhibited no detectable airborne lead or respirable dust, and only negligible amounts of total dust.

Table 7. Air Sampling Analytical Results

	Sampling Period				8 Hour TWA[4]			
Sampling Point	Total Dust mg/m³	Respirable Dust mg/m³	Total Pb mg/m³	Respirable Pb mg/m³	Total[1] Dust mg/m³	Respirable[2] Dust mg/m³	Total[3] Pb mg/m³	Respirable Pb mg/m³
Background	0.6	0.2	0.01	ND	0.3	0.1	.005	ND
Background (D)	ND	ND	ND	ND	ND	ND	ND	ND
Abrasive Blast Area	41.2	12.5	0.32	0.26	20.6*	6.3*	0.2*	0.1*
Abrasive Blast Area (D)	34.1	11.9	1.4	0.1	17.1*	5.9*	0.7*	0.05
Abrasive Blast Operator #1	8.0	0.7	0.1	ND	4.0	0.4	0.05	ND
Abrasive Blast Operator #2	89.2	12.3	0.89	0.24	44.6*	6.2*	0.45*	0.12*
Pentek Area	0.2	ND	ND	ND	0.1	ND	ND	ND
Pentek Area (D)	ND	ND	ND	ND	ND	ND	ND	ND
Pentek Operator #1	2.9	ND	ND	ND	1.5	ND	ND	ND
Pentek Operator #2	2.7	ND	ND	ND	1.4	ND	ND	ND

LEGEND:
D = Duplicate sample
ND - Not detectable
[1] OSHA PEL = 15 mg/m³
[2] OSHA PEL = 5 mg/m³
[3] OSHA PEL = .05 mg/m³
[4] Assuming no exposures during remainder of work day totalling 8 hours.
* Exceeds OSHA PEL

N.D. (not detectable) is used in all cases where all contributing values are below the detection limit. In cases where all contributing values are above the detection limit, the arithmetic mean is used. If one or more values are below the detection limit, and the remainder above, then the arithmetic mean of the values is used, preceded by the "less than" sign (<) where applicable.

It is customary for the laboratory to report all non-detectable or zero values at the DL followed by a "U" or undetectable designation. The values appearing in Table 7 are actual values derived from raw data. Therefore, even if the lab report shows 1.7 (U), the actual value may be zero. In these cases, the zero value is used to complete the applicable Table 7 calculation. For example, for the background total dust sample, the actual amounts of dust detected are 0.2, 0.0 and 0.0mg, respectively, with an air volume of 360 liters. This calculates to 0.55 or 0.6 mg/m³.

Total and respirable lead values, as they appear in Appendix E, are in units of mg/l/cassette and required conversion to mg/m³ via the formula.

$$\text{Conc.}(mg/m^3) = \frac{Cs_1Vs_1 + Cs_2Vs_2 + Cs_3Vs_3}{V_t}$$

Where Cs = concentration of Pb in mg/ml in sample
Vs = volume of sample solution
V_t = total volume of air sampled

The respiratory protection worn by the abrasive blasting nozzle operators appeared to have been adequate for this particular job; (i.e, A type CE, continuous flow respirator carries a protection factor of 25 as assigned by NIOSH which provides protection for up to 1.25 mg/m^3 of lead in air). This level was exceeded by one area sample (1.4 mg/m^3). This is probably not true for ground support labor or cleanup laborers who performed their duties without benefit of any respiratory protection.

Because the tarpaulin containment systems were less than 100% efficient, visible plumes of potentially lead-contaminated material exited the immediate work area. This potentially provides a source of lead exposure to the general public and the environment.

ECONOMICS

The economic evaluations depicted here are not intended to be all-inclusive or representative of all potential project costs. Specifically excluded from this evaluation are costs related to capital equipment, equipment maintenance, vehicles, utilities and fuel, containment structures , and personal protective equipment.

Observations and interviews were utilized in lieu of in-depth time studies for determining and calculating labor costs. For the purposes of simplicity and uniformity, a standard labor rate of $15.00 per hour was assumed for all labor classifications.

Labor Costs

Labor activities were divided into five categories: Paint Removal Operations, Support Labor, Mobilization, Demobilization and Cleanup.

Table 8 shows the paint removal operators' (abrasive blasting nozzle and Pentek CORNER-CUTTER® operators) labor time and surface area of paint removal performed during the evaluation period. This data is used to calculate a production rate in sq. ft. per hour per operator, a unit cost of $/sq. ft. and a "total" cost assuming work on an identical 15,000 sq. ft. bridge. As can be seen, at the production rates demonstrated, it would require approximately eight Pentek systems utilizing three CORNER-CUTTERS® each to equal the production rate of the two operator abrasive blasting process. This translates into approximately an eightfold increase in production labor requirements and a greater than tenfold increase in associated production costs for the Pentek System.

Table 8. Labor Costs - Paint Removal Operations

	# Operators	Time (hr.)	Total Time (hr.)	Total sq.ft. Cleaned	Production Rate (sq.ft./hr.)	Labor Cost[1] $/hr.	Production Unit Cost ($/sq.ft.)	Bridge[2] Total
Abrasive Blasting	2	4	8	1180	147.5	$15.00	$.10	$1500
Pentek	3	3.25	9.75	119	12.2	$15.00	$1.23	$18450

1 Assumed standard labor rate for all labor classifications.
2 Based upon similar bridges with 15,000 sq.ft. of surface area.

The CORNER-CUTTER® calculations were based upon demonstrated production for this study. Pentek Inc., based upon data obtained from contractors in numerous field applications, indicates that production rates could be expected within a range of values (see Figure 3).

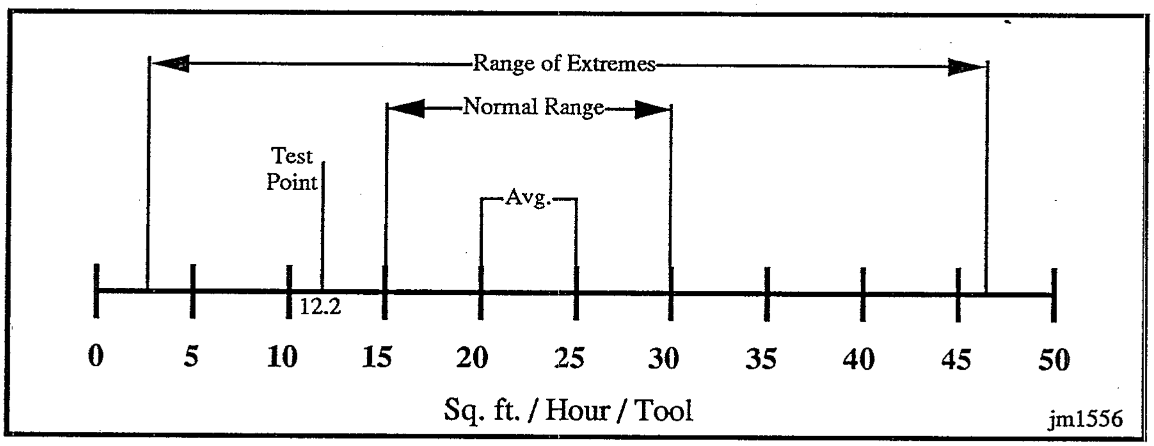

Figure 3. CORNER-CUTTER® Productivity Ranges

Table 9 shows the total time in hours required for support personnel based upon twelve support hours for each sixteen operator hours or eight support hours for each twenty-four operator hours for abrasive blasting and Pentek processes, respectively, assuming work on an identical 15,000 sq. ft. bridge. Again, as shown in Table 9, labor costs are substantially more for the Pentek System based on the assumption that one ground support person is required for each three CORNER-CUTTER® Pentek System. This number could be reduced in practice depending on proximity of the units and the experience level of the ground support personnel.

Table 9. Labor Costs
Paint Removal Operations - Support Labor (Entire Structure)

	Total Time (hr.)	Rate ($/hr.)	Total Cost
Abrasive Blasting	75	$15.00	$1125
Pentek	406	$15.00	$6090

Table 10 shows labor costs for daily mobilization. Again, here it is assumed that eight Pentek Systems requiring thirty-two employees would be required. As before, labor costs are higher due to sheer number of employees, however, the daily time required for this activity is reduced.

Table 10. Labor Costs - Mobilization

	# Personnel	Rate $/hour	# Hours Daily	# Days	Total Cost
Abrasive Blasting	7	$15.00	1.5	6	$945
Pentek	32	$15.00	0.5	6	$1440

Table 11 depicts a one-time demobilization. Again, Pentek costs are higher due to the number of workers required. As with mobilization, however, the times required for this activity are reduced.

Table 11. Labor Costs - Demobilization

	# Personnel	Rate $/hour	# Hours	Total Cost
Abrasive Blasting	7	$15.00	2	$210.
Pentek	32	$15.00	1.5	$720.

Table 12 shows costs associated with cleanup activities for a ground surface area of 26,000 sq. ft. which would be typical for a 15,000 sq. ft. bridge. Here costs are substantially higher for the abrasive blasting process due to the requirements for raising and sweeping ground tarpaulins and manual handling of the abrasive blast debris.

Table 12. Cleanup - 260' x 100' - Ground Area Only

	# Personnel	# Hours[1] Section	# Sections	Total Man Hours	Rate $/hour	Total Cost
Abrasive Blasting	7	8	6.5	364	$15.00	$5460.
Pentek	32	0.5	N/A[2]	20	$15.00	$240.

1 One section = 4000 sq. ft. of flat ground area.
2 Cleanup of ground sections not applicable due to minimal residues noted.

Table 13 compiles the total labor costs developed in Tables 8-12, and shows the Pentek System labor costs to be approximately three times that of abrasive blasting.

Table 13. Total Estimated Labor Costs

	Abrasive Blasting	Pentek
Paint Removal	$1500	$18450
Support	$1125	$ 6090
Mobilization	$ 945	$ 1440
Demobilization	$ 210	$ 720
Cleanup	$5460	$ 240
Labor Totals	$9240	$26940*

* Not including additional labor which would be necessary if a post-blast were required to meet surface preparation specifications.

Material Costs

It was assumed that all Pentek equipment was reusable and that the only expendable material to be evaluated would be the abrasive blasting media used. Table 14 shows this usage and the approximate cost based upon operator usage of 0.5 ton per hour per operator.

Table 14. Materials Costs

	[1]Tons of Abrasive Grit	Cost $/ton	Total
Abrasive Blasting	50.8	$38.50	$1957
Pentek	0	---	0

1 Based upon 0.5 ton of grit usage/hour/operator.

Hazardous Waste Generation and Disposal Costs

Table 15 shows the amount of wastes generated during the evaluation periods and extrapolates these numbers to a complete bridge. As can be seen, abrasive blasting generates approximately 40 times more waste than the Pentek System due to the use of expendable blasting media. The total waste generated by the abrasive blasting process was obtained from New York State Hazardous Waste Manifests and weights determined at the hazardous waste disposal facility. It should be noted that only 31 tons of waste was disposed from this job, and that, based upon usage estimates, approximately 50.8 tons of abrasive grit was used (see Table 14).

Table 15. Hazardous Waste Generation and Disposal Costs

	Removal Area (sq.ft.)	Waste Generated (lbs) Theo.	Waste Generated (lbs) Actual	Lbs. Waste sq.ft.	Est. Total Waste (lbs.)	Total Waste (tons)	[3]Disposal $/Ton	Total Disposal $
Abrasive Blasting	1180	4170[1]	4807	4.1	61,500	30.8	$300	$9240
Pentek	119	7.4[2]	11.5	0.1	1500	0.75	$300	$225
Pentek (post-blast if required)	—	—	—	1.0[4]	15,000	7.5	$300	$2250

1 Theoretical waste generated based upon .175 tons waste/tons of steel cleaned.
2 Theoretical waste generated based upon 11.5 mil. paint thickness and paint solids density of 66.3 lbs./ft^3.
3 Industry average for bulk waste including transportation.
4 Theoretical post-blast abrasive usage as per Pentek historical data.

Table 16 shows a summary of total costs for labor, materials and hazardous waste disposal.

Table 16. Total Costs

	Abrasive Blasting	Pentek
Labor	$ 9240.00	$26,940
Materials	$ 1957.00	$ 0
Haz. Waste Disposal	$ 9240.00	$ 225
Total	$20,437	$27,165*

* Not including additional labor, materials and waste disposal costs if a post-blast was required.

Table 17 shows analytical results for abrasive blasting and Pentek waste samples obtained during the evaluation periods. As can be seen, both wastes are considered characteristically hazardous for lead by TCLP analysis. Total lead analysis shows the Pentek waste to be approximately 39% lead by weight. This waste may now or in the future, be acceptable by some secondary smelting operations for lead recovery which would present a less expensive disposal option. For both wastes, land ban disposal restrictions (LDRs) require that treatment or stabilization be performed and that a leachable lead in waste concentration of less than 5 mg/ℓ be attained prior to land disposal.

Table 17. Waste Analytical Results

Waste Type	TCLP Pb mg/ℓ[1]	Total Pb μg/g
Abrasive Blast	78.0	14,600
Abrasive Blast (MD)[3]	77.7	7560[2]
Pentek	440	391,000
Pentek (MD)[3]	—[4]	381,000

1 Above EPA maximum of 5.0 mg/ℓ categorizes waste as hazardous.
2 Difference due to reported non-homogeneity of waste sample.
3 MD = Matrix Duplicate
4 TCLP MD not performed

The estimate of 1 oz. of paint per ft^2 of area cleaned was provided by Pentek based upon historical data. The actual paint removal, based upon this evaluation, is 11.5 lbs/119 ft^2 or 1.55 oz./ft^2 of area cleaned. This calculates to 114 lbs. of paint waste generated by the abrasive blasting operation. Assuming that 8000 lbs of grit were used and an average of 38.6% Pb in the paint, the average concentration of Pb now should not exceed 5500 ppm ($0.386 \times 114 \times 10^6/8000 = 5500$ ppm Pb). This value is reasonable as compared to the analytical results obtained on the abrasive blasting waste when considering that not all of the paint was removed by the Pentek process. Had all the paint been removed, it is reasonable to assume that paint removal could approximate the 2.1-4.1 oz/ft^2 required to reconcile the 7560-14,600 ppm analytical results.

ANALYTICAL DATA QUALITY ASSURANCE

Although not all quality assurance objectives relative to precision and accuracy of analytical results were met, all data is deemed useable based upon the following results.

Solid Matrix Data Quality Objectives (DQO)

Pentek Bridge #1 analytical results displayed excellent reproduceability (381,000 vs. 391,000 $\mu g/g$) for a relative percent difference (RPD) of 0.13% which is significantly lower than the DQO of <20%. NYSTA Bridge #1 analytical results displayed a significantly higher RPD of 31.8% (7,560 vs. 14,600 $\mu g/g$). Although the RPD for the NYSTA Bridge #10 duplicate analysis exceeds the stated DQO, these results are usable based upon the Pentek results and the reproduceability of results obtained from the analyses of the standard reference material (SRM). The reported apparent heterogeneity of the NYSTA Bridge #10 samples is believed to be the reason for this higher RPD as opposed to any analytical control variances.

Accuracy, measured as % recovery, was 102% for NYSTA Bridge #10 and 83.5% for Pentek Bridge #1. These results, coupled with a 99.7% SRM recovery support the useability of the data. Precision results are all well within Quality Assurance Project Plan stated DQO's of 50-140%.

TCLP Extracts

NYSTA Bridge #1 analytical results displayed excellent reproduceability (78.0 vs. 77.7 mg/l) for a RPD of 0.2%, with an accuracy as % recovery of 101.9% and a SRM recover of 99%. These results all support the useability of the data.

The failure to meet the DQO for the Pentek Bridge #1 matrix spike is the result of serial dilutions necessary to accurately quantitate the sample and is not reflective of uncontrolled analytical recoveries.

SECTION 5

CONCLUSIONS

Although the economic and product quality aspects tend to favor conventional abrasive blasting over the Pentek system for lead paint removal, the volume of hazardous waste generated and its associated increased costs need to be factored in when considering the surface preparation specifications of similar projects.

The decision to specify a lead paint removal system should also be strongly influenced by the potential impacts to worker health and safety and to the environment. Conventional abrasive blasting, as suggested by this evaluation, exposes workers to airborne lead levels which exceed current Permissible Exposure Limits (PELs) as established by OSHA, and potentially exposes the local environment to unacceptable levels of lead-contaminated dusts. On this job alone, based upon the estimated abrasive blast grit usage and the total lead analysis results in the waste samples, it can be estimated that between 465 and 900 lbs. of lead were released to the local environment. The safe use of the abrasive blasting process for the removal of lead-based paints requires the utilization of additional controls which specifically address the issues of worker health and safety and lead-contaminated residuals containment. These controls, depending on the sensitivity of the worksite locations, may require highly engineered containment systems that, while providing for the necessary levels of worker and environmental safety, also significantly increase total paint removal costs.

The option of using alternative processes such as the Pentek dustless needlegun system becomes more economically advantageous when sophisticated containment structures, personal protective equipment, training and medical surveillance programs and their associated costs become unnecessary due to the Pentek system's ability to control potential contaminants at the source.

Additional evaluations of post-blasting requirements necessitated by the Pentek system's apparent inability to remove paint from inaccessible areas, should be performed. Also, future research and development activities for Pentek and other similar blastless technologies should focus on maximizing paint removal efficiencies, especially in inaccessible areas, to eliminate the necessity for post-blasting activities, which would increase overall paint removal costs.

The potential benefits of using the Pentek dustless needlegun system in helping to address the global lead-based paint removal problem are clear. These include:

- Substantial reductions (up to 97.5%) in the generation of hazardous wastes.
- Enhanced worker health and safety through substantial reduction (up to 99%) of airborne dusts and lead-containing residues, thus eliminating the necessity for additional administrative controls necessary to comply with OSHA standards.
- Enhanced protection of the local environment through substantial reduction (up to 99%) of fugitive emissions of lead-containing dusts and spent abrasive debris. This may preclude the necessity for additional measures in order to comply with federal, state and local regulations dictating control over multi-media toxic chemical releases.

- Optimization of the concentration of lead in solids, thus enhancing the potential to reclaim the metal for reuse rather than disposal in secure landfills.
- Economically competitive when factoring in costs of sophisticated containment structures and engineered systems to assure worker health and safety and environmental protection.

APPENDIX A

SURFACE PREPARATION SPECIFICATIONS

SSPC-SP 6
SSPC-SP 11

Reprinted from Volume 2, "Standards and Specifications" of the Steel Structures Painting Manual, Sixth Edition, 1991, Steel Structures Painting Council, 4516 Henry Street, Pittsburgh, PA 15213.

Steel Structures Painting Council

SURFACE PREPARATION SPECIFICATION NO. 6
Commercial Blast Cleaning

1. Scope

1.1 This specification covers the requirements for Commercial Blast Cleaning of steel surfaces by the use of abrasives.

2. Definition

2.1 A Commercial Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining, as noted in Section 2.2.

2.2 Staining shall be limited to no more than 33 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied paint. Slight residues of rust and paint may also be left in the bottoms of pits if the original surface is pitted.

2.3 ACCEPTABLE VARIATIONS IN APPEARANCE THAT DO NOT AFFECT SURFACE CLEANLINESS as defined in Sections 2.1 and 2.2 include variations caused by type of steel, original surface condition, thickness of the steel, weld metal, mill or fabrication marks, heat treating, heat affected zones, blasting abrasive, and differences in the blast pattern.

2.4 When painting is specified, the surface shall be roughened to a degree suitable for the specified paint system.

2.5 Immediately prior to paint application, the surface shall comply with the degree of cleaning as specified herein.

2.6 SSPC-Vis 1-89 or other visual standards of surface preparation may be specified to supplement the written definition.

*NOTE: Additional information on visual standards is available in Section A.4 of the Appendix.

3. Blast Cleaning Abrasives

3.1 The selection of abrasive size and type shall be based on the type, grade, and surface condition of the steel to be cleaned, type of blast cleaning system employed, the finished surface to be produced (cleanliness and roughness), and whether the abrasive will be recycled.

3.2 The cleanliness and size of recycled abrasives shall be maintained to insure compliance with this specification.

3.3 The blast cleaning abrasive shall be dry and free of oil, grease, and other harmful materials at the time of use.

3.4 Any limitations or restrictions on the use of specific abrasives, quantity of contaminants, or degree of embedment shall be included in the procurement documents (project specification) covering the work, since abrasive embedment and abrasives containing contaminants may not be acceptable for some service requirements.

*NOTE: Additional information on abrasive selection is available in Section A.2 of the Appendix.

4. Reference Standards

4.1 If there is a conflict between the cited reference standards and this specification, this specification shall prevail unless otherwise indicated in the procurement documents (project specification).

4.2 The standards referenced in this specification are:

SSPC-SP 1	Solvent Cleaning
SSPC-Vis 1-89	Visual Standard for Abrasive Blast Cleaned Steel

5. Procedure Before Blast Cleaning

5.1 Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP 1 or other agreed upon methods.

5.2 Before blast cleaning, surface imperfections such as sharp fins, sharp edges, weld spatter, or burning slag should be removed from the surface to the extent required by the procurement documents (project specification).

*NOTE: Additional information on surface imperfections is available in Section A.5 of the Appendix.

6. Blast Cleaning Methods and Operation

6.1 Clean, dry, compressed air shall be used for nozzle blasting. Moisture separators, oil separators, traps or other equipment may be necessary to achieve this requirement.

*Notes are not requirements of this specification.

6.2 Any of the following methods of surface preparation may be used to achieve a Commercial Blast Cleaned surface:

6.2.1 Dry abrasive blasting using compressed air, blast nozzles, and abrasive.

6.2.2 Dry abrasive blasting using a closed cycle, recirculating abrasive system with compressed air, blast nozzle, and abrasive, with or without vacuum for dust and abrasive recovery.

6.2.3 Dry abrasive blasting, using a closed cycle, recirculating abrasive system with centrifugal wheels and abrasive.

6.3 Other methods of surface preparation (such as wet abrasive blasting) may be used to achieve a Commercial Blast Cleaned surface by mutual agreement between the party responsible for performing the work and the party responsible for establishing the requirements or his representative.
*NOTE: If wet abrasive blasting is used, information on the use of inhibitors to prevent the formation of rust immediately after wet blast cleaning is contained in Section A.9 of the Appendix.

7. Procedures Following Blast Cleaning and Immediately Prior to Painting

7.1 Visible deposits of oil, grease, or other contaminants shall be removed by any of the methods specified in SSPC-SP 1 or other methods agreed upon by the party responsible for establishing the requirements and the party responsible for performing the work.

7.2 Dust and loose residues shall be removed from prepared surfaces by brushing, blowing off with clean, dry air, vacuum cleaning or other methods agreed upon by the party responsible for establishing the requirements and the party responsible for performing the work. Moisture separators, oil separators, traps, or other equipment may be necessary to achieve clean, dry air.

7.3 After blast cleaning, surface imperfections which remain (i.e., sharp fins, sharp edges, weld spatter, burning slag, scabs, slivers, etc.) shall be removed to the extent required in the procurement documents (project specification). Any damage to the surface profile resulting from the removal of surface imperfections shall be corrected to meet the requirements of Section 2.4.
*NOTE: Additional information on surface imperfections is contained in Section A.5 of the Appendix.

7.4 Any visible rust that forms on the surface of the steel after blast cleaning shall be removed by reblasting the rusted areas to meet the requirements of this specification before painting.
*NOTE: Information on rust-back (rerusting) and surface condensation is contained in Sections A.7 and A.8 of the Appendix.

8. Inspection

8.1 Work and materials supplied under this specification are subject to inspection by the party responsible for establishing the requirements or his representative. Materials and work areas shall be accessible to the inspector. The procedures and times of inspection shall be as agreed upon by the party responsible for establishing the requirements and the party responsible for performing the work.

8.2 Conditions not complying with this specification shall be corrected. In case of dispute the arbitration or settlement procedure established in the procurement documents (project specification) shall be followed. If no arbitration or settlement procedure is established, then the procedure established by the American Arbitration Association shall be used.

8.3 The procurement documents (project specification) should establish the responsibility for inspection and for any required affidavit certifying compliance with the specification.

9. Safety and Environmental Requirements

9.1 Blast cleaning is a hazardous operation. Therefore, all work shall be conducted in such a manner to comply with all applicable insurance underwriter, local, state, and federal safety and environmental rules and requirements.
*NOTE: SSPC-PA Guide 3, "A Guide to Safety in Paint Application," addresses safety concerns for coating work.

10. Comments

10.1 While every precaution is taken to insure that all information furnished in SSPC specifications is as accurate, complete, and useful as possible, the Steel Structures Painting Council cannot assume responsibility nor incur any obligation resulting from the use of any materials, paints, or methods specified therein, or of the specification itself.

10.2 Additional information and data relative to this specification are contained in the following brief Appendix. More detailed information and data are presented in a separate document, SSPC-SP COM, "Surface Preparation Commentary." The recommendations contained in the Notes, Appendix, and SSPC-SP COM are believed to represent good practice, but are not to be considered as requirements of the specification. The table below lists the subjects discussed relevant to Commercial Blast Cleaning and appropriate section of SSPC-SP COM.

Subject	Commentary Section
Abrasive Selection	5
Degree of Cleaning	11.6
Film Thickness	10
Wet Abrasive Blast Cleaning	9
Maintenance Painting	3.2
Rust Back (Rerusting)	8
Surface Profile	6
Visual Standards	7
Weld Spatter	4.1

A. Appendix

A.1 FUNCTION—Commercial Blast Cleaning (SSPC-SP 6) provides a greater degree of cleaning than Brush-Off Blast Cleaning (SSPC-SP 7) but less than Near-White Blast Cleaning (SSPC-SP 10). It should be used where a high but not perfect degree of blast cleaning is required. The primary functions of blast cleaning before painting are: (a) to remove material from the surface that can cause early failure of the coating system, and (b) to obtain a suitable surface roughness.

A.2 ABRASIVE SELECTION—Types of metallic and non-metallic abrasives are discussed in the Surface Preparation Commentary (SSPC-SP COM). It is important to recognize that blasting abrasives may become embedded in or leave residues on the surface of the steel during preparation. While normally such embedment or residues are not detrimental, care should be taken (particularly if the prepared steel is to be used in an immersion environment) to assure that the abrasive is free from detrimental amounts of water soluble, solvent soluble, acid soluble, or other such soluble materials. Requirements for selecting and evaluating mineral and slag abrasives are given in SSPC-AB 1, "Mineral and Slag Abrasives."

A.3 SURFACE PROFILE—Surface profile is the roughness of the surface which results from abrasive blast cleaning. The profile depth (or height) is dependent upon the size, type, and hardness of the abrasive, particle velocity and angle of impact, hardness of the surface, amount of recycling, and the proper maintenance of working mixtures of grit and/or shot.

The allowable minimum/maximum height of profile is usually dependent upon the thickness of the paint to be applied. Large particle sized abrasives (particularly metallic) can produce a profile which may be too deep to be adequately covered by a single thin film coat. Accordingly, it is recommended that the use of larger abrasives be avoided in these cases. However, larger abrasives may be needed for thick film coatings or to facilitate removal of heavy mill scale or rust. If control of profile (minimum/maximum) is deemed to be significant to coatings performance, it should be addressed in the procurement documents (project specification).

Typical maximum profile heights achieved with commercial abrasive media are shown in Table 8 of the Surface Preparation Commentary (SSPC-SP COM). Methods (i.e., comparators, replica tape, depth micrometers) are available to aid in estimating the profile of surfaces blast cleaned with sand, steel grit, and steel shot.

A.4 VISUAL STANDARDS—Note that the use of visual standards in conjunction with this specification is required only when they are specified in the procurement documents (project specification) covering the work. It is recommended, however, that the use of visual standards be made mandatory in the procurement documents (project specification).

SSPC-Vis 1-89, "Visual Standard for Abrasive Blast Cleaned Steel," provides color photographs for the various grades of surface preparation as a function of the initial condition of the steel. The following table lists the photographs for this specification that are applicable to the rust grades listed below.

Rust Grade	Mill Scale and Rust	100% Rust	100% Rust With Pits
Pictorial Standards	B SP 6	C SP 6	D SP 6

Many other visual standards are available and are described in Section 7 of the Commentary (SSPC-SP COM).

A.5 SURFACE IMPERFECTIONS—Surface imperfections can cause premature failure when the service is severe. Coatings tend to pull away from sharp edges and projections, leaving little or no coating to protect the underlying steel. Other features which are difficult to properly cover and protect include crevices, weld porosity, laminations, etc. The high cost of the methods to remedy the surface imperfections requires weighing the benefits of edge rounding, weld spatter removal, etc., versus a potential coating failure.

Poorly adhering contaminants, such as weld slag residues, loose weld spatter, and some minor surface laminations, may be removed during the blast cleaning operation. Other surface defects (steel laminations, weld porosities, or deep corrosion pits) may not be evident until the surface preparation has been completed. Therefore, proper planning for such surface repair work is essential since the timing of the repairs may occur before, during, or after the blast cleaning operation. Section 4 of the Commentary (SSPC-SP COM) contains additional information on surface imperfections.

A.6 CHEMICAL CONTAMINATION—Steel contaminated with soluble salts (i.e., chlorides and sulfates) develops rust-back rapidly at intermediate and high humidities. These soluble salts can be present on the steel surface prior to blast cleaning as a result of atmospheric contamination. In addition, contaminants can be deposited on the steel surface during blast cleaning whenever the abrasive is contaminated. Therefore, rust-back can be minimized by removing these salts from the steel surface, preferably before blast cleaning, and eliminating sources of recontamination during and after blast cleaning. Identification of the contaminants along with their concentrations may be obtained from laboratory and field tests. A number of tests for soluble salts are now under study by the SSPC, ASTM, Maritime Administration, and ISO.

A.7 RUST-BACK—Rust-back (rerusting) occurs when freshly cleaned steel is exposed to conditions of high humidity, moisture, contamination, or a corrosive atmosphere. The time interval between blast cleaning and rust-back will vary greatly from one environment to another. Under mild ambient conditions it is best to blast clean and coat a surface the same day. Severe conditions may require coating more quickly while for exposure under controlled conditions the coating time may be extended. Under no circumstances should the steel be permitted to rust-back before painting regardless of the time elapsed (see Appendix A.6).

A.8 DEW POINT—Moisture condenses on any surface that is colder than the dew point of the surrounding air. It is, therefore, recommended that the temperature of steel surface be at least 5 degrees F (3 degrees C) above the dew point during dry blast cleaning operations. It is advisable to visually inspect for moisture and periodically check the surface temperature and dew point during blast cleaning operations. It is important that the application of paint over a damp surface be avoided.

A.9 WET ABRASIVE BLAST CLEANING—Steel that is wet abrasive blast cleaned may rust rapidly. Clean water should be used for rinsing (studies have shown that water of at least 15,000 ohm-cm resistivity is preferred). It may be necessary that inhibitors be added to the water or applied to the surface immediately after blast cleaning to temporarily prevent rust formation. The coating should then be applied before any rusting is visible. One inhibitive treatment for blast cleaned surfaces is water containing 0.32% sodium nitrite and 1.28% by weight secondary ammonium phosphate (dibasic).
CAUTION: Some inhibitive treatments may interfere with the performance of certain coating systems.

A.10 FILM THICKNESS—It is essential that ample coating be applied after blast cleaning to adequately cover the peaks of the surface profile. The dry paint film thickness above the peaks of the profile should equal the thickness known to be needed for the desired protection. If the dry film thickness over the peaks is inadequate, premature rust-through or failure will occur. To assure that coating thicknesses are properly measured, refer to SSPC-PA 2, "Measurement of Dry Paint Thickness with Magnetic Gages."

A.11 MAINTENANCE AND REPAIR PAINTING—When this specification is used in maintenance painting, specific instructions should be given on the extent of surface to be blast cleaned or spot blast cleaned to this degree of cleanliness. SSPC-PA Guide 4, "Guide to Maintenance Repainting with Oil Base or Alkyd Painting Systems," provides a description of accepted practices for retaining old sound paint, removing unsound paint, feathering, and spot cleaning.

Steel Structures Painting Council

SURFACE PREPARATION SPECIFICATION NO. 11

Power Tool Cleaning to Bare Metal

1. Scope

1.1 This specification covers the requirements for power tool cleaning to produce a bare metal surface and to retain or produce a surface profile.

1.2 This specification is suitable where a roughened, clean, bare metal surface is required, but where abrasive blasting is not feasible or permissible.

1.3 This specification differs from SSPC-SP 3, Power Tool Cleaning, in that SSPC-SP 3 requires only the removal of loosely adherent materials and does not require producing or retaining a surface profile.

2. Definition

2.1 Metallic surfaces which are prepared according to this specification, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portion of pits if the original surface is pitted.

2.2 When painting is specified, the surface shall be roughened to a degree suitable for the specified paint system. The surface profile shall not be less than 1 mil (25 microns). *NOTE: Additional information on profile is contained in Sections A.5 and A.6 of the Appendix.

2.3 Photographs or other visual standards may be used to supplement the written definition. *NOTE: Additional information on visual standards is available in Section A.7 of the Appendix.

3. Power Surface Preparation Tools and Media

3.1 Surface Cleaning Power Tools (that may or may not destroy the surface profile): any tool capable of appropriately driving the media of Section 3.3 is acceptable.

3.2 Impact and Other Profile Producing Power Tools: any tool on which the media of Section 3.4 can be properly mounted and used to produce the required uniform profile is acceptable. *NOTE: Information on suitable tools is found in Sections A.3.a and A.3.b of the Appendix.

3.3 Surface Cleaning Media:

3.3.1 Non-woven abrasive wheels and discs — constructed of a non-woven synthetic fiber web material of continuous undulated filaments impregnated with an abrasive grit. *NOTE: Information on suitable discs and wheels is found in Section A.3.c of the Appendix.

3.3.2 Coated abrasive discs (sanding pads), coated abrasive flap wheels, coated abrasive bands or other coated abrasive devices capable of running on power tools. *NOTE: Information on suitable wheels is found in Section A.3.d of the Appendix.

3.3.3 Other materials that produce the requirements of Section 2.1.

3.4 Surface Profile Producing Media:

3.4.1. Rotary impact flap assembly consisting of a flexible loop construction with carbide spheres bonded to the peening surfaces of each of the metal supports fastened to the loop.* NOTE: Information on suitable flap assemblies is found in Section A.3.e of the Appendix.

3.4.2 Needle guns consisting of a bundle of wire "needles" which can impact a surface, producing a peened effect. *NOTE: Information on suitable needles is found in Section A.3.f of the Appendix.

3.4.3 Other materials which, when mounted on power hand tools, can produce the profile required in Section 2.2.

4. Reference Standards

4.1 The standards referenced in this specification are listed in Section 4.4. and form a part of this specification.

4.2 The latest issue, revision, or amendment of the referenced standards in effect on the date of invitation to bid shall govern unless otherwise specified.

4.3 If there is a conflict between the requirements of any of the cited reference standards and this specification, the requirements of this specification shall prevail.

4.4 STEEL STRUCTURES PAINTING COUNCIL (SSPC) SPECIFICATIONS:

SSPC-SP 1 Solvent Cleaning
SSPC-SP 3 Power Tool Cleaning

5. Procedures Prior to Power Tool Surface Preparation

5.1 Prior to power tool surface preparation, remove visible deposits of oil or grease by any of the methods specified in SSPC-SP 1, "Solvent Cleaning," or other agreed-upon methods.

5.2 Prior to power tool surface preparation, remove surface imperfections such as sharp fins, sharp edges, weld spatter, or burning slag to the extent required by the procurement documents (project specification). *NOTE: Additional information on surface imperfections is available in Appendix A.9.

6. Power Tool Surface Preparation Methods and Operations

6.1 Depending on profile conditions, use either or both of the following methods to remove tightly adhering materials and to retain or produce the required surface profile with power tools:

6.1.1 Profile Condition A, Acceptable Profile Exists: Achieve the cleanliness required in Section 2.1 by using power tools described in Section 3.1.

6.1.2 Profile Condition B. Unacceptable Profile Exists: Achieve the cleanliness required in Section 2.1 and the profile required in Section 2.2 by using power tools described in Section 3. *NOTE: Information on the selection of tools and cleaning media is found in Section A.2 of the Appendix.

7. Procedures Following Power Tool Surface Preparation

7.1 After power tool surface preparation and prior to the application of coatings, reclean the surface if it does not conform to this specification.

7.2 Remove visible deposits of oil, grease, or other contaminants by any of the methods specified in SSPC-SP 1 or other methods agreed upon by the party responsible for estalishing the requirements and the party responsible for performing the work. *NOTE: Information on oil contamination is found in Section A.4.d of the Appendix.

7.3 Remove dirt, dust, or similar contaminants from the surface. Acceptable methods include brushing, blow off with oil free, clean, dry air; vacuum cleaning; or wiping with a clean, dry cloth.

7.4 Power tool prepared surfaces must be coated prior to the reformation of rust or visible contamination.

8. Inspection

8.1 Surfaces prepared under this specification shall be subject to timely inspection by the purchaser or his authorized representative. The contractor shall correct such work as is found defective under this specification. In case of dispute, the arbitration or settlement procedure as established in the procurement documents (project specification), shall be followed. If no arbitration procedure is established, the procedure specified by the American Arbitration Association shall be used.

8.2 The procurement documents (project specification) covering work or purchase shall establish the responsibility for testing and for any required affidavit certifying full compliance with the specification.

9. Safety

9.1 All safety requirements stated in the procurement document as well as this specification and its component parts apply in addition to any applicable federal, state, and local rules and requirements. They also shall be in accord with instructions and requirements of insurance underwriters.

10. Comments

10.1 While every precaution is taken to insure that all information furnished in SSPC specifications is as accurate, complete, and useful as possible, the Steel Structures Painting Council cannot assume responsibility nor incur any obligation resulting from the use of any materials, paints, or methods specified therein. or of the specification itself.

10.2 Additional information and data relative to this specification are contained in the following Appendix. Additional detailed information and data are presented in a separate document, SSPC-SP COM, "Surface Preparation Commentary." The recommendations contained in the Notes, Appendix, and SSPC-SP COM are believed to represent good practice, but are not to be considered as requirements of the specification.

The table below lists the appropriate section of SSPC-SP COM.

Subject	Commentary Section
Degree of Cleaning	11
Film Thickness	10
Maintenance Painting	3
Rust-Back (Rerusting)	8
Surface Profile	6
Visual Standards	7
Weld Spatter	4.1

A. Appendix

A.1 FUNCTION—Power tool surface preparation to remove tightly adherent material produces a surface which is visibly free from all rust, mill scale, and old coatings and which has a surface profile. It produces a greater degree of cleaning than SSPC-SP 3, "Power Tool Cleaning," (which does not remove tightly adherent material) and may be considered for coatings requiring a bare metal substrate.

The surfaces prepared according to this specification are not to be compared to surfaces cleaned by abrasive blasting. Although this method produces surfaces that "look" like "near-white" or "commercial blast," they are not necessarily equivalent to those surfaces produced by abrasive blast cleaning as called for in SSPC-SP 10 or SP 6.

A.2 SELECTION OF TOOLS AND CLEANING MEDIA—Selection of power tools and cleaning media shall be based on (1) the condition of the surface prior to surface preparation, (2) the extent of cleaning that is required to remove rust, scale and other matter from the surface and (3) the type of surface profile required.

A.2.1 Selection of Media—If an acceptable surface profile existed prior to preparing the surface, cleaning media, such as found in Section 3.3, shall be selected that will remove surface contaminants without severely reducing or removing the profile, if possible. If the surface profile is removed or severely reduced when preparing the surface, or if there was no profile prior to surface preparation, surface profiling media, such as found in Section 3.4, shall be selected that will produce an acceptable surface profile as required by this specification. When power tool cleaning rusted surfaces it is important to avoid embedding or peening rust into the substrate. This may require removal of rust prior to use of surface profiling media. These factors may require employing more than one type of medium in order to obtain the desired end result. *NOTE: Power wire brushes when used alone will not produce the required surface profile and may remove or degrade an existing profile to an unacceptable level.

A.2.2 Selection of Tools—Power tools shall be selected on the basis of the size and speed rating of the media. These requirements may differ from one type of media to another and shall be taken into consideration in more than one type of medium will be used in the surface preparation process. Power tools shall be selected that will produce enough power to perform the cleaning operation efficiently. Operator fatigue shall be considered in the selection of power tools.

Further information on the selection of power tools and media is contained in Chapter 2.6, "Hand and Power Tool Cleaning," of *Steel Structures Painting Manual,* Volume 1, "Good Painting Practice," 2nd Edition, 1982.

A.3 SUITABLE TOOLS AND MEDIA—The text of this specification makes reference to the following footnotes. Inclusion of these items in this appendix is intended solely to guide the user to typical types of equipment and media which are available to meet the specification. The items mentioned are not exhaustive of the tools or products available, nor does their mention constitute an endorsement by SSPC.

a. The "Mini-Flushplate"® from Desco Manufacturing Company, Inc., Long Beach, California, has been found suitable as a tool system which meets the requirements of this section.

b. The Aro Corporation, Bryan, Ohio, and VON ARX Air Tools Company, Englewood, New Jersey, are suppliers of needle gun equipment.

c. 3M Scotch-Brite Clean 'n Strip discs and wheels are able to satisfy the requirements.

d. Grind-O-Flex wheels from Merit Corporation, Compton, California and Nu-Matic air inflated wheels, from Nu-Matic Grinders, Euclid, Ohio, have been found suitable.

e. 3M Heavy-Duty Roto-Peen flap assembly has been found suitable.

f. Needles having a diameter of 2 mm have been found to produce a surface profile suitable for many painting systems.

A.4 OPERATION OF TOOLS—The tools shall be operated in accordance with the manufacturers' instructions. In particular, note the following:

a. Observe the recommended operating speed (ROS). The maximum operating speed (MOS) does not necessarily give the most efficient cleaning.

b. The "rpm" (rotational speed) rating of some power tools and the cleaning media may not be compatible and could result in physical injury to the operator.

c. Exercise caution when power tools are used at critical structures (e.g., pressure vessel boundaries) so that excessive base metal is not removed.

d. When air driven tools are used, the exhaust could contain oil and/or moisture that could easily contaminate the recently prepared surface.

e. The media used on power tools have a finite life. When they do not produce the specified profile they shall be replaced.

Additional information on the operation of tools can be found in Chapter 2.6 of Volume 1, "Good Painting Practice" of *Steel Structures Painting Manual,* 2nd Edition, 1982.

A.5 PROFILE—The type of power tools to be used depends upon whether or not an acceptable profile exists on the surface to be cleaned.

Some limitations of the various types of media to produce a specific profile or to preserve an existing profile are as follows:

Media of Section 3.3 produce a profile of approximately one-half mil (10-15 microns), whereas the media of Section 3.4 may produce a profile of 1 mil (25 microns) or more. The profile depends on the abrasive embedded in the rotary flaps or the diameter of the needles.

Impact tools may produce sharp edges or cut into the base metal if not used properly.

It is important to determine whether the profile requirements for the specified coating system can be met by this power tool cleaning method of surface preparation.

A.6 MEASUREMENT OF SURFACE PROFILE—Surface profile comparators and other visual or tactile gages used for abrasive blast cleaning are not suitable for measuring profile produced by power tools because of the differences in appearance. One acceptable procedure is use of coarse or extra coarse replica tape, as described in Method C of ASTM D-4417, "Field Measurement of Surface Profile of Blast Cleaned Steel." Replica tapes are valid for profiles in the ranges of 0.8 to 1.5 mils (coarse) to 1.5-4.5 mils (extra-coarse). (Note: Because of the limitations in compressibility of the mylar film, however, even very smooth surfaces will give readings of 0.5 mils or greater using the replica tape.)

A.7 VISUAL STANDARDS—SSPC-Vis 1-89, "Visual Standard for Abrasive Blast Cleaned Steel," ISO 8501-1:1988, and the National Association of Corrosion Engineers "Blast Cleaning Visual Standards," TM-01-70 and TM-01-75, are not suitable for assessing surfaces power tool cleaned to bare metal.

The SSPC is currently preparing photographs which illustrate typical end conditions achieved using the power tools described in this specification over the initial rust grades depicted in SSPC-Vis 1-89.

A.8 INACCESSIBLE AREAS—Because of the shape and configuration of the power tools themselves, some areas of a structure may be inaccessible for cleaning. These areas include surfaces close to bolt heads, inside corners, and areas with limited clearance. Areas which are inaccessible by this method of surface preparation shall be cleaned using an alternate method of surface preparation which may result in a different degree of surface cleanliness and surface profile. The alternate method shall be mutually agreed upon before commencing work.

A.9 SURFACE IMPERFECTIONS—Surface imperfections can cause premature failure when the environment is severe. Coatings tend to pull away from sharp edges and projections, leaving little or no coating to protect the underlying steel. Other features which are difficult to properly cover and protect include crevices, weld porosity, laminations, etc. The high cost of methods to remedy the surface imperfections requires weighing the benefits of edge rounding, weld spatter removal, etc., versus a potential coating failure.

Poorly adherent contaminants, such as weld slag residues, loose weld spatter, and some minor surface laminations, must be removed during the power tool cleaning operation. Other surface defects (steel laminations, weld porosities, or deep corrosion pits) may not be evident until the surface preparation has been completed. Therefore, proper planning for such repair work is essential, since the timing of the repairs may occur before, during, or after the cleaning operation. Section 4 of the "Surface Preparation Commentary" (SSPC-SP COM) contains additional information on surface imperfections.

A.10 CHEMICAL CONTAMINATION—Steel contaminated with soluble salts (i.e., chlorides and sulfates) develops rust-back rapidly at intermediate and high humidities. These soluble salts can be present on the steel surface prior to cleaning as a result of atmospheric contamination. In addition, contaminants can be deposited on the steel surface during cleaning whenever the media is contaminated. Therefore, rust-back can be minimized by removing these salts from the steel surface, preferably before power tool cleaning, and eliminating sources of recontamination during and after power tool cleaning. Identification of the contaminants along with their concentrations may be obtained from laboratory or field tests.

A.11 RUST BACK—Rust-back (rerusting) occurs when freshly cleaned steel is exposed to conditions of high humidity, moisture, contamination, or a corrosive atmosphere. The time interval between power tool cleaning and rust-back will vary greatly from one environment to another. Under mild ambient conditions, it is best to clean and coat a surface the same day. Severe conditions may require coating more quickly, while for exposure under controlled conditions the coating time may be extended. **Under no circumstances shall the steel be permitted to rust-back before painting regardless of time elapsed (see Appendix A.10).**

A.12 DEW POINT—Moisture condenses on any surface that is colder than the dew point of the surrounding air. It is, therefore, recommended that the temperature of the steel surface be at least 5 degrees F (3 degrees C) above the dew point during power tool cleaning operations. It is advisable to visually inspect for moisture and periodically check the surface temperature and dew point during cleaning operations. It is important that the application of a coating over a damp surface be avoided.

A.13 FILM THICKNESS—It is essential that ample coating be applied after power tool cleaning to adequately cover the peaks of the surface profile. The dry film thickness above the peaks of the profile shall equal the thickness known to be needed for the desired protection. If the dry film thickness over the peaks is inadequate, premature rust-through or failure will occur. To assure that coating thicknesses are properly measured, refer to SSPC-PA 2, "Measurement of Dry Paint Thickness with Magnetic Gages."

A.14 MAINTENANCE AND REPAIR PAINTING—When this specification is used in maintenance painting, specific instructions shall be given on the extent of surface to be power tool cleaned or spot cleaned. SSPC-PA Guide 4, "Guide to Maintenance Repainting with Oil Base or Alkyd Painting Systems," provides a description of accepted practices for retaining old sound paint, removing unsound paint, feathering, and spot cleaning.

APPENDIX B

CONDENSED OPERATING PROCEDURES

PENTEK CORNER-CUTTER®
PENTEK VAC-PAC®

CONDENSED OPERATING PROCEDURES FOR PENTEK CORNER-CUTTER®

Introduction

The CORNER-CUTTER® is designed to remove lead-based paints, radioactivity and other hazardous contaminants from both steel and concrete surfaces in an environmentally-safe manner. Pentek developed the CORNER-CUTTER® to scarify walls, joints, ceilings, girders, equipment supports and other hard to get places in a single step process. Surfaces are left clean and ready to receive new protective coatings, toppings and overlays.

The CORNER-CUTTER® operates by pneumatically driving specially hardened needles into the surface being cleaned. The process takes place within an evacuated enclosure preventing the escape of dust, debris and airborne contamination. Standard shrouds are provided with each unit to allow the cutter to conform to inside corners, outside corners, door jambs and flat surfaces. Special shrouds can be custom engineered to conform to particularly odd geometric shapes.

The CORNER-CUTTER® is one of several types of pneumatically operated scarifiers manufactured by Pentek that operates in conjunction with an ultra-high performance HEPA-filtered vacuum system. The CORNER-CUTTER® incorporates unique vacuum flow design features which provide high efficiency performance in contaminated or clean room environments which require stringent control of loose material. Users will find that the CORNER-CUTTER® minimizes the need for the respiratory protections of operating personnel from airborne radiological and toxic particulate hazards; the need to erect tents or temporary enclosures to protect nearby operating equipment from flying dust and debris is also reduced.

The CORNER-CUTTER®'s light weight, low reaction forces and infinitely adjustable vacuum enclosure minimizes operator fatigue and provide for comfortable operation in any position. The ergonomic design of the operator's handle provides complete operator control, and is equipped with a quick-release-to-off safety feature.

General Safety Precautions

1. Keep hands and feet away from the needles when connected to a compressed air supply.

2. The CORNER-CUTTER® should be operated utilizing an air supply capable of delivering 90 psig measured at the tool, with consumption of approximately 5 scfm.

3. The CORNER-CUTTER® operator and other personnel near the work area must wear safety goggles.

4. Ear protection should be required for all personnel in the vicinity of CORNER-CUTTER® operation.

5. The proper shroud should be installed at the tool end to ensure proper control of contamination. The shroud should be inspected prior to using the equipment; its integrity is important in maintaining the proper contamination control.

Support Requirements

The following are to support the operation of the CORNER-CUTTER®.

1. Clean, dry air supply rated at 90 psig at approximately 5 scfm, supplied through a pressure-rated air hose. The air hose should be at least 1/2 inch in diameter or larger.

2. A HEPA-filtered vacuum system.

3. Standard 1-1/2 inch RX polyethylene-EVA vacuum hose or equivalent.

4. Correct shrouds to provide contamination control to the surfaces encountered in the work area.

Preparing the CORNER-CUTTER® for Operation

1. Check the condition of the CORNER-CUTTER® prior to operation on a new job. The CORNER-CUTTER® maintenance should be current. Bolts and fittings should be tight.

2. Before operation and after each three hours of continuous operation, it is recommended the CORNER-CUTTER® be lubricated with Marvel Mystery Oil or equivalent. Five to ten drops of Marvel Mystery Oil should be placed directly into the CORNER-CUTTER® in the pneumatic supply port at the base of the handle.

3. Another approach is to install an in-line oiler to the air supply line to ensure continuous lubrication during tool operation.

4. Connect a 1-1/2" vacuum hose from the CORNER-CUTTER® to a filtered vacuum system; HEPA filters are required for contamination control; turn the vacuum system on.

5. Connect the pneumatic supply hose. The CORNER-CUTTER® requires a pneumatic supply of 90 psi and a flow of about 5 scfm; in no event should the air supply pressure exceed 120 psig.

Operation of the CORNER-CUTTER®

1. Adjust the orientation of vacuum hose by rotating the vacuum front piece barrel such that it does not interfere with the work or the comfortable operation of the unit.

2. Place the shroud firmly against surface and squeeze the throttle valve to begin operation.

3. Move the CORNER-CUTTER® along the surface or edge to be cleaned at a sufficiently slow and steady rate to allow for complete scarification. Be certain to maintain the shroud in contact with the surface to avoid loss of control of contaminated material.

4. When scarifying concrete, it is possible to control cutting depth. To make a rough-adjustment, loosen Locking Collar and run unit on area to be cleaned. When the desired depth of cut has been attained, hold vacuum slide firmly in place and tighten Locking Collar; finer adjustments may be required after first use.

5. Monitor the hoses and tend them as required; stop the CORNER-CUTTER®, if necessary to permit adjustment of the hoses.

6. When operating the CORNER-CUTTER® on a ceiling, it is recommended to set the locking collar as instructed in Step 4. This will minimize operator fatigue and promote contamination control by maintaining constant clearance between the shrouds and the ceiling surface.

CONDENSED OPERATING PROCEDURES FOR PENTEK VAC-PAC® MODEL 9D

Introduction

Pentek developed the VAC-PAC® ultra-high performance vacuum system to support our line of concrete decontamination equipment: MOOSE®, SQUIRREL III®, AND CORNER-CUTTER®. This manual describes the VAC-PAC® as an independent system for use to support other decontamination operations, or any operation where a high-performance vacuum system is required.

The VAC-PAC® offers two stage positive filtration sufficient to support safe and efficient vacuuming of radioactive and toxic materials. First stage roughing filter efficiency is 95% at 1 micron, with second stage HEPA efficiency of 99.97% at 0.3 microns. The VAC-PAC® features automatic self-cleaning of the first stage filters using reverse-flow pulses of high-pressure air. This exclusive feature virtually eliminates filter clogging, and allows for continuous vacuuming without interruptions to change filters.

The portable VAC-PAC® system utilizes high recovery pneumatic eductors which use compressed air to produce vacuum performance rivaling that produced by much larger truck-mounted "super vacuums".

Also featured in the VAC-PAC® design is Pentek's exclusive controlled seal drum fill system, which allows the operator to fill, seal, remove, and replace the waste drum under controlled vacuum conditions. This assures positive control of waste and dust, and minimizes the possibility of releasing airborne contamination during drum changing operations.

The entire vacuum system is mounted on the VAC-PAC®'s powered lift mechanism. The wheeled lift permits easy transport and positioning of the VAC-PAC®, and for the waste drum as well. The VAC-PAC® can accommodate either 21-, 52-, or 55-gallon waste drums.

General Safety Precautions

1. When charging the battery, use a 110 VAC, 60 Hertz electrical supply which is properly grounded and protected with a Ground Fault Circuit Interrupt.

2. Clean, dry compressed air should be used to drive the VAC-PAC®. Air supplies contaminated with excessive amounts of water and oil should be processed an using an in-line separator located upstream of the VAC-PAC®.

3. Use only lockable air supply fittings when connected an air hose to the VAC-PAC®; e.g., Chicago fittings, Hansen couplings, National couplings.

4. Disconnect the electrical power and the air supply before opening any electrical enclosures, or performing maintenance or any other service on the VAC-PAC®.

5. Disconnect the electrical power and air supply before cutting or disconnecting any tubing on the unit.

6. Ear protection should be required for all personnel in the vicinity of VAC-PAC® operations.

7. Keep hands clear of the vacuum head and lift mechanisms when raising or lowering the vacuum head.

8. Drum changeout procedures must be carefully followed to prevent the release of hazardous materials.

Support Requirements

The following are required to support operation of the VAC-PAC®:

1. Standard 110 VAC electrical outlet (for battery charging).

2. Air supply rated at a nominal 120 psi. Air consumption for the VAC-PAC® 6 is 70 scfm, and for the VAC-PAC® 9 it is 105 scfm; both are 85 psi measured at the VAC-PAC® pressure gauge.

3. Replaceable vacuum nozzles and strap wrench for installation/removal.

4. Standard 1-1/2 inch RX polyethylene vacuum hose or equivalent. Note that while the VAC-PAC® is supplied with standard 1-1/2 inch nozzle/hose connection, 2 inch, 2-1/2 inch, and 3 inch hose connections are available.

5. 21-, 52-, or 55-gallon drums (with lids) to be used as waste containers.

6. Disposable cardboard disks used to provide temporary containment of the vacuum head during drum changeout.

7. Aluminum positioning disc (reusable) used to position the disposable cardboard disc during drum changeout.

8. "Shower Cap" covers to cover the open mouth of the vacuum head during storage and transport of the VAC-PAC®.

9. Selection of plastic caps to cover vacuum nozzles, ports, and hose ends when not is use.

10. Pentek recommends the use of Pentek's line of hand tools whenever aggressive, dust-controlled surface preparation, material removal, and decontamination are desired. The SQUIRREL III® scabblers remove concrete from horizontal surface areas. The CORNER-CUTTER® removes paint and other coatings from corners, floors, walls, beams and from spaces inaccessible to larger equipment.

Preoperational Checks

Physical setup:

1. Ensure that the items described in "Support Requirements" are available.

2. Move the VAC-PAC® to a central location in the work area.

3. Apply the brakes by pulling up on the brake lever until it is locked in the horizontal position.

4. If a drum is not in place, follow the instructions in the "New Drum Installation Procedure."

5. Confirm that a drum is in place and resting against pin locators on the legs of the VAC-PAC®, or on a pallet.

6. Confirm that the vacuum head is fully lowered and resting squarely on the lip of the drum by slowly moving the lift control level to the "Down" position. If there is no motion, the vacuum head is resting on the drum.

7. Insert vacuum nozzles into the vacuum ports which are to be used during the vacuuming operation using the strap wrench supplied with the unit (Figure 2). Plug unused nozzles or ports with appropriate plastic plugs, and tape the plugs securely in place.

   NOTE: It may be necessary to remove the vacuum nozzles to provide sufficient clearance for the VAC-PAC® to pass through some doorways. Insertion and removal of the vacuum nozzles requires the use of the strap wrench provided.

8. Install vacuum hose(s) in the nozzles to be used by threading them into place using a counter-clockwise twisting motion. Tape the hoses securely in place.

Power and Controls

1. When the charging battery, plug the VAC-PAC® power cord into a 110 VAC, 60 Hertz source which is properly grounded. It is also recommended that the VAC-PAC® power supply be protected by a Ground Fault Circuit Interrupt (GFCI).

2. Confirm that the "Vacuum-Exchange" mode selector switch on the main control panel is positioned to "Exchange".

   NOTE: The mode selector switch should be positioned to "Vacuum" ONLY during normal VAC-PAC® vacuuming operation and ONLY when a drum is in position and sealed against the foam drum seal. When the switch is in this position, the green "OK to Vacuum" indicator will light and the lift will be disabled for added safety.

3. Test the drum level detector by placing a solid object (such as a drum lid) directly in front of the blue sensor. Hold the object in place for approximately 30 seconds, or until the "Full Drum" alarm sounds.

4. Confirm that the drum level detector retracts properly. Connect the VAC-PAC® to an air supply, and open the air supply valve. Move the "Vacuum-Exchange" switch to the "Vacuum" mode, then back to the "Exchange" mode. Look to confirm that the drum level detector has withdrawn into the filter housing.

   NOTE: When conducting this test, DO NOT allow the VAC-PAC® to remain in the "Vacuum" mode for more than 15 seconds. As discussed above, the VAC-PAC® should not be in the "Vacuum" mode without a drum in place. This test is the only exception to that rule.

5. The green and red indicator lamps contain push-to-test lamps. The green indicator may only be tested when the mode selector switch is in the "Vacuum" position; the red indicator may be tested with the mode selector switch in any position.

Air Supply

1. Confirm that the air supply valve on the VAC-PAC® is turned to the "OFF" position (i.e., handle in horizontal).

2. Connect an air supply hose to the air supply fitting on the VAC-PAC®.

3. Connect the opposite end of the air hose to the fitting at the main air supply.

4. Open the valve at the main air supply valve. This will start the VAC-PAC® at low flow, even though the air supply valve at the VAC-PAC® inlet manifold is closed.

5. The VAC-PAC® is now ready for operation.

Operation

1. Open the air supply valve at the VAC-PAC®; this initiates full vacuum flow. Check the air supply pressure gauge on the VAC-PAC®; it should be 85 psig. Adjust the optional pressure regulator accordingly; set 9/16 inch locking nut. The VAC-PAC® is now ready to supply vacuum to the hose nozzle.

2. Move the mode selector switch to the "Vacuum" position.

3. When the drum is empty, the green "OK to Vacuum" indicator will light. This indicates that it is all right to proceed with vacuuming operations.

4. When the drum is full, the green "OK to Vacuum" indicator will go out, and the red "Full Drum" indicator will light. This will be accompanies by a loud beeping signal. When this occurs, discontinue vacuuming immediately.

5. Turn the mode selector switch to the "Exchange" position. This will silence the full drum signal, and prepare the VAC-PAC® for drum changeout. The drum level detector will automatically withdraw into the vacuum head, causing the red "Full Drum" indicator to go out as it loses contact with the material in the drum.

6. Begin drum changing operations in accordance with the "Full Drum" changeout procedure.

APPENDIX C

DEMONSTRATION LOG SHEETS

FORM A
CONVENTIONAL ABRASIVE BLASTING LOG SHEET

Location:________________________________ Date:______________

I. Mobilization

Equipment Arrival Time: ____________________
Equipment Set-Up Completed: ____________________
Total Time: ____________________

Equipment Used: ______________________________
____
____

No. Personnel Required: ____________________

II. Operations

Material Use:
Total Abrasive at Start: ____________________
Total Abrasive at Finish: ____________________
Total Abrasive (spent): ____________________

Start Time:__________ Finish Time:__________ Hours/Total:__________

No. Personnel Required:

		Duties
__________ at _______ hours		________________________________
__________ at _______ hours		________________________________
__________ at _______ hours		________________________________
__________ at _______ hours		________________________________

Production:

Paint Removal Area: _______ft. X _______ft. = _______sq. ft.

% Vertical Face _____ % Horizontal Face (top) _____ % Horizontal Face (bottom) _____
No. Inside Corners ____ Total Length ____ft.
No. Outside Corners ____ Total Length ____ft.
No. Bolt Heads ____
No. Nutted Ends ____

Air Monitoring

No.	Type	Location	Time On	Time Off	Flow Rate	Total Air Volume
1.						
2.						
3.						
4.						
5.						

FORM A
CONVENTIONAL ABRASIVE BLASTING LOG SHEET
(Continued)

III. Clean-Up

Method:____
____
____

No. Personnel Required:______
Equipment Used: ______________________________
____
____
____

Start Time:_______ Finish Time:_______ Hours/Total:_______

Waste Collected:

Type	Amount	Lbs.	Ft.^{3}	Gals.	How Stored
		☐	☐		
		☐	☐		
		☐	☐		

IV. Demobilization

Start Time:_______ Finish Time:_______ Hours/Total:_______
No. Personnel Required:_______

V. Quality of Surface Preparation

____
____
____
____

VI. Observations - Other

____
____
____
____
____
____
____

FORM B
DUSTLESS NEEDLEGUN SYSTEM EVALUATION
DEMONSTRATION LOG SHEET

Location:______________________________ Date:______________

I. Mobilization

Equipment Arrival Time: ________________
Equipment Set-Up Completed: ________________
Total Time: ________________

Equipment Used: ________________________
____
____

No. Personnel Required: ________________

II. Operations

Material Use:
Total Abrasive at Start: ________________
Total Abrasive at Finish: ________________
Total Abrasive (spent): ________________

Start Time:________ Finish Time:________ Hours/Total:________

No. Personnel Required:

		Duties
________ at ______ hours		____________________
________ at ______ hours		____________________
________ at ______ hours		____________________
________ at ______ hours		____________________

Production:

Paint Removal Area: ______ft. X ______ft. = ______sq. ft.

% Vertical Face _____ % Horizontal Face (top) _____ % Horizontal Face (bottom) _____
No. Inside Corners ___ Total Length ___ft.
No. Outside Corners ___ Total Length ___ft.
No. Bolt Heads ___
No. Nutted Ends ___

Air Monitoring

No.	Type	Location	Time On	Time Off	Flow Rate	Total Air Volume
1.						
2.						
3.						
4.						
5.						

FORM B
DUSTLESS NEEDLEGUN SYSTEM EVALUATION
DEMONSTRATION LOG SHEET
(Continued)

III. Clean-Up

Method:____
____
____

No. Personnel Required:_______
Equipment Used: ______________________________
____
____
____

Start Time:_______ Finish Time:_______ Hours/Total:_______

Waste Collected:

Type	Amount	Lbs.	Ft.^{3}	Gals.	How Stored
		☐	☐		
		☐	☐		
		☐	☐		

IV. Demobilization

Start Time:_______ Finish Time:_______ Hours/Total:_______
No. Personnel Required:_______

V. Quality of Surface Preparation

____
____
____
____

VI. Observations - Other

____
____
____
____
____
____

APPENDIX D

NYSTA AIR SAMPLING FORMS
AIR SAMPLE CHAIN-OF-CUSTODY FORMS

This Appendix has been deleted because of poor reproducible quality. Copies of p. 49-64 are available from:

Paul Randall
Waste Minimization, Destruction and Disposal Research Division
Risk Reduction Engineering Laboratory
Cincinnati, OH 45268

or

James E. Stadelmaier
Recra Environmental, Inc.
Amherst, NY 14228-2298

APPENDIX E

ANALYTICAL RESULTS

RECRA ENVIRONMENTAL INC.

MEMORANDUM

TO: Jim Stadelmaier

FROM: Deborah J. Kinecki

DATE: March 12, 1993

RE: Analytical Results

Deborah J. Kinecki/KPK

Deborah J. Kinecki

3/12/93

Date

KPK/DJK/dms

I.D. #93-0334
#NY0C2448

ANALYTICAL RESULTS

Prepared For

Jim Stadelmaier

Prepared By

Recra Environmental, Inc.
10 Hazelwood Drive, Suite 106
Amherst, New York 14228-2298

METHODOLOGIES

The specific methodologies employed in obtaining the enclosed analytical results are indicated on the specific data table.

* U.S. Environmental Protection Agency "Test Methods for Evaluating Solid Waste-Physical/Chemical Methods." Office of Solid Waste and Emergency Response. November 1986, SW-846, Third Edition.

* The Toxicity Characteristic Leaching Procedure was performed in accordance with modified method 1311, 40CFR, Appendix II to Part 261, June 1990.

* Methods approved by the National Institute of Occupational Safety and Health.

COMMENTS

Comments pertain to data on one or all pages of this report.

In accordance with the recent update to the TCLP protocol, sample results are not corrected for analytical bias.

TCLP extractions were performed on February 15, 1993.

The qualifier "U" indicates a result below the method detection limit.

The difference between Total Lead results for sample NYSTA BRIDGE 10 and NYSTA BRIDGE 10 MATRIX DUP is attributable to sample non-homogeneity.

The spike percent recovery for sample PENTEK BRIDGE 1 MATRIX SPIKE was 0.0%. This is due to the elevated concentration of Lead in the associated sample.

The results for undetected Total and Respirable Dust analyses are presented in two forms:

1.) Undetected results for samples which had air passed through them are reported as the method detection limit, corrected for the volume of air sampled. The value is qualified with a "U".

2.) Undetected results for samples which have not had air passed through them (ie. FIELD BLANK), are reported as "ND".

The "B" qualifier indicates that associated field blank exhibited detectable levels and are included in one calculation.

TOTAL NUISANCE DUST - NIOSH 0500
AIR MATRIX

Laboratory: Recra Environmental, Inc.
Lab Job No: 93-0334

Units: mg/m^3

CLIENT SAMPLE ID	LAB SAMPLE ID	ANALYSIS DATE	RESULT	Q
T-10792-1	AS026239	02/25/93	1.7	
T-10792-2	AS026240	02/25/93	1.7	U
T-10792-3	AS026241	02/25/93	1.7	U
T-10792-1D	AS026243	02/25/93	1.6	U
T-10792-2D	AS026244	02/25/93	1.6	U
T-10792-3D	AS026245	02/25/93	1.6	U
FIELD BLANK 10792	AS026247	02/25/93	ND	
FIELD BLANK 10792D	AS026248	02/25/93	ND	
T-101392-OP1.1	AS026249	02/25/93	1.7	U
T-101392-OP2.1	AS026250	02/25/93	0.83	
T-101392-OP1.3	AS026251	02/25/93	5.6	
T-101392-OP2.2	AS026252	02/25/93	7.4	
T-1013920OP2.3	AS026253	02/25/93	1.6	U
T-101392-A.1	AS026256	02/25/93	6.7	B
T-101392-A.1.D	AS026257	02/25/93	1.7	B
T-101392-A.3	AS026258	02/25/93	10.0	B
T-101392-A.2.D	AS026259	02/25/93	1.7	B
T-101392-A.3.D	AS026260	02/25/93	1.7	B
FB 101392-A	AS026261	02/25/93	ND	
FB 101392-OP1	AS026262	02/25/93	ND	
FB 101392-OP2	AS026263	02/25/93	ND	
FB 10892-A	AS026267	02/25/93	ND	
T-10892-A.1D	AS026268	02/25/93	25.0	
T-10892A.2D	AS026269	02/25/93	33.0	

TOTAL NUISANCE DUST - NIOSH 0500
AIR MATRIX

Laboratory: Recra Environmental, Inc.
Lab Job No: 93-0334

Units: Mg/M^3

CLIENT SAMPLE ID	LAB SAMPLE ID	ANALYSIS DATE	RESULT	Q
T-10892-A.3D	AS026270	02/25/93	43.0	
FB-10892-AD	AS026272	02/25/93	ND	U
T-10892-OP.1.1	AS026273	02/25/93	19.0	
T-10892-OP1.2	AS026274	02/25/93	5.0	
T-10892-OP1.3	AS026275	02/25/93	1.6	U
FB-10892-OP1	AS026277	02/25/93	ND	U
T-10892-OP2.1	AS026278	02/25/93	5.9	
T-10892-OP2.2	AS026279	02/25/93	6.7	
T-10892-OP2.3	AS026280	02/25/93	250	
FB 10892-OP2	AS026282	02/25/93	ND	U
T-10892-A.1	AS026283	02/25/93	27.0	
T-10892-A.2	AS026284	02/25/93	32.0	
T-10892A.3	AS026285	02/25/93	62.0	
FB 101392 AD	AS026286	02/25/93	ND	U

RESPIRABLE NUISANCE DUST - NIOSH 0600
AIR MATRIX

Laboratory: Recra Environmental, Inc.
Lab Job No: 93-0334

Units: mg/m^3

CLIENT SAMPLE ID	LAB SAMPLE ID	ANALYSIS DATE	RESULT	Q
R-10792	AS026242	02/25/93	0.50	U
R-10792-D	AS026246	02/25/93	0.50	U
FIELD BLANK 10792	AS026247	02/25/93	ND	
FIELD BLANK 10792D	AS026248	02/25/93	ND	
R101392-OP-1	AS026254	02/25/93	0.50	U
R101392-OP-2	AS026255	02/25/93	0.50	U
FB 101392-OP1	AS026262	02/25/93	ND	
FB 101392-OP2	AS026263	02/25/93	ND	
R 101392	AS026264	02/25/93	0.50	U
R 101392-D	AS026265	02/25/93	0.50	U
R 10892-OP1	AS026266	02/25/93	0.71	
FB 10892-A	AS026267	02/25/93	ND	
R10892-D	AS026271	02/25/93	12.0	
FB-10892-AD	AS026272	02/25/93	ND	
R-10892	AS026276	02/25/93	13.0	
FB-10892-OP1	AS026277	02/25/93	ND	
R-10892-OP2	AS026281	02/25/93	12.0	
FB 10892-OP2	AS026282	02/25/93	ND	

TOTAL LEAD - NIOSH 7082
AIR MATRIX

Laboratory: Recra Environmental, Inc.
Lab Job No: 93-0334

Units: mg/l/cassette
Digestion Date: 02/17/93

CLIENT SAMPLE ID	LAB SAMPLE ID	ANALYSIS DATE	RESULT	Q
FB 101392-OP2	AS026263	02/19/93	0.05	U
R 101392	AS026264	02/19/93	0.05	U
R 101392-D	AS026265	02/19/93	0.05	U
R 10892-OP1	AS026266	02/19/93	0.36	
FB 10892-A	AS026267	02/19/93	0.05	U
T-10892-A.1D	AS026268	02/19/93	0.08	
T-10892A.2D	AS026269	02/19/93	0.09	
T-10892-A.3D	AS026270	02/19/93	1.6	
R10892-D	AS026271	02/19/93	0.40	
FB-10892-AD	AS026272	02/19/93	0.05	U
T-10892-OP.1.1	AS026273	02/19/93	0.23	
T-10892-OP1.2	AS026274	02/19/93	0.05	U
T-10892-OP1.3	AS026275	02/19/93	0.06	
R-10892	AS026276	02/19/93	1.3	
FB-10892-OP1	AS026277	02/19/93	0.05	U
T-10892-OP2.1	AS026278	02/19/93	0.14	
T-10892-OP2.2	AS026279	02/19/93	0.06	
T-10892-OP2.3	AS026280	02/19/93	0.89	
R-10892-OP2	AS026281	02/19/93	0.05	U
FB 10892-OP2	AS026282	02/19/93	0.05	U
T-10892-A.1	AS026283	02/19/93	0.05	U
T-10892-A.2	AS026284	02/19/93	0.05	U
T-10892A.3	AS026285	02/19/93	1.1	
FB 101392AD	AS026286	02/19/93	0.05	U

TOTAL LEAD - NIOSH 7082
AIR MATRIX

Laboratory: Recra Environmental, Inc.
Lab Job No: 93-0334

Units: mg/l/cassette
Digestion Date: 02/17/93

CLIENT SAMPLE ID	LAB SAMPLE ID	ANALYSIS DATE	RESULT	Q
T-10792-1	AS026239	02/19/93	0.05	U
T-10792-2	AS026240	02/19/93	0.05	
T-10792-3	AS026241	02/19/93	0.05	U
R-10792	AS026242	02/19/93	0.05	U
T-10792-1D	AS026243	02/19/93	0.05	U
T-10792-2D	AS026244	02/19/93	0.05	U
T-10792-3D	AS026245	02/19/93	0.05	U
R-10792-D	AS026246	02/19/93	0.05	U
FIELD BLANK 10792	AS026247	02/19/93	0.05	U
FIELD BLANK 10792D	AS026248	02/19/93	0.05	U
T-101392-OP1.1	AS026249	02/19/93	0.05	U
T-101392-OP2.1	AS026250	02/19/93	0.05	U
T-101392-OP1.3	AS026251	02/19/93	0.05	U
T-101392-OP2.2	AS026252	02/19/93	0.05	U
T-101392-OP2.3	AS026253	02/19/93	0.05	U
R101392-OP-1	AS026254	02/19/93	0.05	U
R101392-OP-2	AS026255	02/19/93	0.05	U
T-101392-A.1	AS026256	02/19/93	0.05	U
T-101392-A.1.D	AS026257	02/19/93	0.05	U
T-101392-A.3	AS026258	02/19/93	0.05	U
T-101392-A.2.D	AS026259	02/19/93	0.05	U
T-101392-A.3.D	AS026260	02/19/93	0.05	U
FB 101392-A	AS026261	02/19/93	0.05	U
FB 101392-OP1	AS026262	02/19/93	0.05	U

TOTAL LEAD - NIOSH 7082
AIR MATRIX

Laboratory: Recra Environmental, Inc.
Lab Job No: 93-0334

Units: mg/l/cassette
Digestion Date: 02/17/93

CLIENT SAMPLE ID	LAB SAMPLE ID	ANALYSIS DATE	RESULT	Q
FB 101392-OP2	AS026263	2/19/93	0.05	U
R 101392	AS026264	2/19/93	0.05	U
R 101392-D	AS026265	2/19/93	0.05	U
R 10892-OP1	AS026266	2/19/93	0.05	U
FB 10892-A	AS026267	2/19/93	0.05	U
T-10892-A.1D	AS026268	2/19/93	0.08	
T-10892A.2D	AS026269	2/19/93	0.09	
T-10892-A.3D	AS026270	2/19/93	1.6	
R10892-D	AS026271	2/19/93	0.40	
FB-10892-AD	AS026272	2/19/93	0.05	U
T-10892-OP.1.1	AS026273	2/19/93	0.23	
T-10892-OP1.2	AS026274	2/19/93	0.05	U
T-10892-OP1.3	AS026275	2/19/93	0.06	
R-10892	AS026276	2/19/93	1.3	
FB-10892-OP1	AS026277	2/19/93	0.05	U
T-10892-OP2.1	AS026278	2/19/93	0.14	
T-10892-OP2.2	AS026279	2/19/93	0.06	
T-10892-OP2.3	AS026280	2/19/93	0.89	
R-10892-OP2	AS026281	2/19/93	0.36	
FB 10892-OP2	AS026282	2/19/93	0.05	U
T-10892-A.1	AS026283	2/19/93	0.05	U
T-10892-A.2	AS026284	2/19/93	0.05	U
T-10892A.3	AS026285	2/19/93	1.1	
FB 101392AD	AS026286	2/19/93	0.05	U

TOTAL LEAD - NIOSH 7082
AIR MATRIX

Laboratory: Recra Environmental, Inc.
Lab Job No: 93-0334

Units: mg/l/cassette
Digestion Date: 02/17/93

CLIENT SAMPLE ID	LAB SAMPLE ID	ANALYSIS DATE	RESULT	Q
T-10792-1	AS026239	02/19/93	0.05	U
T-10792-2	AS026240	02/19/93	0.05	
T-10792-3	AS026241	02/19/93	0.05	U
R-10792	AS026242	02/19/93	0.05	U
T-10792-1D	AS026243	02/19/93	0.05	U
T-10792-2D	AS026244	02/19/93	0.05	U
T-10792-3D	AS026245	02/19/93	0.05	U
R-10792-D	AS026246	02/19/93	0.05	U
FIELD BLANK 10792	AS026247	02/19/93	0.05	U
FIELD BLANK 10792D	AS026248	02/19/93	0.05	U
T-101392-OP1.1	AS026249	02/19/93	0.05	U
T-101392-OP2.1	AS026250	02/19/93	0.05	U
T-101392-OP1.3	AS026251	02/19/93	0.05	U
T-101392-OP2.2	AS026252	02/19/93	0.05	U
T-101392-OP2.3	AS026253	02/19/93	0.05	U
R101392-OP-1	AS026254	02/19/93	0.05	U
R101392-OP-2	AS026255	02/19/93	0.05	U
T-101392-A.1	AS026256	02/19/93	0.05	U
T-101392-A.1.D	AS026257	02/19/93	0.05	U
T-101392-A.3	AS026258	02/19/93	0.05	U
T-101392-A.2.D	AS026259	02/19/93	0.05	U
T-101392-A.3.D	AS026260	02/19/93	0.05	U
FB 101392-A	AS026261	02/19/93	0.05	U
FB 101392-OP1	AS026262	02/19/93	0.05	U

TOTAL LEAD
SOLID MATRIX - PAINT CHIPS

Laboratory: Recra Environmental, Inc.
Lab Job No: 93-0334
Method: 7420

Units: ug/g
Digestion Date: 02/17/93
Sample Volume: 100 ml

CLIENT SAMPLE ID	LAB SAMPLE ID	ANALYSIS DATE	RESULT	Q
NYSTA BRIDGE 10	AS026236	02/19/93	14600	
NYSTA BRIDGE 10 matrix dup	AS026236MD	02/19/93	7560	
PENTEK BRIDGE 1	AS026237	02/19/93	391000	
PENTEK BRIDGE 1 matrix dup	AS026237MD	02/19/93	381000	

CLIENT SAMPLE ID	LAB SAMPLE ID	ANALYSIS DATE	PERCENT RECOVERY	
NYSTA BRIDGE 10 matrix spike	AS026236MS	02/19/93	102.0	
PENTEK BRIDGE 1 matrix spike	AS026237MS	02/19/93	83.5	

TOTAL LEAD - TCLP EXTRACTION
SOLID MATRIX - PAINT CHIPS

Laboratory: Recra Environmental, Inc.
Lab Job No: 93-0334
Method: 7420

Units: mg/l
Digestion Date: 02/17/93
Sample Volume: 100 ml

CLIENT SAMPLE ID	LAB SAMPLE ID	ANALYSIS DATE	RESULT	Q
NYSTA BRIDGE 10	AS026236	02/19/93	77.7	
PENTEK BRIDGE 1	AS026237	02/19/93	440	
LEAD STANDARD	AS026238	02/19/93	99	
CLIENT SAMPLE ID	**LAB SAMPLE ID**	**ANALYSIS DATE**	**PERCENT RECOVERY**	
NYSTA BRIDGE 10 matrix spike	AS026236MS	02/19/93	101.9	
PENTEK BRIDGE 1 matrix spike	AS026237MS	02/19/93	0.0	