United States
Environmental Protection
Agency

Research and Development

Risk Reduction
Engineering Laboratory
Cincinnati, OH 45268

EPA/600/SR-94/114 September 1994

EPA

Project Summary

Removal and Containment of Lead-Based Paint Via Needle Scalers

Paul B. Kranz, James E. Stadelmaier, and Paul M. Randall

This report describes a comparative technical and economic evaluation of using a dustless needlegun system versus a conventional abrasive grit blasting system to remove lead-based paint from steel structures. The study objectives were 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 with that of conventional abrasive blasting. The needlegun also substantially reduced (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 because of slower production rates that necessitate more operating personnel. These costs are substantially mitigated by reduction of costs associated with expendable abrasive blast material and hazardous waste disposal.

Conventional abrasive blasting proved decidedly superior in the quality of surface preparation based on 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 Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The use of abrasive blasting with expendable grit media for removing lead-based paints from steel structures has been the standard for many years, mainly because of its efficiency both in removing the lead-based paint and in achieving the surface cleanliness and profiles required for subsequent coating operations. In recent years, however, the disadvantages of using abrasive blasting have become increasingly apparent. The process's generation of difficult-to-contain, airborne, lead-contaminated particulates presents a high potential of lead exposure to workers and the local environment. Although sophisticated systems to control or contain airborne particulates would minimize the potential for environmental contamination, they may result in more hazardous localized environments for workers and result in substantially higher overall costs for lead-based paint removal operations. Ad-

Printed on Recycled Paper

ditionally, using expendable abrasive grit to remove lead paint generates excessive amounts of waste material that requires disposal as hazardous waste.

This is a study of the effectiveness and applicability of using a dustless needlegun system to remove lead-based paint from steel bridges. The costs, generation of hazardous waste, and environmental and worker safety are compared with those arising from conventional abrasive blasting.

Procedure

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 highway system. Pentek has been manufacturing dustless surface preparation equipment for use by nuclear facilities and hazardous waste remediation/cleanup contractors since 1985.

The Pentek system is a form of power-tool cleaning that combines material removal and containment. The Pentek CORNER-CUTTER®* (Figure 1), a hand-held needlegun for surface preparation in tight spots and/or vertical and inverted horizontal steel or concrete surfaces, is one of three models of surface preparation tools that Pentek manufactures.

Material is removed through the actions of pneumatically operated reciprocating cutting bits or steel needles that scarify and pulverize the paint or coating. This cutting action does not adversely affect 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-in. thick. The removed material is contained first by using an adjustable shroud located at the tool's point of operation to localize containment, and second, by transporting the contained materials via vacuum to an attached VAC-PAC® containment vessel (DOT 1.7-H drum). The vacuum head of the containment drum (VAC-PAC® system) is equipped with high-efficiency particulate air (HEPA) filters that prevent the escape of airborne dusts at the containment vessel. Based on field experiences, Pentek claims to immediately capture 100% of airborne dusts and 99.5% of solid debris at the surface.

Conventional abrasive blasting (Figure 2) employs compressed air to propel expendable abrasive particles against the surface to be cleaned, to produce a surface profile required by Standards and Specifications of the Steel Structures Painting Council No. 6 (SSPC-SP 6). The spent abrasive and paint debris are manually collected for disposal, usually as hazardous waste.

Both paint removal technologies were evaluated on NYSTA bridges located on Interstate 90 in western New York. The abrasive blasting evaluation was done on NYSTA Bridge #10 on October 7 and 8,

* Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

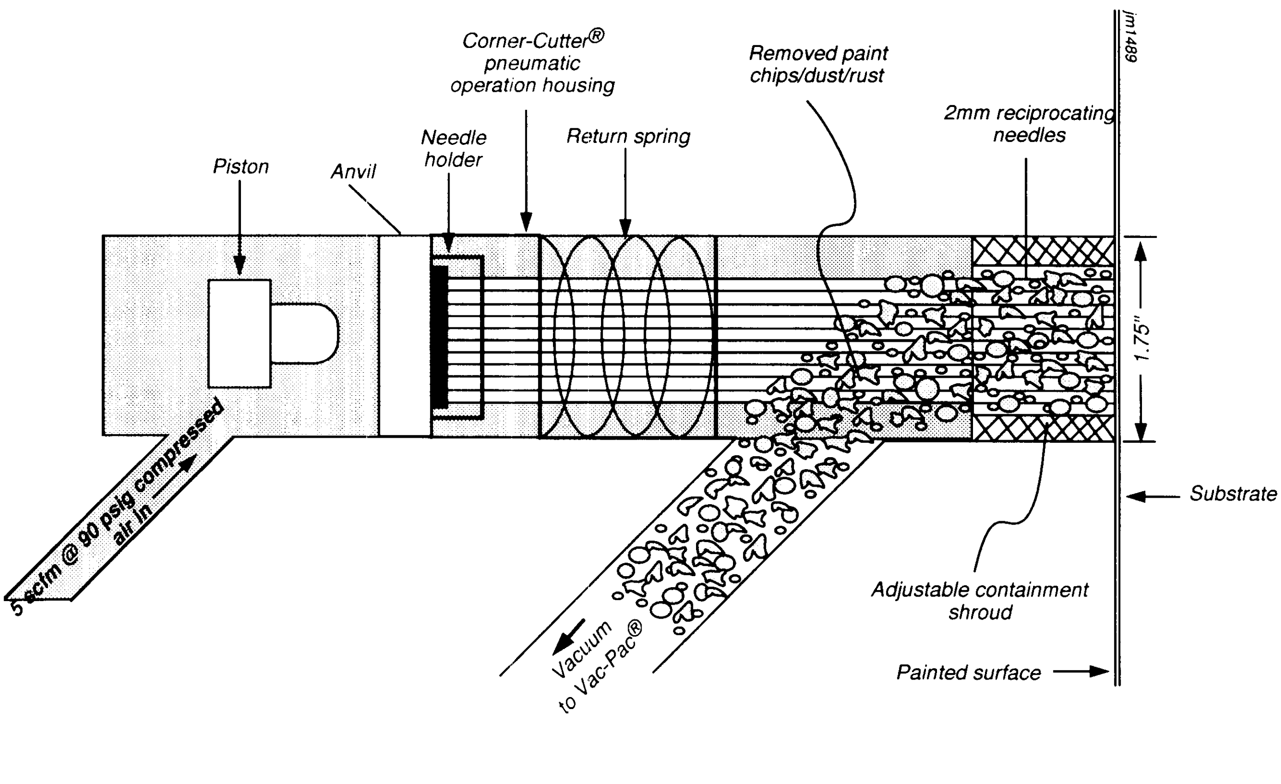

Figure 1. *Pentek CORNER-CUTTER® schematic.*

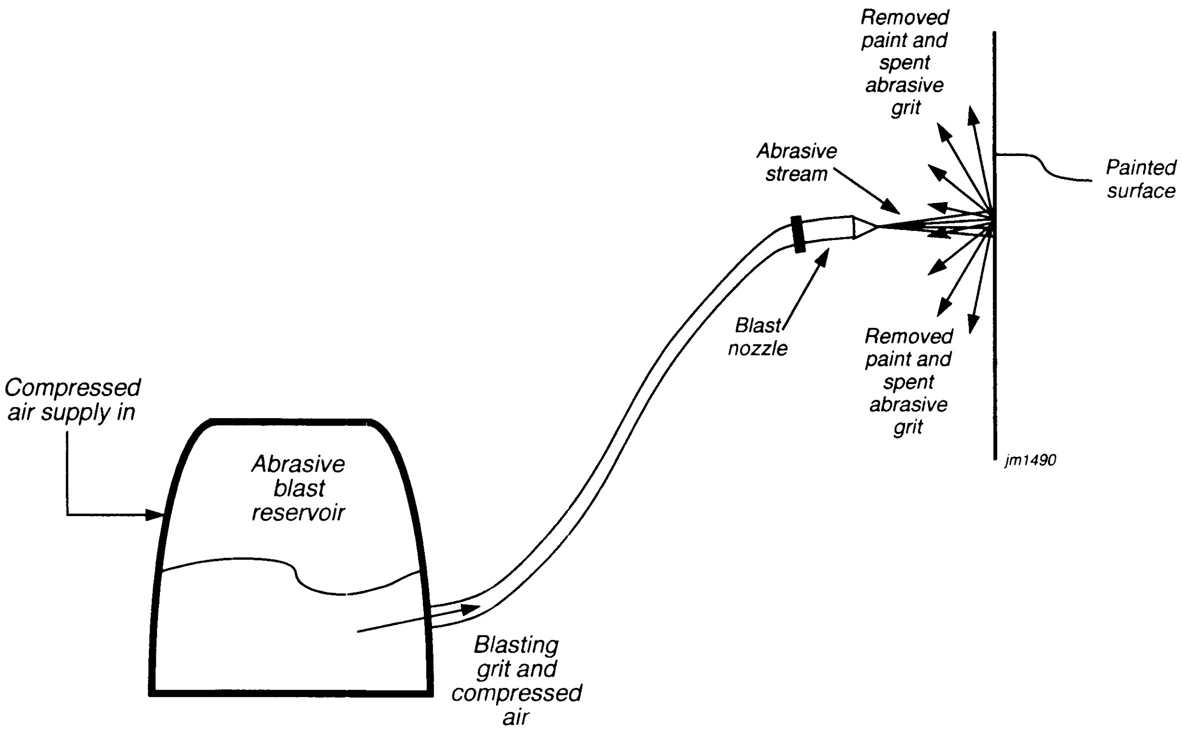

Figure 2. *Abrasive blasting process schematic.*

1992, and the Pentek evaluation was done at NYSTA Bridge #1 on October 13, 1992. The evaluations consisted of observations of work practices, equipment and labor requirements, and time required to complete various tasks as well as to physically measure 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 to obtain background information and historical data relative to the evaluations.

NYSTA Bridge #10 is of rolled beam design and composed of approximately 151 tons of steel and 14,946 ft^2 of surface area, and the paint thicknesses ranged from 10 mils (0.254 mm or 0.01 in.) to 13 mils (0.330 mm or 0.013 in.). 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 to SSPC-SP 6 specifications, has generated an average of 0.15 to 0.20 tons of waste (spent abrasive, paint and miscellaneous dirt, rust, and mill scale) per ton of steel. Theoretically, this would equate to 22.7 to 30.2 tons of hazardous waste generated by conventional abrasive blasting operations at this structure. This waste has been characteristically hazardous because of its leachable lead content.

Bridge #1, also of rolled beam design, is comprised of approximately 315 tons of steel and approximately 25,000 ft^2 of surface area. The paint thickness on this bridge was again estimated by the NYSTA to range from 10 to 13 mils. As with Bridge #10, previous testing by NYSTA had determined the presence of lead-based paints.

Historically, paint removal from similar structures using the Pentek system would generate hazardous paint waste at a rate of 1 oz/ft^2 of area cleaned because of its leachable lead content.

The abrasive blast media consisted of Ebony Grit 20, a nonsilica, lead-free abrasive.

Conventional Abrasive Blasting

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. Because of the similarity of structures and the paint coatings used on each, we believed this would not compromise the quality of the data.

On Day 1 of the conventional abrasive blasting evaluation on Bridge #10, background information regarding the process was obtained and both cleanup activities from the prior day's work and setup activities for work to be performed were observed and recorded. Background lead-in-air concentrations, used as a baseline for both technology evaluations, were also monitored. On Day 2, we observed work procedures, conducted personal and area air monitoring, and recorded appropriate measurements to assess productivity and waste generation.

We interviewed employees and supervisors 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 estimate the man hours required and their associated costs.

Job setup and mobilization required seven workers for 1.5 hr each, mainly to establish traffic control, position equipment, and install hanging enclosure tarps and ground cover tarps. The work enclosures, which are contractually required by the NYSTA, consisted of canvas tarpaulins suspended from cables attached to the bridge structure so as to form a three-sided enclosure: the closed sides face 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 on Day 2 were done simultaneously on the interior eastbound and westbound lanes. Two operators with abrasive blasting nozzles were used per section, which consisted of six 32-in. x 12-in. flange I-beams placed 20 ft on center with connecting 13-in. steel channel bracing mechanically fastened with nuts and bolts. Approximately 1180 ft^2 of surface was completed during the 4-hr evaluation. Grit use, based on past experiences, was estimated to be 4 to 7 tons/day of average production per vessel, based upon 1/2 ton/hr of grit use per nozzle operator. This use was expected to produce specification surface preparation at a rate of 120 ft^2/hr per operator.

Before beginning the evaluation phase, the two nozzle operators working on the westbound section were each fitted with two air sampling pumps (low volume) calibrated to provide a flow rate of 1.5 to 1.7 L of air/min using a digital calibrator. Total and respirable dusts emitted during the blasting process were collected with the use of Millipore 37mm, 0.8μ mixed cellulose ester filter (MCEF) matched-weight cassettes, with cyclone separators for respirable dust collection.

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.

Before the abrasive blasting operation evaluation, cleanup activities from previous blasting were observed. The cleanup activities, described by NYSTA and the contractors as typical, 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-gal steel drums. Six laborers cleaned this section in 1.5 hr. The cleanup operation was noted to be very dusty. The roadway above required additional cleanup; the overspray or deposits of fugitive dusts were dry swept and shoveled to drums.

Pentek Dustless Needlegun System

The Pentek system was evaluated on October 13, 1992, at NYSTA Bridge #1. Evaluation consisted of observing and documenting mobilization, paint removal, and cleanup and demobilization activities, as well as performing personal and area air monitoring and making necessary measurements to assess productivity and waste generation.

Job setup and mobilization, requiring four workers for 0.5 hr each, consisted primarily of positioning equipment. No containment enclosures or ground cover tarpaulins were used.

Three operators, each with a CORNER-CUTTER® unit, removed paint at the evaluation area, which consisted of four 34-in. x 12-in. flange I-beams with connecting 13-in. steel channel bracing and connecting hardware. Paint from approximately 119 ft^2 of surface was removed during the 3.25-hr evaluation period.

Before the evaluation began, two of the three CORNER-CUTTER® operators were each fitted with two air sampling pumps having appropriate media for collecting total and respirable dusts emitted during the paint removal operations.

During the Pentek system paint removal operations, there were no visible emissions of dust or paint residues. The CORNER-CUTTER® units removed the finish paint coat layers with little difficulty; however, the orange primer required considerably more effort and time.

When this paint removal operation ended, it was apparent that nearly all paint residues had been effectively contained and collected by the Pentek system. Some minor residues (large paint chips and rust) were easily collected using the vacuum hose attached to the CORNER-CUTTER®. Cleanup operations, i.e., wiping down, disassembling, and storing of equipment, required four workers for 0.5 hr. This operation would normally only be done after job completion, not on a daily or shift-by-shift basis.

Air sampling consisted of pre-work samples, done 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 the 4-hr period coinciding with the technology evaluations. Work area samples for the abrasive blasting operations were taken within the tarpaulin work enclosure approximately 25 ft from the points of operations. For the Pentek operations, work area samples, taken approximately 25 ft from the point of operations, were more vulnerable to changing air currents from the thruway traffic. Quantities of waste generated by the abrasive blasting operations were determined by examining New York State Hazardous Waste Manifests and extrapolating these data based on total surface areas of the bridge versus total surface area of paint removed.

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 amount for an entire structure based on surface area of paint removal during the evaluation.

Results and Discussion

The economic evaluations depicted here are not intended to be all-inclusive or representative of all relative project costs. Specifically excluded are costs related to capital equipment, equipment maintenance, vehicles, utilities and fuel, containment structures, and personal protective equipment. For simplicity and uniformity, a standard labor rate of $15/hr was assumed for all labor classifications. Labor activities were divided into five categories: paint removal operations, support labor, mobilization, demobilization, and cleanup. Production rates in square foot per hour per operator were used to calculate a total labor cost assuming work on identical 15,000-ft^2 bridges. Based on demonstrated production rates, approximately eight Pentek systems, each using three CORNER-CUTTERS®, would be needed 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.

Labor requirements for support, mobilization, and demobilization were also higher for the Pentek system, primarily because of the number of workers required. Cleanup labor costs were substantially higher for the abrasive blasting process. These comparative labor costs are shown in Table 1.

Table 1. Total Estimated Labor Costs

Labor Category	Abrasive Blasting ($)	Pentek ($)
Paint removal	1,500	18,450
Support	1,125	6,090
Mobilization	945	1,440
Demobilization	210	720
Cleanup	5,460	240
Labor Totals	9,240	26,940

Table 2 shows the amount of waste 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 because abrasive blasting uses expendable blasting media. Note that only 31 tons of waste were disposed from this job, and that, based upon use estimates, approximately 50.8 tons of abrasive grit would be used.

Table 3 summarizes total costs for labor, materials, and hazardous waste disposal. Material costs were based on the assumption that the abrasive blast media was the only expendable material used. This cost was based on each operator using 0.5 ton of grit/hr.

The results of the air sampling done before and during the evaluations are presented in Table 4. Air sampling was done for 4-hr periods on two abrasive blast operators and two Pentek CORNER-CUTTER® operators in addition to sampling work areas proximate to the paint removal activities.

For the 8-hr time-weighted averages (TWA), the abrasive blasting sampling data indicate OSHA Permissible Exposure Limits (PELs) were exceeded for total dust, respirable dust, and total airborne lead on three samples and for respirable lead on two of four samples.

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

The contract specifications for the bridges evaluated called for SSPC-SP 6 (commercial blast) to remove all visible paint and residues from two-thirds of the bridge surface area before repainting. The abrasive blasting operation was able to surpass this level of surface preparation for all areas of the structure.

The Pentek system demonstrated a less efficient removal of paint, especially the orange primer coat; it also was less effective while performing around irregular surfaces such as nuts and bolt heads and in inaccessible corners. The NYSTA bridge inspectors indicated that a post-blast would be needed for the Pentek-cleaned sections to meet SSPC-SP 6 specifications.

Conclusions

The economic and product quality aspects tend to favor conventional abrasive blasting over the Pentek system for removing lead paint; however, the decision to specify a lead paint removal system should be strongly influenced by the increased volumes of hazardous waste generated and the potential for negative effects to worker health and safety and to the environment.

The Pentek dustless needlegun system labor costs were approximately 300% higher than those of the conventional abrasive blasting process; however, the overall costs were mitigated by the 97.5% reduction in generation of hazardous waste. Additionally, fugitive emissions of airborne dusts were reduced up to 99%, which serves to enhance the level of environmental protection and worker health and safety.

The dustless needlegun system is economically competitive when factoring in costs of sophisticated containment structures and engineered systems necessary to ensure worker health and safety and protection of the environment.

The full report was submitted in fulfillment of CR-816762 by Erie County Department of Environment and Planning under the sponsorship of the U.S. Environmental Protection Agency.

Table 2. Hazardous Waste Generation and Disposal Costs

Removal System	Removal Area (ft²)	Waste Generated (lb)		Lb Waste (ft²)	Est. Total Waste (lb)	Total Waste (tons)	Disposal Costs ($/ton)*	Total Disposal Costs ($)
		Theoretical	Actual					
Abrasive blasting	1,180	4,170†	4,807	4.1	61,500	30.8	300	9,240
Pentek	119	7.4‡	11.5	0.1	1,500	.75	300	225

* Industry average for bulk waste including transportation.
† Theoretical waste generated based upon .175 ton waste/ton of steel cleaned.
‡ Theoretical waste generated based upon 11.5-mil. paint thickness and paint solids density of 66.3 lb/ft.³

Table 3. Total Costs

Category	Abrasive Blasting ($)	Pentek ($)
Labor	9,240	26,940
Materials	1,957	0
Hazardous waste disposal	9,240	225
Total	20,437	27,165

Table 4. *Air Sampling Analytical Results*

Sampling Point	Sampling Period: Total Dust (mg/m³)	Sampling Period: Respirable Dust (mg/m³)	Sampling Period: Total Pb (mg/m³)	Sampling Period: Respirable Pb (mg/m³)	8-hr TWA*: Total Dust† (mg/m³)	8-hr TWA*: Respirable Dust‡ mg/m³	8-hr TWA*: Total Pb§ mg/m³	8-hr TWA*: 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

* Assuming no exposures during remainder of 8-hr work day.
† OSHA PEL = 15 mg/m³.
‡ OSHA PEL = 5 mg/m³.
§ OSHA PEL = .05 mg/m³.
** Not detectable.
†† Duplicate sample.
‡‡ Exceeds OSHA PEL.

Paul B. Kranz is with Erie County Department of Environment and Planning, Buffalo, NY 14202; James E. Stadelmaier is with Recra Environmental, Inc., Amherst, NY 14228; and the EPA author ***Paul M. Randall*** *(also the EPA Project Officer), is with the Risk Reduction Engineering Laboratory, Cincinnati, OH 45268 (see below).*
The complete report, entitled "Removal and Containment of Lead-Based Paint Via Needle Scalers," (Order No. PB94-193216; Cost: $19.50, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

United States
Environmental Protection Agency
Center for Environmental Research Information
Cincinnati, OH 45268

BULK RATE
POSTAGE & FEES PAID
EPA
PERMIT No. G-35

Official Business
Penalty for Private Use
$300

EPA/600/SR-94/114