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Separation and Re-Use Of Hazardous Waste From Bridge Paint Removal

MICHAEL E. DOODY
RICK L. MORGAN
JAMES E. NOONAN
NORMAN SCHIPS

RESEARCH REPORT 162

ENGINEERING RESEARCH AND DEVELOPMENT BUREAU
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SEPARATION AND RE-USE OF HAZARDOUS WASTE FROM BRIDGE-PAINT REMOVAL

Michael E. Doody, Engineering Research Specialist I
Rick L. Morgan, Civil Engineer I
James E. Noonan, Civil Engineer I
Norman Schips, Civil Engineer II

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Field Technical Coordinator:
John E. Dewar, Bridge Management Engineer

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16. Abstract

New York has investigated various means of separating lead-based paint from blasting material to reduce the volume of hazardous waste generated in bridge maintenance operations. Alternatives to disposing of paint-removal wastes in landfills were also reviewed and assessed. Several promising techniques were identified for further research, as described here. Additional testing is recommended for the two most promising -- a waste-separation technique using a rotary incinerator furnace, and waste re-use in glass manufacture.

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METRIC (SI*) CONVERSION FACTORS

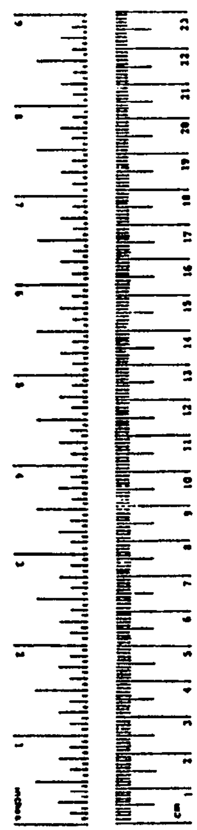
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
	AREA			
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
	MASS (weight)			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
	VOLUME			
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

Symbol	When You Know	Multiply By	To Find	Symbol
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

* SI is the symbol for the International System of Measurements



APPROXIMATE CONVERSIONS TO SI UNITS

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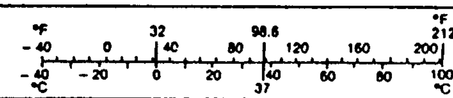
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
	AREA			
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
	MASS (weight)			
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
	VOLUME			
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

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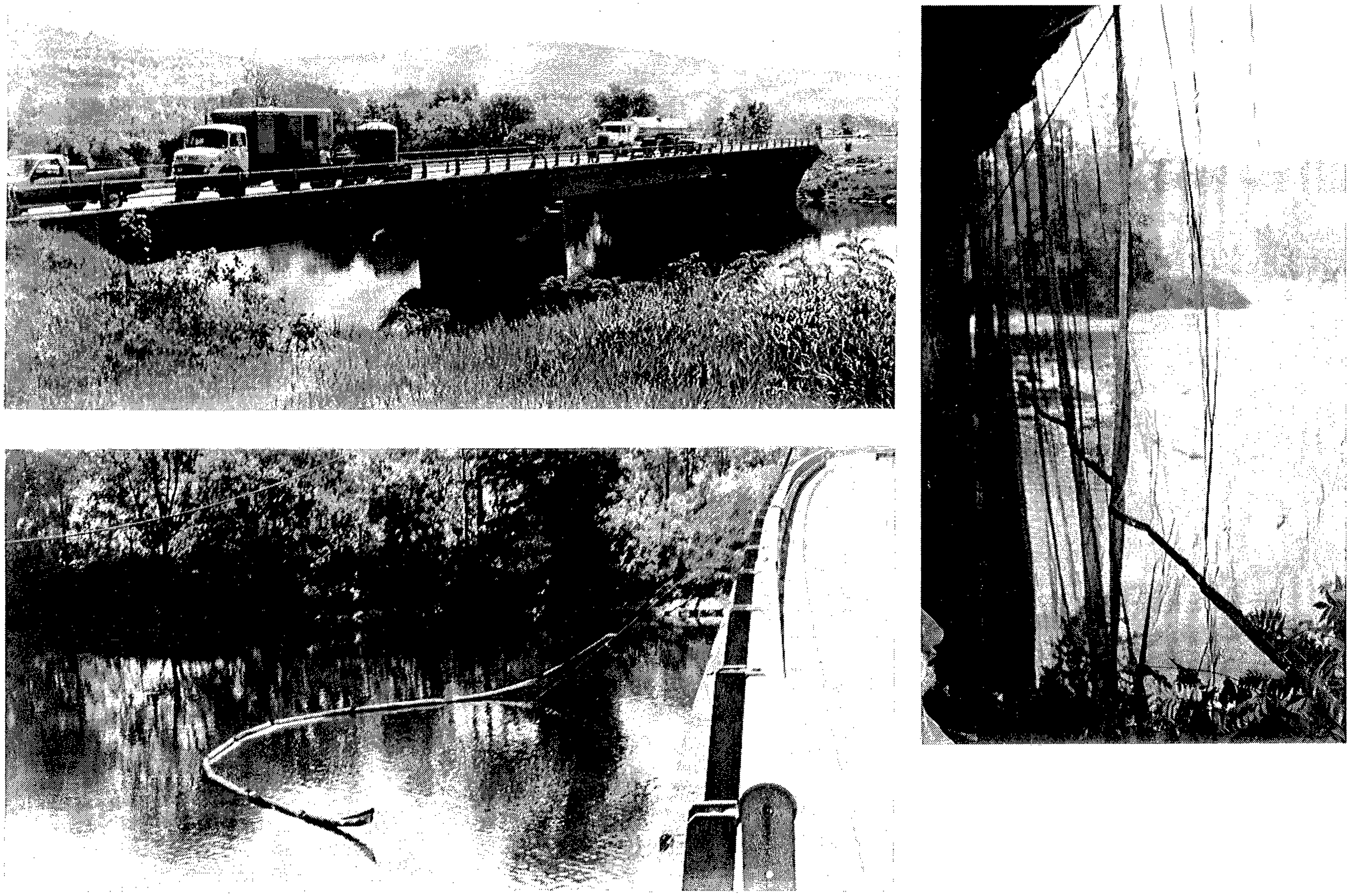


Figure 1. Before 1993, partial containment of structures during blasting included tarpaulins hung beneath the deck (upper left), booms at the water surface (lower left), and screens suspended from the fascia (right).

I. INTRODUCTION

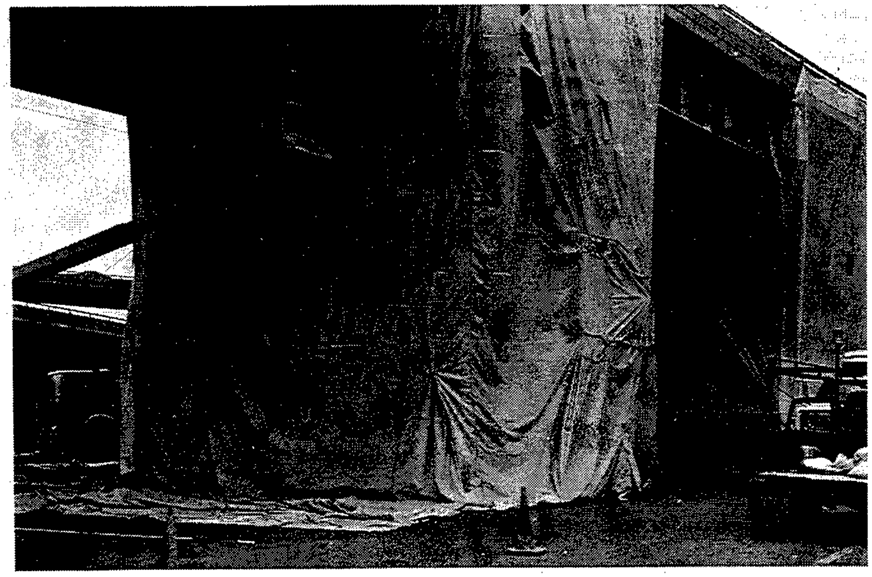
A. Background

The objective of the study reported here was to investigate possible reduction of the volume of paint-removal waste that must be disposed of as hazardous. Techniques exist for reducing the amount of hazardous waste resulting from paint removal by separating paint waste from blasting grit (1,2,3,4,5,6,7,8). Several of these techniques were evaluated for suitability to Department needs from January 1992 through October 1993.

The Department maintains about 7500 bridges throughout the state, of which roughly 4000 are steel bridges requiring painting. NYSDOT's maintenance program includes repainting about 300 steel bridges annually, under contracts generating about 9000 bbl of waste during removal of lead-based paint. Paint-removal waste collected in conjunction with repainting contains small amounts of lead (Pb). The U.S. Environmental Protection Agency (EPA) has established a "Toxicity Characteristic Leachate Procedure (TCLP)" as the standard test method to determine if waste containing lead is hazardous (40 CFR 261). The Department now considers all paint-removal waste to be hazardous waste based on experience with this test. On May 8, 1990, an EPA regulation went into effect banning disposal of untreated hazardous waste in landfills. The current disposal method is stabilization to meet EPA regulations and subsequent landfilling, but landfill availability continues to decline and waste disposal costs as much as $2 million each year. The Department thus is seeking alternatives to current paint-removal practice to reduce the volume of waste requiring disposal. Epoxy mastic coatings with urethane topcoats are now being applied, and are not considered hazardous at this time. (It should be noted, however, that the volume of hazardous waste containing lead that is generated annually will remain about the same from year to year, since removal of non-lead-based paint systems will also result in removal of the underlying over-coated lead-based systems.)

In the winter of 1992-93, NYSDOT changed standard work requirements for bridge paint removal from partial containment for ground and water protection (Fig. 1) to complete containment (Fig. 2) with issuance of Engineering Instruction 93-012 (Appendix A). Although these specifications were included for new projects let after March 1993, a large number of projects requiring bridge paint work were let before adopting the new specifications. NYSDOT has been evaluating these projects on a case-by-case basis, deciding either to continue painting at the higher cost or to eliminate such work (Appendix B). On some projects where painting operations have continued, the added costs are 200 percent or more of the original project bid. Such dramatic increases in the cost of bridge painting

Figure 2. Typical full containment after change of blasting practice.



have led some to discuss superstructure rehabilitation or replacement as alternatives to repainting.

Stabilization of paint-removal debris, efficiency of containment, health hazards to workers, and other environmental aspects are now issues of great importance in bridge maintenance operations. Reduced disposal cost for bridge-paint-removal waste was considered the major potential benefit of this study when it was initiated. However, disposal costs and this potential benefit are dwarfed by the escalating costs of containment, and by the issues of worker safety raised by stricter OSHA regulations for bridge-painting operations. Although no technical alternatives to blasting appear to be imminent in paint removal operations, NYSDOT is continuing to evaluate new technology in an effort to render the paint-removal waste harmless. The work described here thus was directed at separating and re-using inorganic components of lead paint removed from New York's bridges.

B. Identification of Promising Recycling Techniques

The most difficult issue that the EPA has presented to corporate managements and governments at every level is safe disposal of inorganic hazardous wastes. Land disposal laws and restrictions (the "Land Ban") require that all such wastes be treated before disposal. Yet even after treatment, such disposal entails continuing liability for potential cleanup of hazardous-waste dumps in the event of future release of hazardous materials. In addition to cleanup liability, in some circumstances civil and criminal penalties may be risked if wastes are not properly treated and disposed of.

Most abrasive recycling operations involve use of steel shot or steel grit. The high up-front cost of the blast medium makes it economically desirable for the contractor to recover as much of it as possible. The low cost of boiler-slag abrasive (commonly known by the trade name "Black Beauty") makes this a less serious consideration. New regulations requiring containment and recovery of spent abrasive may make its recycling an attractive option -- particularly for NYSDOT, if recovered lead plays an active role in manufacturing operations, ending liability for disposal of lead as a hazardous material.

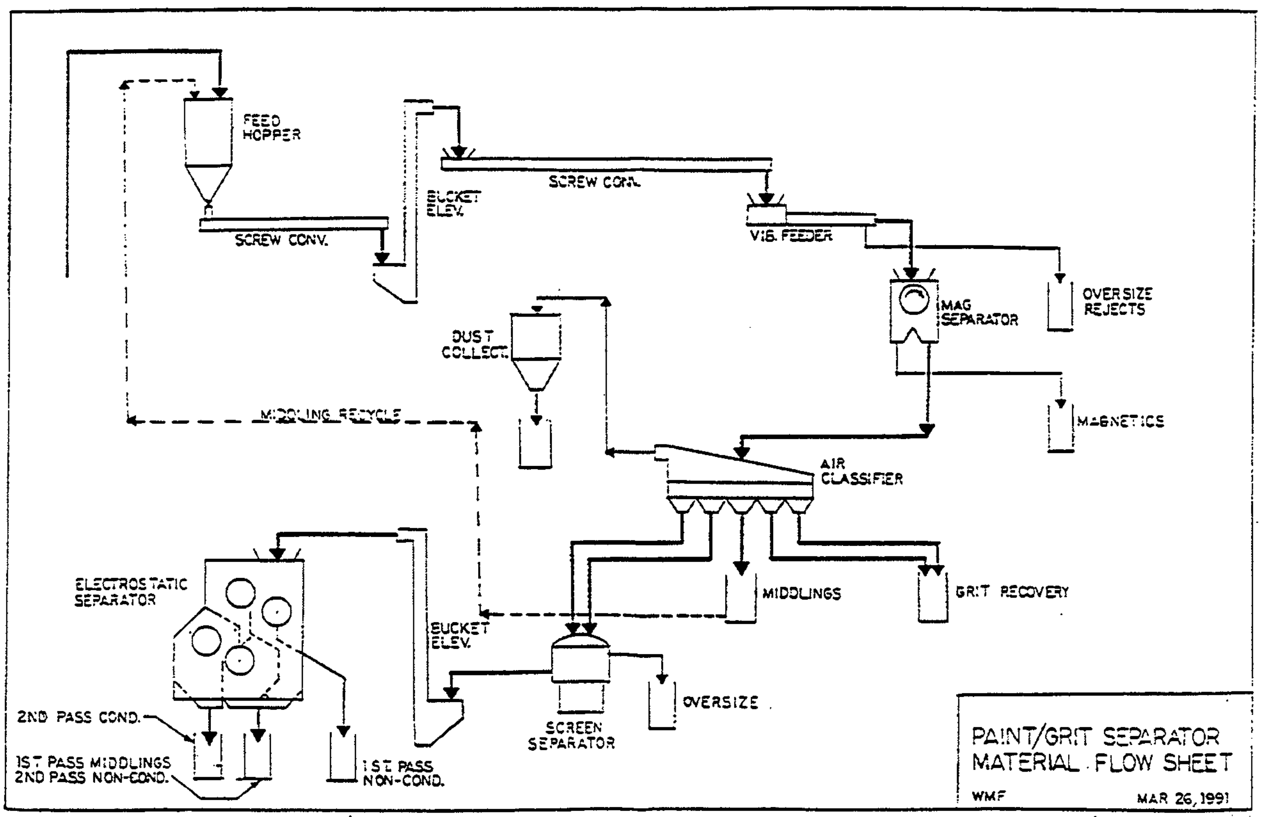
The material previously used to protect steel in New York's bridges is "basic lead silico chromate paint." A number of possible separation techniques are available to reduce the volume of paint-removal waste by separating lead-based paint from sandblasting mixtures. The NYSDOT Materials Bureau also is currently examining means of containing and recycling steel blast grit during the blasting operation, and is researching new surface-treatment coatings under the Department's Experimental Plan.

Alternatives to disposing of paint-removal wastes in landfills were also reviewed, including incorporation into glass. Materials are not "solid waste" when they can be shown as having been recycled by being used or re-used as 1) ingredients in an industrial process to make a product, or 2) effective substitutes for commercial products. Recycling inorganic hazardous materials in paint waste through glass manufacture would sever the Department's liability chain for these materials.

Performance of techniques for each method and/or material was evaluated, whether lab data or literature review were involved. It also fell within the scope of this project to observe field performance of several of the most promising techniques, and they are also evaluated here.

Figure 3. Staging area for storage of blasting debris.

Figure 4. Flow of paint/grit separator material.



II. EVALUATION OF PROMISING RECYCLING TECHNIQUES

A. Magnetic Separation

1. Background

This process is a combination of separation techniques (mechanical, magnetic, and electrostatic) that can be readily adjusted to handle materials of widely differing particle size distribution containing varying proportions of trash, rust, steel, and moisture. This process is an application of existing technology (9,10,11) to paint/abrasive separation. The work reported here was the first field trial of the equipment in such an application. About 200 tons (120 bbl) of material from three projects were to be processed during the demonstration. About 40 bbl of abrasive blast debris were stored on-site for the demonstration (Fig. 3).

2. General Discussion

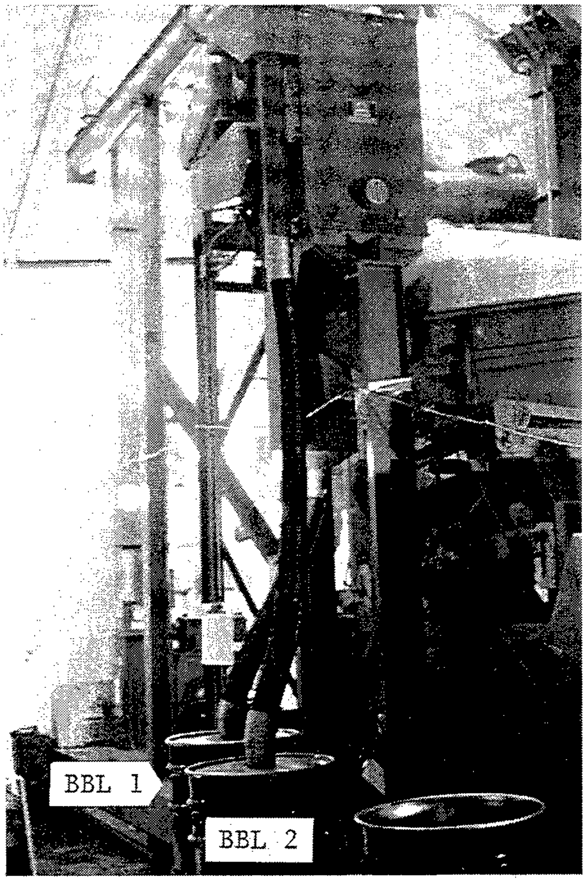
The blast material processed was boiler-slag abrasive, specified as passing the 20/40 mesh and comprising the bulk of the waste stream. The projected commercial capacity is 1.5 to 2.5 tons per hour. When operating at this capacity, the cost for processing is nominally \$250 to \$275 per ton.

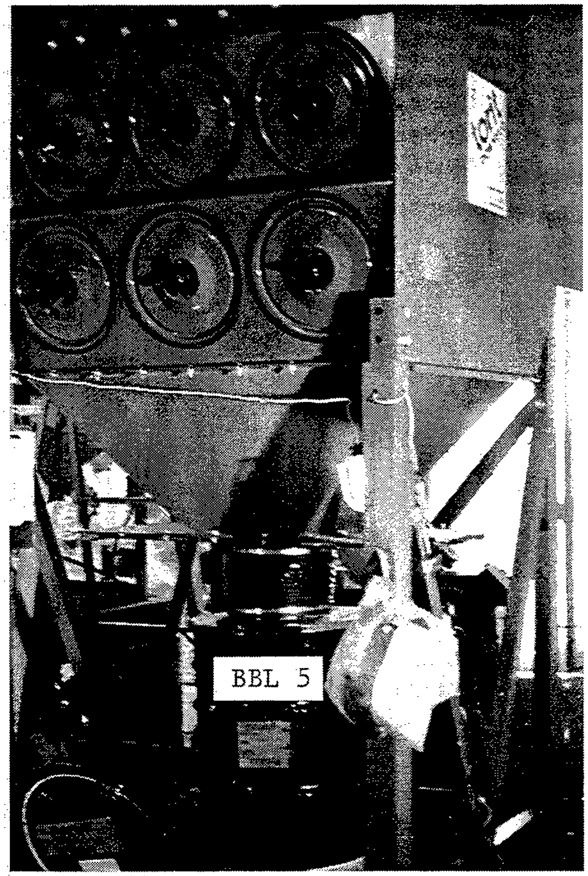
After separation is completed, there are nominally three waste streams. Processing specifics can be followed on the Figure 4 diagram. The first waste stream is reusable abrasive to be recycled in later blasting operations. The second is non-reusable abrasive (<5 ppm Pb, i.e., non-hazardous) for use in bricks or other such end-products. The third is the hazardous material (abrasives/paint chips) to go to a lead smelter. There is thus no hazardous material to landfill.

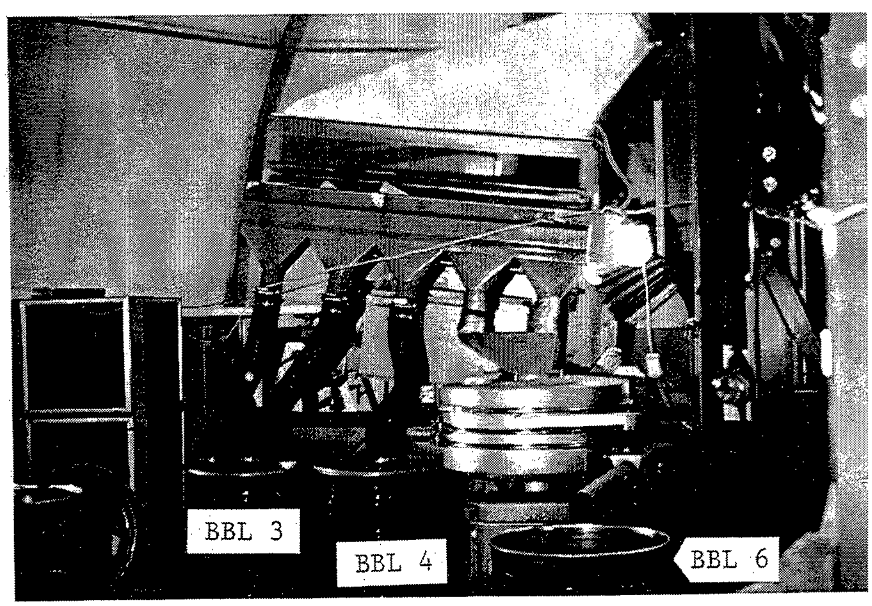
The brick manufacturer (receiving minimum content) and lead smelter (receiving maximum concentration) are interested only in lead content of the waste they will receive. Initial results of the TCLP lead leach test were: Waste Stream 1: 1.2 ppm, Stream 2: 7 ppm, and Stream 3: 65 ppm. The initial waste tested at 25 to 30 ppm Pb. Stream 2 will have to be reprocessed before it can be sent to the brick manufacturer.

No more than 35 percent of the initial waste should be greater than 5 ppm Pb. The cost to the contractor of \$250 to \$275 per ton includes arrangements with the brickmakers and smelters. The smelter is paid \$270

Figure 5. Waste flow processing includes separating large particles and paint chips into Bbl 1, hazardous magnetics by magnetic separator into Bbl 2, reusable grit by air classifier into Bbl 3, dust products for the smelter by dust collector into Bbl 5, and oversize hazardous material for the smelter by screen separator into Bbl 6.







per ton for disposal of Stream 3. Nominal breakdown of arrangements and amounts are as follows:

Stream 1:	30 to 40 percent goes back to the contractor as reusable abrasive (+40 mesh)
Stream 2:	25 to 55 percent goes to the brick manufacturer
Stream 3:	15 to 35 percent goes to the lead smelter

The next generation of this type of magnetic-separation equipment is already in design and will be mounted on flatbed trucks for mobility. The final products are cleaned coarse and fine abrasives and a paint concentrate.

3. Field Notes (see Fig. 4)

Abrasive blast debris is delivered to the hopper through two 4-in. diam hoses feeding one 12-in. diam hose by means of a vacuum generator. This was an on-site substitution for the original system, after determining that not enough product was being delivered. The abrasive delivery system has been further improved to make it more adaptable to field conditions, by using a preheat and agitation system before delivery to the feed hopper. This somewhat alleviates the agglomeration problem encountered during the demonstration. Negative air was introduced into the enclosure due to fines created by the drier.

The vibratory feeder has a 1/8- to 1/4-in. screen. Large particles and paint chips are removed from the stream to an "oversize rejects" barrel (to Bbl 1). These rejects are hazardous, but in this case the volume was small. From the vibratory feeder, the material then goes through a magnetic separator (Fig. 5), where the hazardous "magnetics" (iron filings and other ferromagnetic components such as rust-coated paint chips) are removed (Bbl 2). Handling of these two barrels (oversize rejects and magnetics) was not addressed at the site (the volume of these two items was negligible), but they appear to constitute a fourth waste stream, possibly hazardous.

After these steps, the nonmagnetic residue is discharged onto a slanted gravity concentration table (air classification) which separates the paint and abrasive particles based on the differences in their apparent density (Fig. 5). The 40 mesh determination results in three products:

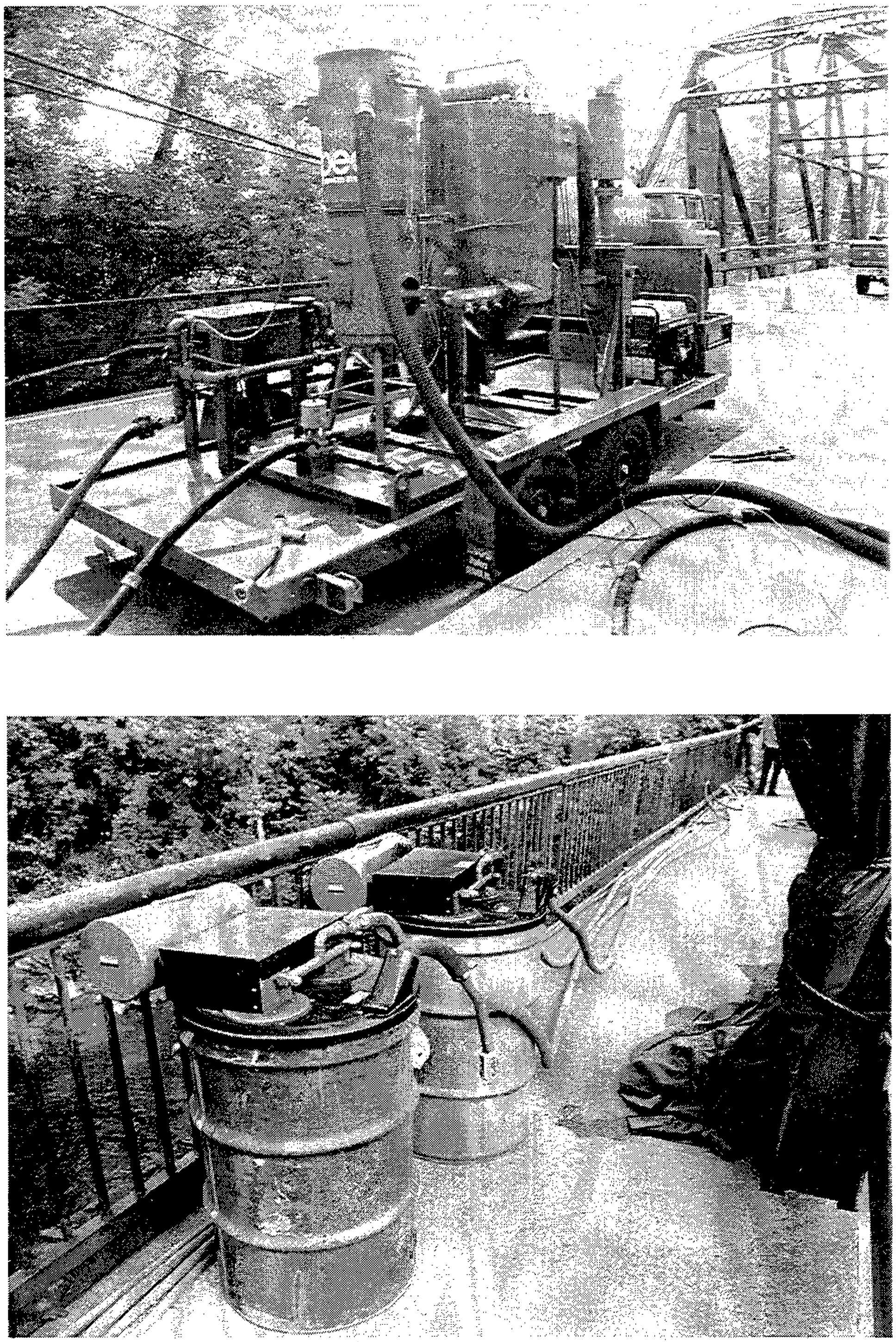
1. Recovered clean, coarse (+40 mesh) grit (non-hazardous) to be reused as abrasive blast material, to Bbl 3,

2. A mixture of paint chip and grit middlings, continually reprocessed for 40 mesh determination, to Bbl 4, and

3. Dust (hazardous), to be shipped to smelter, to Bbl 5 (the dust collector is also shown in Fig. 5).

A screen separator (100 mesh screen) then shunts oversize hazardous material to Bbl 6, to be shipped to smelter (paint chips, etc.).

Figure 6. Reclaim unit (top) and waste cannisters (bottom)at the Bethel bridge.



An electrostatic separator finally removes the remaining paint from the abrasives based on differences in surface electrical conductivity. This produces a paint concentrate: 1) first-pass (Bbl 7) and second-pass (Bbl 8) non-conductive hazardous material to be shipped to the lead smelter and cleaned fine abrasive, and 2) second-pass conductive material (Bbl 9) to be shipped for industrial use (in this case, for bricks).

4. Summary

The equipment ran smoothly only briefly during the technology demonstration. Particulate matter was in the air inside the enclosure during equipment operation. The spent abrasive was damp and the air was cold and humid (causing an agglomeration problem). These were probably the worst possible working conditions for such an operation. The demonstration setup (not normally part of the operation) lasted two weeks, and the demonstration had been delayed for an additional week due to equipment problems (the abrasive delivery system). Some waste had to be processed more than once.

It is now too soon to determine the value of this type of system to the Department. Laboratory test results should indicate whether the end product was cleaned of lead. This is an important characteristic to end users -- especially important for coarse material to be reused as abrasive, because lead in the abrasive might contaminate exposed steel surfaces. The contractor's experience with the abrasive should also be considered, regarding its "recyclability" -- its usefulness for blasting after recycling.

The coarse abrasive can be recycled for further blasting operations. The hazardous product is the paint concentrate, which is 15 to 35 percent of the spent abrasive/paint material.

B. Vacuum Equipment and Power Tools

1. Background

Vacuum-assisted power-tool paint-removal equipment establishes "localized" vacuum-equipped containment (surrounding only the power tool itself) to remove loose paint, rust, and mill scale. Equipment for a demonstration was assembled at the Bethel bridge carrying Vermont Rte 107 over the White River in Bethel, Vermont (Fig. 6). A total-containment enclosure was also observed on the Claremont bridge carrying Vermont Rte 11 over the Connecticut River from Springfield, Vermont.

2. General Discussion (8)

The blast material used was recyclable steel grit, at a nominal processing rate of 3 tons per hour. Vacuum blasting can be considered a variation of open blasting -- the blast nozzle is held much closer to the surface and provides local containment in the form of a blasthead with a built-in vacuum source. The blasthead interface with the area being cleaned is usually some form of brush-ring, whose main purpose is inexpensive maintenance of negative pressure (with respect to ambient pressure) in the blast area and a vacuum air flow of sufficient velocity to transport the entrained particles. Use of the vacuum attachment on power tools thus reduces dust and controls collection of debris by channeling it directly to a container. The attachments somewhat restrict ability to use the equipment in areas of limited access (Fig. 7). Quality of the preparation is the same as with power tools (Fig. 8).

The Vermont Agency of Transportation has adopted vacuum-shrouded power tool cleaning for bridge maintenance by force account. They are currently repainting 20 to 24 bridges per season, down from 36. Removal of steel surface area has been reduced from 80-to-90 percent to 15-to-20 percent, and they are generating 3 to 5 bbl of waste per bridge. Only tarps and screening are needed (not full containment), since they are no longer using open abrasive-blast cleaning. Estimated cost is $3 per sq ft (compared to the previous 75 cents per sq ft). This type of system is practical for touch-up or maintenance work, but may not be of value for general use in New York.

3. Full Containment System

New Hampshire owns the Claremont bridge spanning the Connecticut River. The New Hampshire Department of Transportation's specifications require full containment of the entire blasting and painting operation. Since there are other bridges spanning the Connecticut River from Vermont to New Hampshire, the Claremont bridge could be closed to all traffic. It was thus possible to wrap each span completely, ensuring containment of lead residue and paint particulate (Fig. 9). A unique staging skeleton acted as a framework for the enclosure. Recycling and recovery equipment used steel grit, enhanced by a 30,000 cfm dust collector (Fig. 10). Working under negative pressure, almost 100-percent containment was achieved, which is the type required by NYSDOT since the issuance of Engineering Instruction 93-012 (Appendix A).

C. Rotary Incinerator Furnace

1. Background

This was the first trial of a rotary kiln or "incinerator furnace" for processing spent abrasive blast material. For the demonstration, the equipment was assembled inside a large enclosed room, and 2 bbl of abrasive blast debris were transported to the site and opened inside the enclosure for processing. About 800 kg of material from NYSDOT Project D254382 was processed during the demonstration.

2. General Discussion

The blast material used was boiler slag, specified as passing the 20/40 mesh, comprising the bulk of the waste stream. The nominal processing rate

Figure 7. Underside of the Bethel bridge before, during, and after cleaning, demonstrating maneuverability of vacuum equipment.

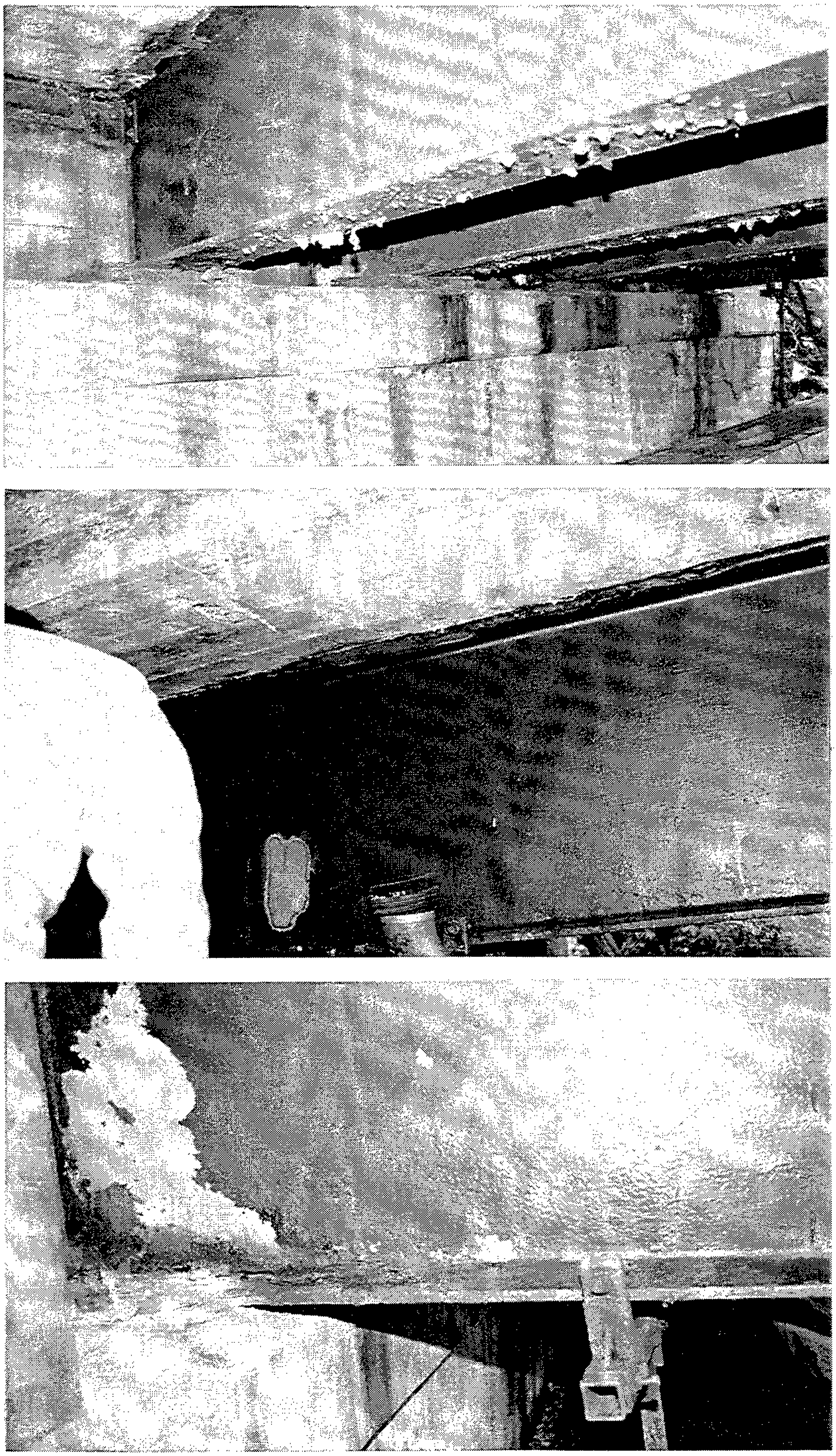


Figure 8. Rivets on the Bethel bridge before and after cleaning.

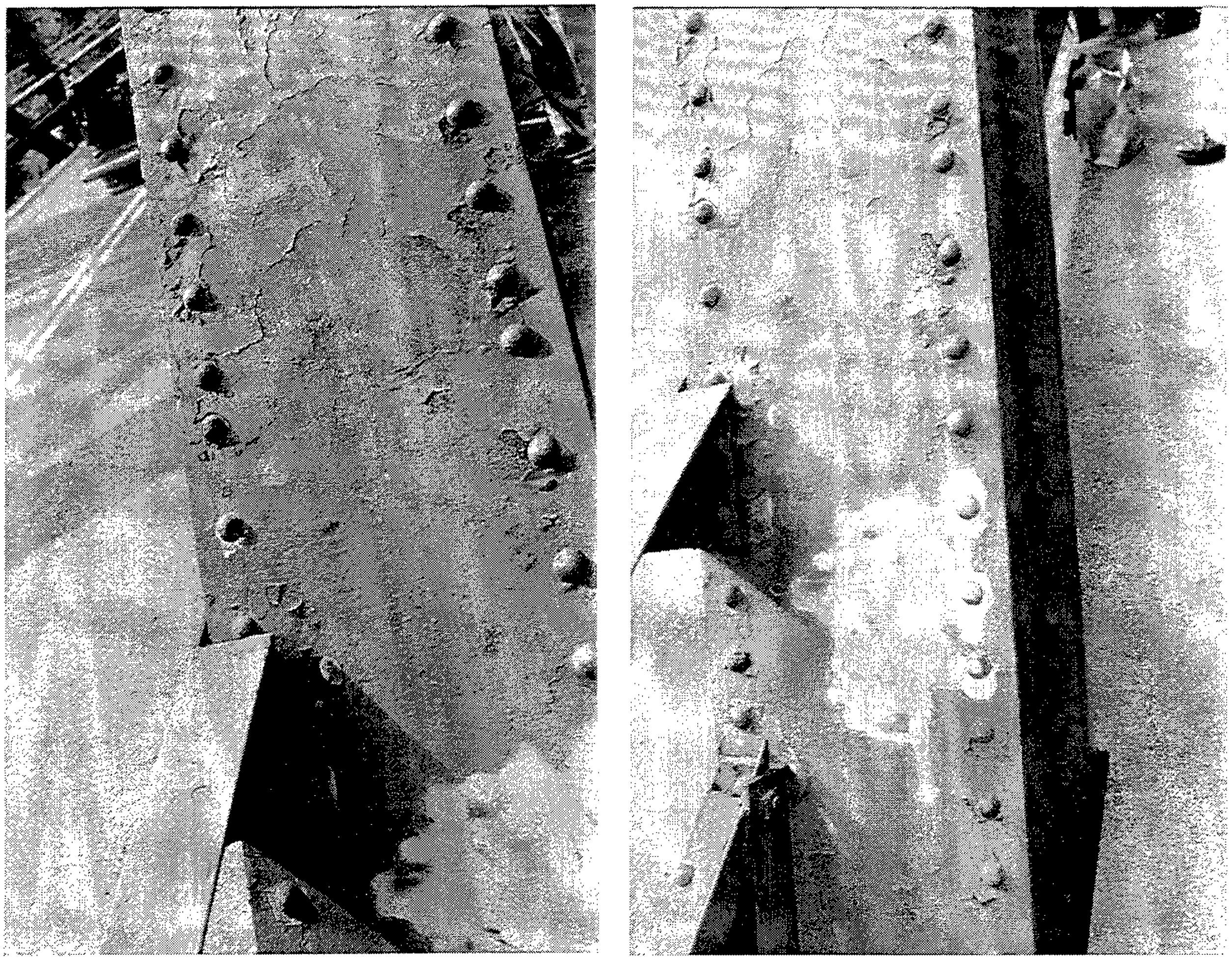


Figure 9. Two views of movable full-containment unit at the Claremont bridge.

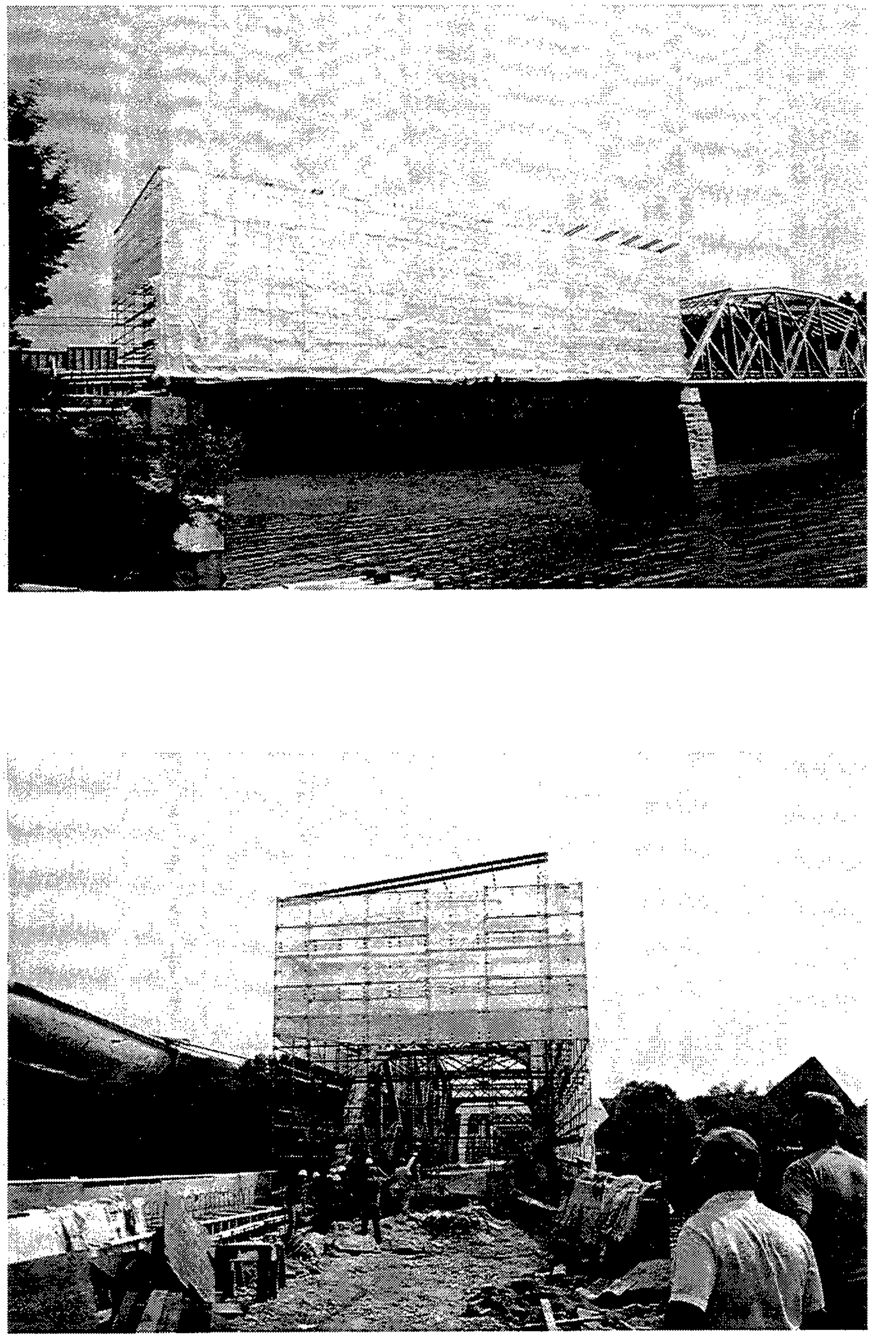
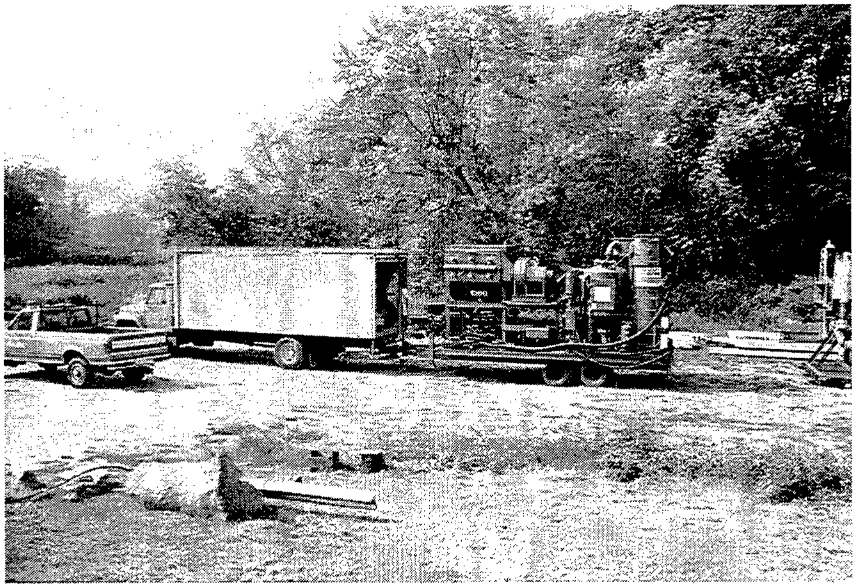
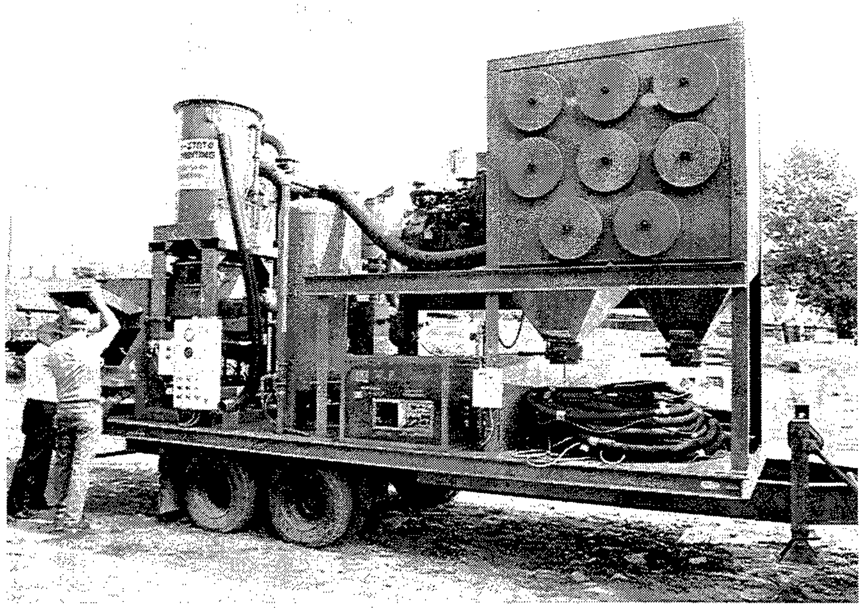


Figure 10. Two views of reclaim unit at the Claremont bridge.





of the equipment model demonstrated (Fig. 11) is 500 kg per hour. The cost of this unit is $125,000 and estimated actual processing cost is about 1¢ per kg.

Preliminary testing of a small sample of abrasive waste indicated that after treatment there were nominally three waste streams. The first was reusable abrasive to be recycled for further abrasive blasting operations (63-percent coarse clean grit, -20 mesh). The second was non-hazardous (<5 ppm Pb) non-reusable industrial waste (21-percent coarse clean grit, 20-50 mesh). The third was the concentrated hazardous material (abrasives/paint chips) going to a lead smelter (3-percent fine grit, +270 mesh), or to be landfilled as hazardous waste (13-percent fine grit, 100-270 mesh) in greatly reduced volume.

Processing specifics can be followed in Figure 12 and Appendix C. Final products are cleaned coarse and fine abrasives and a paint concentrate, with 60-to-65 percent of the initial waste being recyclable +20 mesh material. An additional 20 percent would be clean -20 mesh material. Exhaust gases are monitored constantly (Appendix D) and the equipment is not operational without the pollution control devices.

The breakdown of arrangements and amounts is as follows:

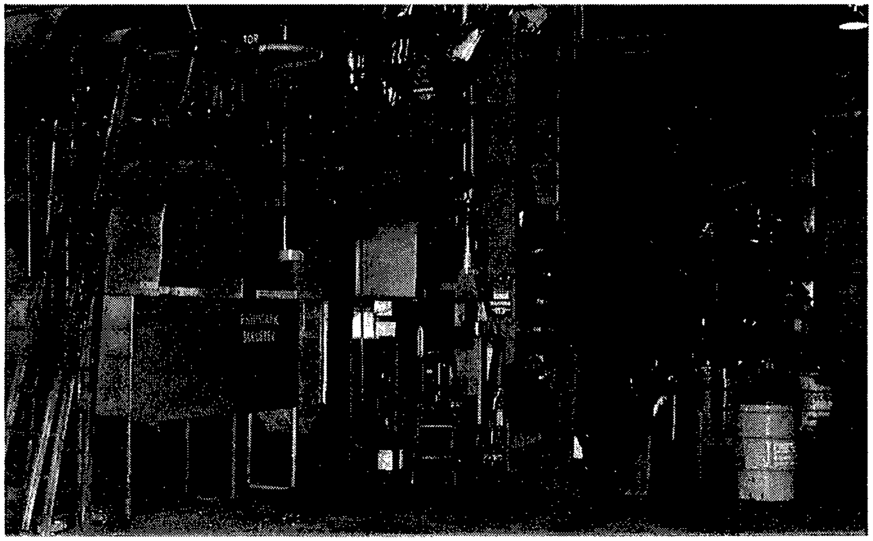
Stream 1: 60 to 65 percent goes to the contractor for reuse
Stream 2: 20 to 25 percent goes for industrial-waste disposal
Stream 3: 10 to 20 percent goes to the lead smelter or for hazardous-waste disposal.

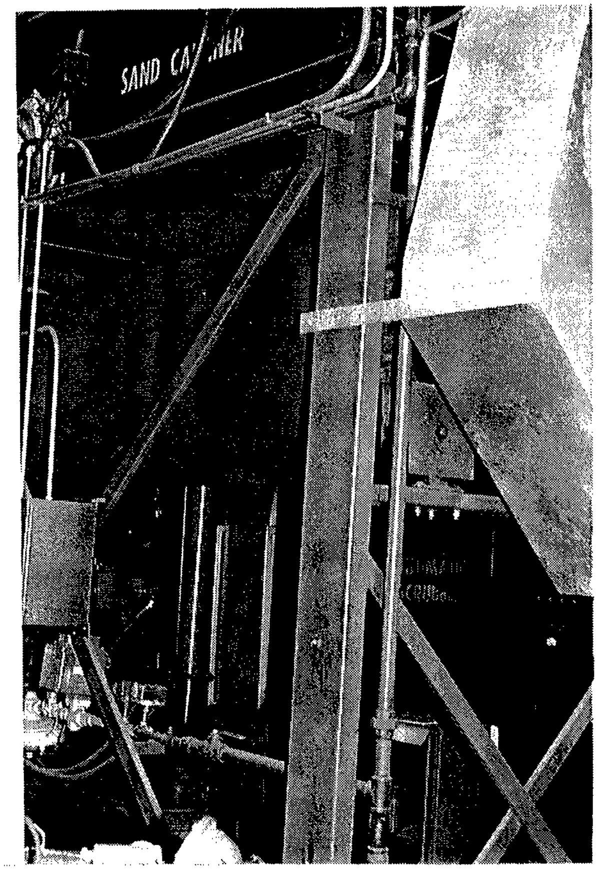
Other sizes (up to 7000 kg per hour) of this type of equipment can be mounted on a pair of flatbed trucks for mobility, and these units are proportionally more expensive. Actual processing costs on-site are estimated to be about 10¢ per kg.

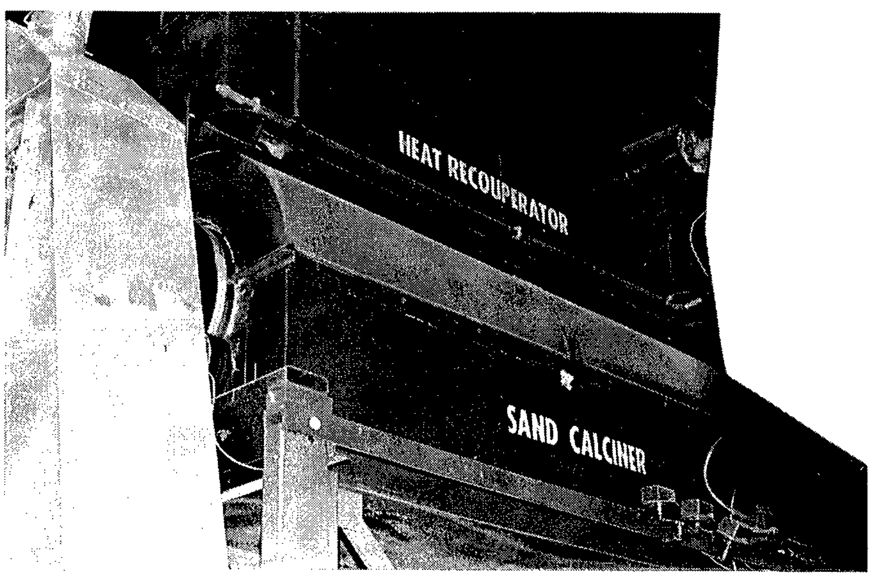
Tests were run on successive days at three processing temperatures to determine optimum operating level. Samples incorporating treated blast waste were taken to evaluate leaching characteristics of materials that had been treated. The NYSDOT Materials Bureau examined samples from all waste streams tested for lead and chromium by EPA Test Method 1311 for Evaluating Soil Waste ["Toxicity Characteristic Leachate Procedure (TCLP)"], with the following results (from NYSDOT Chemical Test 93 LAA17):

	Sampling Point				
Testing Temperature	Oversize (+20 mesh)	Not Scrubbed (-20 mesh)	Scrubbed (-20 mesh)	Cyclone (+10μ)	Baghouse (-10μ)
1400 F	15.5	13.6	11.8	86.5	1393.3
1500 F	10.4	12.1	16.2	76.4	1404.0
1600 F	1.8	11.5	5.1	16.3	451.0

Figure 11. Tested rotary incinerator furnace included raw material infeed (upper left), rotary cooler (upper right), rotary press kiln (lower left), and cyclone and baghouse (lower right).







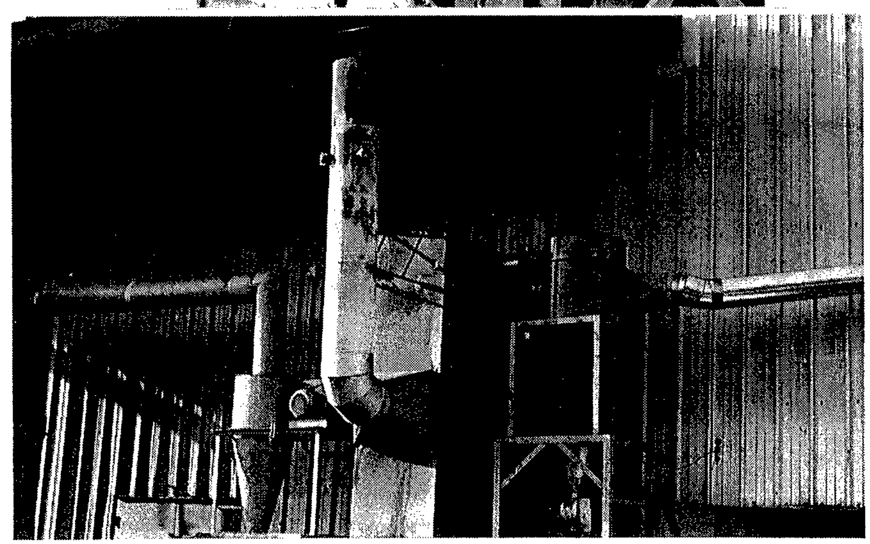
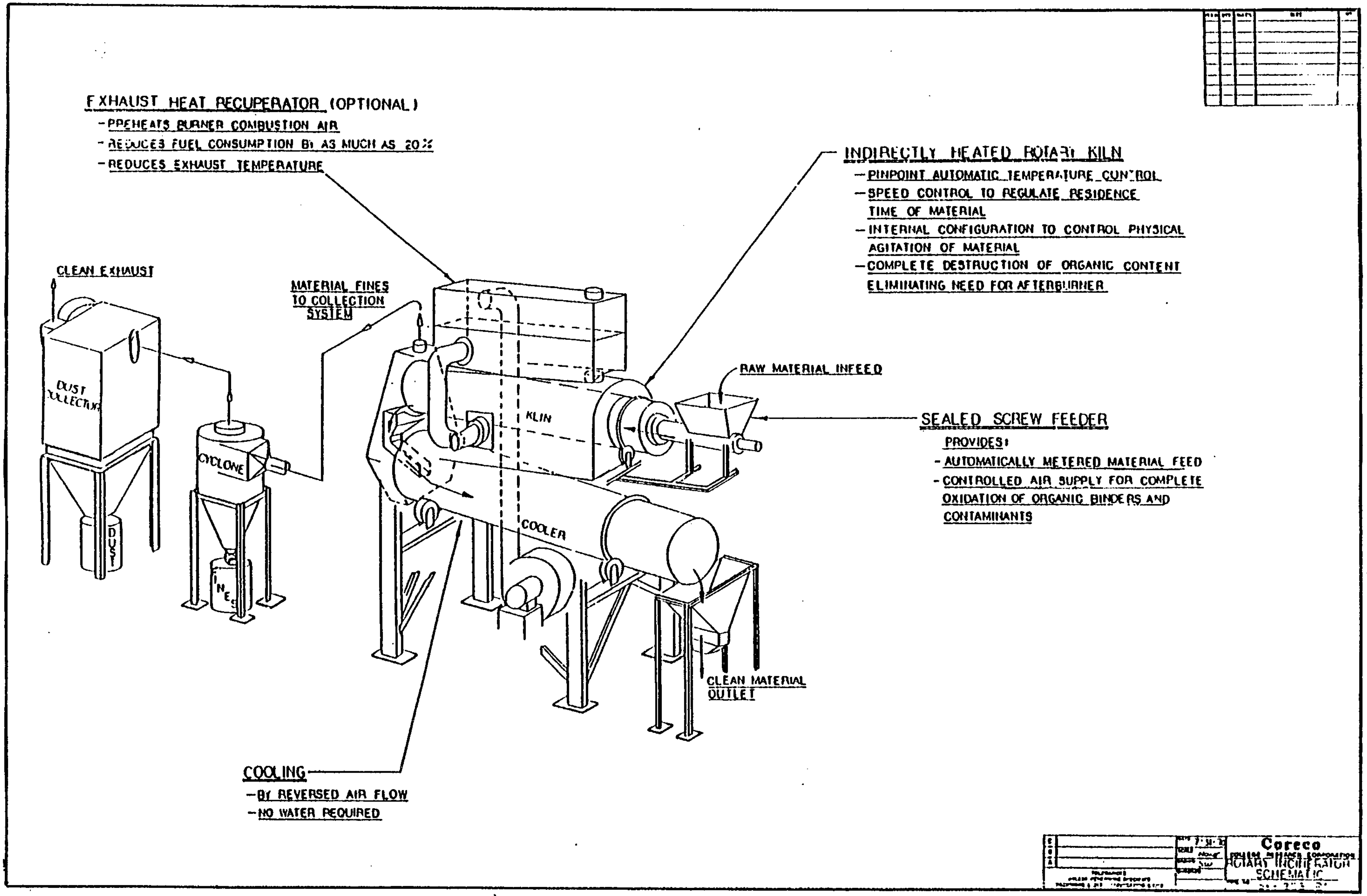


Figure 12. Schematic of the rotary incinerator.



These test results, reported in parts per million (ppm), are the average of three tests for lead (except the baghouse 1600 F sample, tested only twice due to lack of material). The as-received sample average was 23.5 ppm lead. Unused boiler-slag abrasive tested less than 0.01 ppm lead. Only negligible amounts of chromium were found (average for 17 samples was 0.35 ppm).

3. <u>Summary</u>

The equipment ran smoothly (except briefly during the second day) during the three days of testing observed. No particulate matter was visible in the air inside the building during equipment operation. The spent abrasive was not clean (typical of recycling operations) and the air was cool and damp, causing no problems. The demonstration setup did not have the proper screen at the input (normally a part of the operation), causing the brief 45-min delay the second day. This process is a new application of existing patented technology (<u>12</u>), developed to recover and recycle foundry sand from molding operations, and may be appropriate for use in abrasive recycling.

TCLP test results for lead are surprising because this is an EPA-approved treatment method for other similar types of hazardous materials. Waste materials that leach more than 5 ppm (TCLP analysis) are considered hazardous wastes. Two of the three results recorded for material treated at 1600 F and sampled after the scrubber were less than 5 ppm. This method should be tested further at 1600 F with stricter control of the oxidizing atmosphere in the furnace, increased retention times, and/or doping the waste with silica sand to ensure formation of insoluble lead silicates. The EPA has increased the amount of hazardous waste that can be used to perform treatability studies, and the new maximum (10,000 kg) should be tested to ensure a large enough sample for statistical reliability and reproducible results.

D. <u>U.S. Army Corps of Engineers Studies</u>

The Corps (COE) is working in two general areas -- automation of coatings application and removal, and novel approaches to lead-paint removal and disposal. In view of New York's current situation, several aspects of this work are of interest.

Thermal spray techniques were developed from COE experience in coatings for dams and locks on navigation systems. They are now trying to automate these techniques to separate personnel from coatings operations. Extending this idea, they are also examining automation of removal operations. For the former, they hope to demonstrate the technology within one year. For implementation, they are seeking a NYSDOT bridge as a candidate site. NYSDOT would supply a list of such sites, maintenance and protection of traffic, and possibly the power supply. COE would supply an operator; the equipment, materials, and blaster; and meet any other requirements that arise, with appropriate lead time. A laboratory demonstration was planned for Fall 1994. A Demonstration Project or Experimental Features application would be possible if the lab demonstration is successful.

COE's novel approaches to lead paint removal and disposal cover an array of techniques, including several items that have previously generated interest: chemical binding of lead ("Blastox"), lead detection (X-ray), CO_2 blasting, water blast techniques, ceramic rehabilitation materials, and laser paint removal.

They are working to develop and design vitrification and leaching models for glass materials to be used for immobilization of heavy-metal hazardous substances, such as lead in paint, through in-situ vitrification. The process generates no hazardous waste because the lead becomes encapsulated in glass.

One application process under investigation is thermal spraying of a molten glass compound directly onto a lead-containing substrate. This has shown potential for effectively containing hazardous-waste residues. Heavy-metal hazardous-waste residues have been effectively encapsulated in the matrices of glassy or ceramic materials. Use of a stable glass ceramic class of materials to vitrify (in situ) these residues is currently being investigated. The actual mechanism by which these materials mitigate hazardous waste has not been determined. Preliminary experiments have determined that bonds within the glass network may break, providing bonding sites within this network for the hazardous cations. Similarly, the cations may become part of the lattice structure by randomly occupying interstitial and/or defect sites.

Cation leaching rates, effects of pH, and effects of water should be tested for the resultant materials to determine whether they can be safely deposited in a landfill. The mechanism by which these waste materials become immobilized also needs to be investigated. Mechanisms of the vitrification and ion-leaching processes should be modeled to optimize hazardous-waste neutralization by in-situ vitrification. The tetrahedra structure, bond angles, and ionic field strengths of glass-forming and glass-modifying oxides should be characterized.

These tasks can be accomplished through preparation of vitrified materials, laboratory study of the varied processing parameters, investigation of the resultant microstructure through characterization, and development of glassy-materials modeling.

E. Glass Manufacture

1. Background

The purpose of this work is to develop a better solution for companies that generate hazardous inorganic materials. Properly recycled, many of these materials are desirable ingredients for glass formulations. This is true recycling -- under EPA regulations -- producing valuable glass frit products from waste.

Using glass formulation technology, hazardous waste constituents are matched with specific application needs for products that will compete with current commercial products or substitute favorably for them. New glass products can also be developed to serve existing or new industrial markets. In legitimate recycling the waste liability chain not only is cut, but this process will produce safe insoluble products by strict scientific standards. These products will serve useful commercial purposes and thereby eliminate the need for disposal.

2. General Discussion

This process recycles hazardous wastes such as residuals from abrasive blasting and other inorganic wastes from which constituents cannot be reclaimed. These wastes commonly include the following materials useful in glass-making:

Alumina or aluminum oxide, a common constituent in many hazardous wastes, increases chemical resistance of glasses and adds hardness. Alumina-rich glass is valuable for abrasive applications and may also be used as fluxes in industrial ceramics and refractory materials.

Iron oxide (often present) assists in producing glasses that are conductive.

Lead oxide (in small quantities) increases the electrical resistivity and chemical resistance of glass, and also provides glossiness to surfaces. In large quantities, this material is used to add density to glass and to produce a tough, but softer surface.

Fluorine and chlorine salts can be used as "fining agents" in glass to remove bubbles, providing a more homogeneous and stronger material.

Cadmium oxide is a frequent glass constituent for coloring purposes, but in larger quantities will aid in increasing conductivity.

Soda lime glass can be a base material from which many differing glass formulations are produced (13). Technologies exist to develop formulations of soda lime glass incorporating hazardous-waste ingredients and associated constituents into useful frits for a variety of products.

The collected hazardous-waste materials will be sent to a contract melting facility. (Alternatively, melters can be installed and operated at generators' sites.) Additional glass will be added to the waste materials, along with other glass-making or stabilizer materials, according to after-product specifications. More glass will be added to wastes, not premixed with them. Processing specifics can be followed in

Figure 13. Schematic of glass manufacturing process.

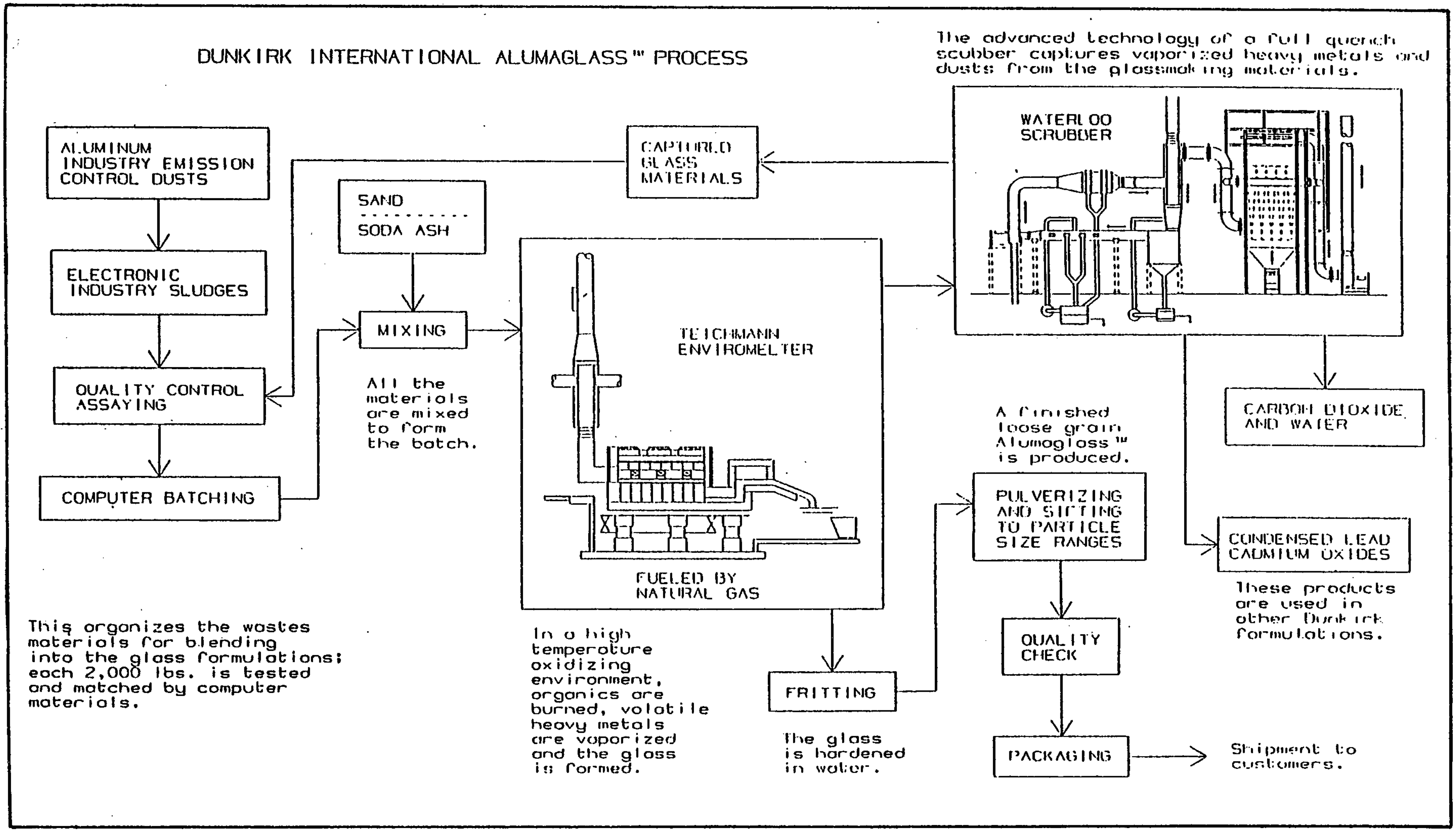


Figure 13. A certification will be given that the material provided by generators has been used to manufacture a recycled product. Lot numbers and all data required by state or EPA regulations will be provided. Quality control data will also be permanently retained to record TCLP and other test results.

3. Prospective After-Products

The anticipated after-product family will be developed at the first contract service plant in cooperation with and guidance from the Center for Advanced Ceramic Technology, New York State College of Ceramics at Alfred University. The objective will be to develop the highest-value products possible from each generator's wastes. The following categories are now anticipated:

Fine Angular Abrasives: Inexpensive fine abrasives may be produced for metal polishing, loose grain blasting, and coated abrasive applications.

Ceramic/Refractory Fluxes: Testing is underway of pilot melt material as a prospective low-melting flux containing high portions of aluminum oxide for acid-resistant ceramics and other similar applications.

Conductive Glass Materials: New markets are opening for conductive glass materials as static dissipators or for electromagnetic shielding. This is a new area of activity in glass-making which needs to be researched.

High-Lead Glasses: These are used as pigment-grinding materials, generally in beaded form, and may also serve as shot peening media in the blasting application, where uniform compressive stresses are induced in the surface of metals to provide extended fatigue life. Lead for these glasses will be accumulated in processing and stored for re-use.

In addition, other products are anticipated. The process will oxidize organic constituents of hazardous wastes and accept large percentages of organics. Inorganic materials mixed with toxic organics (requiring special waste-treatment permits) may also be treated.

4. Qualification Testing

A test program has been proposed to evaluate suitability of prospective hazardous wastes for this recycling technology. Tests measure variability of waste constituents and determine whether the process will successfully melt inorganic material, oxidize organic constituents, and produce a specified after-product.

NYSDOT's bridge blasting residuals (spent boiler slag) would be tested to determine suitability of the inorganic constituents for incorporation in glass or ceramics, to produce useful products with the highest possible value in use. Blasting with glass is also a viable substitute for other technologies and will be tested for end-product usefulness. One possibility is clear (colorless) cullet, and another is garbage (colored) cullet. Both are available from a variety of sources, so competitive bidding and a secure supply of material are virtually guaranteed. Another possibility is "alumaglass," which because of its high aluminum content, melts at a higher temperature than others, allowing greater ease of collection of lead from the melted waste. This alternative blasting material is viewed as the end-product of processing of NYSDOT waste.

Pilot testing may also be performed on large quantities of material in an experimental facility to be certain that organic materials may burn off, and that specific glass can be produced in large quantities. Pilot testing also provides material for sampling in preliminary marketing of the specified after-product.

5. Summary

NYSDOT's problem of hazardous waste generated by paint-removal operations may be eliminated by using waste as an ingredient in glass manufacture. This is a sound approach, but deals only with the paint residue, not the abrasive. Because NYSDOT has no proven separation technology to isolate paint chips from the abrasive, it is proposed that the Department switch to a glass abrasive ("alumaglass") so that total waste can be used in glass-making. This seems to have promise and NYSDOT (in conjunction with the NY State Department of Economic Development) has requested a proposal from a private processor for some experimental work with this glass abrasive.

F. Plasma Hearth Process (14)

1. Background

The Environmental Restoration and Waste Management Office of the U.S. Department of Energy (DOE) has put cost-effective, mixed-waste technology development on the fast track. The plasma hearth process (PHP) is the ultimate processing machine for radioactive and hazardous waste. For years, industry has been using plasma arc torches in various applications. PHP is a high-temperature melting technology, adapted from the specialty-metals processing industry, and applicable to a wide range of DOE waste types.

2. General Discussion

Intact drums of mixed (radioactive and hazardous) waste are placed in a fixed-hearth chamber, minimizing risky waste handling. PHP uses a commercially-available plasma-arc torch, resistively heating the chamber to melt the drum and its contents, destroying the organic materials present. A stabilized, non-leaching, vitrified glass-like phase and a reduced-metal phase are created. In principle, the glass-like, vitreous phase can then be safely stored, and the reduced-metal phase can be recycled. A closed-loop off-gas system, including extensive diagnostics, monitors, and controls, will be incorporated into the PHP to ensure that radioactive and hazardous species are not released to the environment.

Six performance tests were conducted in a pilot-scale PHP facility (3 to 4 bbl of waste per hour) with simulated waste materials consisting of mixed metals (ductile iron, cast iron, steel, aluminum, copper, and brass), metal oxide sludge, combustible solids (paper, polyethylene, and polyethylene terephthalate, cloth, wood, rubber, etc.), and a combustible sludge. All materials were contained in a soil matrix, simulating retrieved waste. Each test consisted of feeding two 30-gal drums containing a simulated waste.

The tests demonstrated successful treatment of many material types and compositions with no pretreatment required; processed at a rate of 60 to 250 kg/hr; showed a thorough processing of combustibles, noncombustibles, and mixtures of both; and produced high-integrity final form in a single processing step. The test series illustrated effective destruction of organics, production of a highly durable and leach-resistant vitreous slag and formation of two distinctly separate phases (metal and slag) in the molten pool. This concept has also been successfully tested on municipal waste in the U.S. and Canada. A commercial unit processing 900 kg per day is estimated to cost $150,000.

V. CONCLUSIONS AND RECOMMENDATIONS

Although this study was altered in scope by changes in NYSDOT policy, it has provided a useful foundation for identifying tasks for further research. The following conclusions can be drawn:

1. Ceramic abrasives have long been used by metallurgists as cleaning and polishing tools. The work described here indicates that ceramic abrasives may be an alternative blast medium for beneficial re-use/recycling.

2. Several active Corps of Engineers projects concerning lead-paint issues are of national interest and scope. This work can probably best be accomplished with NYSDOT (and other interested agencies) supporting their lead.

3. The rotary incinerator furnace shows promise as a means of treating abrasive-blast waste.

Based on this study's work and conclusions, the following recommendations are suggested:

1. Monitor/support/conduct research on use of glass abrasives and wastes in glass manufacture. This approach would support a major interagency policy initiative to develop technologies and industries in New York.

2. Support and monitor work by the Corps of Engineers in this field.

3. EPA now allows transport of 10 000 kg of debris containing hazardous waste for treatability studies. Additional testing of the rotary incinerator can now be conducted under controlled atmosphere, with silica doping of the waste stream.

ACKNOWLEDGMENTS

This study was conducted under the general supervision of Dr. Robert J. Perry, Director of Engineering Research and Development, and direction of Dr. Wes Yang, Engineering Research Specialist II. The authors thank the many contributors to this work. Laboratory analyses and interpretation were performed by NYSDOT Materials Bureau Lab personnel: Jim Finke, Al Ienco, Rosemary Mahoney, and Karen Marquardt. Dave Brewster and Tore Lofving of the Materials Bureau and Jeanne Hewitt of the Environmental Analysis Bureau provided technical information and guidance. Jim Bishop of the Construction Division offered insightful comments on this work. Fred Meli of the Thruway Authority arranged the demonstration of magnetic separation technology, Ron Frascoia and Tina Bohl of the Vermont Agency of Transportation provided insight to their program, and Fred Johnson of the Wisconsin Department of Natural Resources was most helpful in arranging the demonstration of rotary kiln separation technology.

REFERENCES

1. Hower, H. E. "The Dilemma of Removing Lead-Based Paint." Journal of Protective Coatings and Linings, Vol. 5, No. 1, (Jan. 1988), pp.30-37.

2. Snyder, M. K., and Bendersky, D. Removal of Lead-Based Bridge Paints. Report 265, National Cooperative Highway Research Program, December 1983.

3. Lead Base Paint Removal Action Plan. Materials Bureau, New York State Department of Transportation, Approved July 26, 1988.

4. Katauskas, T. "DOT Coats Rusting Bridges with Layers of Problems." R&D Magazine, Vol. 32, No. 5 (May 1990), pp. 42-48.

5. Frederick, R. H. Management of the Solid Waste Generated by the Surface Preparation of Structural Steel Painted with Lead Base Paints. Technical Services Division, New York State Department of Transportation, August 21, 1989.

6. Hare, C. H. Protective Coatings for Bridge Steel. Report 136, National Cooperative Highway Research Program, December 1987.

7. Appleman, B. R. Bridge Paint: Removal, Containment, and Disposal. Report 176, National Cooperative Highway Research Program, February 1992.

8. Trimber, K. A. Industrial Lead Paint Removal Handbook. SSPC 91-18, KTA-Tator, Inc., Pittsburgh, PA, 1991.

9. Norrgran, D. A. "Advances in Magnetic Separation of Fine High-Purity Products." American Ceramic Society Bulletin, Vol. 69, No. 12 (December 1990), pp.1966-1970.

10. Gilbert, S. R., and Weyand, T. E. "Nonmetallic Abrasive Blasting Material Recovery Process Including an Electrostatic Separation Step," US Patent No. 4,943,368, July 24, 1990.

11. Weyland, T. E., and Sutton, W. F. Identification of Acceptable/Beneficial Reuses for Spent Bridge Painting Blast Material. Report FHWA-PA-89-037 +89-02, Office of Research & Special Studies, Pennsylvania Department of Transportation, July 1990.

12. Anderson, M. A., et al. "Method of Fixing Hazardous Substances in Waste Foundry Sand." US Patent No. 4,408,985, October 11, 1983.

13. Doremus, R.H. Glass Science. New York: John Wiley and Sons, 1973, pp. 325-330.

14. Geimer, R. Treatment Technology: Plasma Hearth Process (PHP). Western Governor's Association Committee to Develop On-Site Innovative Technologies, Mixed Radioactive/Hazardous Waste Working Group, March 1994.

APPENDIX A

ENGINEERING INSTRUCTION 93-012

"CLASS A CONTAINMENT ENCLOSURE FOR LEAD PAINT REMOVAL"

TO:

ENGINEERING INSTRUCTION

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

SUBJECT: CLASS A CONTAINMENT ENCLOSURE FOR LEAD PAINT REMOVAL

Subject Code: 7.27-3-18570.1502

Distribution: 30 Main Office 32 Region 34 Special

Code: EI-93-012

APPROVED:

M. J. Cuddy, Asst. Comm. & Chief Engineer

Date: June 7, 1993

Supersedes: EI 92-036

This Engineering Instruction transmits specifications and procedures for the containment of dust and lead paint waste on bridge painting projects with significant quantities of blast cleaning work.

BACKGROUND

The Department is responsible for maintaining roughly 7600 bridges, 5100 of which are painted steel. An estimated 450 bridges per year are repainted under the current annual maintenance painting program, and additional structures are repainted in conjunction with bridge rehabilitation work.

Bridge painting consists of "overcoating" the existing lead based paint with a high performance epoxy/epoxy/urethane coating system. The existing lead paint must be sound and tightly adhered to the steel in order to be overcoated. Areas that do not meet these requirements are cleaned to bare steel by abrasive blast cleaning to remove all loose paint, rust, and mill scale, and then painted with primer. After priming, the entire bridge is then painted the intermediate and finish coats.

Since 1986, the Department has required the use of tarps and covers on bridge painting projects to collect spent abrasive and paint waste debris (EI 86-019 & EI 92-036, Items 570.09 & .10). The paint debris generated from open abrasive blasting was not generally contained, but rather collected by the tarps or covers beneath the structure. Larger size particles fell to the tarps and were vacuumed into containers for proper disposal. Dust-sized particles usually escape from the work site into the environment. A recent investigation found that the effectiveness of tarps and covers for capturing paint debris is between 40 and 60%.

Increasing concern for dust control and the potential lead hazard in paint debris warrants much tighter containment of the work site when open abrasive blasting methods are being used to prepare surfaces for painting. Recent experiences with painting projects in New York City found that even side drapes in combination with ground covers are inadequate for controlling emissions. Strict EPA regulations are being applied to bridge painting projects involving the removal of existing paint to control the emissions of dust alone, and dust containing lead paint debris into the atmosphere. Ambient air quality standards that regulate the release of total suspended particles (TSP), lead particles, and PM10 particles (less than 10 microns in diameter) must be complied with.

The Materials Bureau has conducted an extensive investigation into the various options available for surface preparation and the containment/collection of paint debris. A draft report, "Evaluation of Surface Preparation Alternatives for Repainting Structural Steel", was circulated in January, 1993. Recommendations included the creation of improved specifications for the containment of spent abrasive and paint waste debris on bridge painting projects. Since the issuance of this report, meetings with the Department of Environmental Conservation and the Department of Health have been held to address the containment issue. A specification for an improved containment system has been developed with their concurrence for use on Department projects.

SPECIFICATIONS

Effective immediately, the following specification is to be included for use on maintenance bridge painting projects, and bridge rehabilitation/reconstruction projects that include substantial repainting of the structure in the field.

Item 18570.1502, Class A Containment System for Paint Removal.

Provisions for environmental ground and water protection are included in this item. Item 570.09, Environmental Ground Protection, and Item 570.10, Environmental Waterway Protection, are no longer necessary as separate pay items. Section 740 is being revised to eliminate reference to Items 570.09 and 570.10.

Special specifications and notes that may be prepared by the Regions to modify the attached Item 18570.1502 will not be allowed. The effectiveness of the Class A containment system is being determined by an air monitoring program that is being conducted separately by the Environmental Analysis Bureau. Changes to the specification at this time would complicate this evaluation. Notes by the Regions to identify constraints on the contractors operations must be included and will be allowed, i.e. clearances, lane closures, hours of work.

Engineer's estimates for bridge painting must be adjusted upwards to account for containment costs. Because there has been very little use of containment systems of this type, either in New York or nationwide, good cost information is not available. Class A containment is expected to add at least 30% to the total painting project cost in relatively simple situations and 100% or more in other cases. Additional cost estimating guidance will be provided by the Design Quality Assurance Bureau.

Contract completion dates will have to be extended to allow time for approval of the contractor's working drawings, and time for the contractor to assemble, move, and disassemble the containment system as work progresses at the project site. Depending on the complexity of the structure and the number of structures included in the project, completion dates should be extended 4-8 weeks, or longer.

The attached containment specification for a Class A containment system should not generally be used for bridge rehabilitation projects where small quantities of paint are being removed in conjunction with steel repairs, i.e. welding, cutting, and similar operations. The Structures Division should be consulted on projects of this type. Paint removal using vacuum blast and power tool equipment with vacuum attachments may be appropriate with minimal containment protection. Specifications for vacuum blast equipment are currently being prepared.

Class A containment system is not intended for use during paint application, i.e. to protect against damage from overspray, or paint drift and spatter. Protection against damage from paint application is provided under Section 740.

OTHER ISSUES

1. Working Drawings. The Regions will be responsible for reviewing the contractor's submittal of working drawings, equipment list, and operating plan for conformance with the containment specification, and for acceptability of the traffic control plan. Guidelines to assist with this review are being prepared by the Materials Bureau and will be transmitted separately. Key points to be considered will include containment materials, method of assembly and disassembly, ventilation analysis, design analysis of structural loads, and coordination with Maintenance and Protection of Traffic. By memo dated April 27, 1993, A. M. Shirole distributed to the Regional Directors guidance on structural analysis.

2. Maintenance and Protection of Traffic. While it is desirable for the contract documents to provide detailed traffic control plans, the design of the containment system may significantly impact the traffic control requirements. It may not be possible for the designer of the project traffic control plan to fully address these impacts during design because the contractor must develop the containment system. However, it is important to provide as many details as possible for the contractor's use in developing a suitable traffic control scheme. These details should include typical lane closure and signing layouts, limitations on when the roadway may be occupied, special features such as shadow vehicles, and other considerations. It is not acceptable to merely direct that "the traffic control plan shall be in compliance with the specs and MUTCD".

3. Air Quality Monitoring. The effectiveness of the Class A containment enclosure will be determined by an air monitoring program. The Environmental Analysis Bureau will arrange to perform on-site air monitoring on a sample of projects. Regions will be contacted for a listing of structures that will be included in their painting program, and for assistance in providing support, i.e. power supply for the air monitors. Air quality will be measured on-site using PM10 and high volume air samplers.

   Modifications and adjustments to the requirements for the Class A containment system will be made based on the results of air monitoring.

4. Field Data Collection. Because of the experimental nature of the containment enclosure systems, the Engineer will be asked to maintain records on the size and type of containment, effectiveness, productivity, maintenance and protection of traffic, and related items. A "check off" type form and instructions for this data collection will be prepared by the Materials Bureau and issued separately in the near future.

5. Data Collection for Estimating. To obtain information on the actual cost of bridge painting work, designers will be asked to estimate paint condition and square footage of steel on painting projects. This information will be used to develop a database of costs related to surface preparation, containment, disposal, and painting work, and will be correlated to site-specific conditions, containment type, etc. Additional information on estimating will be provided by the Design Quality Assurance Bureau in the near future.

6. Experimental Work. Alternate methods to contain and to reduce the quantity of paint waste debris air-borne particulates will be evaluated by the Materials Bureau. Several bridges will be used in the repainting program to experiment with new technologies including low dusting abrasives, recyclable abrasives, and wet abrasive blast cleaning. The Regions will be contacted to determine their interest in participating in this evaluation.

7. Health and Safety. The contractor must meet all OSHA and NYSDOH regulations to protect workers from lead exposure. The Construction Division is preparing a special note which highlights the provisions of the 1993 OSHA regulations for lead, and which will provide steps the contractor must take to demonstrate compliance.

   Inspection staff--both DOT and consultants--must also be protected from lead exposure. As a minimum, inspection staff who must enter containment areas must have medical clearance and be fitted and trained for respirator use. This process may require several weeks, and needs to be initiated well in advance of the start of the work.

QUESTIONS AND ASSISTANCE

Questions on the technical aspects of the Class A specification, working drawing approvals, and general questions relating to the bridge painting program should be directed to Gerald Perregaux or David Brewster in the Materials Bureau at 518-457-4285.

Questions related to the review of the structural analysis should be directed to Daniel Feeser in the Structures Division at 518-457-5715 .

Questions related to the contractual aspects of implementation, including the use of the Class A specifications for on-going work should be directed to James Tynan in the Construction Division at 518-457-6472.

Questions relating to the air monitoring program should be directed to John Zamurs in the Environmental Analysis Bureau at 518-457-5672.

Questions relating to the health and safety issues, and to OSHA requirements, should be directed to James Bryden in the Construction Division at 518-457-3225.

ITEM 18570.1502
CLASS A CONTAINMENT SYSTEM FOR PAINT REMOVAL

DESCRIPTION:

This work shall consist of furnishing and installing a total containment enclosure around the immediate work area to contain and collect debris generated during paint removal operations. The work associated with dismantling and moving the enclosure to new locations on the structure as paint removal operations progress, and with removing the enclosure when paint removal operations are completed, is also included. The containment enclosure shall contain all spent materials, dust, and other debris generated: (1) during blast cleaning and paint removal operations; (2) when air blowing or vacuuming the steel surfaces on the structure in preparation for field painting; (3) when collecting and removing paint waste debris. The performance of the containment enclosure will be judged on its ability to prevent visible emissions (releases) of spent materials, dust, or other debris into the environment.

The Class A containment enclosure provided shall be constructed of impermeable materials affixed to a support structure. All seams in containment materials and all joints between the containment enclosure and the bridge shall be sealed by overlapping. An entryway into the work area shall be made using multiple overlapping door tarps. A forced exit air system shall maintain a lower air pressure inside the containment than outside so as to produce an inward air flow at open air entry points. The exhaust system shall be sized to produce a minimum theoretical air movement inside the containment enclosure. Air movement shall be verified by visual inspection. Exit air shall be exhausted into a dust collection system for filtering.

Reference information on containment enclosures can be obtained from the following:

1. SSPC - Guide 6I (CON), Guide for Containing Debris Generated During Paint Removal Operations, Steel Structures Painting Council, Pittsburgh PA.

2. SSPC - Steel Structures Painting Manual, Volume 1, Steel Structures Painting Council, Pittsburgh, PA.

3. Industrial Lead Paint Removal Handbook, by Kenneth A. Trimber, SSPC Publication 91-18, Steel Structures Painting Council, Pittsburgh, PA.

MATERIALS

Materials and equipment as described in Construction Details shall be selected by the contractor and approved by the Engineer prior to use.

ITEM 18570.1502
CLASS A CONTAINMENT SYSTEM FOR PAINT REMOVAL

CONSTRUCTION DETAILS

Rigid or flexible materials may be used to construct the containment enclosure. Rigid materials shall be impermeable and may be comprised of plywood panels, or corrugated panels of steel, aluminum, reinforced fiberglass, or another suitable material. Flexible materials shall be impermeable and fire retardant. Flexible covers will be allowed for flooring only if the ground and paved surfaces are smooth surfaces from which debris can be collected by vacuuming. If a smooth ground surface is not available, rigid materials shall be used for the floor of the enclosure.

A rigid support structure comprised of scaffolding and framing or a flexible support structure comprised of a cabling system may be used as a framework for the enclosure. Containment materials shall be secured to the support structure.

All mating surfaces between the bridge structure and the containment enclosure, and all joints and seams formed in the fabrication of the enclosure shall be sealed. Joints and seams may be sealed by taping or caulking, or by overlapping materials, providing the other provisions of this specification are adhered to. Flexible materials shall be sealed by overlapping. The minimum overlap shall be 24", and the overlapped materials shall be secured by clamping or taping or other suitable methods at intervals not exceeding 24". Multiple overlapping door tarps shall be used for the entryway.

Dust collection equipment shall be 99.9% efficient against the passage of dust and particles 2 microns and greater in size. The size of the exhaust fan system supplied shall be designed to produce an average minimum crossdraft air velocity or an average minimum downdraft air velocity inside the containment enclosure. For enclosures designed with horizontal air flow, the exhaust fan shall have the capacity to produce an average minimum crossdraft velocity of 100 feet per minute, based on theoretical calculations.

> Example: The maximum cross-section of the enclosure in the direction of air flow measures 20' x 10' (200 square feet). Minimum volume of air required for crossdraft is 20,000 cubic feet per minute (200 square feet x 100 feet per minute).

For enclosures designed with vertical air flow, the exhaust fan shall have the capacity to produce an average minimum downdraft velocity of 50 feet per minute, based on theoretical calculations.

> Example: The floor space of the enclosure measures 15' x 16' (240 square feet). Minimum volume of air movement required for downdraft is 12,000 cubic feet per minute (240 square feet x 50 feet per minute).

ITEM 18570.1502
CLASS A CONTAINMENT SYSTEM FOR PAINT REMOVAL

Light intensity by natural or artificial means inside the containment enclosure shall be maintained at a minimum of 50 foot-candles, on the steel surface, throughout surface preparation, inspection, and painting activities. Auxiliary lighting shall be provided as necessary. The contractor shall supply the Engineer with one(1) portable light meter, with a scale of 0 to 50+ foot-candles. The meter will be returned to the contractor at the completion of work.

Prior to the start of any abrasive blast cleaning or paint removal work, the contractor shall submit for approval detailed working drawing(s) of the Class A containment system that is to be supplied for each structure. The drawings shall be prepared and stamped by a registered, licensed Professional Engineer. Eight (8) complete copies of the working drawings shall be directly submitted for approval as follows:

Regional Director - 5 copies
Director, Construction Division - 1 copy
Director, Materials Bureau - 1 copy
Director, Structures Design and Const. Division - 1 copy

Upon receipt, 15 working days shall be allowed for the Regional Director to review and approve the contractor's working drawings.

The working drawings shall detail the proposed containment enclosure and include the following information:

1. Plan and elevation of the containment enclosure in relation to the bridge structure.

2. The type of solid or rigid floor and working platform with appropriate safety and fall protection measures. A description of the method that will be used to provide worker access to the enclosure (personnel lifts, scaffolds, etc.), and the procedures and equipment that will be used to protect workers from falls shall be specified (OSHA Safety and Health Requirements, 29 CFR 1926). If a barge of another type of floating platform is used, include details regarding its construction, such as materials and dimensions, how the platform will be tied-off, how the debris will be collected and off- loaded, etc.

3. A description of how the drainage run-off from existing deck drains will be routed through the enclosure.

4. A description of the type of rigid or flexible material(s) for the containment walls, floor, and ceiling.

5. The type of rigid or flexible support structure that will be used for the floor, walls, and ceiling, including the method by which the containment enclosure materials are to be affixed to the support structure.

6. The method by which the containment enclosure will be supported or attached to the bridge, i.e. rollers, clamps. Welding, bolting, or similar connections will not be allowed.

7. The method that will be used to seal the joints (seams) formed when fabricating the containment enclosure, and the method that will be used to seal the mating joints between the containment enclosure and the bridge structure.

8. The method that will be used to seal the entryway. At a minimum, the use of multiple overlapping door tarps shall be provided to minimize dust escape through the entryway.

9. The ventilation system including open air make-up points, the dust collector and exhaust fan(s), the location, type of equipment, the manufacturer's data sheets, and the airflow capacities.

10. The type, size, and configuration of auxiliary lighting that will be provided for inside the containment enclosure.

11. A design analysis of the loads on the bridge due to the containment enclosure including: maximum dead and live loads of the enclosure, the workers, blast abrasive, and equipment; maximum allowable load for the floor and working platform; wind loads imposed on the structure by the enclosure; and, maximum wind velocity that the containment enclosure is designed to withstand.

    If the containment system is supported by the bridge, the working drawing submittal shall include certification by the Professional Engineer that the loads imposed do not cause the overall stress level of any element of the bridge to exceed the Operating Rating Allowable Stresses defined in AASHTO Manual for Maintenance Inspection of Bridges (current edition).

    The analysis shall account for all loads on the structure, including the enclosure dead load, worker liveload, blast abrasive load, equipment load, wind load, structure dead load, and liveload plus the impact. The highway liveload used for analysis purposes shall be either a HS20 truck or equivalent lane loading, whichever is greater, unless a different highway liveload is shown on the plans. Except as noted, the analysis shall use the loadings and design assumptions in the NYSDOT Standard Specifications for Highway Bridges.

12. Provide details on how the containment enclosure is assembled and disassembled, and moved to a new location on the structure as surface preparation work progresses. Indicate how the dust collector will be included in the containment enclosure. All other pertinent details relating to the containment enclosure shall be included with the working drawings as notes, or as written narrative.

13. Provide details on how the use of the containment enclosure will be coordinated with the maintenance and protection of traffic. Encroachments onto roadways, and clearances over waterways and railroads shall be clearly identified. Whenever a structure spans a railroad, the requirements of §105-09 shall apply. Structures that span a navigable waterway may be subject to regulation by the U.S. Coast Guard, the U.S. Army-Corps of Engineers, the N.Y.S. Thruway Authority - Office of Canals, and the N.Y.S. Dept. of Environmental Conservation.

All abrasive blast cleaning and paint removal work, and all work associated with the collection of paint waste debris, and with the subsequent air blow-down or vacuuming of debris from the steel surfaces on the structure in preparation for painting, shall be performed inside the containment enclosure.

Proper operation of the ventilation system shall be maintained after each assembly of the containment and during all phases of work. The Engineer shall require that the contractor visually demonstrate inward airflow movement into the enclosure at air entry points with smoke tubes.

Extreme care shall be taken to prevent emissions (releases) of waste materials when abrasive blast cleaning and paint removal work are being performed near joints that are formed between the enclosure and the bridge structure, and near seams in the enclosure materials.

The contractor shall make every attempt to limit workers from entering or exiting the containment enclosure when blast cleaning and paint removal operations are being performed.

ITEM 18570.1502
CLASS A CONTAINMENT SYSTEM FOR PAINT REMOVAL

All waste material that results from abrasive blasting and paint removal operations shall be cleaned up and collected from the floor, walls, and other surfaces inside of the containment enclosure by vacuuming. Sweeping, shoveling, or other mechanical means to remove the waste materials will not be allowed. Clean up operations shall be performed daily, before new paint is applied, or before a prolonged work stoppage, such as for weather interruptions.

Prior to disassembly or moving of the paint enclosure, the inside surfaces of the enclosure (walls, floors, ceiling, etc.) shall be cleaned of dust and other spent material by vacuuming. The contractor shall take all measures necessary to prevent the release of waste material during moving or removal of the containment.

All air exhausted from the containment enclosure shall pass through the dust collection system.

The effectiveness of the containment enclosure shall be determined by the Engineer, by visual inspection for dust plumes or other visible evidence of emissions (releases) of waste materials into the environment. Throughout the duration of work there shall be no visible discharges. If the Engineer observes a visible discharge, the contractor shall immediately stop work and perform necessary repairs to the containment enclosure or modifications to blast cleaning operations to the Engineers satisfaction.

The Engineer may direct the contractor to stop all work activities and require the contractor to immediately clean up all waste materials within the enclosure when in the Engineer's opinion, threatening weather conditions exist. This measure may be exercised when an apparent threat exists that could cause the release of waste material to the surrounding environment, such as high winds or heavy rain.

If the wind velocity causes the containment enclosure to billow, or to emit dust, or to otherwise be a hazard in the opinion of the Engineer, the contractor shall immediately cease work and clean-up all the debris. Under severe conditions the contractor shall disassemble the containment enclosure.

For bridge structures that are located over or adjacent to water, if it is determined by the Engineer that floating waste materials may accidently form on the water surface they shall be contained from moving upstream or downstream by the use of floating water booms (straw or screens). Floating waste material shall be collected daily, or more frequently, as directed by the Engineer.

ITEM 18570.1502
CLASS A CONTAINMENT SYSTEM FOR PAINT REMOVAL

Any waste material that is released outside the containment enclosure shall be immediately cleaned up using vacuums. Care shall be taken on pavement and other surfaces to collect all waste material so as to prevent it from being redistributed into the air and environment by traffic.

All used filters from dust collectors and vacuums, and straw and screening from dam devices, shall be disposed of in accordance with all applicable Local, State, and Federal Laws, regulations and codes. The cost for disposing of these materials shall be included in the lump sum price bid for this item.

METHOD OF MEASUREMENT

Payment will be made at the lump sum price bid.

BASIS OF PAYMENT

The lump sum price bid shall include the cost for preparing the working drawings, and all labor, materials and equipment necessary to complete the work. All work shall be done in a manner satisfactory to the Engineer.

Progress payments will be made. They will be based upon the number of work days required to complete all of the abrasive blast cleaning and paint removal work.

Prior to the beginning of any work, the Contractor shall supply the Engineer with an initial estimate of work days required to complete all of the abrasive blast cleaning and paint removal work. This initial estimate will not be considered final. The Engineer may request a revised estimate at any time during the progress of the work.

The Engineer will determine a daily rate of payment using
the lump sum price bid, distributed over the estimate of work days. The daily rate will be used to authorize payment in accordance with §102-17, Article 7.

Should the Engineer request a revised estimate and use that estimate to establish a new daily rate, the lump sum bid price shall be reduced by the total of the amounts previously authorized for payment, prior to the establishment of the new daily rate. Failure on the part of the Contractor to supply a revised estimate when requested, will be cause for the progress payment procedure to be immediately terminated.

Progress payments for this work will be made only for days during which abrasive blast cleaning and paint removal work is actually performed.

ITEM 18570.1502
CLASS A CONTAINMENT SYSTEM FOR PAINT REMOVAL

Payment will be made under:

Item No.	Item	Pay Unit
18570.1502nn	Class A Containment For Paint Removal	Lump Sum (for each Structure)

NOTE: nn denotes serialized pay item. See §101-53.

APPENDIX B
PLAN REVIEW GUIDELINES FOR CLASS A CONTAINMENT ENCLOSURES

MEMORANDUM
DEPARTMENT OF TRANSPORTATION

TO: All Regional Construction Engineers, Region No. ____

FROM: P. T. Wells, Construction Division, 4-101

SUBJECT: PLAN REVIEW GUIDELINES FOR CLASS A CONTAINMENT ENCLOSURES

DATE: June 30, 1993

Attached are guidelines for your use when reviewing plans submitted by contractors under Item 18570.1502, Class A Containment System For Paint Removal. Consider these guidelines a working draft that will be finalized after some experience is gained. At a later date the guidelines will be issued by Engineering Instruction. Any comments that you may have on the guidelines would be appreciated, and may be forwarded to my office.

Guidelines are also being prepared for the inspection and operation of the containment system once it is erected. The intent is to develop procedures for verifying the proper operation of the enclosure system, and for documenting important engineering controls which will assure compliance with air quality regulations in lieu of air monitoring. We expect these guidelines will be available in a couple of weeks or so.

Technical questions on the attached guidelines should be referred to Dave Brewster or Gerald Perregaux of the Materials Bureau at (518) 457-4285.

PTW/GRP/ms
Attachment

cc: Division Directors (Office of Engineering) w/attach.
AGC w/attach.
CIC w/attach.
GCA w/attach.
NSCA w/attach.

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GUIDELINES FOR REVIEWING CLASS A CONTAINMENT PLANS

June 30, 1993

The following are guidelines for use in reviewing containment plans submitted by a contractor under Item 18570.1502. These guidelines do not have the authority of the specification. They are offered as a supplement to aid the contractor and DOT personnel in interpreting the specification so that an acceptable containment system is provided.

These guidelines elaborate on key items in the specification, some of which may be unfamiliar. Specification requirements are summarized for each, and where appropriate, comments are provided on the item's function and importance in the operation of a containment enclosure. Questions that follow the discussion provide a "reasonableness" check for the plan reviewer.

Definitions

Total containment
: The entire localized work area where abrasive blasting operations are performed is enclosed by sheet materials affixed to a support structure. The enclosure is erected to control releases of airborne debris into the environment and to facilitate collection of the debris for disposal. The deck slab may serve as the ceiling of the enclosure if airborne dust would be contained.

Forced filtered air exhaust
: Air is drawn through the containment enclosure by exhaust fans and exited through dust collectors before being discharged into the environment.

General

- Are the detailed working drawing(s) of the Class A containment system prepared and stamped by a registered, licensed Professional Engineer?
- Is adequate space provided between the containment enclosure and the steel to clean and inspect the prepared surfaces?
- Will natural lighting be adequate inside the containment enclosure? If not, are artificial means provided and capable of producing a light intensity of 50 foot-candles?
- Are there provisions to redirect water from deck drains through or around the containment enclosure?
- Are obstructions inside the containment enclosure minimized so as to not block or disrupt the flow of air?
- Can the containment structure be assembled and disassembled, and moved to a new location as work progresses, in a timely manner and without causing disruption to essential operations?

__Containment Materials__ -- Either rigid or flexible materials may be used. Rigid materials consist of panels or modular fabrications constructed of plywood, fiberglass, plastic, or metal materials. Flexible materials include tarps and plastic sheeting that are impervious to wind and dust. Light colored translucent materials are recommended to maximize natural lighting.

- Are the materials impervious to dust or wind?
- Are the materials durable, e.g., resistant to wind forces?
- Is the method, grommets or the equivalent, for securing materials to the support structure adequate?
- If flexible materials are used are they fire retardant?
- Are flexible materials proposed for covering the containment floor? If so, the underlying ground or pavement or supporting surface has to be smooth so paint debris can be vacuumed. Rigid materials would span unevenness and provide a smooth surface for vacuuming.

__Support Structure__ -- Either a rigid or flexible support structure may be used. Rigid support structures are comprised of scaffolding and framing to which containment materials are secured. Flexible support structures use cables, ropes or chains.

- Is movement of the support structure and containment materials sufficiently constrained so joints and seams will remain sealed?

For suspended containment structures:

- If containment is a down draft design, is the working platform an open grate so as to not restrict air flow?
- Does the support structure provide a funnel-shaped bottom to facilitate the collection and removal of waste material?

For containment systems that are not suspended:

- Is the pavement or ground used for the containment floor? If so, the surface must be covered with flexible or rigid containment materials. Refer to the previous section on Containment Materials for discussion on cover materials.

__Joints and Seams__ -- Joints are mating surfaces between containment materials and the bridge structure. Seams are formed where containment materials are joined. Sealing of joints and seams may be accomplished by overlapping the materials, or by taping, caulking, etc.

Check joint details -- joints are particularly difficult to seal.

- Are the sides of the enclosure sealed against the bridge structure?
- Are the air supply and exhaust ends of the enclosure properly sealed against the bridge structure, or specially designed end sections, to

prevent the escape of dust?

Check seam details.

- Are rigid materials taped or caulked?
- Are flexible materials overlapped 24" and secured by tape or some type of clamp or tie at 24" intervals along the seam. It is permissible for some outside air to be drawn through seams into the enclosure by the exhaust fan.

Entryway -- Multiple overlapping door tarps are required. The entryway is a potential area for dust escape if used frequently by workers.

Check entryway details.

- Are two or more sets of overlapping door tarps provided with adequate space between so that one set of tarps remains closed when entering or leaving?

Dust Collection System -- Air laden with lead paint and abrasive dust will be drawn from the containment enclosure by the exhaust fan and forced through dust collectors for filtration before being discharged into the environment. A Class A containment system will, by design, operate as a negative pressure system. Air pressure inside the enclosure will be less than air pressure outside.

A specified air flow -- 100 fpm for air moving in the horizontal direction past the workers (50 fpm for vertical air flow containment systems) -- is used to roughly size exhaust fans. Fan capacity is determined by a theoretical calculation taking into account the cross sectional area of the containment enclosure.

The ducts carrying air from the containment enclosure to the dust collector should be sized to achieve a minimum 3500 fpm air velocity. This velocity is necessary to properly transport the dust laden air.

Usually radial type centrifugal fans are used to move air containing abrasive materials. The fans are designed to operate at an air flow rate at a given number of inches water gauge (wg). The latter term is the ventilation system resistance, or head loss, due to air flow inefficiencies that the fan is able to operate against. System resistance for a typical bridge containment enclosure is not known at this time, but is expected to be at least 6 inches water gauge. System resistance could be higher or lower, depending on design of the air make-up points, duct losses, the type of dust collector, etc. The largest source of system resistance will likely be the dust collector, which experiences a pressure drop as air passes through the filter media. Fabric collectors are usually selected with ratings in the range of 2 to 5 inches water gauge.

A "multi-rating table" available from the fan manufacturer is used for selecting fan equipment. The table shows a range of capacities for a particular fan size. Air flow and pressure (system resistance) requirements of the ventilation system determine fan size and operating RPM. Fan capacity in equipment specifications is reported as an air flow rate at some given pressure, e.g. "X" cubic feet per minute at "Y" inches water gauge.

Specifications require that dust collection equipment be 99.9% efficient against the passage of dust and particles 2 microns and greater in size. Under these conditions, the effluent from the dust collector theoretically would contain a particulate emission concentration in the order of 0.010 grains/dry standard cubic foot. This concentration is well within the no-visible-dust range.

Fabric collectors are suitable for the heavy dust concentrations associated with abrasive blasting. Interruptible-operation dust collectors shut down for a couple of minutes after several hours operation to recondition the filter media by vibration or by reversing the air at low pressure. Continuous-operation dust collectors recondition only a section of the filters periodically, so operations are never interrupted. Reverse pulses of high pressure air are used to recondition the filter media.

Fabric collectors are sized in terms of air flow rate versus fabric media area. This is called the "air-to-cloth ratio" with units of cfm per square foot of fabric. This ratio represents the average velocity of air through the filter media. Air-to-cloth ratios ranging from 1:1 to 5:1 are acceptable (filter velocity 1-5 fpm).

- Are the exhaust ducts leading from the enclosure to dust collector sized to achieve a minimum 3500 fpm air velocity? Determine this by dividing the exhaust duct air flow rate by the area of duct opening.
- Will the fan deliver the specified air flow rate at 6 inches (minimum) water gauge? Refer to the multi-rating table for the specified fan to verify capacity. Fabric collectors with pressure drop ratings on the high side (greater than 4 inches water gauge, for example) may require fans that efficiently operate at pressures higher than 6 inches water gauge.
- From the manufacturer's specifications, is the air-to-cloth ratio within the range of 1:1 to 5:1?

Air Make-up Points -- Fresh outside air has to enter the enclosure to replace the air that is exhausted. A lack of replacement air will raise the internal negative air pressure (increase system resistance) and overtax the fan, severely decreasing exhaust flow rate. Under these conditions the fan will operate inefficiently with increased operating costs, and will cause air movement inside containment to flow well below the specified theoretical rate of 100 fpm (50 fpm for vertical air flow containment systems).

Openings required for air make-up are expected to total 1/5 of the enclosure cross-sectional area. A small amount of outside air may be drawn through overlapped seams in the containment enclosure. Additional air may have to enter through specially constructed air make-up points in the enclosure wall opposite the fan. Simple wooden-framed openings covered with furnace air filters can be installed to function as air make-up points. They will distribute the incoming air and prevent the outflow of airborne debris should the exhaust fan suddenly shut down. More elaborate air make-up points include louvered or baffled openings. Fans or blowers at air entry points to assist air flow into the containment enclosure are not required, nor are they desired.

- Are the air make-up points located at the opposite end of the enclosure from the exhaust fan so that the work area is between?
- Are the openings spaced and positioned to distribute make-up air evenly across the face of the enclosure at entry points?
- Is the total area of air make-up points, including openings in overlapped seams and joints, approximately 1/5 the cross-sectional area of the enclosure?
- Are air entry points sized to ensure air velocities through openings range between 200 and 500 fpm (divide air flow rate through opening by area of opening)?
- Are air make-up points covered by filters, like those used for furnaces, or louvered or baffled?

<u>Other</u>

- Has a design analysis of loads on the bridge from the containment enclosure been performed in accordance with Structure Division directives?
- Will the containment structure interfere with normal traffic operations, and if so, has a reasonable M&PT plan been provided?
- Have minimum clearances over waterways and railroads been maintained? Have construction plans been coordinated with appropriate authorities, i.e., U.S. Coast Guard, U.S. Army Corp of Engineers, etc.?
- Does the method of access to the enclosure and the working platform include safety and fall protection measures in compliance with OSHA?

APENDIX C
OPERATION OF ROTARY INCINERATION SYSTEM

COLLEGE RESEARCH CORPORATION
N116 W16800 MAIN STREET
P. O. BOX 577
GERMANTOWN, WISCONSIN 53022

April 24, 1991

DESCRIPTION OF SYSTEM OPERATION
CORECO MODEL 1225-I ROTARY INCINERATION SYSTEM
WITH INTERNAL AFTERBURNER SEE DWG. #SK-1225-RD

MATERIAL FEED

1. Waste material to be incinerated, in granular, free flowing condition (containing less than 3% combustible organic content) which has been reduced to minus 1/4 inch size is fed into the sealed input Screw Feeder at the rated capacity of the Incinerator.

CALCINING AND INCINERATION

2. The Screw Feeder, which is sealed against the input end of the externally heated rotary hearth of the Calciner unit, feeds the waste material at a constant rate into the rotary hearth where it is heated to a preset selected temperature between 1200 degrees F. and 1600 degrees F. depending upon the temperature required to burn out all of the organic content, calcine the contained mineral contaminates, and completely oxidize the gasses within the transit time through the hearth where the material is mixed and cascaded multiple times through the controlled oxidizing atmosphere until combustion is complete.

POLLUTION CONTROL

Air to provide the oxygen required for the combustion of the contained organics during processing is inserted into the rotary hearth through the center pipe of the Screw Feeder by a pressure blower with an adjustable flow control valve. The amount of air required is adjusted to provide 100% excess oxygen for the required demand.

EXAMPLE

In a small, 1000 pound per hour, machine the normal amount of this air flow is between 40 and 80 cu ft/minute. The internal volume of the rotary hearth 24" diameter x 12' long is 37.7 cubic feet. This internal volume provides a chamber which operates as an afterburner where these gases are retained at elevated temperatures for sufficient time to allow complete combustion to take place prior to their exit into the transfer hood.

Assuming that 1/2 of the rotary hearth provides this afterburning volume, then 19 cubic feet/min. are available for this purpose. At the low end of the operating range(ie; 1200 degrees F and 40 cubic feet ambient air inlet temperature) these gases expand to 122 cu ft/min or 2 cu ft/sec and would be retained for approximately 9.5 seconds at temperature to complete combustion.
At the high end of the operating range,(ie; 1600 degrees F. and 80 cu ft/min) these gases expand to 368 cu ft/min or 6.1 cu ft/sec and would be retained for 3.1 seconds at temperature to complete combustion.

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COLLEGE RESEARCH CORPORATION
N116 W16800 MAIN STREET
P. O. BOX 577
GERMANTOWN, WISCONSIN 53022

For comparison purposes, in the normal afterburner design, the accepted retention time to complete combustion is 0.3 to 0.5 seconds. Thus this internal afterburner system provides more than adequate retention time to complete the required combustion of all contained VOC's.

3. The heated material exits the calcining retort and drops through the transfer hood into the rotary cooler drum where it is cascaded repeatedly through a counter flow induced draft air stream until it exits at ambient temperature through the rotary screen into the collecting hopper. Oversize foreign material flows over the screen at this point and is collected beyond the screen.

The counter flow of cooling air which contains some dust and fines separated from the calcined material is collected in the transfer hood along with the process gases from the calcining retort. This total air stream volume is approximately 1200 CFM at a temperature approximately 400 degrees F.

DUST COLLECTION

4. The air pollution control system consists of a high efficiency cyclone collector (with a 4" wc pressure drop) followed by a 400 sq. ft. baghouse exhausted by an induced draft fan. (7.5 HP 2000/2400 CFM @ 8" wc). The exhaust from the transfer hood (1200 CFM at 400 degrees F) is tempered with (850 CFM @ ambient) in the duct entering the cyclone collector resulting in an air stream approximately 2000 CFM at 150-180 degrees which flows through the cyclone to remove the plus 10 u material, and into the baghouse to collect the balance of the fines prior to exhaust into the atmosphere.

The amount of material collected in this system varies according to the fines contained in the input waste material. but typically the cyclone collects approximately 50 pounds per hour and the baghouse 7 pounds per hour.

5. The system cannot be operated without the Pollution Control system.

ENERGY RECOUPERATION AND CONSERVATION OPTION

6. The exhaust gasses from the calciner heating chamber are vented to the recouperative heat exchanger which transfers the waste heat to the pressurized combustion air stream to the burners. This preheated air at temperatures of 400-800 degrees F. results in fuel savings of 20-30% compared to the use of ambient air for burner operation.

APPENDIX D
OPERATING CHARACTERISTICS OF ROTARY INCINERATION SYSTEM

CORECO INC.
N116 W16800 MAIN STREET
P. O. BOX 577
GERMANTOWN, WISCONSIN 53022

SUMMARY TEST REPORT

CORECO® WASTE INCINERATION TEST

CUSTOMER: N. Y. State Dept. of Transportation: D&P Consulting

TYPE OF WASTE: "Black Beauty" used sand blasting abrasive

DATE: 17 Sept., 1993

RECEIVED FROM CUSTOMER: 1,533 pounds

LAB TEST:

LOSS ON IGNITION: 1.2 - 2.5% (combustibles and moisture)

PROCESS TEMP: 1400-1600° F.

TEST PROCESS
RATE: 500 lbs./hr.

FURNACE SET
POINT: 1400-1600° F.

ACTUAL TEMPERATURE
AT EXIT OF
CALCINER: 1350-1550° F

FUEL CONSUMPTION
RATE: 300 CFH

PROCESS AIR FLOW: 80 CFM

MATERIAL BALANCE

INPUT WGT.	1,533 lbs.
OUTPUT WGT.	1,205 lbs.
	78.6%
CYCLONE FINES	208 - 13.6%
BAGHOUSE FINES	15.5 - 1%
OVERSIZE Stones, Etc.	12
CLEAN OUT AND FLOOR SWEEPINGS	50
LOSSES (MOISTURE-BURNABLE)	12.5 - 1%
SAMPLES	30

COMMENTS:

This material does not present any processing difficulties.

Although material was processed at 3 different temperatures (1400, 1500, 1600° F.) there did not appear to be any difference in the process or the resultant products when examined visually.

A chemical analysis of the finished products by N.Y. DOT lab will be used to confirm this fact.

M. Evans

Marvin Evans, P.E.
President

17 Sept 93

Stack Gas Analysis

NY-DOT-Test

9-16-93

Note: This Airflow @ 1500 CFM is filtered Through a Cyclone Collector and Baghouse with collection efficiency of 99.9% at grain loadings over 1gr/ft³ (actual Loading was (0.13gr/ft³)

ME

SERIAL # 11000991
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: CORECO DUCT

TIME: 07:15:23
DATE: 09/16/93

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	92.1	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	73	°F
OXYGEN:	20.4	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	00.4	%
COMBUSTIBLE GASES:	0.00	%
STACK DRAFT (INCHES H2O):	+ 00.0	
XCESS AIR:	OVER	%
OXIDES of NITROGEN:	0	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1990	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 11000991
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: CORECO DUCT

TIME: 08:10:29
DATE: 09/16/93

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	92.0	%
AMBIENT TEMPERATURE:	72	°F
STACK TEMPERATURE:	71	°F
OXYGEN:	20.4	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	00.4	%
COMBUSTIBLE GASES:	0.00	%
STACK DRAFT (INCHES H2O):	+ 00.0	
EXCESS AIR:	OVER	%
OXIDES of NITROGEN:	0	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1990	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 11000991
ENERAC MODEL 2000
COMBUSTION TEST RECORD

FOR: CORECO DUCT

TIME: 08:31:41
DATE: 09/16/93

FUEL NATURAL GAS:21870 BTU/LB

COMBUSTION EFFICIENCY:	91.9	%
AMBIENT TEMPERATURE:	73	°F
STACK TEMPERATURE:	73	°F
OXYGEN:	20.4	%
CARBON MONOXIDE:	0	PPM
CARBON DIOXIDE:	00.4	%
COMBUSTIBLE GASES:	0.00	%
STACK DRAFT (INCHES H2O):	+ 00.0	
EXCESS AIR:	OVER	%
OXIDES of NITROGEN:	0	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1990	PPM

MODE:PPM OXY_REF=TRUE%