IN-DEPTH SURVEY REPORT

CONTROL TECHNOLOGY FOR REMOVING LEAD-BASED PAINT FROM STEEL STRUCTURES ABRASIVE BLASTING USING STAURITE XL IN CONTAINMENT

AT

BP Oil Corporation
Lima, Ohio

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), a federal agency located in the Centers for Disease Control and Prevention under the Department of Health and Human Services, was established by the Occupational Safety and Health Act of 1970 This legislation mandated NIOSH to conduct research and education programs separate from the standard setting and enforcement functions conducted by the Occupational Safety and Health Administration (OSHA) in the Department of Labor An important area of NIOSH research deals with methods for controlling occupational exposure to potential biological, chemical, and physical hazards

The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering has been given the lead within NIOSH to study the engineering aspects relevant to the control of these hazards in the workplace Since 1976, the ECTB has conducted assessments of control technology methods used in industry on the basis of controls used within a selected industry, controls used for common industrial processes, or specific control techniques The objective of these studies has been to document and evaluate effective control techniques (e g , isolation or the use of local ventilation) that minimize risk of potential health hazards and to create an awareness of the need for and the availability of effective hazard control measures

Because of increased reports of lead poisoning and silicosis among workers in the steel structures painting industry, researchers from ECTB developed a project to evaluate engineering controls in this industry [1] A basic need for nearly all steel structures is protection from corrosion Historically, lead-containing coating systems were used because they were low cost, aesthetically appealing, and corrosion resistant Lead coatings have low surface energies and properties that suppress galvanic corrosion, lead coatings can be used over surfaces with little or no surface preparation [2] Although correct surface preparation is beneficial when using lead-based coatings, it is the primary and most important requirement for satisfactory application of alternative protective coatings for steel structures [2] Without a properly cleaned surface, even the most expensive alternative coatings will fail to adhere to or prevent rusting of the steel substrate [3] The old coating and mill scale (a relatively thick layer of iron oxide formed during the steel fabrication process) must be removed from the steel surface Additionally, an anchor pattern (a rough surface profile) imparted to the steel surface will increase the adhesive character of any new coating system The cleaning process has traditionally been achieved by abrasive blasting Abrasive blast devices are designed to deliver a high-velocity stream of abrasive to remove the coating and mill scale, as well as impart an anchor pattern on the metal surface The workers direct the blasting nozzles at the surface to be cleaned As the paint is removed, small particles of lead paint, silica (if silica is contained in the abrasive), and other debris become airborne, and the used abrasive becomes contaminated with lead-containing paint particles Lead poisoning and silicosis are not uncommon among workers who remove lead-based paints from bridges and other steel structures

Two environmental requirements have been the driving force for contractors to contain paint chips, dust, and used abrasive during paint removal processes

The Resource Conservation and Recovery Act (RCRA) requires that waste material must be collected, tested, and classified as hazardous or not hazardous [4] Secondly, the Clean Air Act limits levels of particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM10) to a maximum of 150 $\mu g/m^3$ average concentration over a 24-hour period [5] The Clean Air Act also limits the amount of lead to 1 5 $\mu g/m^3$, evaluated as a maximum arithmetic mean averaged over a calendar quarter [5] The containment structures used to collect waste materials and control emissions has increased workers' risk of occupational exposure to lead and other waste materials, by increasing the concentration of these agents in and around the paint removal containment structures

Support personnel as well as workers doing abrasive blasting are at risk of high exposures to waste materials Automated waste recovery systems used in conjunction with containment structures are not completely effective, requiring manual sweeping, shoveling, or vacuuming Support personnel may also receive exposure when containment structures (which may contain or be contaminated with residual lead particles) are disassembled and moved High exposures have been observed for auxiliary equipment operators and for those cleaning up the site after paint removal has been completed [6]

A survey was conducted on September 23-25, 1992, at the BP Oil Refinery in Lima, Ohio, where lead-based paint was removed from a small process tank The engineering controls used during this evaluation consisted of containment, ventilation, and low silica abrasive blasting In addition to this survey, other existing and developing engineering controls for this industry will be evaluated A final report will summarize the engineering controls evaluated from all of the surveys

PLANT AND SITE DESCRIPTION

BP Oil is a major refiner of petroleum products and manufacturer of chemical intermediates and products They are attempting to reduce occupational exposure to lead by replacing failing coatings with nonlead containing paints Previously, BP Oil used open abrasive blasting to remove deteriorated coatings before repainting the structures They have now instituted procedures to prevent occupational exposure to lead dust, fume, and vapor generated by the removal of lead-based coatings and by the heating or cutting of metals protected by lead-based coatings

During this study, lead-based paint was removed from the Treated Gas Knock-out Tank (TGKO) in the Sulfur Recovery Unit The tank was about 4 5 feet in diameter and 11 75 feet tall It was mounted on a concrete 2-foot high, octagonal base, the top of the tank was about 20 5 feet above grade (Figure 1) Abrasive blasting with Starblast® XL (DuPont Company), a staurolite sand typically containing less than 1 percent quartz, was used inside a ventilated containment The Sour Gas Knock-out Tank (SGKO) was adjacent to the TGKO and similar in size Paint had been removed from this tank previously, but a brush-off blasting was needed to remove the rust prior to painting BP Oil personnel erected an aluminum scaffold approximately

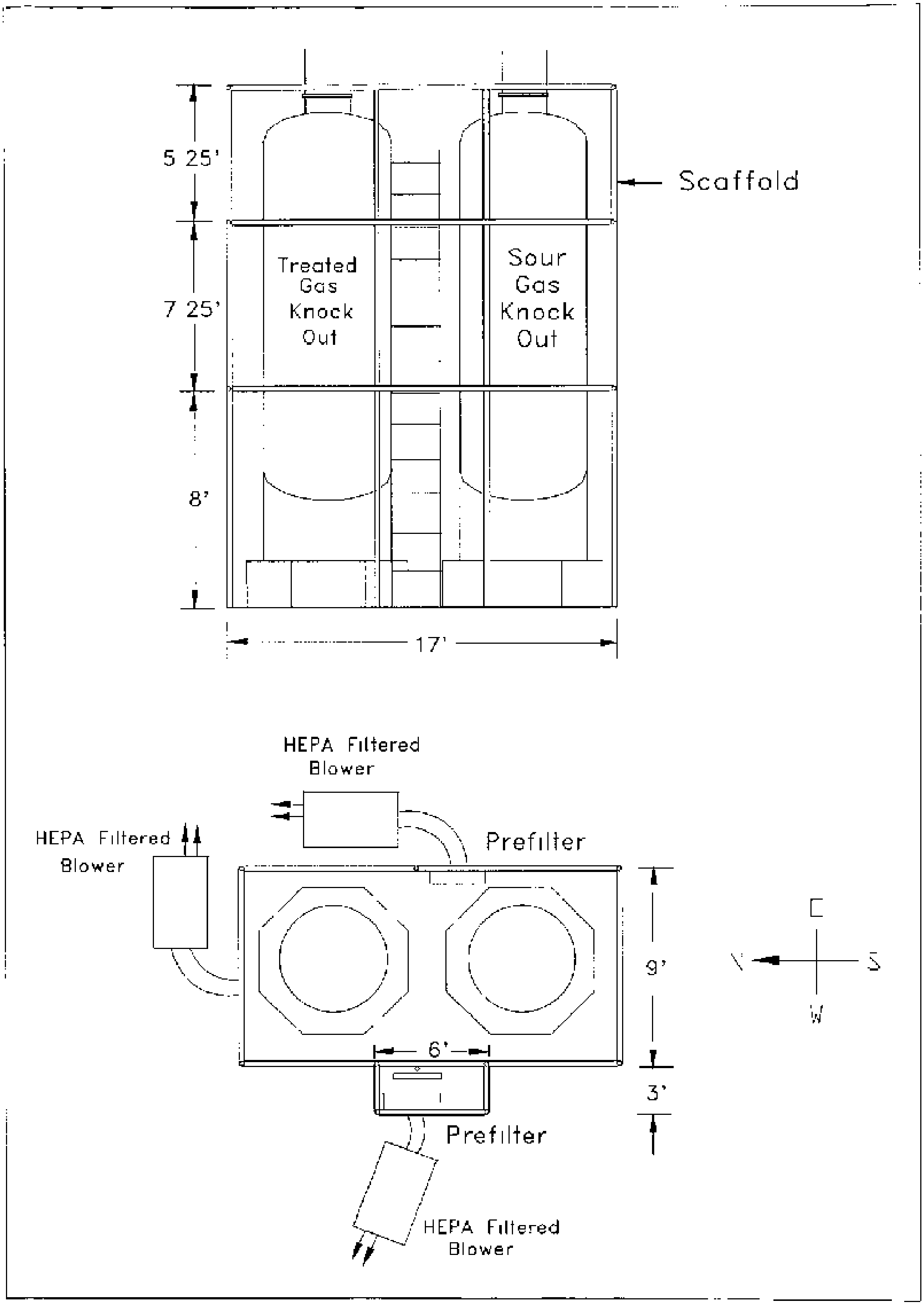

Figure 1. Lead-Based Paint Removal Site

17 feet long, 9 feet wide, and 21 feet high around the two tanks A scaffold extension approximately 6 feet long and 3 feet wide was added on the west side to provide room for a ladder to access two platforms which were constructed approximately 8 and 15 feet from the ground Personnel from the painting contractor, Mack & Mack Tank Service, constructed the containment by enclosing the scaffold with 6-mil nylon-reinforced polyethylene, a double flap entry was provided in the extension A work area about 20 ft x 30 ft was taped off around the containment to limit access and to reduce the risk of contamination of adjacent areas Lead exposure warning signs were posted

The enclosure was exhausted through high efficiency particulate air (HEPA) filters by means of pneumatic driven blowers attached to 12-inch wire-reinforced, polyethylene ducts installed in the east, north, and west sides of the containment The ducts on the east and west were preceded by a 2-foot square prefilter inside the enclosure Each blower was rated at 2000 cubic feet per minute (cfm) when driven by 90 psi air Fresh air entered at the top of the enclosure along the north and south sides through 6-inch diameter polyvinyl chloride (PVC) drain pipe with 0 5-inch perforations to provide distribution of the make-up air

Blasting was conducted from 10 15 to 13 40 with several interruptions Staurite was added to the blast pots at 12 05 (5 min), 12 35 (7 min), 13 10 (7 min) and 13 30 (5 min) The prefilters in the containment and also those in the blower units were changed at 11 20 (30 min) and again at 12 50 (15 min) Blowdown was started at about 15 00 and finished at 15 35

The contractor provided a change trailer with shower facilities and separate areas for dirty and clean clothing, however, it was used only for the purpose of donning or removing work clothing At the request of the refinery, sanitary services were actually provided in the refinery change room located about 100 yards from the tank repainting site The workers showered at the completion of each days work All contract personnel working in the refinery are required to attend a mandatory half-day safety training session and to wear hard hats and fire retardant Nomex® coveralls In addition, the paint removal workers wore Tyvek® coveralls over the Nomex and used foam type ear plugs and a half-face respirator with particulate filters when entering the designated (taped off) work area However, to reduce the potential for heat exhaustion, the blaster did not wear the Nomex coveralls while blasting, but instead, wore Tyvek coveralls over his cotton work clothing and blasting cape He used a new type CE, continuous-flow, air-supplied blasting respirator (Clemco Industries Corp , Washington, MO) Whenever the blaster exited the containment, the foreman immediately vacuumed the blaster's Tyvek coveralls and respirator hood

HEALTH EFFECTS

LEAD

Common symptoms of acute lead poisoning are loss of appetite, nausea, vomiting, stomach cramps, constipation, difficulty in sleeping, fatigue, moodiness, headache, joint or muscle aches, anemia, and decreased sexual drive Severe health effects of acute lead exposure include damage to the nervous system, including wrist or foot drop, tremors, and convulsions or seizures Acute lead poisoning from uncontrolled occupational exposures has resulted in fatalities [7] The frequency and severity of medical symptoms increase with the concentration of lead in the blood Many adults with a blood lead level (BLL) of 80 micrograms per deciliter of whole blood (μg/dl) or greater have symptoms or signs of acute lead poisoning, although in some individuals, symptoms may be so mild that they are overlooked [8,9,10] Chronic lead poisoning may result after lead has accumulated in the body over time, mostly in the bone Long after exposure has ceased, some physiological event such as illness or pregnancy may release this stored lead from the bone and produce health effects such as impaired heme synthesis, alteration of the central and peripheral nervous systems, effects on male and female reproduction, hypertension, and damage to the developing fetus [11] These health effects may occur at BLLs below 50 μg/dl

SILICA

Inhalation of crystalline silica dust has been associated with the development of silicosis In its earliest stage, silicosis can be seen on chest x-rays as scarring on the lungs without physical symptoms As the disease progresses, the symptoms include frequent dry coughing, shortness of breath, wheezing, increased tiredness, and cyanosis (bluish skin), it may often be misdiagnosed as pulmonary edema (fluid in the lungs), pneumonia, or tuberculosis These symptoms become worse in the advanced stages until death results from respiratory failure, heart failure, pneumonia, or other complications Severe mycobacterial or fungal infections often complicate silicosis and may be fatal in many cases [12,13,14]

A worker may develop any of three types of silicosis, depending on the airborne concentration of crystalline silica 1) Chronic silicosis, which usually occurs after 10 or more years of exposure to crystalline silica at relatively low concentrations, 2) Accelerated silicosis, which results from exposure to high concentrations of crystalline silica and develops 5 to 10 years after initial exposure, and 3) Acute silicosis, which occurs where exposure concentrations are the highest and can cause symptoms to develop within a few weeks to 4 to 5 years after the initial exposure [14,15]

NOISE

Noise-induced hearing loss is a sensorineural condition caused by irreversible damage to nerve cells of the inner ear (cochlea) that progresses with exposure and cannot be treated medically Hearing ability normally declines with age (presbycusis) in all populations, however, exposure to excessive noise produces hearing loss greater than that resulting from the aging process

OCCUPATIONAL EXPOSURE CRITERIA

The primary sources of environmental evaluation criteria in the United States that can be used for the workplace are NIOSH Recommended Exposure Limits (RELs)[16] and the U S Department of Labor (OSHA) Permissible Exposure Limits

(PELs)[17,18] The OSHA PELs are required to consider the feasibility of controlling exposures in various industries where the agents are used, the NIOSH RELs, by contrast, are based primarily on concerns relating to the prevention of occupational disease

LEAD

At the time of this study the OSHA PEL was 200 $\mu g/m^3$ for the construction industry[19] Recently, OSHA has promulgated a final interim lead standard for construction which took effect June 3, 1993[18] The OSHA PEL for exposure to inorganic lead is now 50 micrograms of lead per cubic meter of air ($\mu g/m^3$) as an 8-hr time-weighted average (TWA), equal to the PEL for general industry[17] The new standard requires monitoring of BLL for employees exposed to airborne lead at or above the Action Level of 30 $\mu g/m^3$ (8-hr TWA), specifies medical removal of employees whose average BLL is 50 $\mu g/dl$ or greater, and provides economic protection for medically removed workers The NIOSH REL for lead is less than 100 $\mu g/m^3$ as a TWA for up to 10 hours This REL is an air concentration to be maintained so worker blood lead remains below 60 $\mu g/100$ grams of whole blood NIOSH is presently reviewing literature on the health effects of lead and may reevaluate its REL The OSHA PEL for lead is currently recommended by the NIOSH investigators as a more protective criteria

SILICA

The current OSHA PEL for respirable crystalline silica (quartz) is 100 $\mu g/m^3$ as an 8-hr TWA The NIOSH REL for respirable crystalline silica is 50 $\mu g/m^3$ as a TWA for up to 10-hr/day during a 40-hr work week This REL is intended to prevent silicosis However, evidence indicates that crystalline silica is a potential occupational carcinogen and NIOSH is reviewing the data on carcinogenicity

NOISE

The A-weighted decibel (dBA) is the preferred unit for measuring sound levels The unit is dimensionless and represents the logarithmic relationship of the measured sound pressure level to an arbitrary reference sound pressure (20 micropascals, the normal threshold of human hearing at 100 Hertz) The dBA scale is weighted to approximate the sensory response of the human ear

The OSHA standard for occupational exposure to noise specifies a PEL of 90 dBA (slow response) for a duration of 8 hours per day The regulation, in calculating the PEL, used a 5 dBA time/intensity trading relationship This means that in order for a person to be exposed to noise levels of 95 dBA, the amount of time allowed at this exposure must be cut in half in order to be within the PEL Conversely, a person exposed to 85 dBA is allowed twice as much time at this level (16 hours) to be within the daily PEL

The OSHA regulation has an additional Action Level (AL) of 85 dBA which stipulates that an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds the AL The program must include monitoring, employee notification, observation, hearing protectors, training programs, and record-keeping requirements The OSHA noise standard also states that when workers are exposed to noise levels in excess of the PEL of 90 dBA, feasible engineering or administrative controls shall be implemented to reduce the worker's exposure levels

The NIOSH REL and the ACGIH TLV for noise specify an exposure limit of 85 dBA for 8 hours, 5 dB less than the OSHA standard These criteria also use a 5 dB time/intensity trading relationship in calculating exposure limits

EVALUATION METHODS

Personal breathing zone (PBZ) samples for both the blaster and the foreman were collected on 37-millimeter (mm), 0 8-micrometer (μm) pore size, cellulose ester membrane filters in closed-face cassettes The cassettes were connected via Tygon® tubing to SKC Model 224-PCXR3 (SKC Inc , Eighty Four, PA) battery-operated sampling pumps adjusted to a flow rate of approximately 2 0 liters/minute (L/m), the pumps were calibrated prior to and after sampling The samples were collected in the breathing zone (at the shirt collar) of the foreman For the blaster, paired samples were taken both inside and outside the blasting helmet The inside-the-helmet sampling filter cassette was placed next to the worker's face using a special cassette holder (SKC Inc , Eighty Four, PA) and connected to a belt-mounted sampling pump via Tygon® tubing which passed through the elastic neck collar of the helmet The outside-the-helmet sampling cassette was placed at the back of the blaster's neck, to reduce sample loss from direct contact with the high-velocity abrasive blast, and connected to a second belt-mounted pump

Five side-by-side area samples were taken inside the containment (Area I) in the northwest corner and midway between the two platforms (about 12 ft from grade) These samples were for the determination of total lead, respirable silica, inhalable particulate, total particulate, and particle size Total lead samples were taken with equipment and media described above for the personal samples Samples for respirable silica were collected on pre-weighed 37-mm, 5 0-μm pore size, PVC filters in closed-face cassettes preceded by a MSA nylon cyclone (MSA Inc, Pittsburgh, PA) at a flow rate of 1 7 L/m The total particulate samples were collected using similar PVC filters in closed face cassettes, but at a flow rate of 2 0 L/m The inhalable particulate was collected using a sampler developed by the Institute of Occupational Medicine of Edinburgh (IOM) The IOM sampler (SKC Inc , Eighty Four, PA), operated at a flow rate of 2 L/m, is designed to collect particles with equivalent diameters of up to approximately 100 μm The collection medium was a 25-mm diameter, 0 5-μm pore size, PVC filter The sampler cassette containing a filter is pre-weighed The determination of particle size was attempted using a six-stage Marple Personal Cascade Impactor Kit, Model 290 (Anderson 2000 Inc , Atlanta, GA) at a rate of 2 0 L/m The collection substrates were uncoated, 34-mm diameter, mixed cellulose ester Also included in the sampling array were a Quest M-27 Noise Logging Dosimeter (Quest Electronics, Oconomowoc, WI) to record sound levels and a direct reading Respirable Air Monitor (RAM) (MIE Inc , Billerica, MA) Output of the RAM was recorded by a Rustrak Ranger Data Logger (Gulton Inc , East Greenwich, RI)

Analyses for lead and major metals were made according to NIOSH Method 7300 using inductively coupled argon plasma, atomic emission spectrometry, when the lead results were below the limit of detection, samples were then analyzed using flame atomic absorption spectroscopy (NIOSH Method 7105) [20,21] Silica analyses were made in accordance with NIOSH Method 7500 using x-ray diffraction [22] Total particulate and inhalable particulate analyses were made using NIOSH Method 0500 [23]

Area samples were also taken outside the containment (see Figure 2) A sampling array (A), located about 20 feet west of the containment entry, included all of the sampling devices that were used inside the containment except for the RAM and the Marple Personal Cascade Impactor Sampling for lead only was conducted (B) about 20 feet southwest of the southwest corner of the containment, (C) 10 feet north of the northwest corner, 4 feet from the effluent of a HEPA-filtered blower, and (D) 18 feet northeast of the northeast corner, 6 feet from the effluent of another HEPA-filtered blower A sampling array (E), consisting of respirable silica, total particulate, and total lead samplers, was located 5 feet east of the southeast corner of the containment The prevailing wind, gusting to approximately 15 miles per hour, was generally from the east, however, the proximity of other refinery processing towers and equipment created eddy currents of varying velocity and direction

Bulk samples of the deteriorated paint from the process tank (TGKO) were obtained by scraping the surface of the tank with a steel wood chisel One sample of the paint was obtained at a preliminary visit, another sample and a portion of the peeling top coat were obtained during the in-depth study A bulk sample of fresh abrasive was obtained while the abrasive pot was being filled Several samples of used abrasive were obtained from different areas at the bottom of the containment and combined for analysis

RESULTS AND DISCUSSION

VENTILATION

The enclosure and exhaust ventilation system appeared adequate to contain the particulate except on a few occasions when the blasting nozzle was directed at the entry flaps or at a weak seal in the containment, at these times visible emissions were observed If the air flow of 6000 cfm is assumed to be distributed evenly over the cross-sectional area of the containment (130 ft^2), the average velocity would be about 46 feet per minute (fpm) However, the platforms restricted the air flow, therefore, higher velocities occurred in the vicinity of the irregular openings in the platforms that surrounded the tanks Velocity measurements made with a Series 400 Hot-wire Anemometer (Kurz Instruments Inc , Monterey, CA) ranged from 60 to 120 fpm (av = 80) at the opening in the top platform and ranged from 20 to 100 fpm (av = 60) at the opening in the bottom platform The velocity was dependant upon the distance of the gap between the edge of the platform and the tank

After about 20 minutes of operation there was a tendency for the wire-reinforced polyethylene fabric ducts to crimp or collapse, thereby reducing

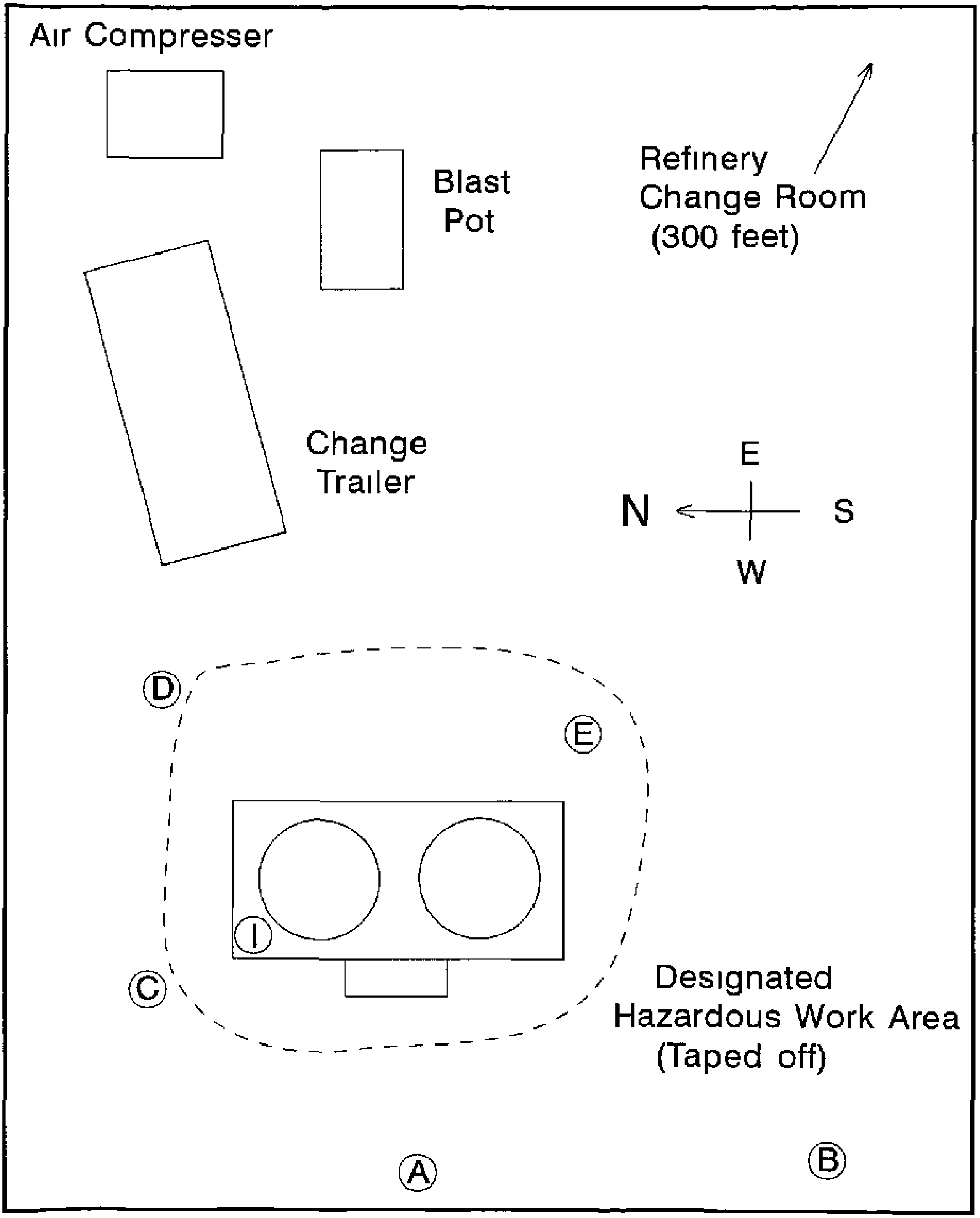

Figure 2. Sketch of Work Area

exhaust ventilation by an unknown amount Several slits were cut into the top of the containment in an attempt to increase the supply air into the enclosure, however, it did not prevent the ducts from collapsing

LEAD

Table 1 shows the results of analyses for major metals of the paint samples and of samples of new and used abrasive The total paint samples contained approximately 25 percent lead, mostly in the undercoat The lead content increased from 15 parts per million (ppm) in the unused abrasive to 3800 ppm in the used abrasive, however, the analysis was made from a grab sample and may not be representative of the total used abrasive

Table 1 Major Elements in Bulk Samples (ppm by weight)
Samples analyzed using NIOSH Method 7300

Element	Paint			Abrasive	
	Total*	Total	Topcoat	New	Used
Lead	260,000	230,000	30,000	15	3,800
Calcium	21,000	29,000	46,000	30	2,200
Iron	11,000	17,000	11,000	140	1,600
Magnesium	3,400	3,400	1,600	5	81
Aluminum	1,000	2,400	3,800	350	400
Titanium	880	1,500	1,100	170	220
Zinc	80	70	530	9	40

*Sample taken during preliminary visit

The results of sampling for airborne lead are shown in Table 2 Although occasionally visible emissions were observed escaping the enclosure, the peripheral area sampling indicated that very little lead escaped the enclosure The highest lead concentration was found in the Area C sample which was nearest to the containment entry This may indicate that the double baffle was not a completely effective seal, but may be sufficient for this application The foreman entered the containment briefly several times during the blasting and blowdown periods and this may have resulted in some contaminant escape

Inside the containment, area samples (during blasting and during blowdown after the blasting was completed) indicated a concentration of about 10,000 $\mu g/m^3$ The personal exposure sample outside the helmet of the blaster was about twice that, 22,000 $\mu g/m^3$ and is consistent with the area result in that the personal sampler was closer to the blasting process The NIOSH

Table 2 Area and Personal Breathing Zone Air Sampling for Lead					
Location	Distance from containment	Activity	Samplin g Time (min)	TWA Based on Sampling Time ($\mu g/m^3$)	8-hr TWA ($\mu g/m^3$)
Area A	20' west		390	0 1	<0 1
Area B	20' southwest		380	0 1	<0 1
Area C	10' northwest		380	4	3
Area D	18' northeast		385	0 4	0 3
Area E	5' east		390	0 2	0 2
Area I	Inside Containment	Blasting	308	10,000	6,440
Area I	Inside Containment	Blowdown	61	9,800	1,250
Area I	*Inside Containment*	*Combined*	*369*	*10,000*	*7,690*
Person					
Foreman	Outside Containment	Blasting	220	276*	126*
Foreman	Outside Containment	Blowdown	110	690*	158*
Foreman	*Outside Containment*	*Combined*	*330*	*414**	*285**
Blaster	Inside Respirator	Blasting	215	2	1
Blaster	Outside Respirator	Blasting	215	22,000	9,900

*The exposure of the foreman is elevated because he entered the containment briefly several times to give orders and to assist the blaster

assigned protection factor for the type CE blast hood respirator is 25, thus the maximum allowable lead concentration outside the respirator should be 1250 $\mu g/m^3$ to comply with the OSHA general industry PEL However, the lead concentration inside the respirator was determined to be only 2 $\mu g/m^3$ during the period that abrasive blasting was performed The calculated program protection factor (PPF) based on this one data set, 10,000, was remarkably high The blaster donned a new, type CE supplied-air blasting helmet before entering the enclosure and did not remove it until after leaving the enclosure He also used very good work practices

AIRBORNE PARTICULATE

The results of sampling for inhalable, total, and respirable particulate are shown in Tables 3, 4, and 5, respectively Area sampling showed that apparently very little particulate escaped the containment, which confirms the results of sampling for lead Particulate concentrations inside the containment were very high The sampling devices used were designed for use under isokinetic conditions, where the air flow rate into the sampler is similar to ambient flow near the sampler In the very turbulent conditions which occur during blasting and blowdown it is quite likely that large particles may be propelled into the sampler and thus bias the results

Table 3 Area Air Sampling for **INHALABLE PARTICULATE**					
Location	Distance from containment	Activity	Sampling Time (min)	TWA Based on Sampling Time (mg/m³)	8-hr TWA (mg/m³)
Area A	20' west		390	< 0 03	< 0 03
Area I	Inside Containment	Blasting	310	3,900	2,520
Area I	Inside Containment	Blowdown	59	5,400	630
Area I	*Inside Containment*	*Combined*	*369*	*4,130*	*3150*

Table 4 Area Air Sampling for **TOTAL PARTICULATE**					
Location	Distance from containment	Activity	Sampling Time (min)	TWA Based on Sampling Time (mg/m³)	8-hr TWA (mg/m³)
Area A	20' west		390	< 0 03	< 0 03
Area E	5' east		390	0 04	0 03
Area I	Inside Containment	Blasting	311	1,030	669
Area I	Inside Containment	Blowdown	58	333	40
Area I	*Inside Containment*	*Combined*	*369*	*922*	*709*

Table 5 Area Air Sampling for **RESPIRABLE PARTICULATE**					
Location	Distance from containment	Activity	Sampling Time (min)	TWA Based on Sampling Time (mg/m³)	8-hr TWA (mg/m³)
Area A	20' west		390	0 09	0 07
Area E	5' east		390	0 06	0 05
Area I	Inside Containment	Blasting	312	39	25
Area I	Inside Containment	Blowdown	57	49	6
Area I	*Inside Containment*	*Combined*	*369*	*41*	*31*

Although the results obtained may lack the accuracy normally associated with this type of sampling, they are indicative of the relative concentrations of contamination

The particulate matter collected in the Marple sample overloaded the early stages and large particles of abrasive and paint chips were found in the air passages leading to the third and fourth stages The respirable particulate samples are preceded by a cyclone separator and thus may be more reliable The concentration measured was 6 times the OSHA PEL of 5 mg/m³ for respirable particles not otherwise classified (nuisance dust)

Dust concentrations inside the containment were also monitored with the direct reading respirable aerosol monitor (RAM) Output from this instrument is qualitative in nature, providing only relative measures of respirable dust concentrations The variation of relative concentrations was similar to the sound level (see Figure 3) The dust levels decayed rapidly when blasting ceased, dropping 80 to 90 percent in the first two or three minutes and reaching minimum levels in 5 to 10 minutes

SILICA

Personal sampling for silica was not conducted The results of area sampling for free silica are shown in Table 6 The Material Safety Data Sheet for Starblast XL indicated the quartz concentration to be typically <1 percent However, the 8-hr TWA concentration for silica inside the containment was over 1200 μg/m³, 24 times the OSHA PEL of 100 μg/m³ This shows that, even though a low-silica abrasive is used, excessive silica exposure can result because of the quantity of abrasive released during blasting within the containment

Note that this analysis was made on the same sample collected to determine the respirable particulate for the 8-hr TWA (31000 μg/m³) shown in Table 5, this would indicate that 4 percent of the respirable particulate was silica

Table 6 Area Air Sampling for FREE SILICA

Location	Distance from containment	Activity	Sampling Time (min)	Sampling Time TWA (μg/m³)	8-hr TWA (μg/m³)
Area A	20' west		390	< 15*	< 15
Area E	5' east		390	< 15	< 15
Area I	Inside Containment	Blasting	312	1,530	990
Area I	Inside Containment	Blowdown	57	1,880	220
Area I	*Inside Containment*	*Combined*	*369*	*1,580*	*1210*

*Value is less than the Limit of Detection

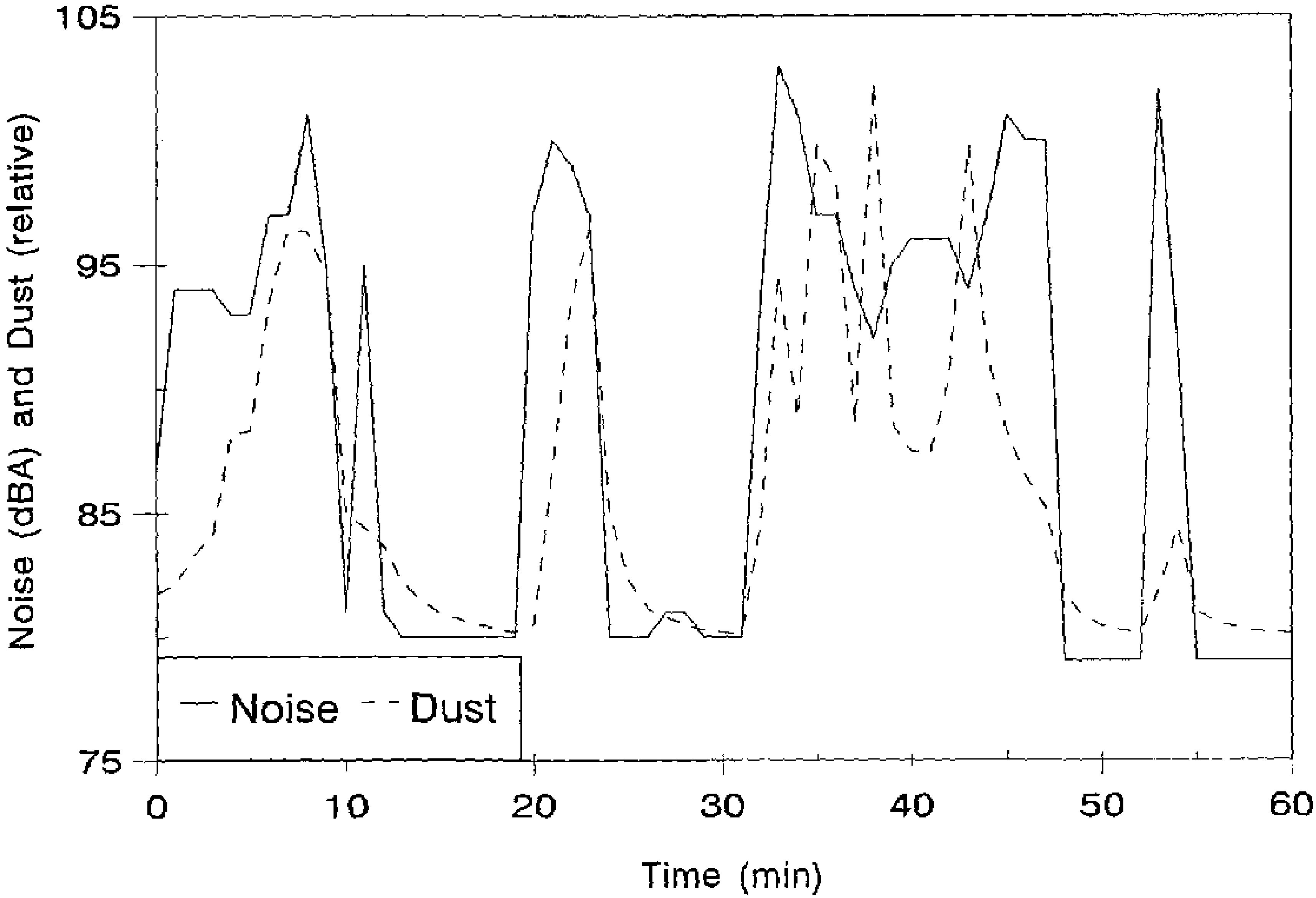

Figure 3. Noise and Dust Exposure

NOISE

Area noise levels measured are summarized in Table 7 Apparently the containment provided attenuation of the noise coming from nearby equipment, the average sound level over the 6 5 hour period monitored was 80 dBA in the containment and 87 dBA outside The minimum noise inside during rest periods was 60 dBA, but about 84 dBA outside The highest peak inside the containment, 116 dBA, occurred during blowdown, it was attenuated to 99 dBA at the outside sampler The inside containment sound levels were measured in a corner of the enclosure, since sound levels are attenuated by distance, the sound levels in the immediate vicinity of the blaster were likely to be higher, possibly approaching the maximum levels recorded Because of the noise from nearby process equipment, noise levels measured outside the containment exceeded the NIOSH REL of 85 dBA, but were below the OSHA PEL of 90 dBA Measurement of the sound levels provided additional data high noise levels were recorded during blasting, this made it possible to track the times of blasting without an observer being in the containment

Table 7 Noise Levels (dBA) During Paint Removal

	Overall		During Blasting		During Blowdown	
Containment	Inside	Outside	Inside	Outside	Inside	Outside
Maximum	116	99	106	97	116	99
Minimum	60	84	62	84	70	84
Average	80	87	85	87	89	89
Time (min)	380	390	200	200	70	70

CONCLUSIONS AND RECOMMENDATIONS

The containment used at this site was adequate to prevent contamination of the surrounding atmosphere with dust created by the abrasive blasting of lead-based paint from the tank surfaces Visible emissions were observed at infrequent intervals, however, area samples (Table 2) taken outside the containment indicated negligible dust and lead concentrations Although the exhaust ventilation provided for rapid decay of dust levels when blasting ceased, it was insufficient to control airborne dust and lead concentrations within the containment during abrasive blasting and blowdown Airborne lead concentrations measured by the PBZ sampler worn by the blaster inside the containment (22,000 $\mu g/m^3$) greatly exceeded the OSHA PEL, however, based on the inside-the-respirator lead concentration (2 $\mu g/m^3$), the blaster was adequately protected by the type CE respirator he was wearing The respirator, unused before this work, and the excellent work practices used were obviously very effective in reducing the lead exposure of the abrasive blaster

Because of equipment and set-up costs, it may not be economically feasible to ventilate containment structures sufficiently to reduce concentrations of airborne lead and particulate to below the OSHA PELs when abrasive blasting is used for small jobs such as this Under these conditions workers must rely on good work practices, including personal hygiene, and superior respiratory protection or use other methods. **It is recommended that research be conducted to determine the significant factors affecting the protection factors of supplied-air, blasting hoods, and other possible respiratory protection**

Alternative methods for lead-based paint removal such as vacuum blasting, wet blasting, or chemical removal, may effectively reduce lead exposure concentrations but each removal method has limitations

Shortly after the exhaust blowers were started, the light gage, wire-reinforced polyethylene ducts tended to collapse **It is recommended that sturdy materials be used to connect exhaust blowers to the containment** Where possible, 22-gage minimum (preferably 18-gage) long radius (2 or more duct diameters) sheet metal elbows should be used when changes of direction are necessary

Even though the blasting media contained typically less than 1 percent quartz, the airborne silica concentration inside the containment exceeded the OSHA PEL Based on the measured protection provided by the CE respirator for lead, the blaster should not have been endangered by this concentration **Other commercially available abrasives, containing less silica, should be used when blasting is performed inside containment**

Noise levels were at approximately the NIOSH REL (85 dBA) in the location where they were measured Because distance attenuates noise, it is probable that noise levels at the blaster exceeded the OSHA PEL **Workers inside the containment wore hearing protection, it is recommended that this practice be continued**

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