

PRELIMINARY SURVEY REPORT:  
EVALUATION OF BRAKE DRUM SERVICE CONTROLS  
AT  
Pennsylvania Bureau of Vehicle Management  
Vehicle Maintenance Division  
Harrisburg, Pennsylvania

REPORT WRITTEN BY:  
Harold D. Van Wagenen

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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH  
Division of Physical Sciences and Engineering  
Engineering Control Technology Branch  
4676 Columbia Parkway  
Cincinnati, Ohio 45226

PLANT SURVEYED: Pennsylvania Vehicle Maintenance  
Division Garage  
2221 Forster Street  
Harrisburg, Pennsylvania 17103

SIC CODE: 7538

SURVEY DATE: March 13, 1986

SURVEY CONDUCTED BY: Thomas C. Cooper  
Harold D. Van Wagenen

EMPLOYER REPRESENTATIVES CONTACTED: Jerry Swanger, Garage Manager  
(717) 787-3933

EMPLOYEE REPRESENTATIVES CONTACTED: Levi Hite, Steward of Union Local 2533,  
AFSCME (AFL-CIO)

SUPPLIER REPRESENTATIVE ON HAND: Brian M. Shaw, Clayton Associates, Inc.  
(CAI) - Customer Service Manager

## I. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) is the primary Federal agency engaged in occupational safety and health research. Located in the Department of Health and Human Services (formerly DHEW), it was established by the Occupational Safety and Health Act of 1970. This legislation mandated NIOSH to conduct a number of research and education programs separate from the standard setting and enforcement functions carried out 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 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 of health hazard prevention and control.

Since 1976, ECTB has conducted a number of assessments of health hazard control technology on the basis of industry, common industrial process, or specific control techniques. Examples of these completed studies include the foundry industry; various chemical manufacturing or processing operations; spray painting; and the recirculation of exhaust air. The objective of each of these studies has been to document and evaluate effective control techniques for potential health hazards in the industry or process of interest, and to create a more general awareness of the need for or availability of an effective system of hazard control measures.

These studies involve a number of steps or phases. Initially, a series of walk-through surveys is conducted to select plants or processes with effective and potentially transferable control concepts or techniques. Next, in-depth surveys are conducted to determine both the control parameters and the effectiveness of these controls. The reports from these in-depth surveys are then used as a basis for preparing technical reports and journal articles on effective hazard control measures. Ultimately, the information from these research activities builds the data base of publicly available information on hazard control techniques for use by health professionals who are responsible for preventing occupational illness and injury.

This plant was visited as part of a study of asbestos control during the maintenance and repair of vehicular brakes. The study will evaluate the effectiveness of various control technologies designed to reduce asbestos exposure to brake mechanics. Ultimately, this project will result in a proposed journal article describing the effectiveness of such controls.

### Background

Asbestos is found in motor vehicle brake materials throughout industry. Recognition of asbestos' carcinogenic properties has currently resulted in substitution of less toxic fibers for some brake materials. However, asbestos is still used in a large number of brakes. This study is concerned with the control of asbestos exposures to workers who are required to repair motor vehicle brakes.

Dubrow and Wegman published a research and control priority assessment of occupational carcinogens.(1) Their objective was to identify occupations with potentially high cancer risk by combining the results of 12 major occupational disease surveillance studies and to make recommendations concerning priorities for occupational cancer research and control on the basis of the results of this analysis in conjunction with other available epidemiologic, industrial hygiene, toxicologic, and employment data. On the basis of the principles outlined in their paper, some priorities for research and control clearly stood out. Their results pointed to the investigation and control of occupational exposure to asbestos as the number one priority in occupational cancer research and control. "In this situation, where occupational disease surveillance studies point to a likely problem with a known carcinogenic agent, the priority should be placed on industrial hygiene investigations of asbestos exposure in the suspect occupations. If likely exposure is found, control measures should be developed and instituted."

There are frequent asbestos exposures during brake repair in the vehicle maintenance work force. NIOSH in the National Occupational Exposure Survey estimates that a work force of 151,000 brake mechanics and garage workers in the U.S. are potentially exposed to asbestos.(2) Other estimates run as high as 900,000 potential exposures.(3)

A study of brake service operations is needed because of the following: the known carcinogenic potential of asbestos; a large number of workers are exposed; primarily small businesses perform brake servicing and lack resources to evaluate control devices; and the general lack of information on the effectiveness of control devices currently available. Therefore, the NIOSH Engineering Control Technology Branch undertook this study.

## II. PLANT AND PROCESS DESCRIPTION

### PLANT DESCRIPTION

This garage facility occupies an entire floor of a very large two-story Pennsylvania state building located adjacent to the main business district of the state's capitol, Harrisburg. A main floor houses the headquarters for the state:

- 1) Bureau of Telecommunications and Information Technology Services
- 2) Bureau of Supplies and Surplus Operations
- 3) Bureau of Vehicle Management (Director - J.M. Robb and a staff of 45)

The entire lower level, operated by the Bureau of Vehicle Management Maintenance Division, comprises a large heated indoor parking area for at least 300 cars and an adjacent walled off well-equipped garage - having dimensions of 150 foot length, 45 foot width, and 18 foot height. Originally designed to routinely handle 300 cars, this garage has been upgraded in the last few years with new equipment including elaborate ventilation units (both local and general) to meet current rigorous state building code requirements. Ostensibly mandated to handle all 3,800 non-truck state vehicles operating within a 50-mile radius of Harrisburg, this garage provides complete general

maintenance on 168 executive cars, periodic inspection of all the vehicles, and some major repairs for the older cars, vans, and pickup trucks in the district. An auction of about 300 vehicles is conducted yearly at this facility to cull out the older poor performers subject to replacement with new vehicles. A crew of seven veteran mechanics are full time employees of the garage. Both overhead hoists and floor based hydraulic lifts are employed in a series of bays to raise the vehicles off the floor. The number of brake jobs varies considerably with time, but generally is in a range of 5 to 10 weekly. Housekeeping in the garage is good and there was no dust in the air on visual inspection.

#### PROCESS AND EQUIPMENT DESCRIPTION

Brakes have been serviced for the past year using a BCE-1000 Clayton brake cleaning unit - sized for cars, vans, and pickups. A larger Clayton unit, BCE-2000 sized for brake drums up to 17 inches in diameter, can be purchased for servicing heavy trucks. The Clayton Customer Service Manager (Mr. Brian Shaw) present during this visit provided pertinent information and acted out the Clayton approved procedures for handling and changing the various unit filters. His demonstrations were filmed with the NIOSH VHS recorder and video camera. The Clayton BCE-1000 model purchased by this Pennsylvania state garage is currently priced (1986) at \$3,100. This price included individualized training of the mechanics conducted by a Clayton Associate sent to the site from their New Jersey headquarters. Clayton is now developing a training tape to be supplied to future purchasers for self training, accompanied by possible reduction in the purchase price.

The readily portable Clayton unit consists of an adjustable height glove box for enclosing the brake assembly (after wheel removal) connected by hose to a three-stage vacuum dust filter assembly. Figure 1 shows a mechanic both positioning and working within the glove box, while Figure 2 is a detailed sketch of the dust filter assembly. Discussion of the Clayton unit and the procedures followed in its operation will be presented in detail under III - Controls.

### III. CONTROLS

#### PRINCIPLES OF CONTROL

Occupational exposures can be controlled by the application of a number of well-known principles, including engineering controls, work practices, personal protective equipment, and monitoring. These principles may be applied at or near the hazard source, to the general workplace environment, or at the point of occupational exposure to individuals. Measures applied at the source of the hazard, including engineering controls (material substitution, process/equipment modification, isolation or automation, local ventilation) and work practices, are generally the preferred and most effective means in terms of occupational and environmental concerns. Controls which may be applied to hazardous materials that have escaped into the workplace or environment include dilution ventilation, dust suppression, and housekeeping. Control measures applied near individual workers may include the use of remote

# ASBESTOS IN AUTOMOTIVE SHOPS!

***Ceilings and pipes aren't the  
only places to look for  
ASBESTOS HEALTH HAZARDS***

A Mt. Sinai Medical Center research study, "Asbestos Exposure During Brake Lining Maintenance and Repair" (December 1975), confirmed that free **asbestos fibers are present** in decomposed lining dust. Virtually, all these fibers are small enough to be inhaled, although they are invisible to the naked eye.

Conventional cleaning methods still practiced in most garages and school industrial arts classes expose workers and students to *lethal* concentrations of asbestos fibers.

The use of common industrial vacuums, without H.E.P.A. filters, to collect asbestos-ridden dust actually creates a greater hazard: microscopic asbestos fibers pass through the filters and are blown into the air to be inhaled.



## BE ASBESTOS FREE...

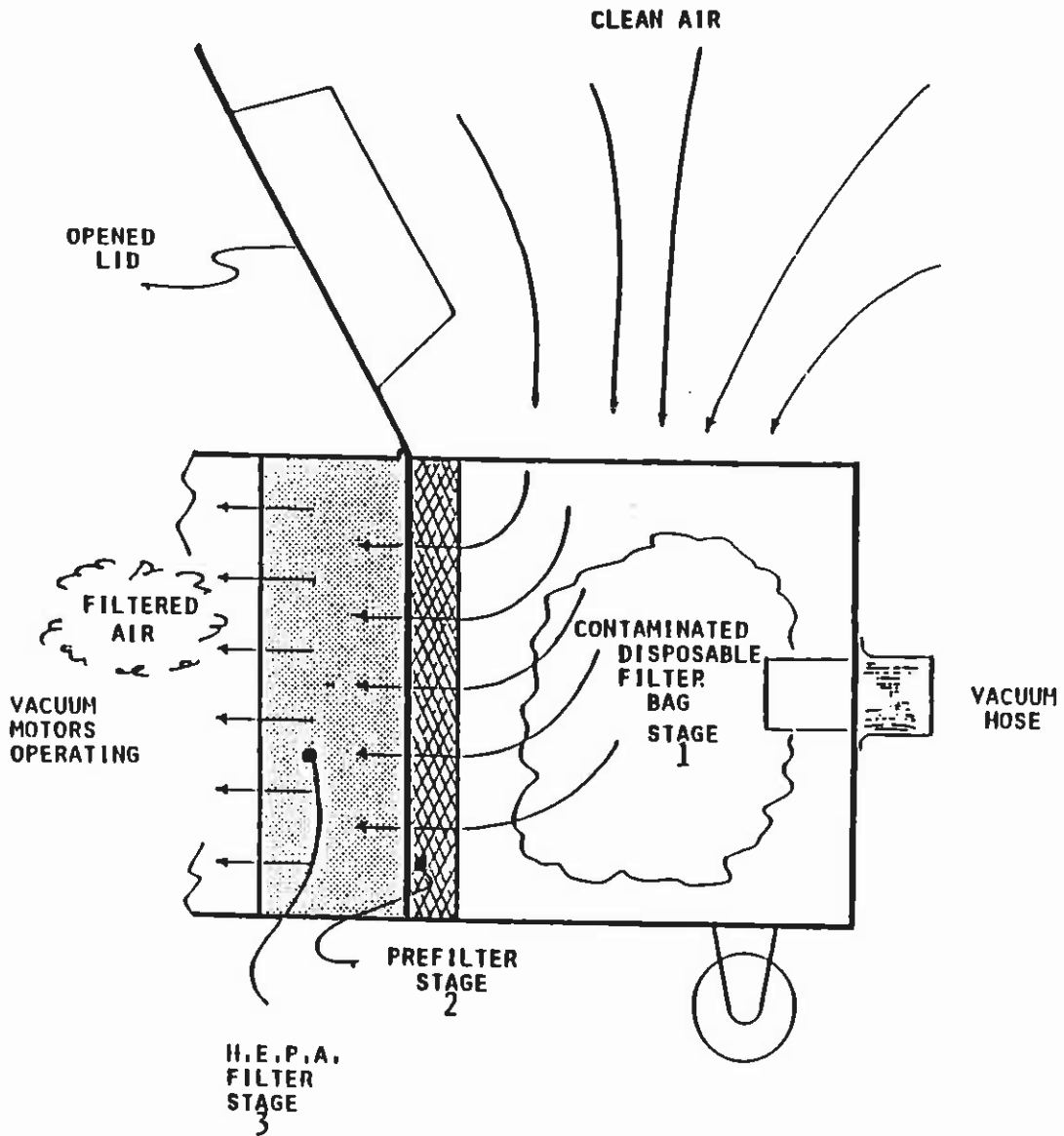
***...Use the only  
equipment designed with  
SAFE FILTER CHANGE™ and  
99.999% FILTRATION.***

**CLAYTON ASSOCIATES  
BRAKE CLEANING EQUIPMENT**

Figure 1

# Safe Filter Change™

PATENT PENDING



**Clayton Associates, Inc.**  
P.O. Box 589 • 30 Southard Avenue, Farmingdale, N.J. 07727 • (201) 938-6700  
COLLECTION & DISPOSAL SYSTEMS FOR ASBESTOS AND OTHER HAZARDOUS SUBSTANCES

Figure 2

control rooms, isolation booths, supplied-air cabs, work practices, and personal protective equipment.

In general, a system comprised of the above control measures is required to provide worker protection under normal operating conditions as well as under conditions of process upset, failure, and/or maintenance. Process and workplace monitoring devices, personal exposure monitoring, and medical monitoring are important mechanisms for providing feedback concerning effectiveness of the controls in use. Ongoing monitoring and maintenance of controls to insure proper use and operating conditions, and the education and commitment of both workers and management to occupational health are also important ingredients of a complete, effective, and durable control system.

These principles of control apply to all situations, but their optimum application varies from case to case.

#### ENGINEERING CONTROLS

This Pennsylvania state garage uses the BCE-1000 Clayton unit, comprising a transparent enclosure hood and an HEPA vacuum filter dust collector, for servicing of all vehicular brakes during their cleaning, maintenance, repair, and particularly replacement. The Clayton unit, especially designed to contain and collect all brake lining dust (including its hazardous asbestos fiber content) exemplifies the engineering control principles of source enclosure, local ventilation, and dust entrapment and removal through effective filtration. The toxicological effects of worker inhalation of asbestos fibers is well documented and instances of auto repair workers developing mesothelioma identified. Referring to Figure 2, the first stage filter bag is similar to a conventional home vacuum cleaner bag, while the second stage 12" by 12" square prefilter is similar to home hot air furnace filters. The third stage, the high efficiency particulate filter (HEPA), is a unique and expensive filter which has been tested as removing 99.999% of all particulate matter larger than 0.12 microns in size. All three types of filters are standard items purchased from outside suppliers. Filter life is dependent on usage and resultant total collection. With both vacuum pumps operating the vacuum gauge mounted on the vacuum pump case normally shows about 4-5" water vacuum. When the vacuum reading drops to 1"-2" after continued use, the bag and prefilter are subject to removal and replacement with new ones. Under normal operation (5-10 brake jobs per week) of the Clayton unit, the first stage bag filter will likely need replacement in 1-2 months, the second stage prefilter in 3-12 months, and the third stage HEPA filter in 3-5 years. The recommended procedure for removal and replacement of the first and second stage filters involves common sense work practices (see work practices). Removal of the HEPA filter and especially its careful replacement to prevent any bypass leakage poses a problem. With this in mind, Clayton is introducing a special exchange service involving fast shipment of the complete base assembly to the Clayton plant and its immediate replacement by another reconditioned assembly containing a new HEPA filter. Clayton proposes maximum 72-hour turnaround time with an approximate \$75 charge added above the \$400 cost of the replacement HEPA filter. The glove box enclosure is constructed of clear Lexan plastic with the opaque backside comprising four overlapping neoprene fabric flexible strips. These allow easy passage of the



brake drum assembly into the enclosure and also provides the essential tight fit around the axle. Fastened to the front face of the enclosure and extending inwardly are two long gloves into which the mechanic shoves his hands and arms up to and sometimes past the elbows. These loosely fitting gloves permit the mechanic to readily operate the following items which either penetrate the enclosure or are kept within it to assist dismantling of the brake drum and subsequent cleaning of the brake linings, pads, and other elements of the brake system. These items comprise (1) a conventional compressed air gun, (2) a vacuum line with brush attachment, (3) a hammer and/or mallet, and (4) a separate brush. Referring to Figure 1, the entire hood enclosure can be quickly moved up or down the four corner frame posts to permit servicing of vehicular brakes at nearly floor level as well as at higher levels. A lift rack will position the vehicle to suit the stature and optimum working levels for the various individual mechanics. Consequently, the hood enclosure is positioned at this optimum working level. The Clayton unit has plenty of extension cord to reach the working bays and rolls readily to its destination. The mechanics expressed satisfaction with both the quality and operation of their Clayton BCE-1000 unit and operated it with confidence. There had been a few complaints which merited equipment changes and their rectification was the purpose of Mr. Brian Shaw's (Customer Service Manager for CAI) visit. He had just completed the following equipment modifications prior to our visit:

- 1) Mounting a newly designed four piece neoprene flexible fabric facing as the back side of the hood enclosure.
- 2) Replacing existing gloves with a larger hand size to fit all mechanics.
- 3) Installing a pressure relief valve in the side of the Lexan enclosure to prevent enclosure collapse through excessive vacuum.

#### WORK PRACTICES

Vendor personnel had provided on-site initial training on the Clayton unit demonstrating both the optimum technique for its usage and also the safest way for removal and disposal of the first and second stage dust filters. No respirator usage or wearing of protective clothing was deemed essential nor recommended by Clayton, rather the application of optimum work practices was stressed. The Clayton recommended sequence of steps encompassing the best work practices during use of their unit for brake shoe replacement is:

- 1) Raise the rear end of the vehicle, remove the wheel, and set it safely aside.
- 2) Hoist the rear of the vehicle to the level which best suits the mechanic doing the job.
- 3) Roll the Clayton in front of the wheel and start its vacuum pumps.
- 4) Make sure all the necessary auxiliary items are placed within the clean enclosure. Next move the entire unit forward so the enclosure

completely envelopes the brake assembly (be sure the rear side four way flap tightly wraps around the axle).

- 5) First order of business, and sometimes quite difficult, is removal of the wheel drum. Using the gloves and either a hammer or mallet for loosening the drum, the mechanic removes the drum and sets it safely aside within the enclosure face up.
- 6) Next the vacuum hose with attached brush is manipulated to remove all loose dust from the inside of the wheel drum, the surface of the brake shoes and related assembly, and the inside surfaces of the Lexan enclosure. This intensive vacuuming removes only part of the fine dust which clings tenaciously to the various surfaces.
- 7) To remove the remainder of the fine dust, blowing with compressed air intermixed with severe brushing is performed. The extent of residual dust removal by this action is typified by the dark swirling dust clouds within the enclosure. This gradually dissipates as the vacuum pumps pull the contaminated air through the sequence of three dust filters.
- 8) When the brake assembly and enclosure interior surfaces are completely cleaned of residual dust, the Clayton unit is removed from the brake assembly and the brakes serviced.

The sequence of steps 1 through 8 normally occupies not more than a 5-minute period.

When the first and second stage filters contained within the closed bottom assembly require replacement, the following sequence of steps is recommended by Clayton:

- 1) Start the vacuum pumps and prop open the flap on top of this assembly to allow access to these separate filter units. By so doing, the bag and prefilter are under negative pressure with the dust being drawn to the surface of the filters. This action substantially reduces the possibility of hazardous dust being emitted from the filters during their removal.
- 2) Carefully wrap a minimum 6 ml thickness impermeable plastic bag around the first stage filter bag. Simultaneously pull the bag filter loose and fasten the enveloping bag opening with tape. With the first stage filter bag successfully removed, employ the same technique and work practices to enclose the second stage prefilter.
- 3) These waste containers should be labeled as "Containing Asbestos Fibers - Avoid Breathing Dust."

Disposal of the resultant waste containers should be done in accordance with Environmental Protection Agency (EPA) regulations detailed in Title 40, CFR, Part 61, Subparts A and B. These require that waste containers enclosing asbestos dust shall be buried in an EPA-approved hazardous waste disposal

site. The current practice of this Pennsylvania state garage sending these waste containers to the local municipal incinerator should be discontinued.

#### AIR MONITORING RESULTS

Real time dust aerosol concentrations (total dust) in the air space adjacent to the Clayton unit both before, during the 5-minute brake cleaning cycle, and after this were obtained using a GCA RAM-1 Model portable instrument. This unit reports total dust concentrations in terms of milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ) over a possible range of 0-20  $\text{mg}/\text{m}^3$ . With readings taken every two seconds, the observed readings over the entire testing period of approximately 15 minutes lay in a 0.08-0.12  $\text{mg}/\text{m}^3$  range. There were essentially no differences in the averaged readings over the different periods (1) before brake cleaning, (2) during brake cleaning, and (3) after conclusion of brake cleaning.

If only nuisance dust were present, these 0.08-0.12  $\text{mg}/\text{m}^3$  values are way below the OSHA PEL (permissible exposure level) limit of 10  $\text{mg}/\text{m}^3$  for 8-hour TWA (time-weighted average) airborne concentrations. However, there is an unknown amount of asbestos present and the OSHA PEL limit for asbestos fibers, at the time of this survey, was 2 fibers per cubic centimeter (2 f/cc) of air. The present OSHA PEL limit is 0.2 f/cc of air. Results from prior NIOSH investigations demonstrate that the brake dust taken from Clayton bag and prefilter surfaces should contain a low proportion of asbestos fibers (possibly 5-10 percent). To determine this proportion will require an in-depth plant survey to collect further air samples and the running of a number of analytical methods on these air samples.

#### IV. CONCLUSIONS AND RECOMMENDATIONS

The Clayton BCE-1000 dust control unit appears to do an effective job of containing and collecting brake dust during all vehicular brake maintenance and replacement jobs in this Pennsylvania state garage. For small garages, the main difficulty in acceptance would be economic - the relatively high cost of the unit.

This Pennsylvania state garage is recommended for such an in-depth survey because the management and mechanics were knowledgeable, well trained, and very cooperative during this preliminary survey. Its distance from the NIOSH Cincinnati headquarters is a negative factor.