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HAYWARD POOL PRODUCTS, INC.
ELIZABETH, NEW JERSEY

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SUMMARY

In July 1993, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request for a Health Hazard Evaluation (HHE) from employees at Hayward Pool Products, Inc. in Elizabeth, New Jersey. The employees' primary concerns were the occurrence of skin disorders among workers associated with the molding process, as well as deaths among co-workers.

NIOSH investigators visited the facility on September 28 and 29, 1993. During the visit, 63 day shift employees assigned to the Tool, Model, and Maintenance Shops and Molding Department were interviewed. Death certificates, OSHA 200 Injury and Illness logs, nurse's first aid logs, and Material Safety Data Sheets (MSDSs) were reviewed, and volatile organic compounds were measured in the Molding area.

The most consistent complaint reported during the interviews was dry, itchy or irritated skin on the hands and arms. Workers frequently reported a rash associated with the irritated areas, though none was seen by the NIOSH investigators. These symptoms seemed to occur while handling products molded from fibrous glass and during maintenance of machines that had molded these products. Other complaints included respiratory irritation when servicing the machines that mold PVC products and eye irritation in the Modelling Shop.

The OSHA 200 Injury and Illness and nurse's first aid logs supported the workers' complaint of skin problems. Also, many of the MSDSs warned that the materials could be irritating to the skin and/or mucous membranes.

Workers at Hayward Pool Products, Inc. were not exposed to excessive air concentrations of volatile organic compounds, except possibly methylene chloride. Skin symptoms among Molding Department workers were consistent with a diagnosis of intermittent eczematous dermatitis due to repeated contact with water. Use of tongs or gloves is recommended. Personal protective equipment should be worn during maintenance or purging of machines that were molding fibrous glass, acrylonitrile-butadiene-styrene terpolymer (ABS), or polyvinyl chloride (PVC) products. Furthermore, the findings of the death certificates review provide no basis for concluding that deaths among Hayward Pool Products, Inc. employees are related to exposures in the workplace.

KEYWORDS: SIC 3089 (plastic products, not elsewhere classified), fibrous glass, intermittent eczematous dermatitis, polyvinyl chloride (PVC), acrylonitrile-butadiene-styrene terpolymer (ABS), methylene chloride.

INTRODUCTION

In July 1993, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from employees for a health hazard evaluation at the Hayward Pool Products Inc. in Elizabeth, New Jersey. These employees were concerned about possible health effects, such as dermatitis, nausea, and light-headedness among the workers in the Tool, Model, and Maintenance Shops and the Molding Department. The employees attributed these health effects to contact with plastics and/or fibrous glass resin used in the molding process. The requestors also expressed concern about deaths among their co-workers. NIOSH representatives conducted a site visit on September 28 - 29, 1993, to interview workers, review records, and conduct an industrial hygiene assessment.

BACKGROUND

Hayward Pool Products, Inc. manufactures pool filters, pumps, and accessories. The original 50,000-square foot building was constructed in 1954 as a stainless steel manufacturing facility. Hayward Pool bought the building in 1966 and gradually expanded the plant to approximately 250,000 square feet. The permanent workforce is 270 employees in manufacturing and 50 in administration. During the peak season (December to May) as many as 100 seasonal employees are hired.

Prototypes of new or improved products are developed and tested in the Model Shop. Following development and testing the products are produced in large quantities in the Molding and Assembly areas. The Tool Shop cleans and repairs molds which are removed from their machines and transported to the Tool Shop. All remaining maintenance is done in the Maintenance Shop or out on the floor.

The Molding Department has no heating, ventilation, and air conditioning (HVAC) system. All of the remaining areas have their own HVAC system. The Model Shop has an air handler with supplies and returns and five exhaust fans. The Tool and Maintenance Shops both have air handlers with supplies and returns. The Molding Department has exhaust fans in the ceiling/roof, no air-conditioning, and relies on the molding machines to provide heat in the winter.

The Model Shop, Tool Shop, and Maintenance Shop operate only during the day shift. The Molding Department runs 24 hours a day, five days a week.

The Molding Department contains 36 molding machines of various sizes, 34 of which operate on a regular basis. Although four machines are capable of molding polyvinyl chloride (PVC), usually PVC parts are only produced on one machine. Most of the machines produce acrylonitrile-butadiene-styrene terpolymer (ABS) products, and a few produce fibrous glass products. None of the machines have local exhaust ventilation (LEV). Workers remove the molded parts from the machines, place them in a water bath to cool, and then assemble or process them. A few of the machines have conveyor belts that carry the molded products from the machine to a box where the worker can process them before sending them to the Assembly area.

EVALUATION PROCEDURES

Medical Evaluation

The NIOSH medical investigators interviewed 63 of the 65 day-shift employees assigned to the Tool, Model, and Maintenance Shops and Molding Department who were present on the days of the investigation. During the interviews, information was gathered about medical symptoms that were potentially related to workplace exposures. The workers were not examined for signs of dermatitis. Additionally, management and union representatives were interviewed regarding workplace conditions and work practices. Death certificates, available from the company's Group Life Benefits (The Guardian

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Insurance, New York, New York), were reviewed to determine if there were clusters of diseases that could be linked to exposures at the facility. Also, the OSHA 200 Injury and Illness logs for 1990 through 1993 were evaluated. Finally, the nurse's first aid logs for 1992 and 1993, and insurance claim summaries from the workers' compensation carrier were reviewed.

Industrial Hygiene Evaluation

The NIOSH industrial hygienist conducted walkthrough inspections of the Tool Shop, Maintenance Shop, Model Shop, and Molding Department. Processes were observed, and relevant Material Safety Data Sheets (MSDSs) were reviewed. Qualitative and quantitative air samples for volatile organic compounds (VOCs) were collected on 150 mg charcoal tubes in the Molding Department using Gillian Low Air-Flow pumps at 50 milliliters per minute (mL/min), and methylene chloride levels were estimated using Dräger Direct Reading Detector Tubes (6724601 110/a). Had significant exposures been measured (or suspected through observation), a return visit would have been scheduled to obtain a more detailed exposure assessment.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ evaluation criteria for the assessment of a number of chemical (and physical) agents. The primary sources of environmental evaluation criteria for the workplace are the following: (1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs), (2) OSHA Permissible Exposure Limits (PELs), and (3) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs).^{1,2,3} The objective of these criteria for chemical agents is to establish levels of exposure to which the vast majority of workers may be exposed without experiencing adverse health effects.

Full-shift and shorter duration criteria are available depending on the specific physiologic properties of the agent. Full-shift limits are based on the time-weighted average (TWA) airborne concentration of a substance that workers may be repeatedly exposed to during an 8 or 10 hour work day, up to 40 hours a week for a working lifetime, without adverse health effects. Some substances have short-term exposure limits (STELs) or ceiling limits (CLs) which are intended to supplement the full-shift criteria where there are recognized irritative or toxic effects from brief exposures to high airborne concentrations. STELs are based on 15 minute TWA concentrations, whereas CL concentrations should not be exceeded even momentarily.

Occupational health criteria are established based on the available scientific information provided by industrial experience, animal or human experimental data, or epidemiologic studies. Differences between the NIOSH RELs, OSHA PELs, and ACGIH TLVs may exist because of different philosophies and interpretations of technical information. It should be noted that RELs and TLVs are guidelines, whereas PELs are standards which are legally enforceable. OSHA PELs are required to take into account the technical and economical feasibility of controlling exposures in various industries where the agents are present. The NIOSH RELs are primarily based upon the prevention of occupational disease without assessing the economic feasibility of the affected industries and as such tend to be very conservative. ACGIH is not a government agency, it is a professional organization whose members are industrial hygienists or other professionals in related disciplines and are employed in the public or academic sector. TLVs are developed by consensus agreement of the ACGIH TLV committee and are published annually. The documentation supporting the TLVs (and proposed changes) is periodically reviewed and updated if believed necessary by the committee. It is not intended by the ACGIH for TLVs to be applied as the threshold between safe and dangerous exposures.

Not all workers will be protected from adverse health effects if their exposures are maintained below these occupational health exposure criteria. A small percentage may experience adverse effects due to individual susceptibility, a pre-existing medical condition, previous exposures, and/or a hypersensitivity

(allergy). In addition, some hazardous substances may act in combination with other workplace exposures, or with medications or personal habits of the worker (such as smoking) to produce health effects even if the occupational exposures are controlled to the limit set by the evaluation criterion. These combined effects are often not considered by the chemical specific evaluation criteria. Furthermore, many substances are appreciably absorbed by direct contact with the skin and thus potentially increase the overall exposure and biologic response beyond that expected from inhalation alone. Finally, evaluation criteria may change over time as new information on the toxic effects of an agent become available. Because of these reasons, it is prudent for an employer to maintain worker exposures well below established occupational health criteria.

The health effects of the substances observed during this survey and their specific evaluation criteria are summarized below.

Fibrous glass

Glass fibers of diameters greater than 3.5 micrometers (μm) are known to cause dermatitis through skin irritation.⁴ The risk of fibrous glass dermatitis is increased in warm, humid climates or during the winter in temperate climates when the relative humidity is low. For most workers, symptoms disappear within a week or two of the cessation of exposure, but may persist for longer in some individuals. Allergic contact dermatitis has not been associated with glass fibers but may be caused by skin contact with the resins used in fibrous glass products. Fibrous glass can also cause eye and upper respiratory tract irritation.^{4,5}

Several studies of skin irritation in office employees due to contact with airborne glass fiber have been published.⁶⁻¹⁰ In these studies, exposed employees reported a prickling sensation, and itching and rashes on exposed surfaces such as the forearms, neck, and face. The rashes were most severe where there was rubbing against clothes such as around the collar. Symptoms were usually most severe following first exposure to the glass fibers.¹¹ Individuals who handle fibrous glass repeatedly may develop a tolerance to its irritant effects, while symptoms usually recur in persons who have intermittent exposure. Skin symptoms usually resolved following cessation of exposure. In these studies, employees have been exposed to glass fibers falling from ceiling spaces and through the air conditioning system.⁶⁻⁸ Based on experimental studies in animals and epidemiologic studies in humans, the International Agency for Research on Cancer (IARC) has concluded that certain man-made mineral fibers (MMMF), including glass wool and fibrous glass, are possibly carcinogenic to humans.¹² Epidemiological studies of cancer risks in the MMMF manufacturing industry have shown a small excess of lung cancer in these workers, particularly in the mineral wool sector.¹³

In 1977, NIOSH proposed a recommended exposure limit (REL) of 5 milligrams per cubic meter (mg/m^3) time-weighted average (TWA) for total fibrous glass dust and a 3 fibers per milliliter (fiber/mL) limit for fibers having a diameter equal to or less than 3.5 μm and a length equal to or greater than 10 μm , based on evidence that small diameter fibers produce fibrosis in animals and respiratory tract irritation in humans.¹⁴ In 1988, as part of the proposed rules on air contaminants, OSHA proposed to adopt the NIOSH recommendation of 5 mg/m^3 for total fibrous glass dust as a permissible exposure limit (PEL), but not the 3 fiber/mL limit for small-diameter fibers.¹⁵ In July 1992, an 11th circuit court ruled that the 1988 OSHA PELs for 212 air contaminants, including fibrous glass dust, were invalid. In many states, including New Jersey, PELs reverted to the less protective limits set in 1971 of 15 mg/m^3 time-weighted average (TWA) for total fibrous glass dust.

Polyvinyl chloride (PVC)

Polyvinyl chloride (PVC) is a compound used in the manufacture of some plastic products. PVC plastic wrap, when cut with a hot knife, has been associated with "meat wrappers asthma."¹⁶ Substances which have previously been identified in heated PVC emissions include hydrochloric acid, benzene, and xylene,¹⁷ and exposure to hydrochloric acid has been associated with acute respiratory symptoms.^{18,19}

Methylene Chloride

Methylene chloride is a colorless, volatile liquid used as a multipurpose solvent. A mild central nervous system depressant and an eye, skin, and respiratory tract irritant, methylene chloride is carcinogenic in experimental animals. Exposure routes are through inhalation and skin contact.¹⁹ Because methylene chloride is metabolized to carbon monoxide, excessive carboxyhemoglobin levels in the bloodstream may follow exposure, putting persons with cardiac disease at increased risk.²⁰ Methylene chloride has produced tumors of the lung, liver, salivary, and mammary glands in animal studies.²¹ Since the carcinogenicity of methylene chloride has been documented in several experimental animal studies, but its potential for human carcinogenicity has not yet been determined, NIOSH feels that reducing exposure could reduce the probability of a population of exposed workers having an increased incidence of cancer. NIOSH recommends treating methylene chloride as a potential human carcinogen and reducing exposure to the lowest feasible concentration.²² The ACGIH TLV is 50 ppm, with a notation that methylene chloride is a suspect human carcinogen and that exposure should be controlled to levels as low as reasonably achievable (ALARA) below the TLV. OSHA proposed in November of 1991 a PEL of 25 ppm for an eight-hour TWA, with an action limit of 12.5 ppm, and a STEL of 125 ppm. This standard is expected to be promulgated in the fall of 1994.

Acrylonitrile-butadiene-styrene terpolymer (ABS)

Acrylonitrile-butadiene-styrene terpolymer (ABS) is a plastic used to make molded or extruded products or as a component of other industrial products. It consists primarily of high-molecular-weight polymers that, when melted can produce irritating fumes, containing nitrogen oxides and cyanide. These fumes can cause eye, skin, and respiratory tract irritation.²³

RESULTS AND DISCUSSION

Medical

The NIOSH medical investigators interviewed 63 of the 65 day shift employees in the Tool, Model, and Maintenance Shops and Molding Department who were present on the days of the investigation. The following paragraphs describe the interview findings by work area.

Tool Shop

Nine of the ten (90%) employees working on the days of the investigation were interviewed. The average age was 52 years (range, 41 - 63 years). The average length of employment was 12 years (range, 2 - 24 years). They did not report any significant work-related health problems.

Model Shop

All four employees working on the days of the investigation were interviewed. The average age was 42 years (range, 36 - 46 years). The average length of employment was 5 years (range, 6 months - 8 years). The primary complaint was a strong chlorine odor and associated eye irritation at the beginning of the work week. The workers stated the odor and eye irritation usually resolved after the area was ventilated.

Maintenance Shop

All seven assigned workers were interviewed. The average age was 39 years (range 28 - 65 years). The average length of employment was 10 years (range 3 - 20 years). Three of the seven reported episodes of itchy skin or skin rashes. The skin complaints occurred during maintenance of machines in which

fibrous glass has been used in the molding process. Additionally, four of the seven workers complained of acute respiratory symptoms, such as shortness of breath, cough, and asthma, after servicing machines in which PVC materials had been used. One maintenance worker, who was not present on the day of the survey, was reportedly rushed to the hospital with acute respiratory irritation after servicing a PVC molding machine.

Molding Department

All 43 employees on duty during the day shift were interviewed. The average age was 34 years (range, 26 - 64 years). The average length of employment was 8 years (range, 6 months - 17 years). The frequencies of symptoms reported by these workers are show in Table 1.

Table I
Symptoms Experienced By Molding Department Employees At
Hayward Pool Products Inc.,
Elizabeth, New Jersey, September 28 & 29, 1993.
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Symptoms Of 43 Workers	Number and Percentage of Workers Experiencing Symptom at Work	Have Symptoms that Improve When Away from Work
Dry, itching, or irritated eyes	5 (12%)	5 (12%)
Dry, itching, or irritated skin	11 (26%)	11 (26%)
Eczematous dermatitis	4 (9%)	2 (5%)
Asthma, bronchitis	3 (7%)	2 (5%)
Nausea	1 (2%)	1 (2%)
Light-headedness	2 (5%)	1 (2%)

The second column of Table 1 shows the percentage of the 43 workers who reported the occurrence of symptoms any time during their employment at Hayward Pool Products, Inc. Dry, itching, or irritated eyes and/or skin were the most commonly reported symptoms. Employees linked the skin problems to two potential sources, contact with fibrous glass and the practice of immersing the molded product in the water bath to cool. Workers associated exposure to dust in the work area and "smoke" from machines molding PVC products as the source of their eye irritation.

The third column of Table 1 shows the percentage of employees who reported experiencing the respective symptoms during their employment at Hayward Pool Products, Inc. and also reported that the symptom improved when they were away from work. Nearly all symptoms improved when away from work, suggesting the symptoms were work-related.

A review of OSHA 200 Injury and Illness logs for 1990 through 1993 revealed 12 incidents of skin problems. One case of chronic skin disease was reported; the other 11 were acute irritations. Two cases, reported by employees, were to have resulted from contact with fibrous glass. Three of the 12 cases involved lost work days.

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A review of the company nurse's first aid logs for 1992 and 1993 contained several entries for skin and eye irritation. All of these visits were consistent with the findings on the OSHA 200 Injury and Illness logs for that same time period.

Insurance claim summaries from the workers' compensation carrier were reviewed for the period November 1989 through 1993. Nine claims were due to skin complaints among the employees of the investigated areas. The claims were consistent with the OSHA 200 Injury and Illness log information.

In the last eight years, nine of the 270 Hayward Pool Products, Inc. employees (seven male and two females) have died. The length of their employment at the facility ranged from 4 months to 14 years; their ages at time of death ranged from 32 to 62 years. Of the nine deceased, three persons had worked in the Molding Department. Seven of nine death certificates were reviewed. Causes of death were different in each of the seven. The findings of this review provide no basis for concluding that deaths among Hayward Pool Products, Inc. employees are related to exposures in the workplace.

Environmental

Activity in the two rooms that comprised the Model Shop was rather slow during the site visit. Work in this area is more intermittent than in the others since it is mainly involved in developing and testing prototypes. One room of the Model Shop contains a small pool and jacuzzi and the other room contains machining tools and a ventilation hood. The hood exhaust is connected to another ducted ceiling exhaust and exits via one of the five exhaust fans in this shop. This fan is not on unless someone is using the hood. One of the exhausts is a large wall fan located in the corner of the tool room just below the ceiling. It is rarely turned on because it is noisy. The other three exhausts are also manually controlled. One is always operating, one is turned on during the work day, and one is rarely used.

Interviews and observations did not provide evidence of worker overexposure to chemicals in the Tool Shop or in the Maintenance Shop. However, many of the MSDSs warned that the materials could be irritating to the skin. Very few of the workers wore gloves in the Molding Department.

The qualitative area air sample identified n-butanol, propylene glycol methyl ether acetate (PGMEA), and n-decane in the Molding Department. The concentrations of n-butanol and PGMEA detected on the quantitative area air sample were 0.27 ppm and 0.44 ppm, respectively. n-Butanol is a colorless liquid used in plastics manufacturing that may be irritating to the eyes and mucous membranes. At very high concentrations it may cause central nervous system depression. NIOSH, OSHA, and ACGIH all recommend a ceiling limit of 50 ppm and note that dermal absorption is a major route of entry into the body.¹⁹ PGMEA is not specifically regulated by OSHA or the ACGIH. Usually, at least 95% of PGMEA is the alpha-isomer, but there is often a small amount of the beta-isomer present. NIOSH suggests that the beta-isomer impurities be monitored and kept as low as feasibly possible since it has teratogenic (causing fetal malformations) potential.²⁴ n-Decane was not detected on the quantitative area air sample, and thus if present was at a concentration below 0.04 ppm, the minimal detectable concentration.

One of the workers was required to use methylene chloride as part of the work process. A cotton swab was used to wipe methylene chloride on one of the parts before it was placed on top of another one. The methylene chloride was in an open, unlabelled, quart-sized container with a handle. The cotton swab was left in the container when not being used so that the handle for the

swab was inside the container, although not totally submerged in methylene chloride. A Dräger detector tube measurement taken directly above the container was approximately 100 ppm, and was approximately 20 ppm about two feet above the work table on which the container sat.

CONCLUSION

Based on employee interviews, the molding of parts with either PVC or fiberglass appears to result in more health-related complaints than molding ABS products. The purging and maintenance of the PVC machines has reportedly caused respiratory tract irritation. This irritation can potentially be quite serious, as demonstrated by the maintenance worker who had to be hospitalized immediately following exposure. Thus, exposures need to be reduced.

Working with the fiberglass has reportedly resulted in skin irritation and rashes. This effect has been documented in other situations of working with fibrous glass, and the skin symptoms usually resolve once the exposure has ceased. Proper protection of skin surfaces should help to reduce the symptoms.

Also in the Molding area, low levels of solvents were detected. The small concentrations could possibly result in minor irritation to sensitive individuals. The exposure, both from inhalation and skin contact, to methylene chloride is a potential health hazard.

The findings of the death certificates review provide no basis for concluding that deaths among Hayward Pool Products, Inc. employees are related to exposures in the workplace.

RECOMMENDATIONS

1. Respiratory protection may be necessary if suitable engineering and/or administrative controls are not available to reduce employee exposures to potential PVC decomposition products during maintenance and purging of the molding machines. Since heated PVC has the potential to release toxic vapors and gases such as hydrochloric acid and carbon monoxide, these exposures should be characterized and controls should be implemented or appropriate respirators should be selected.²⁵ Until these potential decomposition products are characterized by further sampling, the most protective respirators, such as supplied-air or self-contained breathing apparatus (SCBA) respirators, are recommended. Guidelines for choosing a respirator and implementing a respirator protection program are outlined in Appendix A.
2. Personal protective equipment (PPE) should be worn during maintenance or purging of machines that are molding fibrous glass or ABS products. General purpose gloves (cotton or leather) and either disposable clothing, such as Tyvek[®], or long sleeve shirts and long pants should be used to prevent any skin contact.
3. Water resistant gloves and/or tools, such as tongs, should be used when immersing products. Prolonged immersion of hands in water can result in intermittent eczematous dermatitis.
4. NIOSH considers methylene chloride a potential human carcinogen and recommends that exposure be as low as feasibly possible. OSHA has proposed to lower the PEL of methylene chloride to 25 ppm, with a STEL of 125 ppm. The previous substitution of methyl ethyl

ketone (MEK) with methylene chloride did not reduce the potential health hazard. To avoid any major ventilation or work practice changes, substitution with a less toxic substance should be considered. If use is continued, the container of methylene chloride should be completely covered and LEV should be provided. The swab used to apply the methylene chloride should have a long enough handle so that the worker does not have to reach into the container to retrieve it. Protective gloves should be worn since methylene chloride can be absorbed through the skin. Polyethylene/ethylene vinyl alcohol gloves are recommended, but since these gloves do not provide good resistance to tears, an outer protective glove made from nitrile or neoprene is also recommended. Almost any replacement solvent used should at least be in a covered container and the swab should have a long enough handle to avoid skin contact with the solvent when picking up the swab.

5. Installation of an exhaust system in the Molding Department (currently there is no ventilation system), may help to reduce workers' complaints of odors by providing more dilution ventilation. The vapors from the melted plastics and solvents can be irritating.
6. Routine operation of the exhaust fans in the Model Shop, especially overnight and on weekends, or at least several hours before the work shift starts, should help dilute the chlorine that accumulates in the shop and reduce worker irritation. If problems persist, consider covering the pool and whirlpool and installing a local exhaust ventilation (LEV) system.

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1. Hayward Pool Products Inc.
2. Affiliated International Brotherhood of Teamsters, Local 210
3. Confidential Requestor
4. OSHA Region 2

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

APPENDIX A

Implement an effective respiratory protection program, in accordance with the requirements described in 29 CFR 1910.134.¹ Publications developed by NIOSH, which should be referenced to choose the appropriate respirator and develop an effective respirator program, include NIOSH Respirator Decision Logic and the NIOSH Guide to Industrial Respiratory Protection.^{2,3} It is recommended that the written program designate one individual with the responsibility for administering the respiratory protection program. The written respirator program should also contain information on the following topics: (a) the departments/operations which require respiratory protection; (b) the correct respirators required for each job/operation; (c) specifications that only NIOSH/MSHA approved respiratory devices shall be used; and (d) the criteria used for the proper selection, use, storage, and maintenance of respirators, including limitations. The respirator program should also reference the requirements contained in the confined space program to assure that employees are adequately protected when working in these areas. A respiratory protection program should include the following elements:

- a. written operating procedures
 - b. appropriate respirator selection
 - c. employee training
 - d. effective cleaning of respirators
 - e. proper storage
 - f. routine inspection and repair
 - g. exposure surveillance
 - h. program review
 - i. medical approval
 - j. use of approved respirators
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