SURVEY OF PERSONAL PROTECTIVE EQUIPMENT

USED IN FOUNDRIES

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PREFACE

The National Institute for Occupational Safety and Health is responsible for developing new approaches to assure a safe and healthful work environment. To this end, the Institute engages in basic and applied research in various areas of occupational safety and health.

The Institute has investigated the personal protective equipment used to protect workers against four of the common hazards in the foundry industry: hot environments, silica, metal fumes, and noise.

This report presents the results of the study and prototype survey forms and methodology that, with modifications, can be used to evaluate the availability, use, acceptance, and deficiencies of personal protective equipment in other industries.

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ABSTRACT

The National Institute for Occupational Safety and Health (NIOSH) has investigated the nature and extent of use of the personal protective equipment (PPE) in four problem areas (hot environments, silica, metal fumes, and noise) in the foundry industry. The study is intended as a prototype for similar studies in other areas utilizing personal protective equipment. NIOSH was provided a master list of 4,897 foundries (establishments) by the Occupational Safety and Health Administration (OSHA). It had been prepared by OSHA in conjunction with their National Emphasis Program (NEP). The original sample consisted of two strata: Stratum I--59 establishments that had been cited by OSHA, and Stratum II--710 establishments from a systematic sampling with random starts. Because a number of these establishments had gone out of business or were no longer doing metal founding, an additional 103 establishments were selected also by the systematic sampling scheme with random starts.

An adjusted response rate of 57% was obtained from a mailed questionnaire. Questionnaire information was validated by site visits to a number of the establishments surveyed, and was found to be reliable.

The data from the questionnaires were tabulated and analyzed. It was found that the foundry industry has a need for many different types of PPE and that those in use or made available may not adequately protect the wearer from the workplace exposures. The PPE may not be worn for a variety of subjective and objective reasons.

The need for education and training of foundry personnel responsible for the selection, acquisition, wearing, and maintenance of PPE is great. The duties incumbent on responsible person(s) may be neither well defined nor closely supervised, resulting in failure to conform with existing PPE regulations and/or misapplication of the PPE available.

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CONCLUSIONS AND FINDINGS

With slight modifications, the prototype survey forms and methodology will provide the protocol and instruments needed to effectively and efficiently collect data on personal protective equipment in any industry.

From analysis of all the data collected, the following conclusions were drawn:

General

1. Personal protective equipment is used extensively in the foundry industry to protect against noise, hot environments, metal fumes, and silica exposures.

2. Management and employees often do not recognize the degree of need for personal protective equipment, particularly where engineering and administrative controls are not used.

3. A large percentage of those who are aware of the degree of need do not have the information necessary to properly select and administer the use of personal protective equipment and do not always attach a sufficiently high degree of importance to the need for the equipment.

4. A large percentage of the wearers of personal protective equipment feel that many of the designs could and should be improved.

5. The responsibility for the care, custody, and control of the personal protective equipment in the foundry is often not well defined.

6. It is essential that the name of the person who will complete the questionnaire be the addressee to whom it is mailed.

7. The establishment mailing list should be validated prior to mailing of the questionnaire.

Specific

1. Some personal protective equipment manufactured for chemical protection provides ineffective and/or inadequate protection for foundry workers.

2. It appears that a large percentage of the foundry industry does not supply personal protective equipment to workers as defined in the applicable safety and health regulations.

3. A small number of manufacturers supply the majority of the personal protective equipment being used in the foundry industry.

4. The same respiratory protection is frequently worn to protect against all air contaminants in the foundry work environment.

5. Some personal protective equipment used for thermal protection of foundry workers can contribute to heat stress by reducing convective body heat loss.

6. Some types of personal protective equipment, especially high temperature-exposure clothing, are bulky to wear and interfere with worker mobility. The present state of the art is not sufficiently advanced to provide insulating qualities efficient enough to reduce the bulk of the protective clothing now required for worker protection.

7. Earmuffs were the most frequently used form of personal protective hearing device.

INTRODUCTION

As a result of government regulations, labor-management agreements, and increased public awareness, the requirements for, and the use of, personal protective equipment in the United States have greatly increased in the past few years. In addition, the recognition that many more chemical and physical agents require more stringent personal protection than in the past has resulted in a large increase in the use of such equipment.

The 1976 Metal Casting Industry Census Guide[1] reported that there were 4,938 ferrous and nonferrous foundries in the United States and Canada. During recent years there has been a continuing trend toward fewer but larger foundries, although over 60% of the foundries in the U.S. and Canada, in 1975, employed fewer than 50 persons. There are, on the average, 75 fewer foundries every year, and most of those going out of business have been small operations.

The number of large foundries, on the other hand, is increasing; the net production of the industry doubled from 1960 to 1975. This study's findings support that contention. This trend toward large, high-production foundries necessitates more and more mechanization. Metal casting is becoming less labor-intensive as more processes are automated. This trend does not seem to have lessened the need for personal protective equipment.

Based on this study's findings, it was estimated that there are 4,016 ferrous and nonferrous foundries in the United States, rather than the 4,897 in OSHA's NEP master list compiled in 1975.

In order for NIOSH to develop valid criteria for employee protection from substances known to be hazardous to health, information is required on the current availability, usage, quantity, and types of personal protective equipment, along with an assessment of the acceptance and performance of the equipment. Since adequate data are not available, a survey study was needed for those industries where personnel are heavily exposed to hazardous substances and conditions, and for which personal protective clothing and equipment is being or has been developed.

To establish whether the necessary data are available, a contractor[2] and NIOSH personnel reviewed the literature available on personal protective equipment. The literature review included:

"Personal Protective Devices in the Industrial Environment--Its Evaluation and Control" by Harry F. Schulte.

"Accident Prevention Manual for Industrial Operations," Seventh Edition, Chapter on "Personal Protective Equipment," National Safety Council.

DHEW (NIOSH) Publication No. 76-146, "Human Variability and Respirator Sizing."

DHEW (NIOSH) Publication No. 74-104, "Abrasive Blasting Respiratory Protective Practices."

DHEW (NIOSH) Publication No. 79-107, "NIOSH Certified Equipment List, as of July 1, 1978."

None of these literature sources or surveys include statistics or provide information on the current availability, usage rates, acceptance, or deficiencies of personal protective equipment (as related to occupational health hazards) in United States' industry today.

In addition, it was determined that little information is presently available to determine if there is, in fact, personal protective equipment of sufficient quantity and quality available to American workers at a reasonable cost to fully protect them against identified hazardous chemical and physical agents. Thus, NIOSH undertook this survey of the foundry industry to obtain data in this area. It was determined that the current state of the art for personal protective equipment should be surveyed in the following areas:

Number of establishment users.

Wearer and use acceptance.

Problems and deficiencies of existing equipment.

Occupations where need is not being met by commercially available equipment.

Recommendations by wearers and users to improve types and methods of protection, where needed.

Total number and types of equipment now being worn.

Total number and types of equipment now available to be worn by foundry workers.

Since this was a limited study, it was necessary to concentrate on only four hazards in the foundry industry and to develop a prototype survey that could be modified to meet the future needs of any industry.

The authority and responsibilities for obtaining the required data and for performing the surveys are:

(1) Section 22 of Public Law 91-596, the Occupational Safety and Health Act of 1970 (the Act), authorizes the Director of NIOSH to conduct such research and experimental programs as he determines necessary for the development of criteria for new and improved occupational health and safety standards.

(2) Section 21 (a) (2) of the Act charges the Secretary of Health, Education, and Welfare with conducting informational programs on the importance and proper use of adequate safety and health equipment.

(3) Sections 21 (c) (1) and (2) charge the Secretary of HEW with providing consultation to the Secretary of the Department of Labor (DOL) (1) in establishing and supervising programs for the education and training of employers and employees in the recognition, avoidance, and prevention of unsafe or unhealthful working conditions in employments covered by the Act, and (2) in consulting with and advising employers and employees as to effective means of preventing occupational injuries and illnesses.

(4) Section 6 (b) (7) of the Act and Section 1910.132 of Title 29, Code of Federal Regulations, require every employer to provide protective equipment, including personal protective equipment for eyes, face, head, and extremities; protective clothing; protective respiratory devices; and protective shields and barriers. This equipment shall be provided, used, and maintained in a sanitary and reliable condition wherever its use is necessary by reason of hazards of process or environment (including chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact).

METAL FOUNDING OPERATIONS

All foundries have one thing in common--they melt metals and cast them into useful shapes.[3] There are a number of variables in the way the melting and casting take place, and many of the variables have a substantial impact on the extent and controllability of hazards by the means of personal protective equipment. The truth of the statement "no two foundries are alike" can be quickly realized when the diversity of factors relating to the physical and chemical agent hazards in foundries and the personal protective equipment needs of the workers exposed to those hazards are understood. A few of the major variables are:

- Types of metal.
- Process methods employed.
- Type of foundry.
- Production rate.
- Casting size.
- Age, size, and layout of plant.
- Climatic conditions.

TYPES OF METAL

Ferrous and nonferrous alloys contain many metals in varying percentages. Toxic properties of the metals vary widely. For example, the iron oxide exposure limitation is based mainly on nuisance effects, whereas copper fume has a Threshold Limit Value (TLV) many times lower than that of iron because copper fumes can cause upper respiratory tract irritation and possibly metal fume fever. The fume emission rate for a particular metal is dependent on the relationship of its boiling point to the melting temperature of the alloy. Boiling points of the metals vary widely, as do the melting ranges for ferrous and nonferrous alloys. Zinc always fumes when it is present in either ferrous or nonferrous molten alloys because its boiling point is lower than the range of melting temperatures of the other metals making up the alloy. Manganese, on the other hand, has a boiling point higher than the melting temperature of the other metals in common use. Its presence is seen more in welding processes than in foundry operations.

PROCESS METHODS EMPLOYED

Furnaces differ widely in the technique and rate of melting. Induction melting is a relatively quiet and nonturbulent method in which scrap is loaded into a molten bath, into which it gradually sinks as it melts.

Fume generation is light to moderate. Arc melting, on the other hand, is a violent and noisy process in which the temperature at the arc is higher than the boiling points of all the metals in the alloy, and consequently fume generation is high.

Molding methods and materials are even more diverse, as are the hazards involved. The hazards from silica when molding may be far greater than during the use of permanent molds. Silica and moldmaking create a severe respirable dust hazard at many founding operations. The hazard is not limited to just the casting process. Cleaning and finishing of castings may be made extremely hazardous by a condition during the sand casting process that allows mold materials to be deposited in the surface layer of the casting. Personal protective equipment may be the only current, state-of-the-art, feasible means of protecting foundry workers performing cleaning and finishing operations. A variety of organic and inorganic binders and additives are used in molding and coremaking. Products of their decomposition released into the air from just-cast molds may vary because of a variety of factors, among them:

Casting size.
Organic materials present in mold and core binders and additives.
Sand/metal ratio.
Pouring temperature.
Production rate.
Ventilation present.

The need for personal protective equipment is greatly influenced by these factors.

TYPE OF FOUNDRY[4]

Industry Group: Ferrous Foundries (Iron and Steel) SIC* 332

Definition: This group of industries includes establishments primarily engaged in the manufacture of iron and steel castings. These establishments often operate on a job or order basis, manufacturing castings for sale to others or for interplant transfer. Specifically excluded are establishments which produce iron and steel castings and which are also engaged in fabricating operations, such as machining, assembling, etc., in manufacturing a specified product.

Industry Title: Gray Iron Foundries (SIC 3321)

Definition: Establishments primarily engaged in the manufacture of gray iron castings, including cast iron pressure and soil pipes and fittings.

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* The SIC designation means Standard Industrial Code and is used for identifying industries in the United States.

General Characteristics:

Industry Size:	-- Number of Units in U.S.	--	898
	-- Total Employment (1,000's)	--	122.7 persons
	-- Average Employment	--	137 persons/unit

Principal End Products:

Cast iron is essentially an alloy of iron, carbon (2 to 4%), and silicon in which the carbon is present in excess of the amount which can be retained in solid solution in austenite at the eutectic temperature. It received its name from the fact that it is readily cast into almost any desired shape in an ordinary sand mold. The American Society for Testing and Materials defines cast iron as an iron containing so much carbon that it is not malleable at any temperature. The low limit is about 1.7% carbon. Cast iron is of two kinds: white cast iron and gray iron. The first is a chemical compound with most of the carbon in combination with the iron; the second contains most of the carbon in the form of graphite mechanically mixed with the iron. Ordinary cast iron, including gray iron, is brittle and not malleable; it is relatively low in cost, and easy to machine. When cast iron contains a specifically added element or elements in amounts sufficient to produce a measurable modification of the physical properties of the section under consideration, it is called alloy cast iron. Silicon, manganese, sulfur, and phosphorus, as normally obtained from raw materials, are not considered alloy additions.

Industry Title: Malleable Iron Foundries (SIC 3322)

Definition: Establishments primarily engaged in the manufacture of malleable iron castings.

General Characteristics:

Industry Size:	-- Number of Units in U.S.	--	80
	-- Total Employment (1,000's)	--	181.1 persons
	-- Average Employment	--	226 persons/unit

Principal End Products:

Malleable iron is a mixture of iron and carbon including smaller amounts of silicon, manganese, sulfur, and phosphorus which, after being cast as white iron, is converted structurally by heat treatment into a matrix of ferrite containing nodules of temper carbon, and is substantially free of all combined carbon. Iron for malleable iron is usually melted in the reverberatory furnace, which gives it greater strength and ductility than iron melted in the cupola in contact with the fuel. Malleable iron must have enough silicon to promote graphitization of the iron carbide at sustained high temperature, and sufficient manganese to offset the stabilizing effect of sulfur. Standard malleable iron contains 2.3 to 2.7% carbon, 0.6 to 1.1% manganese, and 0.8 to 1.5% silicon. When melted, it is very fluid and will produce thin and intricate castings with a tensile strength of 50,000 psi and elongation of 10%.

Industry Title: Steel Foundries (SIC 3323)

Definition: Establishments primarily engaged in the manufacture of steel castings.

General Characteristics:

Industry Size:	-- Number of Units in U.S.	-- 305
	-- Total Employment (1,000's)	-- 48.5 persons
	-- Average Employment	-- 159 persons/unit

Principal End Products:

Cast steel is steel that has been cast into sand molds to form finished or semifinished machine parts or other articles. Steel castings are used to replace forgings where only small quantities are required that would not justify the cost of forging dies, and for large parts that could not be forged easily; but the most general use of steel casting is for intricate parts that would usually require much machining by other methods of production. There are five general classes of commercial steel castings: low-carbon steels, with carbon content below 0.20%; medium-carbon steels, with carbon between 0.20 and 0.50%; high-carbon steels, with carbon above 0.50%; low-alloy steels with alloy content totaling more than 8%; and high alloy steel. Federal specifications for cast steel call for 0.35% carbon in the soft grade, 0.45% in the medium grade, and 0.50% in the hard grade. Cast steel, if not produced under controlled conditions, has the disadvantage, in comparison with forged steel, that it may contain blow-holes, slag, sand holes, shrinkage cavities, or cold shuts; the latter comes from pouring at too low a temperature. Thus companies usually feature careful metallurgical control for classification rather than merely chemical content of the steel, and the cast steels are generally sold under trade names.

Industry Group: Nonferrous foundries (SIC 336)

Definition: This group of industries includes establishments primarily engaged in the manufacture of castings and die castings of aluminum, brass, bronze, and other nonferrous metals and alloys. These establishments generally operate on a job or order basis, manufacturing castings for sale to others or for interplant transfer. Specifically excluded are establishments which produce nonferrous castings and which are also engaged in fabricating operations, such as machining, assembling, etc., in manufacturing a specified product.

Industry Title: Aluminum Castings (SIC 3361)

Definition: Establishments primarily engaged in the manufacture of castings and die castings of aluminum.

General Characteristics:

Industry Size:	-- Number of Units in U.S.	-- 875
	-- Total Employment (1,000's)	-- 49.6 persons
	-- Average Employment	-- 52 persons/unit

Principal End Products:

Cast aluminum and aluminum alloys have physical properties and, consequently, uses that are highly dependent on the presence of very small amounts of other elements. The metal, obtained chiefly from bauxite, is light, strong (except at high temperatures), quite malleable, and nonmagnetic even when alloyed with iron. Aluminum alloys are classified by their general use characteristics rather than by composition groups such as wrought alloys for construction and manufacturing uses, sand-casting alloys, permanent-mold casting alloys, and die-casting alloys.

Industry Title: Brass, Bronze, Copper, Copper-Based Alloy Castings (SIC 3362)

Definition: Establishments primarily engaged in the manufacture of castings and die castings of copper and copper-based alloy.

General Characteristics:

Industry Size:	-- Number of Units in U.S.	-- 411
	-- Total Employment (1,000's)	-- 14.0 persons
	-- Average Employment	-- 34 persons/unit

Principal End Products:

Brass Castings--
Brass is an alloy of copper and zinc, although some brasses also contain other elements. The brasses constitute one of the most important groups because they are easy to work with, are corrosion resistant, and present an attractive appearance. They are more ductile than corresponding copper-tin alloys or bronzes, but are not as hard and do not contain the hard crystals that make bronzes valuable as bearing metals. Commercial ingots made in standard composition grades are employed for casting various articles designated as brass and bronze. The ingots are seldom true brasses, but are composition metal intermediate between the brasses and the bronzes, and their selection for any given purpose is based on a balance of the requirements in color, strength, hardness, ease of casting, and machinability. Brass ingot metal is usually made from secondary metals but, in general, the grading is now so good that high-grade uniform castings are produced.

Casting brasses are usually made from brass ingot metal and are seldom plain copper-zinc alloys. The most widely used alloy is the one usually designated as composition metal, containing 85% copper, 5% zinc, 5% tin, and 5% lead. In melting brass for casting, any overheating causes loss of zinc by vaporization, thus lowering the zinc content. Small amounts of antimony, or some arsenic, are used to overcome this loss of zinc. The casting brasses are roughly divided into two classes as red casting brass and yellow casting brass, which are various compositions of copper, tin, zinc, and lead to obtain the required balance of color, ease of casting, hardness, and machining qualities.

Brass castings are used for:
- Machine parts and
- Highly corrosion-resistant pipes and fittings.

Bronze is usually a copper-tin alloy, but the name is now also applied to many copper alloys that have crystalline, bronze-like structure, such as silicon bronze, aluminum bronze, and manganese bronze. In the true bronzes, tin is the predominant alloying element with the copper, but some brasses are called bronzes because of their color, or because they contain some tin. Most commercial copper-tin bronzes are now modified with zinc, lead, or other elements. Bronze is essentially a casting metal, while brass is used mostly in wrought forms.

Copper and Copper-Based Alloy Castings--
Copper is one of the most useful of the metals, and probably the one first used by man. It is found in nature and in a large number of ores, but it is much less plentiful than nickel and some other metals. It is yellowish-red in color, tough, ductile, and malleable; gives a brilliant luster when polished; and has a disagreeable taste and a peculiar odor. Copper does not have the ductility of brass for metalworking, but does not work-harden as rapidly as brass. Pure copper is difficult to cast, as the molten metal absorbs oxygen, forming oxides. Toxic fumes may also be formed from certain alloys, such as beryllium copper. Cast copper has only 80 to 90% the conductivity of wrought copper. A special grade of copper having high ductility, high conductivity, and fatigue resistance is made, without melting, by converting electrolytic cathode copper directly into rods and strips by rolling at an elevated temperature in a reducing atmosphere.

Industry Title: <u>Not Elsewhere Classified (NEC)</u> (SIC 3369)

Definition: Establishments primarily engaged in the manufacture of nonferrous castings but not included in SIC's 3361 or 3362.

General Characteristics:

Industry Size:	-- Number of Units in U.S.	-- 328
	-- Total Employment (1,000's)	-- 19.2
	-- Average Employment	-- 58 persons/unit

Principal End Products:

Specialty castings.

PRODUCTION RATE

Foundry production varies widely from the production of only a few specialized castings to thousands of production castings per shift. The number of potential hazards may be the same in each case, but the extent of those hazards varies dramatically. At any production level, the degree of hazard is dependent on how many shifts of operation are utilized. Foundries with three shift operations perform a large portion of their maintenance during production time. In these foundries, the temperature never has a chance to be reduced. In large, high-production foundry situations, workers probably have a single assignment, e.g., molder, shakeout operator, grinder. In small shops, a single worker may be responsible for charge makeup, furnace operation, hot metal transfer, slagging, pouring, and cleaning.

CASTING SIZE

The degree of hazard from processing castings is quite dependent on the size of the casting. In the cleaning room, small castings are chipped, ground, and welded on benches. The castings may be easily repositioned as necessary to accomodate control measures. When processing large castings, the operator sits, kneels, or stands next to, atop, or inside the casting while performing the job functions and the personal protective equipment needs may vary considerably.

AGE, SIZE, AND LAYOUT OF PLANT

Some old, wood-framed foundries have low ceilings; whereas new, steel-trussed buildings have high bay areas entirely serviced by crane systems. General ventilation is very different in the two types. An infinite variety of foundry layouts is possible, each with its own unique requirements for methods to transport charge materials, mold and core constituents, hot metal, and castings.

CLIMATIC CONDITIONS

The foundry industry is spread throughout the country, and foundries are subject to the heat extremes of the South and the cold extremes of the North. Some sections of foundries in hot climates may not have walls, whereas foundries in northern climates must be closed up tightly in winter. Ventilation requires substantial seasonal adjustments and the fresh air which is moved and not conditioned at small expense during the summer is moved and conditioned at great expense during the winter. These adjustments have a direct bearing on the use, as well as the performance of personal protective equipment.

PAST RESEARCH

Where engineering or administrative (work practices) controls against hazards have not been implemented for one reason or another, it is necessary to provide potentially exposed employees with personal protective equipment as recommended in the following documents:

-- Published NIOSH Criteria Documents.
-- Published and Proposed OSHA Standards.
-- The American Industrial Hygiene Association Industrial Hygiene Guides.
-- The National Safety Council Industrial Safety Data Sheets.
-- The Hazard Process Indexes for 350 Selected Agents (NIOSH Contract HSM-99-73-62).
-- The U.S. Air Force Manual 127-101, Industrial Safety Accident Prevention Handbook.
-- The Toxicology of Drugs and Chemicals, by Reichmann and Gerarde.
-- The Merck Index.
-- Chemical Safety Data Sheets of the Manufacturing Chemists Association.

It was desired to quantify the presently available personal protective equipment usage rates, acceptance, and deficiencies throughout all American industry identified in the above documents. It was decided that this study should be a microanalysis from which empirical conclusions could be safely drawn, and would not be an excessive burden for respondents if it were limited to a few hazards. The foundry industry was selected for the following reasons:

-- It was known that personal protective equipment was extensively used.
-- OSHA's National Emphasis Program (NEP) had identified the United States'foundry industry universe.
-- The NEP Compliance Strategy was devised by a consensus of representatives from labor unions, industry, professional associations and societies, state health and safety agencies, NIOSH, and OSHA so foundries would come into compliance with safety and health regulations.
-- OSHA had compiled a list of foundries from American Foundryman's Society, Unemployment Insurance, and Bureau of Labor Statistics records.

On March 22-24, 1977, an International Conference on the Working Environment in Iron Foundries was held at the University of Warwick, England. Four hundred persons, a quarter of them speakers and delegates from 15 countries, attended. Attention was directed to the fact that increasing pressures to provide adequate personal protective equipment are being exerted on the foundry industry by legislators. The physical agents (noise, vibration, and heat) as well as the chemical agents (dust and fumes) were widely discussed. These international concerns, plus a review of literature from Finland[5] and various NIOSH-sponsored research[6-7], support our selection of the foundry industry as an appropriate industry to be studied. In fact, Egan[7] reported a complex mixture of chemical emissions from foundry molds ranging from methane to the polynuclear aromatic compounds. The profiles of the foundry industry developed by OSHA in their NEP program was used as a basis for study (Table 1). Metal stamping establishments (SIC 346) with captive founding operations were not included.

Table 1: OSHA Foundry NEP Scope Summary

Included Industries:

o Iron and Steel Foundries	SIC 332
-- Gray Iron Foundries	SIC 3321
-- Malleable Iron Foundries	SIC 3322
-- Steel Foundries	SIC 3323
o Nonferrous Foundries	SIC 336
-- Aluminum Castings	SIC 3361
-- Brass, Bronze, Copper, Copper-Based Alloy Castings	SIC 3362
-- NEC	SIC 3369
o Metal Stampings	SIC 346*
-- Metal Stampings	SIC 3461

Size and Distribution:

	No. of Units	Total Employment (1,000's)	Units %	Employment %
o All 7 SICs	5,523	494.8	--	--
o SIC 332	1,283	189.3	100.0	100.0**
-- SIC 3321	898	122.7	70.0	64.9
-- SIC 3322	80	18.1	6.2	9.6
-- SIC 3323	305	48.5	23.8	25.6
o SIC 336	1,614	78.8	100.0	100.0
-- SIC 3361	875	45.6	54.2	57.9
-- SIC 3362	411	14.0	25.5	17.8
-- SIC 3369	328	19.2	20.3	24.3
o SIC 346	2,626	226.7	100.0	100.0
-- SIC 3461 (same as SIC 346)				

* Metal stamping establishments with captive founding operations.
** Totals may not equal 100 because of rounding.

REASON FOR CONDUCTING SURVEY

The methods by which the exposure of workers to hazardous chemical and physical agents can be controlled have been listed in order of priority by NIOSH and OSHA, as follows:

(1) Engineering
(2) Administrative (work practices)
(3) Personal Protective Equipment

Industry has advanced the engineering controls' state of the art a long way in recent years, and labor and management have worked together to greatly improve work practices. However, OSHA and NIOSH industrial hygienists continue to find worker breathing zone levels of air contaminants exceeding both OSHA Permissible Exposure Levels (PEL's) and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's). Until such time as engineering and administrative controls are adequate, personal protective equipment must be provided and worn. However, it is still necessary to provide protective equipment for use during emergencies, unscheduled maintenance or operations, and where hazards cannot otherwise be controlled.

The problem inherent with a policy that may require the use of personal protective equipment that is either inadequate or unavailable was one reason for conducting this study. Inadequate protective equipment which does not protect the wearer may provide a false feeling of security.

This prototype survey was conducted to learn about the items of personal protective equipment (PPE) worn by foundry workers to protect against four physical and chemical agents present and, by thus limiting the survey, to encourage respondent response while not being an excessive burden to the respondent.

To learn what the foundry industry used as personal protective equipment against heat, noise, metal fumes, and silica, and to make constructive recommendations for research in the area, it was necessary to contact the users of the equipment and determine their needs and concerns. This survey addressed two concerns: the first, most recently pointed out by J. Yao, was that sufficient information on personal protective equipment worn in foundries was unavailable;[8] and the second was to develop a prototype survey form and methodology to be used in the conduct of future surveys.

To effectively utilize the data obtained, the following goals were established:

(1) To determine the types and manufacturers of PPE used.
(2) To determine the usage rates of the PPE.
(3) To identify the employee/employer concerns dealing with the utility of PPE.
(4) To determine employee acceptance of PPE.
(5) To determine the percentage of approved PPE in use.
(6) To document the needs and/or requirements for PPE.
(7) To compile demographic and geographic information on the sampled population of the PPE users.
(8) To recommend:
  (a) Research to improve PPE.
  (b) Education and training for proper use and enhanced acceptance of PPE.
  (c) Improvements in the survey scheme and forms.

METHODOLOGY

SAMPLE SELECTION

The questionnaire sample utilized information already available within the government. In 1976, the foundry industry recorded 18.21 disabling injuries per 1 million hours worked; whereas the average of all industries reporting to the National Safety Council was 10.87. Consequently, the Occupational Safety and Health Administration (OSHA) selected the foundries as their first target industry under its National Emphasis Program (NEP). Announced in late 1975, the NEP made its first inspection on March 15, 1977.[9]

During their preparation to institute the NEP, OSHA compiled a listing of all foundries throughout the United States. A printout of this master listing was obtained from OSHA.[10] It provided the following information on 4,897 foundries:

NEP No.________________________	(keyed by state)
Company Name________________________	
Company Division________________________	
Address________________________	
City, State________________________	
Employment________________________	(by ranges: under 10, 10-49, 50-249, 250 and over)
Region________________________	(by OSHA's regions 1-10)
SIC Code________________________	(4 digits)

OSHA retained a contractor (Contract J-9-F-5-0135) to conduct a preliminary review of the relationship between OSHA standards cited at establishments under the NEP in foundries and the injuries and illnesses reported at these establishments. A review of the Contract Interim Report[11] summary revealed that, of the standards cited since the start of NEP, personal protective equipment and mechanical power transmission were found most significant in terms of the number of related cases. In view of the contractor's findings, it was decided to include the 63 NEP numbers of foundries cited.

Stratum I--Cited Foundries

This is a listing of foundries which were cited by OSHA. This list contained 63 NEP numbers. One was a duplicate. Three were not on the master list of foundries and, therefore, were excluded. Thus, 59 were included in this stratum. Three characteristics of this stratum are shown in Tables 2 and 3.

Stratum II--All Other Foundries

The master listing contained 4,897 foundries, from which the 59 in Stratum I were excluded, leaving a total of 4,838 foundries. A systematic sample based on a random start "skip value" technique produced a list of 710 foundries. Three characteristics of this stratum are shown in Tables 2 and 3.

Because a large number of the Stratum II foundries had gone out of business, no longer did metal founding, or could not be identified (See Tables 2 and 3), an additional 103 were selected also by systematic sampling with a random start which resulted in a total original sample of 813 foundries in Stratum II. The geographical distribution of foundries surveyed by state is shown in Tables 4 and 5 and in Figure 1.

Table 2: Information Concerning Sample Size by Strata--
Foundry Equipment Survey

	Total	Stratum I	Stratum II
Original Sample	872	59	813
No Identifiable Foundry	170	11	159
Adjusted Sample	702	48	654

Table 3: Information Concerning Sample Size by Number of
Employees in Foundries

	Total	Under 10	10-49	50-249	250 or more	Unknown
Original Sample	872	212	370	215	67	8
No Foundry or Not Identifiable	170	78	60	19	7	6
Adjusted Sample	702	134	310	196	60	2

Based on the finding that 18% of the sample had no identifiable foundry, it was estimated that there are 4,016 operating foundries rather than the 4,897 foundries in OSHA's NEP master list. Further, it was found that 1.3% of the foundries were unidentifiable as users of personal protective equipment. This is an estimated 64 foundries, which further reduces the number of applicable foundries to 3,952.

Table 4: Number of Foundries per State by NEP State Number in Stratum I

State Number	Name of State	Number of Foundries
01	Alabama	5
05	Arkansas	1
12	Florida	9
13	Georgia	7
17	Illinois	4
25	Massachusetts	1
28	Mississippi	1
33	New Hampshire	2
34	New Jersey	5
36	New York	15
39	Ohio	3
48	Texas	2
55	Wisconsin	4
	Total	59

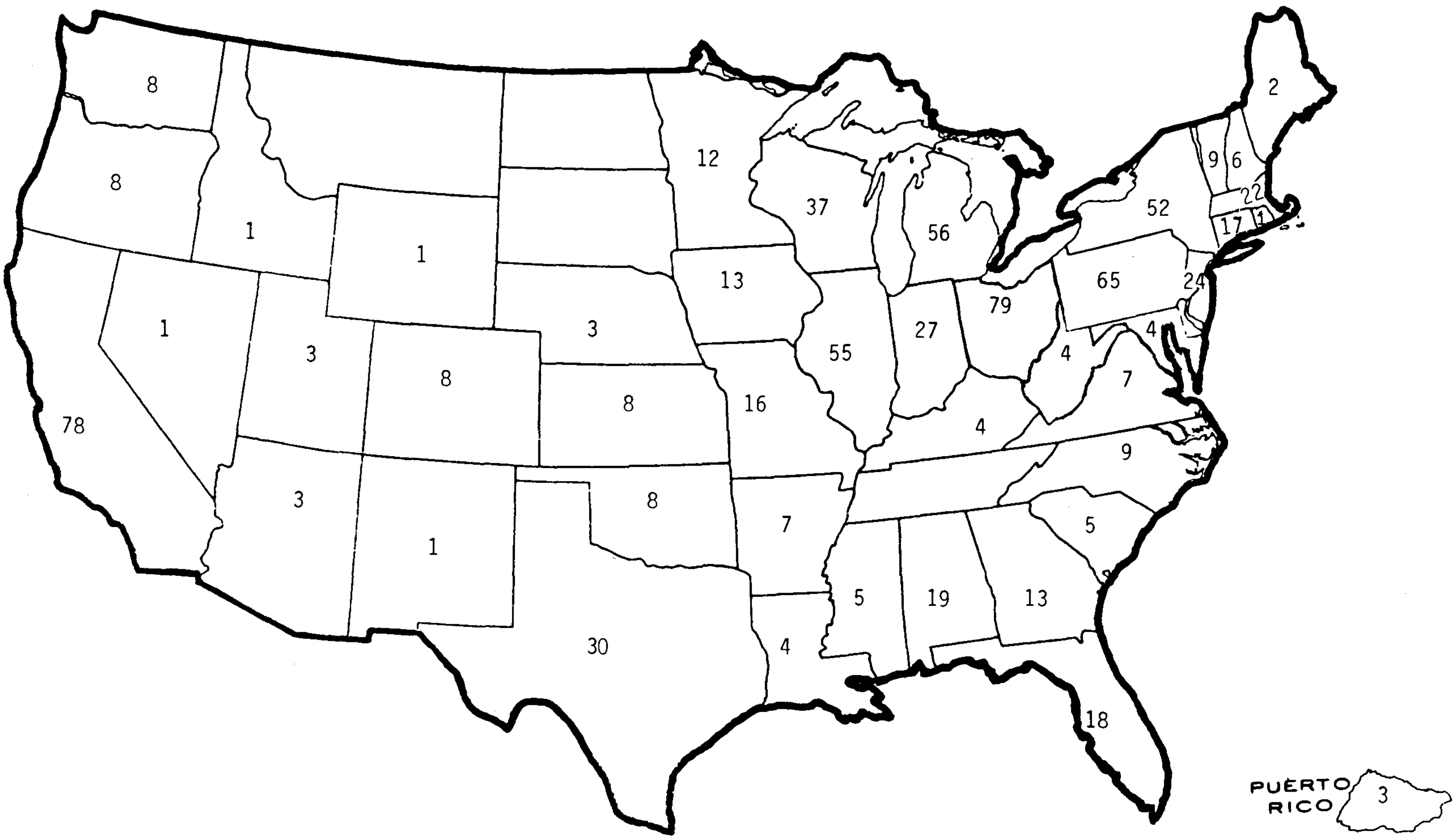
Table 5: Number of Foundries per State by NEP State Number in Stratum II

State Number	Name of State	Number of Foundries	State Number	Name of State	Number of Foundries
01	Alabama	14	18	Indiana	27
04	Arizona	3	19	Iowa	13
05	Arkansas	6	20	Kansas	8
06	California	78	21	Kentucky	4
08	Colorado	8	22	Louisiana	4
09	Connecticut	17	23	Maine	2
10	Delaware	1	24	Maryland	4
12	Florida	9	25	Massachusetts	21
13	Georgia	6	26	Michigan	56
16	Idaho	1	27	Minnesota	12
17	Illinois	51	28	Mississippi	4

Table 5: (Continued)

State Number	Name of State	Number of Foundries	State Number	Name of State	Number of Foundries
29	Missouri	16	42	Pennsylvania	65
30	Montana	1	44	Rhode Island	9
31	Nebraska	3	45	South Carolina	5
32	Nevada	1	47	Tennessee	12
33	New Hampshire	4	48	Texas	28
34	New Jersey	19	49	Utah	3
35	New Mexico	1	50	Vermont	1
36	New York	37	51	Virginia	7
37	North Carolina	9	53	Washington	8
39	Ohio	76	54	West Virginia	4
40	Oklahoma	8	55	Wisconsin	33
41	Oregon	8	72	Puerto Rico	3
				Total	710

Figure 1: Map of the United States Showing the Number of Foundries Surveyed by State



SURVEY PROCEDURE

Phone calls were made by NIOSH employees to each selected establishment to identify the person in charge of safety and/or safety equipment. A protocol for making the calls was developed and followed by each caller. To do this, correct telephone numbers were obtained from such sources as telephone information operators, Chambers of Commerce, police departments, city clerks, etc. In 70 instances, no phone was listed or the telephone had been disconnected.

The identification of the person in charge of safety and/or safety equipment was usually made by whoever answered the telephone at the establishment surveyed. It was learned that the majority of foundries had no person whose title was "Safety Director" or "Safety Engineer." In these establishments, the person put in charge of safety or safety equipment did so in addition to other duties.

In some cases, telephone discussions had to be conducted with several individuals at an establishment before the qualified person was identified and contacted. In several establishments surveyed, the person in charge of foundry safety was at another plant (which might be in another state) and was telephoned there.

After being contacted, the qualified individual at each surveyed establishment acknowledged capability to complete the questionnaire and agreed or refused to complete it. Table 6 gives reasons why establishments originally selected to receive questionnaires were not sent them. In some cases, the qualified person asked that the questionnaire be sent for examination before any decision on completing it would be made.

Table 7 gives a breakdown by numbers and position titles stated over the telephone by the qualified establishment persons contacted. Thirteen qualified persons would not fill out questionnaires, but offered to answer the questions when contacted by phone, and did so. One establishment was not sent a questionnaire, but completed one during a visit by a NIOSH employee.

Table 8 shows the response rate by position title of those who received questionnaires.

Table 6: Information Concerning Original Sample Not Sent Questionnaires

Reason	No. of Establishments
Closed or out of business	45
Not a foundry or metal casting operation	31
Unable to identify the person in charge of safety equipment (phone number known)	20
No phone listed or phone disconnected (phone number unknown)	70
Refused (no specific reason given by establishment)	50
Establishment too busy	29
Foundry or casting operation which does not use personal protective equipment listed on questionnaire	16
Establishment management policy or legal staff objection	4
Establishment had too many other surveys to complete*	5
Total	270

* At the time this survey was being conducted, the Environmental Protection Agency (EPA) was asking foundries to complete a questionnaire concerning waste treatment and disposal.

Table 7: Position Titles and Method of Response by Persons in Charge of Safety Equipment Who Completed Questionnaire

Position Title	No. Who Did Not Receive Questionnaire but Provided Information by Phone or Visit	No. Who Received, Completed, and Returned Questionnaire by Mail	No. Who Received but Did Not Complete and Return Questionnaire by Mail, but Provided Information by Phone or During Site Visit
Owner	4	18	6*
President or Chairman	1	36	3
Vice-President	--	24	4*
Secretary, Secretary-Treasurer, or Treasurer	1	9	2
Manager, Superintendent, or Supervisor, etc.	4*	59	2
Foreman	--	9	--
Safety Director, Safety Manager, Safety Supervisor, etc.	--	46	--
Director, Safety plus Additional Function (e.g., Safety and Engineering, Safety and Training, etc.)	--	18	--
Safety Engineer	--	9	--
Engineer (nonsafety)	--	9	1
Accountant, Bookkeeper, Controller, and Cost Accountant	--	4	1
Manager, Industrial Relations or Personnel	--	29	2

Table 7: (Continued)

Position Title	No. Who Did Not Receive Questionnaire but Provided Information by Phone or Visit	No. Who Received, Completed, and Returned Questionnaire by Mail	No. Who Received but Did Not Complete and Return Questionnaire by Mail, but Provided Information by Phone or During Site Visit
Purchasing Agent	--	13	--
Facilities or Maintenance Manager	--	4	1
Office Manager	--	6	--
Nurse	--	4	--
Miscellaneous	--	7**	1
Unknown	4	36	5
Total	14	340	28

* Includes one site visit.

** Includes persons with position titles as follow: Purchasing and Personnel Manager, Personnel and Purchasing Agent, Personnel Assistant, Specialist--Employee Relations, Foundry Operator, Foundryman.

Table 8: Position Titles and Response Rate of Persons in Charge of Safety Equipment

Position Title	No. Who Completed Questionnaire	No. of Persons Who Received Questionnaires but Did Not Return Them	Response Rate in Percentage
Owner	27	19	59
President or Chairman	40	26	61
Vice-President	27	14	66
Secretary, Secretary-Treasurer, or Treasurer	12	3	80
Manager, Superintendent, or Supervisor, etc.	65	40	62
Foreman	9	4	69
Safety Director, Safety Manager, Safety Supervisor, etc.	46	24	66
Director, Safety plus Addition Function (e.g., Safety and Engineering, Safety and Training, etc.)	18	9	67
Safety Engineer	9	6	60
Engineer (nonsafety)	10	4	71
Accountant, Bookkeeper, Controller, and Cost Accountant	5	2	71
Manager, Industrial Relations or Per sonnel	31	20	61
Purchasing Agent	13	10	57
Facilities or Maintenance Manager	5	2	71
Office Manager	6	5	55

Table 8: (Continued)

Position Title	No. Who Completed Questionnaire	No. of Persons Who Received Questionnaires but Did Not Return Them	Response Rate in Percentage
Nurse	4	0	100
Miscellaneous	8	5*	62
Unknown	45	29	61
Total	380	222	67

* Includes persons with position titles as follow: Sales Coordinator, Personnel Assistant, Officer, Office Clerk.

Each mailed questionnaire included a return envelope on which was a coded number that identified the establishment. When the questionnaires were sent out, a list of these code numbers was made. When the questionnaires were returned, a notation on the list was made of the date each was received.

After 2 months, the establishments which did not return questionnaires were contacted by the NIOSH employee who had originally contacted and identified the qualified establishment individual who agreed to complete the questionnaire and was asked to do so again. In 112 cases, the person contacted stated that the forms were not received at all or had been misplaced. In these cases, a second questionnaire was sent to the individual. In some cases, the qualified individual was different for the second mailing than for the first due to promotion, resignation, etc.

At 26 establishments, the persons sent questionnaires said they were too busy to fill them out, but offered to provide information to complete the questionnaires, and did so on the phone.

After the first and second questionnaires had been sent out, a few establishments had questions upon receiving them. They telephoned the number given in the survey explanation letter for answers to their questions before completing the forms. Several of the callers asked for an extension of the completion date specified in the cover letter (Figure 2).Tables 9 and 10 show the time intervals between when the questionnaire was mailed and when it was completed and returned.

Table 9: Time Interval between First Questionnaire Mailing and Receipt of Completed Questionnaire

Time Interval (days)	Number of Establishments
1 to 10	74
11 to 20	9
21 to 30	63
31 to 40	13
41 to 50	14
51 to 60	25
61 to 70	19
71 to 80	12
81 to 90	10
91 to 100	12
101 to 110	10
111 to 120	2
121 to 130	1
131 to 140	4
141 to 150	none
151 to 160	none
161 to 170	none
171 to 180	none
181 to 190	1*

* Data were received too late to be included in this study.

Table 10: Time Interval between Second Questionnaire Mailing and Receipt of Completed Questionnaire

Time Interval (days)	Number of Establishments
1 to 10	10
11 to 20	10
21 to 30	4
31 to 40	8
41 to 50	1

Figure 2: Cover Letter

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

February 28, 1979

Mr. Robert Noname, Plant Manager
No Name Aluminum Castings Company
1400 North Street
Any Town, Indiana 47808

Dear Mr. Noname:

The National Institute for Occupational Safety and Health, Department of Health, Education and Welfare, is conducting a nationwide survey to review the use, acceptance, and deficiencies of personal protective equipment in controlling employee occupational exposures to toxic chemical and physical agents. As part of an industry which must deal with occupational exposure to the agent or agents indicated on the enclosed survey form(s), your participation in this study will provide important information.

When filling out the survey form, please consider only the personal protective equipment related to this exposure. If you do not have this exposure or do not use personal protective equipment in controlling an exposure, please indicate on the survey form in the "Comments" section. If you use engineering methods or administrative procedures to control the exposure, please esplain in the "Comments" section.

It is our intent to summarize and publish the results of this survey. Individual company responses will not be identified. If you have any questions concerning the survey or filling out the form, please contact:

Mr. Robert D. Mahon, P.E., C.S.P.
Chief, Protective Equipment Section
Control Technology Research Branch
Division of Physical Sciences and Engineering
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati, Ohio 45226
(513)-684-4224

Your prompt completion and return of this form by March 22, 1979 will be appreciated and a prepaid return envelope is included for your convenience.

Sincerely,

Robert D. Mahon
Chief, Protective Equipment Section
Control Technology Research Branch
Division of Physical Sciences and Engineering

Enclosures:
Survey form(s)
Postage-paid return envelope

QUESTIONNAIRE

Under NIOSH Contract 210-78-0108,[2] a total of 180 chemical and physical agents were identified (Appendix A) that pose industrial health hazards to the potentially exposed workforce. For these substances, it has not been physically possible and/or feasible[12] to institute strict engineering or administrative controls. An "information sheet" (example for acetaldehyde is shown in Appendix B) was developed for each of the agents.

A review of the contract report and recommendations, in conjunction with the resources available, resulted in the decision to perform a prototype survey of a statistically determined sampling of just one segment of industry in the United States. The foundry industry was selected. Two chemical agents (silica and metal fumes) and two physical agents (noise and hot environments) common to the selected industry were identified as hazards against which personal protective equipment is frequently worn by the workers. A survey form and instruction sheet were developed in-house for each of these two toxic substances and physical agents. The forms were reviewed by a local safety director[13] and a trade association representative.[14] A preliminary phone survey of nine randomly selected foundries identified some of the factors that contribute to the two broad classes of errors that commonly arise in data collection,[15] i.e., errors arising from nonresponse and from inaccurate response.

Since the survey required the answering of the same questions by 10 or more persons, Office of Management and Budget (OMB) clearance was required. An OMB clearance package was assembled, submitted, and approval of same was obtained. In conjunction with the preparation of the OMB clearance package and in cooperation with the NIOSH Statistical Services Branch (SSB), the statistical aspects of the study were reviewed and approved by the NIOSH Statistical Project Review Group (SPRG).

The mail-out questionnaire and associated instruction sheets bearing their respective OMB clearance numbers are included as Appendix C of this report.

RESULTS

SURVEY RESPONSE

The results of this prototype study indicate that the methodology employed is basically sound. Although a 58% response rate is not as high as desired, it did provide a great deal of meaningful information. The validation visits gave good correlation between survey form data and those obtained during the visits. The visits were as follows:

Location	Number of Establishments Visited
Boston, Massachusetts area	5
Philadelphia, Pennsylvania area	2
Pittsburgh, Pennsylvania area	2
Milwaukee, Wisconsin area	2
Chicago, Illinois area	5
Los Angeles, California area	1

Discussions at the foundries visited revealed more problems in the selection, care, and use of personal protective equipment than were evident on the questionnaires.

Based on the finding that approximately 18% of the sample taken from OSHA's NEP master list had no identifiable foundry, it is estimated that there were actually 4,016 foundries rather than the 4,897 foundries on the list. It was also found that 1.3% of the foundries used no personal protective equipment. This is an estimated 64 foundries, which further reduces the number of applicable foundries to 3,952. Each of the sample foundries, therefore, represents 9.9 (or about 10) foundries in the population. To make a national estimate, therefore, one would multiply by 9.9. It should be noted that there may be variation due to sampling; however, such variation would be far outweighed by other factors that have potential bias such as the lack of response from over 40% of the sample.

DATA ANALYSIS

Two methods were used to tabulate the data on the hot environments questionnaires. One method involved personal examination of each questionnaire, with tabulation and summarization by an individual familiar with protective equipment and foundries. The other involved programming/keypunching/tabulating by computer. The keypunching was done by individuals not familiar with protective equipment and/or foundries. The difference between the results was about 10%. It was felt that the conclusions were not significantly changed because of the difference.

The questionnaire's "Comments" entries were not programmed for detailing during keypunching, but were included in the hand tabulation. Before keypunching the survey, questionnaires were examined for obvious errors. For example, the value of 84,000 earplugs in use by an establishment with 50 employees was not keypunched.

The results of the data analysis are presented in the following order:

Part I-- Hot Environments
Part II--Silica
Part III--Metal Fumes
Part IV--Noise

PART I--HOT ENVIRONMENTS

Introduction

The foundry personal protective equipment survey sought to find information on several items concerning protective clothing or devices frequently used in hot environments. For the 17 specific types of protective clothing or devices used, the style or type, manufacturer, number in use, acceptance ratings, and comments were asked.

The four most frequently used items were gloves and mittens for flame and heat hazard, leggings for flame and heat hazard, face shields for heat hazard, and safety goggles for heat hazards (Table 11). It should be noted that the numbers given are for the 401 responding foundries.

Gloves or Mittens

Nearly 75% of the 401 responding foundries used this type of protective clothing. An average of 11 gloves or mittens were used in each place that used these items (Table 11).

Nearly 70% of the gloves and mittens in use (in 67% of the foundries) were made of leather (Table 12). An average of over 19 of these were used in each foundry. Asbestos gloves or mittens were used in 43% of the foundries, but accounted for only 30% of the items in use--nearly seven used per foundry. About 68% of the foundries where gloves and mittens were used were of four company types--aluminum casting; gray iron foundries; brass, bronze, copper, or copper-based alloy castings; and steel foundries. This was also observed for the other items of protective clothing and equipment and thus will not be repeated.

Only 4% of the foundries considered the performance of the gloves and mittens as unsatisfactory (Table 13). The acceptance was considered good (greater than 75% acceptance) by 85% of the foundries, while 14% considered the acceptance average (25 to 75%). Aluminized and fire retardant gloves and mittens had a higher percentage of foundries which considered them average (18 to 19%) compared with leather (9%) and asbestos (12%). About 86% of the foundries considered that the gloves or mittens were very adequate and 13% considered them partially adequate. Again, aluminized and fire retardant gloves and mittens had a higher percentage considering them partially adequate (20% and 16%, respectively) compared to leather (9%) and asbestos (12%).

There were some complaints (8% of the foundries) and recommended improvements (31% of the foundries). The short use-life was a complaint of about 57% of those who responded; 45% who recommended improvements had "long use-life" as the improvement. Wearing comfort was a recommended improvement by 16% of the foundries.

Leggings

About 53% of the responding foundries used leggings. There was an average of eight leggings used per foundry (Table 11). Over half of the leggings used were leather, and leather leggings were used in 40% of the locations--over nine used per location. The other three materials used ranged from 16 to 27%, and about the same number used in each location (Table 14).

As with gloves or mittens, only 4% considered the performance unsatisfactory. About 71% considered the acceptance good (greater than 75% acceptance), and 23% considered the acceptance average (25 to 75%). Over 40% of the foundries considered fire retardant leggings average. Over 75% of the foundries considered the leggings as very adequate, with asbestos (81%) having the highest percent and fire retardant the lowest (67%) (Table 15).

There were some complaints (15% of the foundries) and recommended improvements (42% of the foundries). Short use-life was the most frequent complaint and 20% of the recommendations were for a longer use-life. The most frequent recommendation was wearing comfort.

Face Shields

About 45% of the foundries used face shields--an average of eight per foundry.

Only 3% considered the performance unsatisfactory. About 78% considered the acceptance good, and 19% average. Nearly 85% considered the face shields as very adequate and 15% partially adequate (Table 16).

There were some complaints (6%) and recommended improvements (26%). There was no one complaint which stood out. Two improvements were recommended--longer use-life and wearing comfort.

Safety Goggles

There were about 36% of the foundries which used safety goggles--an average of 14 per establishment.

Only one foundry indicated unsatisfactory performance. Acceptance was high--84% indicated acceptance was good, and 16% average. Over 90% indicated that safety goggles were very adequate (Table 17).

Only 3% had a complaint and 16% recommended improvements. Wearing comfort was the primary recommended improvement.

Aprons

About one-third of the foundries used aprons--six per foundry on the average. Three types of aprons were used by almost equal numbers of foundries--leather, aluminized, and asbestos. Only three asbestos aprons were used per foundry as compared to between seven and eight for the other two types. Few foundries used fire retardant aprons, but those that did used nearly 19 per foundry.

Only 4% considered apron performance unsatisfactory. There were 74% who indicated good acceptance, and 23% indicated average acceptance. Aluminized aprons had a higher acceptance than other types. Very adequate was the rating by 87% of the foundries, with asbestos getting the rating in 95% of the foundries.

About 19% of the foundries had a complaint and 38% recommended improvements. Nearly 90% of the foundries using aluminized aprons recommended improvements. The primary complaints were too hot, too bulky, and too heavy. Recommended improvements were increased wearing comfort, longer use-life, and weight reduction.

Sleeves

Nearly one-fourth of the foundries used protective sleeves with an average of eight per foundry. Most foundries used aluminized sleeves (38%). The remainder were divided among the other three types (17 to 25%). The number used per foundry is quite different, however. This ranges from about 3 per foundry for asbestos to 17 for fire retardant material. About 8% consider the performance unsatisfactory. About 75% indicate good acceptance, and 16% average . About 86% consider sleeves very adequate. Fire retardant sleeves are low with only 67%.

About 12% of the foundries registered complaints (35% of those using fire retardant sleeves). Too bulky was the most prominent complaint. About one-fourth recommended improvements--35% for aluminized and 47% for fire retardant. Longer use-life and increased wearing comfort were the two major recommendations.

Suits or Coveralls

About 15% of the foundries used suits or coveralls--12 per foundry on the average. About 42% of these foundries used fire retardant suits or coveralls which accounts for 78% of all those being used (26 per foundry). While aluminized items were used in 33% of these foundries, there were only four per location.

There were about 7% which considered performance unsatisfactory (three out of four were asbestos). Acceptance was considered good by 86% and average by 12 to 33% of those using asbestos said there was average acceptance. Nearly one-fourth considered that the suits or coveralls were partially adequate (one-third for asbestos and fire retardant). Nearly 18% complained--too hot, primarily, and 44% recommended improvements--longer use-life, increased wearing comfort, and weight reduction.

Cape Sleeves

About 14% of the foundries used cape sleeves--six per foundry on the average. Three types are primarily used: leather in 31% of the foundries (but 68% of the items over eight per foundry), aluminized in 38% of the foundries (but 24% of the items, two and one-half per foundry), and asbestos in 22% of the foundries (but only 10% of the items, two per foundry) (Table 11).

About 8% considered cape sleeves unsatisfactory. About 32% considered the acceptance average--somewhat higher than many items (this is considered poor since usually the good acceptance is quite high). About three-fourths considered them very adequate.

Performance complaints were noted by 12% of the foundries and recommended improvements by 41%. The three major recommendations were increased wearing comfort, weight reduction, and longer use-life.

Hand Pads

Only a little more than 10% of the foundries used hand pads, but each used an average of 20. Leather was the primary material--65% of the foundries used leather which accounted for 65% of the hand pads. Asbestos was the next most frequently used material.

Because of the small number of foundries, only limited use can be made of the detailed breakdowns. Performance, acceptance, and adequacy are similar to previous items, as are complaints and recommendations.

Fire Resistant Synthetic Fiber Suits or Coveralls

About 7% of the foundries used this item and there were but four in use (on the average) per foundry. Aluminized and fire retardant materials were about equal, but far more fire retardant and leather items were in use than for the other materials.

Nearly 20% rated the performance unsatisfactory. Complaints were short use-life and too hot; improvements were longer use-life.

Other

The other items in Table 11 are too few in number to give detailed tables.

Table 11: Foundries Using Particular Personal Protective Equipment for Hot Environments (Computer Analysis)

Clothing or Devices	Foundries Using	Number in Use	Foundry Using as Percent of Responding Foundries	Number Use per Foundry
Flame and Heat Hazard--gloves or mittens	297	3,304	74	11
Flame and Heat Hazard--leggings	213	1,708	53	8
Heat Hazard--face shields	180	1,493	45	8
Heat Hazard--safety goggles	145	2,048	36	14
Flame and Heat Hazard--aprons	131	844	33	6
Flame and Heat Hazard--sleeves	91	740	23	8
Flame and Heat Hazard--suits or coveralls	61	729	15	12
Flame and Heat Hazard--cape sleeves	58	329	14	6
Flame and Heat Hazard--hand pads	43	876	11	20
Fire Resistant Synthetic Fiber Suits or Coveralls (Nomex or Kynol)	28	124	7	4
Combination Device--blasting hood and clothing	13	30	3	2
Combination Device--respirator and clothing	5	13	1	3
Flame and Heat Hazard--finger guards	5	162	1	32

Table 11: (Continued)

Clothing or Devices	Foundries Using	Number in Use	Foundry Using as Percent of Responding Foundries	Number Use per Foundry
Flame and Heat Hazard--knee pads	4	19	1	5
Air-Cooled Clothing--no refrigerant	2	2	0.5	1
Water-Cooled Clothing	2	2	0.5	1
Air Conditioner for Clothing--refrigerant	1	2	0.25	2

Table 12: Flame and Heat Hazard--
Gloves or Mittens by Material Type

Material Types	Total Foundries	Percent Foundries Where Type is Specified	Total Used	Percent Used Where Type is Specified	Number Used per Foundry
Asbestos	87	43	591	30	6.8
Aluminized	17	8	182	9	10.7
Fire Retardant	28	14	284	14	10.1
Leather	69	34	1,338	70	19.4
No Type Given	96	---	1,305	---	13.6
Total	297	---	3,700	---	----

Table 13: Ratings of Acceptance, Performance, and Adequacy Against Flame and Heat Hazards--Gloves or Mittens by Material Type (Computer Analysis)

Rating	Total	Type Not Given	Asbestos	Aluminized	Fire Retardant	Leather
Total Responding	297	96	87	17	28	69
Total Acceptance	226	65	67	16	22	56
Good	191	51	58	13	18	51
Average	32	12	8	3	4	5
Poor	3	2	1	0	0	0
Total Adequacy	206	54	65	15	19	53
Very Adequate	177	46	56	12	16	47
Partially Adequate	27	8	8	3	3	5
Not Adequate	1	0	1	0	0	0
Other	1	0	0	0	0	1
Total Performance	265	80	81	17	23	64
Satisfactory	254	76	76	16	22	64
Unsatisfactory	11	4	5	1	1	0

Table 13: (Continued)

Rating	Total	Type Not Given	Asbestos	Aluminized	Fire Retardant	Leather
Performance (Unsatisfactory)	23	9	10	1	1	2
Too Heavy	1	1	0	0	0	0
Not Flexible	2	1	1	0	0	0
Too Bulky	2	1	1	0	0	0
Weight Distribution	0	0	0	0	0	0
Short Use-Life	13	4	5	1	1	2
Too Hot	1	1	0	0	0	0
Too Cold	0	0	0	0	0	0
Other	4	1	3	0	0	0
Recommended Improvement	91	20	31	9	8	23
Better Design	4	1	1	0	0	2
Weight Reduction	3	1	0	0	1	1
Longer Use-Life	41	8	15	4	3	11
Wearing Comfort	15	4	5	0	4	2
Simpler Operation	0	0	0	0	0	0
Other	28	6	10	5	0	7

Table 14: Flame and Heat Hazards--Leggings by Material Type (Computer Analysis)

Material Types	Total Foundries	Percent Foundries Where Type is Specified	Total Used	Percent Used Where Type is Specified	Number Used per Foundry
Asbestos	37	25	292	27	7.89
Aluminized	29	19	215	20	7.14
Fire Retardant	24	16	181	16	7.54
Leather	61	40	564	51	9.25
No Type Given	62	--	610	--	9.8
Total	213	--	1,862	--	--

Table 15: Ratings of Acceptance, Performance, and Adequacy Against Flame and Heat Hazards--Leggings by Material Type

Rating	Total	Type Not Given	Asbestos	Aluminized	Fire Retardant	Leather
Total Responding	213	62	37	29	24	61
Total Acceptance	171	45	30	25	19	52
Good	122	30	23	18	11	40
Average	40	11	4	6	8	11
Poor	9	4	3	1	0	1
Total Adequacy	156	39	27	24	21	45
Very Adequate	119	30	22	19	14	34
Partially Adequate	34	6	5	5	7	11
Not Adequate	2	2	0	0	0	0
Other	1	1	0	0	0	0
Total Performance	187	50	31	26	22	58
Satisfactory	179	48	29	25	21	56
Unsatisfactory	8	2	2	1	1	2

Table 15: (Continued)

Rating	Total	Type Not Given	Asbestos	Aluminized	Fire Retardant	Leather
Performance (Unsatisfactory)	33	11	7	4	5	6
Too Heavy	3	1	2	0	0	0
Not Flexible	2	1	1	0	0	0
Too Bulky	5	2	3	0	0	0
Weight Distribution	2	1	0	0	0	1
Short Use-Life	7	2	0	1	2	2
Too Hot	4	1	0	2	1	0
Too Cold	1	0	1	0	0	0
Other	9	3	0	1	2	3
Recommended Improvement	89	17	22	13	19	18
Better Design	13	2	4	1	2	4
Weight Distribution	8	2	3	1	1	1
Longer Use-Life	18	2	6	3	4	3
Wearing Comfort	29	6	5	6	4	8
Simpler Operation	4	0	1	1	2	0
Other	17	5	3	1	6	2

Table 16: Ratings of Acceptance, Performance, and Adequacy Against Heat Hazards--Face Shields (Computer Analysis)

Rating	Total
Total Responding	180
Total Acceptance	144
Good	112
Average	27
Poor	5
Total Adequacy	136
Very Adequate	114
Partially Adequate	21
Not Adequate	1
Other	0
Total Performance	157
Satisfactory	152
Unsatisfactory	5
Comments	Total
Total Responding	180
Performance (Unsat.)	11
Too Heavy	1
Not Flexible	1
Too Bulky	1
Wt. Distribution	0
Short Use-Life	2
Too Hot	3
Too Cold	0
Other	3
Recommended Improvement	46
Better Design	5
Wt. Reduction	4
Longer Use-Life	17
Wearing Comfort	10
Simpler Operation	2
Other	8

Table 17: Ratings of Acceptance, Performance, and Adequacy Against Heat Hazards--Safety Goggles (Computer Analysis)

Rating	Total
Total Responding	145
Total Acceptance	104
Good	87
Average	17
Poor	0
Total Adequacy	94
Very Adequate	86
Partially Adequate	8
Not Adequate	0
Other	0
Total Performance	120
Satisfactory	119
Unsatisfactory	1
Comments	Total
Total Responding	145
Performance (Unsat.)	4
Too Heavy	0
Not Flexible	0
Too Bulky	0
Wt. Distribution	0
Short Use-Life	1
Too Hot	2
Too Cold	0
Other	1
Recommended Improvements	23
Better Design	1
Wt. Reduction	2
Longer Use-Life	6
Wearing Comfort	11
Simpler Operation	0
Other	3

PART II--SILICA

Introduction

There are primarily two types of respirators used for protection against silica hazards. Nearly 40% of the responding foundries used the single use dust respirator, which is completely discarded after use, and nearly 30% used the dust, fume, or mist respirator, which has replaceable or reusable filters (Table 18). Over two-thirds of the foundries (for each type of respirator) are of four industries: gray iron foundries; steel foundries; aluminum castings; and brass, bronze, copper, and copper-based alloy castings. Table 19 reflects the fact that many respirators in use are not certified. NIOSH and MSHA are the respirator certification agencies, and their approval indicates that the equipment meets certain minimum requirements (30 CFR 11).

Single Use Dust Respirator

Nearly 40% of the responding foundries used this type of respirator--over 24 per foundry on the average (Table 20). Of these, 93% were the half mask, for an average of about 25 per foundry. The remainder, 7%, were the fullface masks, for about 18 per foundry. Nearly 50% indicated that the approval number had a "TC" prefix.

Only about 53% of the users indicated that the performance was satisfactory. Of these, over 70% considered the respirators very adequate; however, 26% indicated the respirators were only partially adequate. Nearly 60% judge acceptance as good (over 75%), 33% average (25 to 75%), and 8% poor (under 25%) (Table 21).

Nearly 25% of the users gave unsatisfactory comments. The two major areas of concern are strap design and short use-life. The 37% who provided recommendations for improvement listed wearing comfort, longer use-life, and better designs as most important.

Dust, Fume, or Mist Respirator

About 30% of the foundries used this type of respirator with an average use of nearly 18 per foundry. Again, about 90% of these foundries used the half mask and the remainder used the fullface mask (Table 22). Each used an average of 18 per foundry (Table 18).

Less than half (46%) of the users (Table 23) indicated that the performance was satisfactory; but, of these, 81% indicated that the respirators were very adequate. Acceptance was judged good (over 75%) by 49%, average (25 to 75%) by 41%, and poor (less than 25%) by 9%.

About 23% gave unsatisfactory comments concerning primarily the contour face mask and strap design. Recommendations for improvement were indicated by 51%. Wearing comfort was the major recommendation. Weight reduction and better design were also mentioned.

Other

There were only a few foundries which used other types of respirators, and thus few meaningful details can be provided. See Table 21 for more detail. The 13 foundries which used supplied air respirators--continuous flow are divided about evenly among fullface mask, hood, and helmet. For all of these types of respirators, over half of the respondents considered their wear qualities as unsatisfactory. They were generally considered to provide adequate protection. Acceptance was considered good (over 75%) for supplied air respirators (continuous flow and pressure demand flow), but poor (under 25%) for power air purifying respirators and supplied air respirators--demand flow.

The responses received indicate some lack of understanding of what is and what is not an approved or certified respirator. Table 24 shows the numbers and types of respirators in use against silica hazards.

Table 18: Users of Respirators by Types Against Silica Hazards (Hand Analysis)

Device	Foundries Using	Number In Use	Percent of Responding Foundries	Number Used per Foundry
Single Use Dust Respirator	158	3,839	39	24.3
Dust, Fume, or Mist Respirator	118	2,096	29	17.8
Powered Air Purifying Respirator	9	63	2	7
Supplied Air Respirator--Demand Flow	8	26	2	3.25
Supplied Air Respirator--Pressure Demand Flow	1	1	0.2	1
Supplied Air Respirator--Continuous Flow	13	40	3	3.1

Table 19: Users of Certified, Uncertified, and Unknown or Uncertain Respirators Against Silica Hazards* (Hand Analysis)

Respirator Type	Number of Establishments Which are Users of MSHA/NIOSH Certified Respirators	Number of Establishments Which are Users of Uncertified Respirators	Number of Establishments Which are Users of Respirators with Certification Unknown or Uncertain
Disposable	106	27	17
Replaceable Filters and/or Cartridges	137	9	28
Gas Masks	1	1	--
Powered Air Purifiers	2	4	--
Supplied Air	21	--	10
Self-Contained Breathing Apparatus	2	--	--
Unknown	--	--	4

* A specified establishment may be a user simultaneously of respirators which are certified, uncertified, or whose certification is unknown or uncertain.

Table 20: Users of Single Use* Type Respirators Approved or Unapproved by Number and Percentage (Computer Analysis)

Type of Device	Total Foundries	Percent of Foundries Where Approval is Specified	Total Used	Percent Used Where Approval is Specified	Number Used per Foundry
Fullface Mask	15	10	271	7	18.1
Half Mask	142	90	3,566	93	25.1
Hood	0	0	0	0	0
Helmet	0	0	0	0	0
No Type Given	1	---	2	---	2
Total	158	---	3,839	---	24.3

* Respondents apparently had difficulty identifying single use type respirators.

Table 21: Ratings of Acceptance, Performance, and Adequacy of Single Use Respirators by Types (Computer Analysis)

Rating	Total	Fullface Mask	Half Mask	No Type Given
Total Responding	158	15	142	1
Total Acceptance	136	14	121	1
Good	80	8	71	1
Average	45	5	40	0
Poor	11	1	10	1
Total Adequacy	127	14	112	1
Very Adequate	90	12	77	1
Partially Adequate	33	2	31	0
Not Adequate	3	0	3	0
Other	1	0	1	0
Total Performance	296	28	266	2
Satisfactory	158	15	124	1
Unsatisfactory	138	13	142	1

Table 21: (Continued)

Comments	Total	Fullface Mask	Half Mask	No Type Given
Total Responding	158*	15	142	1
Unsatisfactory Comments	37	3	34	--
Strap Design	14	1	13	--
Contour Face Mask	4	0	4	--
Other	1	0	1	--
Too Heavy	0	0	0	--
Distribution	1	1	0	--
Other	2	0	2	--
Valves Stick	1	0	1	--
Valves Do Not Last	0	0	0	--
Filt-Diff-Replace**	0	0	0	--
Air System Problems	0	0	0	--
Short Use-Life	10	0	10	--
Visibility	2	1	1	--
Other	2	0	2	--
Recommended Improvements	59	5	54	--
Better Design	11	0	11	--
Weight Reduction	1	1	0	--
Longer Use-Life	17	0	17	--
Wearing Comfort	20	2	18	--
Simpler Operation	1	0	1	--
Other	9	2	7	--

* Includes one foundry which did not give a type and did not give comments on recommendations.
** Filter difficult to replace.

Table 22: Users of Dust, Fume, and Mist* Type Respirators Approved or Unapproved by Number and Percentage (Computer Analysis)

Type of Device	Total Foundries	Percentage of Foundries Where Approval is Specified	Total Used	Percentage Used Where Approval is Specified	Number Used per Foundry
Fullface Mask	13	11	230	10	17.7
Half Mask	105	89	1,891	90	18
Hood	0	0	0	0	0
Helmet	0	0	0	0	0
No Type Given	0	0	0	0	0

* Respondents apparently had difficulty identifying dust, fume, and mist respirators.

Table 23: Ratings of Acceptance, Performance, and Adequacy of Dust, Fume, and Mist Respirators (Computer Analysis)

Rating	Total	Fullface Mask	Half Mask
Total Responding	118	13	105
Total Acceptance	95	11	84
Good	47	4	43
Average	39	7	32
Poor	9	0	9
Total Adequacy	84	10	74
Very Adequate	68	9	59
Partially Adequate	15	1	14
Not Adequate	1	0	0
Other	0	0	0
Total Performance	218	24	194
Satisfactory	100	11	89
Unsatisfactory	118	13	105

Table 23: (Continued)

Comments	Total	Fullface Mask	Half Mask
Total Responding	118	13	105
Unsatisfactory Comments	27	6	21
Strap Design	7	1	6
Contour Face Mask	8	1	7
Other	0	0	0
Too Heavy	2	0	2
Distribution	2	0	2
Other	4	2	2
Valves Stick	0	0	0
Valves Do Not Last	0	0	0
Filt-Diff-Replace*	0	0	0
Air System Problems	0	0	0
Short Use-Life	1	0	1
Visibility	1	1	0
Other	2	1	1
Recommended Improvements	60	8	52
Better Design	9	1	8
Weight Reduction	12	2	10
Longer Use-Life	4	0	4
Wearing Comfort	26	3	23
Simpler Operation	3	1	2
Other	6	1	5

* Filter difficult to replace.

Table 24: Number and Types of Respirators in Use Against Silica Hazards* (Hand Analysis)

Respirator Type	Number of MSHA/NIOSH Certified Respirators	Number of Uncertified Respirators	Number of Respirators with Certification Unknown or Uncertain
Disposable	4,020	291	103
Replaceable Filters and/or Cartridges	1,645	194	341
Gas Masks	4	2	--
Powered Air Purifiers	6	19	1
Supplied Air	66	--	--
Self-Contained Breathing Apparatus	14	--	--
Total	5,755	506	445

* Data are not included for surveyed establishments which reported they were users of respirators, but did not give numbers of respirators in use.

PART III--METAL FUME

Introduction

This study indicates (Table 25) there are primarily two types of certified respirators in general use for metal fume hazards: dust, fume, and mist respirators with replaceable filters and single use disposable respirators.

Dust, Fume, or Mist Respirators with Replacable Filters and Single Use Disposable Respirators

Nearly 30% of the responding foundries used these types of respirators for an average of nearly seven per foundry (Table 25). About three-fourths of the foundries are in four industries--brass, bronze, copper and copper-based alloy castings (27%); gray iron foundries (22%); aluminum castings (21%); and steel foundries (4%).

About 90% of the respirators used are the half mask type. Nearly 50% of those indicated that the approval number had a NIOSH Testing and Certification (TC) or Bureau of Mines (BM) prefix (Table 26). Table 27 shows the different numbers and types of certified and uncertified respirators reported. Only 9% (Table 28) indicated the performance was unsatisfactory. Adequacy was judged by 72% as very adequate, 22% as partially adequate, and 6% as not adequate. Only 50% indicated that acceptance was good (over 75%), and 15% indicated poor acceptance (under 25%) (Table 28).

Over 28% considered the respirators unsatisfactory for a variety of reasons including strap design, visibility, short use-life, too heavy, and contour face mask. Nearly 50% recommended improvements. Of the recommended improvements, 37% concerned wearing comfort. Almost all the others on the list were mentioned about equally as often.

Other Respirators

A few foundries indicated they used other types of respirators. When they did, they were frequently hood or helmet type. Generally they were considered satisfactory, adequate, and acceptable.

There were no unsatisfactory comments. Recommendations for improvement were few; weight reduction was the most frequent.

Table 25: Users of Respirators, by Types, Against Metal Fume Hazards (Computer Analysis)

Device	Foundries Using	Number In Use	Percent of Responding Foundries	Number Used per Foundry
Dust, Fume, or Mist Respirator with Replacable and/or Single Use Disposable Respirators	117	773	29	6.6
Supplied Air Respirator Demand Flow	4	22	1	5.5
Supplied Air Respirator Pressure Demand Flow	2	5	0.5	2.5

Table 25: (Continued)

Device	Foundries Using	Number In Use	Percent of Responding Foundries	Number Used per Foundry
Supplied Air Respirator Continuous Flow	7	24	2	3.4
Powered Air Purifying Respirator	4	5	1	1.3

Table 26: Users of Dust, Fume, and Mist Type Respirators Approved or Unapproved by Number and Percentage (Computer Analysis)

Type of Device	Total Foundries	Percentage of Foundries Where Approval is Specified	Total Used	Percentage Used Where Approval is Specified	Number Used per Foundry
Fullface Mask	11	9	59	7	5.4
Half Mask	105	90	724	93	6.9
Hood	0	0	0	0	0
Helmet	1	1	0*	0	0
No Type Given	0	--	0	--	0
Total	117	--	773	--	6.6

* Information not given.

Table 27: Users of Different Types of Respirators Certified or Uncertified Against Metal Fumes (Hand Analysis)

Respirator Type	Number of Establishments Which are Users of MSHA/NIOSH Certified Respirators	Number of Establishments Which are Users of Uncertified Respirators	Number of Establishments Which are Users of Respirators with Certification Unknown or Uncertain
Single Use Disposable	28	8	6
Replaceable Filters and/or Cartridges	48	31	29
Powered Air Purifiers	1	--	2
Supplied Air	5	--	6
Self-Contained Breathing Apparatus	4	--	--

* A specified establishment may be a user simultaneously of respirators which are certified, uncertified, or whose certification is unknown or uncertain.

Table 28: Ratings of Acceptance, Performance, and Adequacy of Dust, Fume, or Mist Respirators with Replaceable Filters, by Type (Computer Analysis)

Rating	Total	Fullface Mask	Half Mask
Total Responding	117*	11	105
Total Acceptance	96	9	87
Good	48	4	44
Average	34	3	31
Poor	14	2	12
Total Adequacy	83	8	75
Very Adequate	60	7	53
Partially Adequate	18	1	17
Not Adequate	5	0	5
Total Performance	111	10	101
Satisfactory	101	8	93
Unsatisfactory	10	2	8
Comments	Total	Fullface Mask	Half Mask
Total Responding	117	11	105
Unsatisfactory Comments	33	4	29
Strap Design	9	1	8
Contour Face Mask	4	0	4
Other	2	0	2
Too Heavy	4	1	3
Weight Distribution	0	0	0
Other	1	0	1
Valves Stick	0	0	0
Valves Do Not Last	0	0	0
Filt-Diff-Replace*	1	0	1
Air System Problems	0	0	0
Short Use-Life	4	0	4
Visibility	5	2	3
Other	3	0	3
Recommended Improvements	57	4	53
Better Design	6	0	6
Weight Reduction	7	0	7
Longer Use-Life	9	2	7
Wearing Comfort	21	1	20
Simpler Operation	3	0	3
Other	11	1	10

* Filter difficult to replace.

PART IV--NOISE

Introduction

Information was sought on 15 types of hearing protective devices for noise hazards. Earmuffs--general were the most frequently used. Next were rubber and silicone rubber earplugs (Table 29).

Earmuffs--General

About 34% of the responding foundries (Table 29) used "earmuffs--general," with an average of 16 per foundry. About 65% of the foundries were of four types: gray iron (25%); aluminum castings (18%); brass, bronze, copper, copper-based alloy casting (13%); and steel (9%).

About 6% of the foundries indicated that the earmuffs were unsatisfactory (Table 30). Of those that indicated acceptance, 18% said acceptance was poor (less than 25% acceptance). Most indicated they were adequate.

Unsatisfactory comments were primarily tight fit on head, too heavy, and too hot. Over half who recommended improvements indicated wearing comfort. Most others indicated weight reduction.

Earmuffs--Sound Discriminating

About 8% of the responding foundries used sound discriminating earmuffs as hearing protectors. There were too few to do much detailed analysis, but of the users, 99% were satisfied, 21% indicated acceptance was poor (less than 25%), and 80% indicated very adequate. Improvements desired were primarily in wearing comfort and weight reduction.

Earmuffs--Other

About 4% of the foundries used low profile, folding, or communications headphones earmuffs. However, the foundries which used the low profile earmuffs used about 69 per foundry. There were too few foundries using them to make further observations from the data.

Ear Valves

About 4% of the foundries used ear valves, with an average of 11 per foundry. All of the foundries consider them satisfactory and adequate; however, 29% indicated poor acceptance (under 25%). Because of the small numbers, no further comments can be made.

Earplugs--Rubber

Of the wide variety of earplugs used, rubber is used by most foundries--17%. There were an average of about 31 used in each foundry (Table 29). Of the foundries where a rating is specified in Table 31, 5% indicate the performance was unsatisfactory. Almost all indicated they were adequate. Fifteen percent of the foundries stated acceptance was poor (less than 25%). Wearing comfort was the primary improvement recommended.

None of the remaining types of earplugs were used in a sufficient number of foundries to have meaningful detailed data. Only items of an exceptional nature will be reported.

Earplugs--Silicone Rubber

Ten percent of the foundries used silicone rubber earplugs, with an average of 57 per foundry. In terms of number in use, this makes this type of hearing protection the most frequent. Wearing comfort is the improvement most frequently recommended.

Earplugs--Expanding Foam Polymer

Ten percent of the foundries used this type of earplug, with an average of 34 per foundry. A somewhat higher percentage of foundries (than for other hearing protectors) indicated the performance unsatisfactory (9%). Adequacy and acceptance, however, were similar to other types. Again, wearing comfort was the major recommended improvement, but longer use-life and simpler operation were also mentioned.

Earplugs--Plastic

Eight percent of the foundries used plastic earplugs, with an average of 42 per foundry. About 90% of the foundries considered them satisfactory. Wearing comfort and longer use-life were the primary recommendations.

Earplugs--Soft Polymer Self-Forming

About 8% of the foundries used this type of earplug, with an average of about 35 per foundry. Most indicated they were satisfactory. The primary recommendation was for longer use-life.

Earplugs--Waxed Cotton

About 6% of the foundries used wax cotton earplugs, with 34 per foundry on the average. Eighty-three percent indicated they were satisfactory. Comments included tight fit in ear and short use-life.

Earplugs--Glass Fiber

There were 5% of the foundries which used this type of earplug, but each foundry used over 60, on the average. No significant comments were noted.

Earplugs--Cord Attached and Custom Molded

About 3% of the foundries used each of these earplugs, with an average of between 34 and 35 per foundry. Of those foundries using cord attached earplugs, 31% indicated the acceptance was poor (less than 25%). The recommended improvement for cord attached earplugs was wearing comfort.

Table 29: Users of Hearing Protectors, by Types, Against Noise (Computer Analysis)

Device	Responding Foundries		Number of Devices In Use	
	Percent	Number	Total	per Foundry
Earmuffs--General	34	137	2,139	15.6
Earmuffs--Sound Discriminating	8	32	375	11.7
Earmuffs--Low Profile	2	7	480	68.6
Earmuffs--Folding	1	3	24	8.0
Earmuffs--w/Communications Headphones	1	4	74	18.5
Ear Valves	4	16	174	10.9
Earplugs--Custom Molded	3	13	453	34.8
Earplugs--Waxed Cotton	6	25	855	34.2
Earplugs--Glass Fiber	5	21	1,264	60.2
Earplugs--Plastic	8	34	1,421	41.8
Earplugs--Rubber	17	69	2,126	30.8
Earplugs--Silicone Rubber	10	39	2,221	56.9

Table 29: (Continued)

Device	Responding Foundries Percent	Responding Foundries Number	Number of Devices In Use Total	Number of Devices In Use per Foundry
Earplugs--Expanding Foam Polymer	10	39	1,311	34.1
Earplugs--Soft Polymer Self-Expanding	8	31	1,081	34.9
Earplugs--Cord Attached	3	14	469	33.5

Table 30: Ratings of Acceptance, Performance, and Adequacy of Earmuffs--General (Computer Analysis)

Rating	Total	Satisfactory	Unsatisfactory	Not Specified
Total Responding	137	117	8	12
Total Acceptance	112	101	6	5
Good	51	50	0	1
Average	41	39	1	1
Poor	20	12	5	3
Total Adequacy	100	92	5	3
Very Adequate	86	82	3	1
Partially Adequate	13	9	2	2
Not Adequate	1	1	0	0

Comments	Total	Satisfactory	Unsatisfactory	Not Specified
Total Responding	137	117	8	12
Unsatis. Comments	28	11	14	3
Tight Fit on Head	7	3	3	1
Tight Fit on Ear	2	1	1	0
Loose Fit on Ear	0	0	0	0
Loose Fit on Head	1	1	0	0
Too Heavy	6	2	4	0
Short Use-Life	0	0	0	0
Too Hot	11	4	5	2
Other	1	0	1	0

Table 30: (Continued)

Comments	Total	Satisfactory	Unsatisfactory	Not Specified
Recommended Improvements	66	51	13	2
Better Design	4	3	1	0
Weight Reduction	16	10	5	1
Longer Use-Life	3	2	1	0
Wearing Comfort	35	31	3	1
Simpler Operation	2	1	1	0
Other	6	4	2	0

Table 31: Ratings of Acceptance, Performance, and Adequacy of Earplugs--Rubber (Computer Analysis)

Rating	Total	Satisfactory	Unsatisfactory	Not Specified
Total Responding	69	59	3	7
Total Acceptance	54	50	2	2
Good	23	22	0	1
Average	23	22	1	0
Poor	8	6	1	1
Total Adequacy	51	47	2	2
Very Adequate	34	33	0	1
Partially Adequate	16	14	1	1
Not Adequate	1	0	1	0
Other	0	0	0	0
Comments	**Total**	**Satisfactory**	**Unsatisfactory**	**Not Specified**
Total Responding	69	59	3	7
Unsatis. Comments	7	3	3	1
Tight Fit on Head	0	0	0	0
Tight Fit on Ear	3	2	0	1
Loose Fit on Ear	1	0	1	0
Loose Fit on Head	0	0	0	0
Too Heavy	0	0	0	0
Short Use-Life	3	1	2	0
Too Hot	0	0	0	0
Other	0	0	0	0

Table 31: (Continued)

Comments	Total	Satisfactory	Unsatisfactory	Not Specified
Recommended Improvements				
Better Design	25	24	1	0
Weight Reduction	3	3	0	0
Longer Use-Life	3	3	0	0
Wearing Comfort	18	17	1	0
Simpler Operation	0	0	0	0
Other	1	1	0	0

DISCUSSION

This prototype survey of personal protective equipment used in foundries was conducted by NIOSH personnel. The basic reasons why the foundry industry was selected were: (1) they are large users of personal protective equipment; (2) because of OSHA's on-going NEP, a listing of foundries, addresses, and other important information was readily available, and (3) NIOSH was in the process of writing a Foundry Criteria Document for which there was very little information available on personal protective equipment.

In selecting the foundries to be included in the survey, two strata were quantified. Stratum I was a listing of 59 foundries that had been cited by OSHA. Stratum II was a systematic sample with a random start of every seventh foundry (excluding Stratum I) from OSHA's NEP master listing of foundries.

Each foundry was called by phone prior to sending them a questionnaire. This exercise revealed that a large number of foundries in Stratum II were, for a variety of reasons, no longer foundries. An additional 103 foundries were selected using the same systematic approach described above. The adjusted sample included 702 foundries and yielded a response rate of 57%.

The need to contact the establishment being surveyed prior to sending the questionnaire (so the person to whom it is to be sent is identified and is expecting it) cannot be overemphasized. Telephone follow-up on non-responders is also very important, as some questionnaires were not received, were lost, or were misdirected because of personnel responsibilities change.

Although it may appear that there is adequate, comfortable, and effective personal protective equipment available and being used by foundry employees, the validation visits and questionnaire responses did not always support this assumption.

Even though this prototype study was designed only to survey the nature and extent of use of personal protective equipment for four problem areas (hot environments, noise, metal fumes, and silica) in the foundry industry, it demonstrated its effectiveness as a method of data collection.

SUMMARY

With slight modifications to fit a particular need, this microstudy methodology can be used for empirical data collection on personal protective equipment.

In the foundry industry, some employees are being exposed to hot environments, noise, metal fumes, and silica without the benefit of all of the protection provided by available personal protective equipment. The personal protective equipment being selected and issued to exposed workers all too often is neither appropriate nor adequate. There appears to be a great need for education and training of employees in the foundry industry as regards personal protective equipment selection, maintenance, fitting, and usage.

The founding of metal is an ancient craft, and apparently many employers and employees still regard the hot, dusty, and dangerous working conditions as inevitable. Although silica dust and its concomitant pneumoconiosis are well documented and can be safely assumed to be present in many of the foundries surveyed, personal protective equipment for silica dust was generally not being provided.[6] All too often, if personal protective equipment was provided, it was not suitable for the application. See Tables 32 and 33 for illustrations found in the survey.

OSHA regulations (1910.134) require that approved or accepted respirators shall be used when they are available. The two agencies (NIOSH and MSHA) given authority under 30 CFR 11 to test and certify respirators have done so on many respirators that can be worn to protect against hazardous concentrations of metal fumes and silica.

Table 32: Calculation of Grand Total of Number of Respirators Reported by Survey to be in Use Against Metal Fumes and Silica* (Hand Analysis)

Certification Status of Respirator	Number of Respirators In Use Against Metal Fumes	Number of Respirators In Use Against Silica	Total Number of Respirators in Use
Certified	863	5,755	6,618
Uncertified	449	506	955
Certification Unknown or Uncertain	89	453	542
		Grand Total = 8,115**	

* Data are not included for surveyed establishments which reported they were users of respirators, but did not give numbers of respirators in use.

** Total may be larger than actual use because establishments surveyed may use one respirator to protect against both metal fumes and silica.

Table 33: Number of Respirators Reported in Use Against Metal Fumes* by Surveyed Establishments (Hand Analysis)

Respirator Type	Number of MSHA/NIOSH Certified Respirators	Number of Uncertified Respirators	Number of Respirators with Certification Unknown or Uncertain
Disposable	425	24	5
Replaceable Filters and/or Cartridges	403	425	76
Powered Air Purifiers	1	--	1
Supplied Air	27	--	7

Table 33: (Continued)

Respirator Type	Number of MSHA/NIOSH Certified Respirators	Number of Uncertified Respirators	Number of Respirators with Certification Unknown or Uncertain
Self-Contained Breathing Apparatus	7	--	7
Total	863	449	96

* Data are not included for surveyed establishments which reported they were users of respirators, but did not give numbers of respirators in use.

An illustration of the need for education in respirator testing and certification is shown in Table 34. During the survey, at least one person in each foundry was identified who was responsible for safety and/or safety equipment. The results indicate that additional training and education in personal protective equipment for many of those responsible would promote increased safety and health.

Table 34: Use by Foundries of Respirators, Which Formerly Had BOM Certificates of Approval, but Whose Approval Had Expired (Hand Analysis)

Number of Foundry Users		Number of Expired Approval In Use		
Against Metal Fumes	Against Silica	Against Metal Fumes	Against Silica	Total Number of Expired Approval Respirators in Use
15*	20**	301	124	425

* Includes 2 foundries which did not list number of respirators in use.

** Includes 3 foundries which did not list number of respirators in use.

The information from the unsatisfactory, other, and comments questionnaire entries indicated a great need for improved design and applied research. The results of this study support the fact that there is a trend towards fewer but larger foundries. Although it should be noted that in the "less than 10 employees" foundries identified in Table 35, there were many with only two or three employees.

Table 35: Total Number of Employees By Foundry Size Range

	Total No. of Employees	Foundry Size Range
	416	Less than 10 Employees
	3,400	10--49 Employees
	12,614	50--249 Employees
	27,380	More than 249 Employees
Grand Total	43,810	

The response rate appeared to have been affected by respondents' concern about regulatory implications from completion of a questionnaire. This was illustrated by the fact that Stratum I foundries (those that had been cited by OSHA) had a response rate of 38%, as opposed to Stratum II (non-cited) of 59%. Size of foundry did not have a significant effect on response rate.

On the basis of the number of calls for explanation of questions and procedures by questionnaire recipients, the instructions were satisfactory and the form easily understood. Most calls received were requests for return date extensions. The vast majority of the foundry personnel contacted in conjunction with the survey were cooperative and appreciative of the objectives of the study.

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14. Huelson, William B. (American Foundryman's Society, Des Plaines, Illinois.) 1977. (Personal visit, August 1977.)

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APPENDIX A

Master List of Chemical and Physical Agents Requiring
Personal Protective Equipment

Agent	Known or Suspected Carcinogen	NIOSH Criteria Documents Pre 1976	1976	1977	1978	OSHA Standards 1900.1000 Subpart Z
Acetaldehyde					o	
Acetamide	o					
2-Acetylaminofluorene						o
Acetylene			o			
Acrolein						o
Acrylamide			o			
Alkali Metal Hydroxides					o	
Alkanes			o			
Allyl Chloride			o			
Allyl Glycidyl Ether					o	
4-Aminodiphenyl						o
Ammonia						o
Ammonium Nitrate					o	
sec-Amyl Acetate						o
Amyl Alcohol					o	
Anesthetic Gases			o			
Anilines			o			
Antimony Compounds				o		
Asbestos		o				
Asphalt Fumes				o		
Benzene		o				
Benzidine						o
Benzoyl Peroxide				o		
Benzyl Chloride	o					
Beryllium		o				
Boron Oxide					o	
Boron Tribromide					o	
Boron Trifluoride			o			
Bromine Pentafluoride					o	
2-Butanone						o
n-Butyl Acetate						o
sec-Butyl Acetate						o
tert-Butyl Acetate						o

APPENDIX A (Continued)

Agent	Known or Suspected Carcinogen	NIOSH Criteria Documents Pre 1976	1976	1977	1978	OSHA Standards 1900.1000 Subpart Z
n-Butyl Glycidyl Ether					o	
Butyl Mercaptan					o	
p-tert-Butyl Toluene						o
Cadmium			o			
Camphor	o					
Carbaryl			o			
Carbon Black					o	
Carbon Dioxide			o			
Carbon Disulfide			o			
Carbon Monoxide		o				
Carbon Tetrachloride		o				
Chlorine			o			
Chloroform		o				
alpha-Chloracetophenone	o					
bis-Chloromethyl Ether						o
Chloroprene				o		
Chromic Acid		o				
Chromium					o	
Chromium VI		o				
Coal Tar Products				o		
Cobalt	o					
Coke Oven Emissions		o				
Cold Environments					o	
Cotton Dust		o				
Cresols (Cresylic Acid)				o		
Cumene						o
Cyanides			o			
Cyclohexane						o
Cyclohexanone						o
Crystalline Silica		o				
Diazomethane					o	
Dibutyl Phosphate					o	
Dichloroacetylene					o	
p-Dichlorobenzene					o	
3-3'-Dichlorobenzidine						o
Dichloroethyl Ether					o	
Diethyl Sulfate	o					
Diglycidyl Ether					o	
1-Dimethylaminoazobenzene						o
Dimethyl Sulfate	o					
Dioxane			o			
Diphenyl						o
Epichlorohydrin			o			
2-Ethoxyethyl Acetate						o

APPENDIX A (Continued)

Agent	Known or Suspected Carcinogen	NIOSH Criteria Documents Pre 1976	1976	1977	1978	OSHA Standards 1900.1000 Subpart Z
Ethyl Benzene						o
Ethyl Butyl Ketone				o		
Ethylene Chlorohydrin	o					
Ethylene Dibromide				o		
Ethylene Dichloride		o				
Ethyleneimine						o
Ethylene Oxide	o					
Ethylene Thiourea	o					
Ethyl Mercaptan					o	
Ethyl sec-Amyl Ketone				o		
Fibrous Glass			o			
Fluorides (Inorganic)		o				
Fluorine			o			
Fluorocarbons				o		
Formaldehyde			o			
Furfural						o
Furfural Alcohol					o	
Hexone						o
Hot Environments		o				
Hydrazines				o		
Hydrogen Fluoride		o				
Hydrogen Sulfide				o		
Hydroquinone				o		
Indium Compounds		o				
Inorganic Arsenic		o				
Inorganic Lead		o				
Inorganic Mercury		o				
Inorganic Nickel			o			
Iron Compounds					o	
Isoamyl Acetate						o
Isobutyl Acetate						o
Isobutyl Alcohol					o	
Isopropyl Alcohol		o				
Isopropyl Glycidyl Ether					o	
Kepone		o				
Magnesium Compounds					o	
Malathion			o			
Mesityl Oxide	o					
Methyl Acetate						o
Methyl Acrylate						o
Methyl Alcohol		o				
Methyl Chloromethyl Ether						o
Methyl Mercaptan					o	
Methyl n-Amyl Ketone				o		
Methyl Parathion			o			

Agent	Known or Suspected Carcinogen	NIOSH Criteria Documents Pre 1976	1976	1977	1978	OSHA Standards 1900.1000 Subpart Z
Methyl Silicate				o		
alpha-Methyl Styrene						o
4,4'-Methylene bis (2-chloroaniline)						o
Methylene Chloride		o				
alpha-Naphthylamine						o
beta-Naphthylamine						o
Nitric Acid		o				
Nitric Oxide		o				
4-Nitrobiphenyl						o
p-Nitroaniline	o					
Nitrogen Dioxide		o				
Nitroglycerine				o		
N-Nitrosodimethylamine						o
Noise		o				
Oil Mists				o		
o-Tolidine				o		
Parathion			o			
2-Pentanone						o
Perchloromethyl Mercaptan					o	
Phenol		o				
Phenothiazine					o	
Phosgene		o				
Phosphine			o			
Phosphorus			o			
Pival	o					
Polychloronated Biphenyls				o		
Polytetrafluoroethylene Decomposition Products				o		
Portland Cement				o		
beta-Propiolactone						o
n-Propyl Acetate						o
Radiation (nonionizing)					o	
Refined Petroleum			o			
Sodium Hydroxide		o				
Sulfur Dioxide		o				
Sulfuric Acid		o				
Styrene				o		
Terphenyls						o
1,1,2,2-Tetrachloroethane			o			
Tetrachloroethylene			o			
Thallium and Compounds				o		
Thioacetamide	o					
Toluene		o				
Toluene Diisocyanate		o				

APPENDIX A (Continued)

Agent	Known or Suspected Carcinogen	NIOSH Criteria Documents Pre 1976	1976	1977	1978	OSHA Standards 1900.1000 Subpart Z
1,1,1-Trichloroethane			o			
Trichloroethylene		o				
Tungsten and Compounds				o		
Ultraviolet Radiation		o				
Vanadium and Compounds				o		
Vinyl Acetate				o		
Vinyl Bromide				o		
Vinyl Chloride		o				
Vinylidene Chloride				o		
Vinyl Toluene						o
Xylene		o				
Zinc Chloride				o		
Zinc Oxide		o				

APPENDIX B

Example of Agent Information Sheet
Chemical--Acetaldehyde

Current Threshold Limit Value (TLV)--100 parts per million (ppm)
Recommended Personal Protective Equipment:

Respirators

Respirator--Chemical Cartridge--Organic Vapor
Gas Mask--Organic Vapors
Hose Mask--Supplied Air/Blower
Respirator--Air Line--Comb./S.C.B.A.
Respirator--Air Line--Continuous Flow
Breathing Apparatus--Self-Contained--Positive Pressure Demand

Other

Impervious Coveralls or Suits
Impervious Gloves
Impervious Boots
Safety Hoods
Safety Goggles
Face Shields

Users and/or Manufacturers of Acetaldehyde SIC Code 2869

1. Borden Incorporated
   Borden Chemical Division
   Petrochemicals
   Geismar, LA 70734

2. Celanese Corporation
   Celanese Chemical Co. Div.
   P.O. Box 937
   Pampa, TX 79065

3. Continental Oil Company
   Conco Chemicals Division
   P.O. Box 37
   Westlake, LA 70660

4. Celanese Corporation
   Celanese Fibers Co., Div.
   P.O. Box 1000
   Narrows, VA 24124

5. Diamond Shamrock Corporation
   Diamond Shamrock Chemical Co.
   Agricultural Division
   P.O. Box 9637
   Greens Bayou, TX 77015

6. Dow Badische Company
   602 Copper Road
   Freeport, TX 77541

7. Celanese Corporation
   Celanese Chemical Co. Div.
   P.O. Box 509
   Bay City, TX 77414

8. Eastman Kodak Company
   Eastman Chemical Products
   Inc. Sub.
   Texas Eastman Company Div.
   P.O. Box 2068
   Longview, TX 75601

9. Ethyl Corporation
   P.O. Box 472
   Pasadena, TX 77501

10. PMC Corporation
    Chemical Group
    Industrial Chemical Division
    12000 Bay Area Blvd.
    Bayport, TX 77062

11. PMC Corporation
    Chemical Group
    Industrial Chemical Division
    Dunham Road
    Meadville, PA 16335

12. Georgia-Pacific Corporation
    Chemical Division
    P.O. Box 1236
    Bellingham, WA 98225

13. Grain Processing Corporation
    P.O. Box 341
    Muscatine, IA 52761

14. Hurcules Incorporated
    Coatings & Specialty Products
    Dept.
    Louisiana, MO 63353

15. Inland Chemical Corporation
    Juneau, WI 53039

16. Eastman Kodak Company
    Eastman Chemical Products Inc.
    Tennessee Eastman Co. Div.
    P.O. Box 511
    Kingsport, TN 37662

17. National Distillers & Chemical
    Corp.
    Chemicals Division
    U.S. Industrial Chemical Co.
    P.O. Box 218
    Tuscola, IL 61953

18. International Minerals & Chem.
    Chemical Group
    Commercial Solvents Corp. Sub.
    P.O. Box 420
    Terre Haute, IN 47808

19. Pan American Chemical Corp.
    600 Matzinger Road
    Toledo, OH 43612

20. Publicker Industries, Inc.
    P.O. Box 86
    Gretna, LA 70053

21. Publicker Industries, Inc.
    1429 Walnut St.
    Philadelphia, PA 19102

22. Shell Chemical Co.
    Base Chemicals P.
    P.O. Box 2633
    Deer Park, TX 77536

23. Shell Chemical Company
    Base Chemicals
    P.O. Box 10
    Norco, LA 70079

24. Union Carbide Corp.
    Chemicals & Plastics Div.
    Brownsville, TX 78520

25. Union Carbide Corporation
    Chem. & Plastics Div.
    Institute & S. Charleston WV
    25303

26. Monsanto Company
Monsanto Polymers & Petrochemicals
P.O. Box 1311
Texas City, TX 77590

26. Montrose Chemical Corp. of Ca.
P.O. Box 37
Henderson, NV 89015

28. Union Carbide Corp.
Chemicals & Plastics Division
Texas City, TX 77590

29. W. R. Grace and Company
Hatco Group
Hatco Chemical Division
King George Post Road
Fords, NJ 08863

Chemicals & Plastics Division
Institute & S Charleston, WV
25303

30. Union Carbide Corporation
Chemicals & Plastics Division
Seadrift, TX 77983

APPENDIX C

Questionnaires and Instruction Sheets

OMB No. 68-S77049
Exp. 11-78

INSTRUCTIONS

Hot Environments

Column No.

1. The left-hand column lists the various types of protective clothing or devices that might be used for employee protection against the physical agent (heat) being surveyed. The other columns provide boxes to indicate specific information pertaining to the items. Please use check marks in the appropriate box to indicate your answer. If you use an item (protective clothing or device) not on the list, please indicate under "Other"; and if it is not commercially available, please explain in the comment section at the bottom of the form.

2. If the item is not being used in your personal protective equipment program, please check the "no" box under "Is item being used?" column and proceed to the next item of personal protective equipment.

3. If the item is a "Flame and Heat Hazards" item, please indicate type in the next column.

4. In the next column, please supply the clothing manufacturer's name and approximate date of purchase.

5. In the next column, please supply the manufacturer's catalog number of the item, if known.

6. Please indicate the quantity of the item in use during a typical workday in the "Number of Items Currently in Use" column. For example, the number of pairs of earplugs.

7. Please indicate whether the item is satisfactory or unsatisfactory for your particular application in the "Use Performance" column.

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8. If the item is unsatisfactory, the next column provides for several responses as to types of problems that cause the item to be unsatisfactory. Please check the box that most closely describes the problem. If a problem exists that needs more explanation, such as the part of the clothing that wears out first under the "Short Use-Life" heading or some problem that is not listed here, please use the "Comment" space to provide your reply.

9. In the next column, please check the box that most closely identifies with the general employee use acceptance of the item.

   Good: If 75% or more of the employees find the item satisfactory from a user's point of view.

   Average: If from 25 to 75% of the employees find the item satisfactory from a user's point of view.

   Poor: If less than 25% of the employees find the device satisfactory from a user's point of view.

10. The next column gives you a choice of responses to most clearly define the adequacy of the device.

    Very Adequate — The device, in most cases, provides the type of protection intended for your particular application.

    Partially Adequate — The device provides some, but not most, of the protection desired for your application.

    Not Adequate — The device affords no or very little protection for your application.

11. The last column provides for responses for the improvement of the device for your application. Please check the box most applicable to your response and elaborate, if necessary, in the "Comment" section.

Thank you for your time and trouble.

APPENDIX C (continued)

OMB No. 68-S77049
Exp. 11-78

SIC CODE ______________

RESPONDENT CODE ______________

HOT ENVIRONMENT

1 PROTECTIVE CLOTHING OR DEVICE	2 Is Item Being Used? Yes	No	3 Style or Type Asbestos	Aluminized	Fire Retardant Fabric	Leather	4 Device or Clothing Manufacturer	5 Device or Clothing Manufacturer Catalog Model or Part Number	6 Number of Items Currently in Use	7 Use Performance Satisfactory	Unsatisfactory	8 If Unsatisfactory, Reason Too Heavy	Not Sufficiently Flexible	Too Bulky	Weight Distribution	Short Use Life	Too Hot	Too Cold	Other(e.g.,too expensive)	9 Use Acceptance Good-greater than 75%	Average-25% to 75%	Poor-less than 25%	10 Adequacy of Item Very Adequate	Partially Adequate	Not Adequate	Other	11 Improvement for Company Use Better Design	Weight Reduction	Longer Use Life	Wearing Comfort	Simpler Operation	Other(e.g.,lower cost)
Air conditioner for clothing-refrigerant																																
Air-cooled clothing-no refrigerant																																
Combination device-respirator & clothing																																
Combination device-blasting hood & clothing																																
Fire resistant synthetic fiber suits or coveralls (Nomex or Kynol)																																
Flame & heat hazards-suits or coveralls																																
Flame & heat hazards-cape sleeve																																
Flame & heat hazards-apron																																
Flame & heat hazards-leggings																																
Flame & heat hazards-finger guard																																
Flame & heat hazards-hand pad																																
Flame & heat hazards-gloves or mittens																																
Flame & heat hazards-sleeves																																
Flame & heat hazards-knee pad																																
Water-cooled clothing																																
Safety goggles-heat hazards																																
Faceshields-heat hazards																																
*Other																																

*If items used are not commercially available, please explain:

Comments:

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OMB No. 68-S77049
Exp. 11-78

INSTRUCTIONS

Silica

Column No.

1. This colum lists the various types of respirators that might be used for employee protection against silica. If you use an item not on the list, please indicate under "Other"; and if it is not commercially available, please explain in the comment section at the bottom of the form.

2. Please indicate the type of respirator facepiece.

3. Please indicate the respirator manufacturer's name and approximate date of purchase.

4. Please indicate the manufacturer's catalog number of the item, if known.

5. Please indicate the type of filter. This information can be found on the filter label. Use "Comment" section if more space is needed.

6. Please indicate the approval number which is normally found on the filter label.

7. Please indicate the quantity of each respirator type normally used during a typical workday (three shifts).

8. Please indicate whether the item is satisfactory or unsatisfactory for your particular application.

9. If the item is unsatisfactory, this column provides for several responses as to types of problems that cause the item to be unsatisfactory. Please check the box that most closely describes the problem. If a problem exists that needs more explanation or some problem exists that is not listed here, please use the "Comment" space to provide your reply.

10. Please check the box that most closely identifies with the general employee use acceptance of the item.

    Good: If 75% or more of the employees find the item satisfactory from a user's point of view.

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Average: If from 25 to 75% of the employees find the item satisfactory from a user's point of view.

Poor: If less than 25% of the employees find the device satisfactory from a user's point of view.

11. Choose a response that most clearly defines the effectiveness of the item.

Very Adequate — The item, in most cases, provides the type of protection intended for your particular application.

Partially Adequate — The item provides some, but not most, of the protection desired for your application.

Not Adequate — The item affords very little protection for your application.

12. This column provides for responses for the improvement of the item for your application. Please check the box most applicable to your response and elaborate, if necessary, in the "Comment" section.

Thank you for your time and trouble.

APPENDIX C (continued)

OMB No. 68-S77049
Exp. 11-78

SIC CODE ____________

RESPONDENT CODE ____________

1	2				3	4	5	6	7	8		9													10			11				12					
SILICA	Type of Facepiece				Manufacturer	Catalog Number	Filter Type	Approval Number	Number of Items Currently in Use	Use Performance		If unsatisfactory, reason													Use Acceptance			Adequacy of Item				Improvement for Company Use					
												Fit			Wt.			Mechanical																			
	Full	Half-mask	Hood	Helmet						Satisfactory	Unsatisfactory	Strap Design & Placement	Contouring-Face Mask	Other	Too Heavy	Distribution	Other	Valves Stick	Valves do not last	Filters-Difficult Replacement	Air System Problems	Short Use Life	Visibility	Other (e.g., too expensive)	Good-greater than 75%	Average-25% to 75%	Poor-less than 25%	Very Adequate	Partially Adequate	Not Adequate	Other	Better Design	Weight Reduction	Longer Use Life	Wearing Comfort	Simpler Operation	Other (e.g., lower cost)
Single-use dust respirator																																					
Dust, fume or mist respirator with replaceable filters																																					
Powered air-purifying respirator																																					
Supplied-air respirator																																					
Demand flow																																					
Pressure-demand flow																																					
Continuous flow																																					
Other respirators																																					

Comments:

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Exp. 11-78

INSTRUCTIONS

Metal Fumes

Column No.

1. This column lists the various types of respirators that might be used for employee protection against metal fumes. If you use an item not on the list, please indicate under "Other"; and if it is not commercially available, please explain in the comment section at the bottom of the form.

2. Please indicate the type of respirator facepiece.

3. Please indicate the respirator manufacturer's name and approximate date of purchase.

4. Please indicate the manufacturer's catalog number of the item, if known.

5. Please indicate the type of filter. This information can be found on the filter label. Use "Comment" section if more space is needed.

6. Please indicate the approval number which is normally found on the filter label.

7. Please indicate the quantity of each respirator type normally used during a typical workday (three shifts).

8. Please indicate whether the item is satisfactory or unsatisfactory for your particular application.

9. If the item is unsatisfactory, this column provides for several responses as to types of problems that cause the item to be unsatisfactory. Please check the box that most closely describes the problem. If a problem exists that needs more explanation or some problem exists that is not listed here, please use the "Comment" space to provide your reply.

10. Please check the box that most closely identifies with the general employee use acceptance of the item.

    Good: If 75% or more of the employees find the item satisfactory from a user's point of view.

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Average: If from 25 to 75% of the employees find the item satisfactory from a user's point of view.

Poor: If less than 25% of the employees find the device satisfactory from a user's point of view.

11. Choose a response that most clearly defines the effectiveness of the item.

Very Adequate	The item, in most cases, provides the type of protection intended for your particular application.
Partially Adequate	The item provides some, but not most, of the protection desired for your application.
Not Adequate	The item affords very little protection for your application.

12. This column provides for responses for the improvement of the item for your application. Please check the box most applicable to your response and elaborate, if necessary, in the "Comment" section.

Thank you for your time and trouble.

APPENDIX C (continued)

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Exp. 11-78

SIC CODE ________

RESPONDENT CODE ________

1	2				3	4	5	6	7	8	
METAL FUMES	Type of Facepiece				Manufacturer	Catalog Number	Filter Type	Approval Number	Number of Items Currently in Use	Use Performance	
	Full	Half-mask	Hood	Helmet						Satisfactory	Unsatisfactory
Dust, fume or mist respirator with replaceable filters											
Supplied-air respirator Demand flow											
Pressure-demand flow											
Continuous flow											
Powered air-purifying respirator											
Other											

1	9													10			11				12					
METAL FUMES	If unsatisfactory, reason													Use Acceptance			Adequacy of Item				Improvement of Company Use					
	Fit			Wt.			Mechanical																			
	Strap Design & Placement	Contouring-Face Mask	Other	Too Heavy	Distribution	Other	Valves Stick	Valves do not last	Filters-Difficult Replacement	Air System Problems	Short Use Life	Visibility	Other (e.g., too expensive)	Good-greater than 75%	Average-25% to 75%	Poor-less than 25%	Very Adequate	Partially Adequate	Not Adequate	Other	Better Design	Weight Reduction	Longer Use Life	Wearing Comfort	Simpler Operation	Other (e.g.,lower cost)
Dust, fume or mist respirator with replaceable filters																										
Supplied-air respirator Demand flow																										
Pressure-demand flow																										
Continuous flow																										
Powered air-purifying respirator																										
Other																										

Comments:

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INSTRUCTIONS

Noise

Column No.

1. The left-hand column lists the various types of hearing protection devices that might be used for employee protection against the physical agent (noise) being surveyed. The other columns provide boxes to indicate specific information pertaining to the devices. Please use check marks in the appropriate box to indicate your answer. If you use a device not on the list, please indicate under "Other"; and if it is not commercially available, please explain in the comment section at the bottom of the form.

2. If the device is not being used in your personal protective equipment program, pleaase check the "No" box under "Is device being used?" column and proceed to the next item of personal protective equipment.

3. In the next column, please supply the device manufacturer's name and approximate date of purchase.

4. In the next column, please supply the manufacturer's catalog number of the device, if known.

5. Please indicate the quantity of devices used in the typical workday in the "Number of Devices Currently in Use" column. For example, the number of pairs of earplugs.

6. Please indicate whether the device is satisfactory or unsatisfactory for your particular application.

7. If the device is unsatisfactory, this column provides for several responses as to types of problems that cause the device to be unsatisfactory. Please check the box that most closely describes the problem. If a problem exists that needs more explanation, such as the part of the device that wears out first under the "Short Use-Life" heading or some problem that is not listed here, please use the "Comment" space to provide your reply.

8. In the next column, please check the box that most closely identifies with the general employee use acceptance of the device.

   Good: If 75% or more of the employees find the device satisfactory from a user's point of view.

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Average: If from 25 to 75% of the employees find the device satisfactory from a user's point of view.

Poor: If less than 25% of the employees find the device satisfactory from a user's point of view.

9. The next column gives you a choice of responses to most clearly define the adequacy of the device.

Very Adequate — The device, in most cases, provides the type of protection intended for your particular application.

Partially Adequate — The device provides some, but not most, of the protection desired for your application.

Not Adequate — The device affords very little protection for your application.

10. This last column provides for responses for the improvement of the device for your application. Please check the box most applicable to your response and elaborate, if necessary, in the "Comment" section.

Thank you for your time and trouble.

APPENDIX C (continued)

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SIC CODE ______________

RESPONDENT CODE ______________

NOISE	2		3	4	5	6		7								8			9				10					
1	Is Device Being Used?		Device Manufacturer	Device Manufacturer Catalog Model or Part Number	Number of Devices Currently in Use	Use Performance		If Unsatisfactory, Reason								Use Acceptance			Adequacy of Device				Improvement for Company Use					
NOISE PROTECTIVE DEVICES	Yes	No				Satisfactory	Unsatisfactory	Tight fit on Head	Tight Fit in Ear	Loose Fit in Ear	Loose Fit on Head	Too Heavy	Short Use Life	Too Hot	Other (e.g., too expensive)	Good-greater than 75%	Average-25% to 75%	Poor-less than 25%	Very Adequate	Partially Adequate	Not Adequate	Other	Better Design	Weight Reduction	Longer Use Life	Wearing Comfort	Simpler Operation	Other (e.g., lower cost)
Earmuffs-general																												
Earmuffs-sound discriminating																												
Earmuffs-low profile																												
Earmuffs-folding																												
Earmuffs-with communications headphones																												
Ear valves																												
Earplugs-custom molded																												
Earplugs-waxed cotton																												
Earplugs-glass fiber																												
Earplugs-plastic																												
Earplugs-rubber																												
Earplugs-silicone rubber																												
Earplugs-expanding foamed polymer																												
Earplugs-soft polymer self-forming																												
Earplugs-cord attached																												
*Other																												

*If devices used are not commercially available, please explain:

Comments:

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