

Safety Equipment

WEDNESDAY AFTERNOON SESSION

October 16, 1935

The session was called to order by Chairman, Irwin W. Millard, president, Industrial Gloves Corporation, Danville, Ill. Chairman Millard mentioned some of the problems of providing adequate safety equipment for industry.

Respiratory Protective Devices

(An interpretation of the U. S. Bureau of Mines, Schedule 21)

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The respiratory protective devices of industrial hygienic importance are those designed to protect against the inhalation of harmful solid, gaseous, or liquid atmospheric contaminants, or the inhalation of air deficient in oxygen.

The devices in common use are the mechanical filter respirator (commonly referred to as respirator) for protection against the inhalation of dusts, smokes, fumes, and mists or what may be referred to collectively as atmospheric particulate matter; gas masks for protection against the inhalation of gases and vapors; oxygen breathing apparatus, hose masks, and air-line respirators for protection against the inhalation of any atmosphere provided it does not contain harmful constituent which can be absorbed readily through the skin; and the abrasive blasting helmet or hood for protection against the inhalation of and the impact and abrasion from the atmospheric particulate matter generated in sand blasting or abrasive blasting with steel shot.

These devices are designed to furnish protection either by making the wearer's inspired air safe to breathe or by supplying the wearer with safe air from a supply which he carries or from outside the contaminated zone.

The wearer of the first or air-purifying type, on inspiration draws air from his immediate surroundings through the device which either removes the contaminant, usually by chemical or mechanical filtration, or converts it into a harmless substance. This type, of course, offers no protection against atmospheres deficient in oxygen as it does not add oxygen to the air.

There are two types of respiratory protective devices of the second type designed to supply the wearer with safe air. In one, the wearer receives his air supply from a cylinder of compressed oxygen, liquid oxygen, liquid air, or from a chemical which yields oxygen upon decomposition. This air supply is part of the self-contained unit, all of which is carried by the wearer. In the other type a hose, attached to a face-piece, is connected to a compressor or blower whose intake is located in safe air. Air is forced through the hose to the wearer.

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There is some confusion in the use of the term "respirator," to designate devices for protection against the inhalation of atmospheric particulate matter. Such devices were the first and for a long time were the only respiratory protective devices. They were logically called respirators, and as long as they were the only devices of this kind there was no confusion. The development of other devices of industrial hygienic importance and the development of devices for maintaining artificial respiration over long periods and for enabling men trapped in submerged submarines to reach the surface safely, all called respirators, was responsible for the confusion. The Bureau of Mines suggests that the term "respirator" be retained for all of these devices, but that respiratory protective devices of industrial hygienic importance be called industrial respirators and that the different kinds of industrial respirators be assigned a name which will indicate their operating principle or field of use or both. Satisfactory names in common use should be retained. On this basis, the Bureau of Mines suggests the following classification for respiratory protective devices of industrial hygienic importance:

Industrial Respirators

1. Supplied-Air Respirators
 - a. Self-contained type
 - (1) Oxygen breathing apparatus*
 - b. Hose type
 - (1) Hose mask
 - (2) Air-line respirator^b
 - (3) Abrasive blasting respirator^c
2. Air-Purifying Respirators
 - a. Chemical filter respirator^d
 - (1) Acid gas or type A^e chemical filter respirator
 - (2) Organic vapor or type B^e chemical filter respirator
 - (3) Ammonia or type C^e chemical filter respirator
 - (4) Carbon monoxide or type D^e chemical filter respirator
 - b. Mechanical filter respirator^f
 - (1) Dust or type A^g mechanical filter respirator
 - (2) Fume or type B^g mechanical filter respirator
 - (3) Mist or type C^g mechanical filter respirator
 - c. Chemical and mechanical filter respirator^h

Testing and Approving of Industrial Respirators by the U. S. Bureau of Mines

Since its organization the U. S. Bureau of Mines has been interested in industrial respirators as a means of protecting workers in the mineral industry against harmful atmospheric contaminants. To this end the Bureau has developed an approval system, the purposes of which are: (1) To encourage and aid manufacturers in the development and marketing of safe and suitable equipment; and (2) to encourage the consumer to use such equipment, to aid him in obtaining it and to instruct him in its usage. These purposes are accomplished by establishing a schedule of the material and performance requirements that a safe and suitable device should meet; by making approval tests for conformance to such a schedule; and by informing the public of the

* Sometimes called mine rescue breathing apparatus.

^b Sometimes called paint-spray respirator or positive pressure respirator.

^c Sometimes called sand-blast helmet or hood.

^d Commonly called gas mask.

^e Letters assigned to canisters of chemical filter respirators. See U. S. Bureau of Mines Approval Sched. 14D, Procedure for Testing Gas Masks for Permissibility, 17 pp., 1935.

^f Commonly called respirator. Sometimes referred to as dust respirator or mechanical filter-type respirator.

^g Letters assigned to mechanical filter respirator filters. See U. S. Bureau of Mines Approval Sched. 21, Procedure for Testing Filter-Type Dust, Fume, and Mist Respirators for Permissibility, 14 pp., 1934.

^h The devices now referred to as Type N or All Service Gas Mask and the chemical cartridge respirator fall under this heading.

advantages in the use of devices bearing Bureau of Mines approval. If the device is found by examination and test to meet the requirements of the schedule the Bureau of Mines gives the manufacturer a certificate of approval which he may display as evidence of the quality of his product. The approved devices are marked in a manner which clearly distinguishes them and indicates the purpose for which they are approved and the limitations under which they may be used. As an aid to the consumer, the Bureau of Mines periodically issues a list of the devices which have met the requirements.

The submission of equipment is entirely voluntary on the part of the manufacturer. On making application for tests, the manufacturer deposits a fee which is turned into the miscellaneous receipts of the treasury of the United States; none of the money accrues to the Bureau of Mines. The approval system is motivated entirely by the desire of the manufacturers to produce and market good equipment, the interest of the Bureau of Mines in having safe equipment available commercially, and the demand of the consumer for such equipment.

Approval schedules have been issued for oxygen breathing apparatus,¹ chemical filter respirators or gas masks,² hose masks³ and mechanical filter respirators.⁴ The schedule covering hose masks is being revised to include the other kinds of supplied-air respirators, namely, air-line and abrasive-blasting respirators. When this revision is completed, the Bureau of Mines will have approval schedules for all types of respirators now in common use. The approval system undoubtedly is largely responsible for the development of fundamentally safe and suitable devices, and the elimination of confusion in their selection and use.

The general plan of the various schedules is similar. The requirements may be divided into 3 parts:

(1) Pre-test requirements, or those with which the manufacturer must comply before examination and test of a device will be undertaken. For example, the respirator must be in a fully developed form ready for market and available for purchase if approval is granted. Also, the manufacturer must be prepared to test and maintain control of the essential characteristics of his device by a method which meets the approval of this Bureau.

(2) Material, construction, and performance requirements which the equipment must meet by examination and test.

(3) Post-test requirements, or those with which the manufacturer must comply after the device is approved. From the viewpoint of the consumer the most important of these concern labeling and marking, provision of adequate instructions for proper use of the device, and maintenance of design and quality of the product marketed under the approval. As a check on the latter, the Bureau of Mines obtains samples of the device on the open market and subjects them to the various inspections and tests of the appropriate schedule. The Bureau reserves the right to withdraw its approval of any device for cause.

Interpretation of U. S. Bureau of Mines Approval Schedule 21, Procedure for Testing Filter-Type Dust, Fume, and Mist Respirators for Permissibility

Among the reasons for the development of Schedule 21, Procedure for Testing Filter-Type Dust, Fume, and Mist Respirators for Permissibility, was the realization by the Bureau of Mines and others that there was a definite need for mechanical filter respirators to protect workers against harmful atmospheric particulate matter in situations where better methods of control of dust production and removal were either not available or practical, the inefficiency of existing mechanical filter respirators, and

¹ Bureau of Mines, Procedure for Establishing a List of Permissible Self-Contained Oxygen Breathing Apparatus; Fees, Character of Tests, and Condition Under which Mine Rescue Breathing Apparatus will be Tested: Sched. 13A, January 21, 1930, 12 pp.

² Bureau of Mines, Procedure for Testing Gas Masks for Permissibility: Sched. 14D, May 9, 1935, 17 pp.

³ Bureau of Mines, Procedure for Testing Hose Masks for Permissibility: Sched. 19, April 28, 1927, 8 pp.

⁴ Bureau of Mines, Procedure for Testing Filter-Type Dust, Fume, and Mist Respirators for Permissibility: Sched. 21, August 20, 1934, 14 pp.

requests from manufacturers and consumers that this bureau test and approve such devices.

Schedule 21 follows the general plan of the other bureau approval schedules for industrial respirators; the pre-test and post-test requirements are quite similar, and the general principles of the test requirements are the same. The primary purpose of this paper is to explain the reasons for the various test requirements.

Pre-Test Requirements

The pre-test requirements of Schedule 21 require that the manufacturer submit information, drawings, and samples of the device to be tested. The device must be completely developed and ready for release to the public, and the device when tested by the manufacturer or his agent must have passed tests of the nature described in Schedule 21. The reasons for the third requirement are: (1) To assure the bureau that the manufacturer is prepared to control the filtering characteristics of his respirator; (2) to eliminate any question of competition with private consulting agencies in developing respirators; (3) to furnish evidence that the respirator really is ready for release to public market; and (4) to save the manufacturer's and the Bureau's time. After the manufacturer has complied with all the above pre-test requirements he must submit a fee for the examination and test of his device. This fee is turned into the miscellaneous funds of the U. S. treasury and none of the money reverts to the Bureau of Mines.

Test Requirements

In developing the tests for mechanical filter respirators consideration was given first to the general requirements for a safe and suitable device. These requirements are similar for all types of industrial respirators. The respirator must (1) give adequate protection, (2) be reasonably comfortable and physically convenient to wear, and (3) provide an acceptable service life.

Adequate protection implies that the mechanical filter respirator when properly maintained and worn must prevent the wearer from breathing enough particulate matter to cause a harmful physiological response under the conditions of occupational exposure for which it is designed to be used.

Comfort and physical convenience factors are equal in importance to adequate protection. Even though aware of the ultimate serious effect which will be produced after prolonged daily exposure, workmen are inclined to be diffident and unwilling to suffer much daily inconvenience and discomfort from the respirator.

Encumbrance and discomfort also increase fatigue, cause distraction, and in general handicap the wearer's ability to take care of himself, thus increasing the possibility of accident. Important specific items include the weight of the respirator, its carriage on the face or head, effect on vision, heating of the area of the skin under the facepiece, inability to expectorate, difficulty in talking, and resistance to breathing. The importance of comfort and physical convenience cannot be over estimated.

The service life involves elements of practicability in the wearing and maintenance of the device, and indirectly the safety. This type of respirator is primarily not an emergency device, but a part of the workman's equipment for doing his regular job safely. If the service life is short, the bother of changing of filter elements will be reflected in the workman's attitude toward good maintenance and use.

All mechanical filter respirators are subjected to certain inspections and tests and they must fulfill certain requirements. The general design and construction, particularly as to facial fit, freedom from irritating facial contacts, weight, effect on vision and the wearing of goggles, and ease of changing filter elements, and examined. The materials are examined to determine if they are obviously suited for the purpose for which they are designed. Rubber parts which come in contact with the skin must not contain any skin-irritating constituent.

Resistance to Air Flow Requirements

The requirements for resistance to air flow are the same for all approved mechanical filter respirators. At no time during or after the filter efficacy testing period must the resistance to air being drawn through the device at the rate of 85 liters

(3 cubic feet) per minute exceed 50 millimeters (1.97 inches) of water column height or the resistance to air being blown through the device at the same rate of flow exceed 25 millimeters of water column height. An air flow of 85 liters per minute is approximately equivalent to the respiratory rate of a man doing heavy work. The amount of particulate matter pulled to the device during the filter efficacy tests is roughly equivalent to the amount that would be pulled to the filter by a worker wearing the mechanical filter respirator in a moderately concentrated suspension of the particulate matter during an 8-hour period. Thus resistance to air flow of an approved mechanical filter respirator should not become excessive when worn for an 8-hour period in most suspensions of atmospheric particulate matter encountered in industry. The manufacturer is required to give instructions on cleaning or changing the filter elements when the resistance to air flow noticeably increases.

Direct Leakage and Man Test

All mechanical filter respirators are subjected to a direct leakage and man test to determine facial fit, whether there is any direct leakage of unfiltered air, and to obtain information on the comfort of the device. Three of the mechanical filter respirators are worn for 30 minutes by 3 men with different facial features in an atmosphere containing a heavy suspension of bituminous-coal dust. At the end of the period, the respirators are removed and that part of the face covered by the facepiece is examined for evidence of any leak under the edge of the facepiece. Sticks a millimeter thick were wedged under the edges of the facepieces worn by subjects A and C to cause the leaks. The location and approximate magnitude of the leaks are shown by the black streaks on that part of the face covered by the edges of the facepieces. The nasal passages and sputum of the subjects are also examined before and after the tests.

Filtering Efficacy Tests

In the development of the filtering-efficacy tests, particular attention was given to the physical properties, especially particle size, of the significant kinds of atmospheric particulate matter encountered in industry. Previous studies of filtering materials had shown that, in general, filtering efficacy decreases with a decrease in particle size.

It was decided that most of the significant industrially generated atmospheric particulate matter could be classified into the following three groups in accordance with method of generation, physical state, and particle size:

1. *Mechanically generated dusts* resulting from the disintegration of a solid, such as the dust clouds produced in the various processes of mining, quarrying and tunneling and the grinding, crushing, and general processing of solid materials. This type of atmospheric particulate matter is referred to as Type A atmospheric particulate matter and mechanical filter respirators designed to furnish protection against these suspensions are referred to as Type A mechanical filter respirators.

2. *Fumes* of various metals (usually their chemical compounds, as oxides or carbonates) such as lead, mercury (except mercury vapor) manganese, magnesium, aluminum, antimony, arsenic, copper, chromium, iron, cadmium, and zinc resulting from sublimation or the condensation of their vapor, or from the chemical reactions between their vapor and gases. This type of atmospheric particulate matter is referred to as Type B atmospheric particulate matter and mechanical filter respirators designed to furnish protection against these suspensions are referred to as Type B mechanical filter respirators.

3. *Mists* as produced by spray-coating with paint and vitreous enamels, chromic acid mist as produced in chromium plating, and other mists of materials whose liquid vehicle does not produce harmful gases or vapors. This type of atmospheric particulate matter is referred to as Type C atmospheric particulate matter and mechanical filter respirators designed to furnish protection against these suspensions are referred to as Type C mechanical filter respirators.

The mechanically generated dusts and fumes consist of solid particles while the mists consist of liquid or liquid-coated solid particles. The particle size of mechanically generated dusts extends over a wide range, in some cases, from particles visible to the naked eye probably down to molecular dimensions. The range in particle size of fumes is much smaller. The upper limit is in the lower microscopic

range (about 0.5 micron), while the lower limit probably approaches molecular dimensions. The particles of some fumes, particularly zinc and magnesium, readily join and form large flocklike clusters. The effect is least pronounced in the case of lead. Mist particles are spherical and probably more uniform in particle size than those of dusts and fumes.

Suspensions of each of the types of industrially-generated atmospheric particle matter were selected for use in the filtering-efficacy tests. These suspensions were chosen on the basis of their industrial hygienic significance and their physical properties, such as particle-size distribution and tendency to aggregate, which have an appreciable effect on filtration. It was desired to test the mechanical filter respirators against the most common or widespread harmful suspensions of each type; the test suspensions to have physical properties, such as particle size and aggregation tendency, which would render them as difficult to remove by filtration as any other suspension of the same type. The test suspensions selected are:

(a) For testing Type A mechanical filter respirators or those designed to furnish protection against mechanically generated dusts a suspension generated from very fine (99+ per cent through 325 standard mesh sieve) silica dust consisting of 99+ per cent free silica (SiO_2) is used. The suspension is generated in such a way that all particles larger than about 3 microns are removed before the suspension enters the test chamber. The particle-size distribution of the test suspension must not exceed a geometric mean of 0.6 micron and a standard geometric deviation of 1.90. The particle-size determination is made by collecting samples of the suspension by the Owens-jet dust counter and determining the particle size distribution by a microprojection method developed by the Bureau of Mines.*

(b) For testing Type B mechanical filter respirators or those designed to furnish protection against fumes, a lead oxide fume generated by the combustion of natural gas containing lead tetraethyl vapor is used. The particles of this fume are extremely small and have about the least tendency to aggregate of any fume, hence they are very difficult to remove from the air by mechanical filtration. A suspension of magnesium oxide is also used to determine the effect of a fume, whose particles readily aggregate in large clusters, on the resistance to air flow of the filter of the device.

(c) For testing Type C mechanical filter respirators or those designed to furnish protection against mists, three different suspensions are used. Chromic acid mist generated by electrolyzing an aqueous solution of chromic acid, as is done in industrial chromium plating; lead paint mist generated by spray-coating with lead paint; and a water mist carrying silica dust generated by spraying a 2 per cent aqueous suspension of silica dust are used. The water-mist carrying silica dust is used to simulate the mists generated in spray-coating with vitreous enamels.)

The concentration of the particulate matter in the test suspensions was chosen to represent more or less the higher concentrations found in industry. Since the concentration of mechanically generated dust found in industry varies over such wide limits it was decided to test Type A mechanical filter respirators against two concentrations; one to represent the more or less average dusty industrial conditions, and the other to represent very dusty conditions.

The complete mechanical filter respirator is tested on a mechanical testing apparatus. The test suspension is pulled through the device at the rate of 32 liters (1.13 cubic feet) per minute, continuous flow. The volume of air pulled through the mechanical filter respirator is 10 cubic meters in all cases except in some tests against particular kinds of suspensions as mechanically generated lead dusts and in the high-silica dust-concentration test and the magnesium oxide test whose primary object is to determine the increase in resistance to air flow of the filter with the amount of particulate matter retained. Ten cubic meters is approximately equivalent to the volume of air breathed by a worker in 8 hours. The samples of particulate matter for concentration determinations are precipitated electrically from the air of the test suspension both before and after it has passed through the mechanical filter respirator. The samples are collected in containers which can be weighed readily on an analytical balance. For reasons of convenience, speed,

* Brown, C. E. and Yant, W. P. The Microprojector for Determining Particle Size Distribution and Number Concentration of Atmospheric Dusts. U. S. Bureau of Mines Report of Investigations 3289, 1935.

and accuracy the samples of silica dust are quantitated by weight rather than by count. Samples of the other particulate matter are quantitated chemically.

The requirements as to the amount of particulate matter that the mechanical filter respirators must remove from the air pulled through them is based on the best available information on the concentration of the particulate matter that is safe to breathe. These requirements are subject to change with the accumulation of knowledge on the physiological effects of industrially generated atmospheric particulate matter. In other words, the filtering-efficacy requirement is that the air inhaled by the wearer of such a device must be safe to breathe, and not that the device have any particular percentage filtering efficiency.

Mechanical filter respirators are not approved for any substance more harmful than the particulate matter in the test suspension against which they are tested. Thus Type A respirators are not approved for any substance more harmful than free silica (SiO_2) dust. However, Schedule 21 provides for testing and approving mechanical filter respirators against any kind of industrially generated atmospheric particulate matter. For example, Type A mechanical filter respirators are not approved for protection against poisoning by breathing dusts whose main harmful constituents are metals or their compounds. However, two mechanical filter respirators have been submitted and approved for protection against the inhalation of mechanical generated lead dusts.

Table 1 summarizes the details of the filtering-efficacy tests and lists the mechanical filter respirators which have been approved to date. (Pages 140-141.)

Post-Test Requirements

The manufacturer of an approved mechanical filter respirator is required to mark his device with the name of his company, the name letter, or number by which the type is designated for trade purposes, and the approval number assigned to the device by the Bureau of Mines; and the filter unit must be marked with the approval number and with the type or kind of atmospheric particulate matter for which it is approved.

The mechanical filter respirator and replacement filter units must be provided with substantial and durable containers. Copies of the approval labels issued to the manufacturer by the Bureau of Mines must be attached to these containers. The approval label gives the approval number, shows to whom the approval is issued, states what the device is and is not approved for, and cautions the wearer to follow the manufacturer's instructions for the use and care of the device.

The following is a sample of the required instructions furnished by the manufacturer. These instructions are similar for all of the approved mechanical filter respirators.

Instructions for Use of Mechanical Filter Respirator

1. Respirators will not protect unless placed on the face properly each time they are worn. Carelessness in face-fit means dangerous leakage. In general, a better fit is obtained if the mask is worn not too high on the nose.

2. To fit the respirator to the face hold the respirator, exhaust valve pointing downward, by the metal screw connection with either hand, and hold the headstrap with the other hand. Place the facepiece against the face and hold it in place while pulling the headstrap over the head and below the ears. Then adjust the facepiece until a firm snug fit is obtained. The headstrap may be adjusted while the respirator is in place by holding the metal slide between the thumb and forefinger of one hand and pulling on the proper strap with the other hand.

3. To instruct the wearer in the proper adjustment of the headstraps and position of the respirator on the face a cardboard disc is enclosed. To use this disc unscrew the filter bag, place the disc against the felt washer in the metal connection on the felt bag, assemble the respirator, and put it on. The wearer should not be able to breathe through the respirator or feel any inward leakage of air under the edges of the facepiece.

The presence or absence of dust streaks on the face inside the line of fit of the facepiece after wearing the respirator in a dusty atmosphere can also be used to tell whether a proper fit was obtained.

4. The recommended procedure for cleaning the filter bag is to insert loosely the nozzle of a high-pressure air hose into the bag opening and to blow several

TABLE 1. DETAILS OF FILTERING EFFICACY TESTS AND LIST

Kind of mechanical filter-type respirator	Industrially generated atmospheric particulate matter against which the device is designed to furnish protection	Test suspensions used	
Type A	Mechanically generated dusts resulting principally from the disintegration of a solid, such as the dust clouds produced in mining, quarrying and tunneling, and the industrial operations of grinding, crushing, and processing of minerals	Air-suspended ground flint, which consists of 99+ percent free silica (SiO_2). Over 99 percent of the dust passes through 325-mesh standard sieve	(a) 15 ±
Type B	Fumes of various metals (usually their chemical compounds, as oxides or carbonates) such as lead, mercury (except mercury vapor), manganese, copper, chromium, iron, cadmium, zinc, magnesium, aluminum, antimony, and arsenic resulting from sublimation or condensation of their vapor, or from chemical reactions between their vapor and gases	(a) Lead oxide fume produced by the decomposition and combustion of lead tetraethyl	15 ±
Type C	Mists as produced by spray-coating with paint and vitreous enamels, chromic acid mist as produced in chromium plating, and other mists of materials whose liquid vehicle does not produce harmful gases or vapors	(b) Magnesium oxide fume, freshly produced by burning magnesium ribbon (a) Chromic acid mist produced by electrolyzing an aqueous solution (200-500 grams of chromic acid per liter) of chromic acid	100 ± 15 ± cf
		(b) Lead paint mist produced by spraying a paint having the following composition: white lead (paste having approximately 91 percent white lead and 9 percent linseed oil by weight), 100 grams; linseed oil, 50 cubic centimeters; and steam-distilled turpentine, 25 cubic centimeters	300 ±
		(c) Mist produced by spraying a 2 percent aqueous suspension of ground flint, air-floated (99+ percent through 325 standard mesh sieve). The ground flint consists of 99+ percent free silica (SiO_2). Mixture used in making negative plates of lead storage batteries. Contains 72 percent litharge, PbO ; 25 percent red lead, Pb_2O_3 ; and 3 percent lampblack	10 ± sil
Mechanically generated lead dusts	Mechanically generated dusts whose main harmful constituent is lead, such as lead dusts generated in manufacturing storage batteries; enameling; pottery making; rubber compounding; sandpapering and chip-ping painted surfaces; paintmaking; preparing litho-transfers; and mining, milling and processing lead ores		15 ±

^a One milligram = 0.0154 grain.

^b One cubic meter = 35.315 cubic feet.

^c Rate of sampling = 32 liters (1.13 cubic feet) per minute.

^d One milligram of this silica dust contains approximately 300 million particles as determined by the impinger method as described by the U. S. Public Health Service. Hence, 1 milligram per cubic meter of this dust is approximately equivalent to 8.5 millions of particles per cubic foot.

^e See previous listing of company for complete address.

OF APPROVED MECHANICAL FILTER-TYPE RESPIRATORS

Concentration of test suspension, milligrams per cubic meter ^b of air	Volume of test suspension pulled through the device, cubic meters ^c	Maximum amount of particulate matter permitted to pass through the device		Name and manufacturer of mechanical filter-type respirators approved to date, September 25, 1934
		Milligrams	Milligrams per cubic meter of air	
(a) 50 ± 10^d	2.88	4 mg. for any 1 of 3 devices, or an average of 3 mg. for each of the 3 devices	1.0^d	M.S.A. Comfo Respirator. Approval No. 2101, issued to Mine Safety Appliances Co. Willson Bag Respirator No. 300. Approval No. 2102, issued to Willson Products, Inc.
(b) 5 ± 2^d	9.98	12 mg. for any 1 of 3 devices, or an average of 10 mg. for each of the 3	1.0^d	Willson Bag Respirator No. 400. Approval No. 2103, issued to Willson Products, Inc.* Pulmosan M-15 Pouch-Type Filter Respirator. Approval No. 2104, issued to Pulmosan Safety Equipment Corp. Biever Respirator. Approval No. 2105, issued to Standard Safety Equipment Co.
15 ± 5 of lead	9.98	1.5	0.15	Willson Bag Respirator No. 4. Approval No. 2106, issued to Willson Products, Inc.*
100 ± 25 ± 5 of chromic acid	2 9.98	— 1	— 0.1	M.S.A. Comfo Respirator. Approval No. 2101, issued to Mine Safety Appliances Co.*
300-600 of lead	9.98	1.5	0.15	M.S.A. Comfo Respirator not approved for lead containing mists.
10 ± 5^d of silica dust	9.98	5	0.5^d	M.S.A. Comfo Respirator. Approval No. 2101, issued to Mine Safety Appliances Co.*
15 ± 5 of lead	2.88	0.43	0.15	M.S.A. Comfo Respirator with special filters for lead dust. Approval No. 2107, issued to Mine Safety Appliances Co.* Willson Bag Respirator No. 400L. Approval No. 2108, issued to Willson Products, Inc.*

short blasts of air into the bag. This procedure removes from the bag dust and grit which clogs the pores of the filter and makes breathing difficult. The proper time for cleaning the bag is when the wearer experiences discomfort in breathing. When compressed air is not available some dust may be removed by tapping the bag lightly and brushing the outside of the bag.

5. To prevent irritation of the skin and for general sanitary purposes the respirator should be cleaned after each day's use. The rubber and metal parts may be cleaned with soap and water, and for general sterilization they may be dipped in a 3 per cent solution of carbolic acid, a 2 per cent solution of lysol, or a 70 per cent solution of denatured alcohol, then rinsed with water, assembled, and hung up by the loop in the felt bag to dry. The filter bag and headstrap always must be removed before the respirator is washed or sterilized.

6. While not in use the respirator should be kept in a dust-free place, preferably in the original container.

The manufacturer is required to maintain the quality of his product and to see that each mechanical filter respirator in all its parts is constructed according to the drawings or records that have been accepted by the Bureau for this device and that are in the Bureau's files. Mechanical filter respirators that exhibit changes in design or include any parts that have not been approved are not permissible respirators and must not bear the Bureau's approval label. Schedule 21 provides for the manufacturer to apply for an extension of approval on any change in the mechanical filter respirator which does not affect the filtering characteristics of the filter. Changes in the filter require the application for a new approval.

The Bureau obtains information on the maintenance of design and quality of approved mechanical filter respirators by testing samples of the devices obtained on the open market. The Bureau reserves the right to rescind for cause any approval issued.

A Safety Style Show

By E. J. SMITH

**Safety and Health Director, Western Electric Company Hawthorne Works,
Chicago**

For the purpose of assisting our foremen in the selection of the proper safety equipment we have standard specifications and every foreman has a copy. In it he will find the protective equipment required for any class of work.

Molders, cupola tenders, furnace tenders and helpers in foundry and forge are equipped with heavy duty metal or composition cup goggles with hardened lenses. The lenses in the furnace tender's goggles are of a forge and furnace shade. Electric furnace tenders, however, wear a welder's goggle, described later. When a goggle is equipped with clear lenses, it is used for such operations as breaking defective castings, cleaning castings with compressed air, grinding castings to remove gates or fins, pounding on castings to remove sand cores, pouring molten metal into molds with hand or bull ladles, removing gates or fins from castings with air chisels, or hand chisels and hammers, and working in vicinity of chipping hammers.

Leggings are of the non-lacing, non-buckling and snap buttoning type held in place by hidden steel springs similar to the old bicycle pants guard. They will come off instantly from a tug at any point. There are no gadgets to confuse you or those who are trying to help you in an emergency. Just one simple thing to remember—grab anywhere and pull.

Men wear safety hats when chipping slag out of cupolas. Our construction crews of masons, carpenters, millwrights, and so on, wear them whenever they are engaged in work where there is the slightest chance of objects falling from overhead.

Our employees wear "Congress" safety shoes for their protection in addition to the leggings.

We use a leather steel faced glove when charging a cupola or handling pig iron.

Full leather palm gloves with band top are used in chipping casting fins, loading and unloading tumbling barrels, and removing castings from sand.

For the protection of health, workers in the brass foundry are provided with overalls and undershirts with full length sleeves. This is in accordance with Illinois

labor laws. At the termination of a shift molders take shower baths on company time. Workers in this classification are provided with two lockers, one for working clothes and the other for street clothes.

For protection against solid, non-volatile particles suspended in air men cleaning inside of a cupola are provided with respirators.

Incidentally, our supervisors make periodic inspection of respirators and other safety equipment to insure that they have not become worn, damaged, or deteriorated to such an extent that they no longer provide adequate protection. Special precautions are also taken to see that cracked, broken, or pitted lenses in goggles are not used, leggings are not worn threadbare nor with torn places so as to permit molten metal to get into the upper portion of the shoe and Congress shoe soles are not worn through, nor upper torn outside the area covered by leggings.

Employees operating woodworking machines are required to wear goggles, when, in the opinion of the supervisor there is the slightest eye hazard present. Goggles are mandatory on all tool grinding operations.

The hands of all employees handling rough lumber on machines such as swing saws, rip saws, molders, automatic and glue jointers are protected against cuts, scratches, and slivers with leather-palm canvas gloves.

Those engaged in shellac dipping operations are supplied with rubber gloves.

The fingers of employees gluing wooden parts are protected with finger cots.

The personal clothing of employees dipping parts in shellac or spraying parts is protected with overalls.

In the manufacture of rubber and in other operations our supervisors instruct employees in the proper manner in which equipment is to be worn to insure the greatest possible protection.

When mixing rubber compound, sifting or handling sulphur or powdered shellac, cleaning dust collectors, sacking powdered rubber, breaking rubber scrap, blowing soapstone and sandblasting rubber parts, our employees wear heavy duty cup type goggles. They protect against large heavy particles, severe impacts and high dust concentrations.

When handling india-rubber yellow or vermilion, or cleaning brass equipment in an acid dip tank our men wear light acid gloves.

Gauntlet gloves are worn when mixing shellac or rubber compounds containing poisonous substances on milling rolls. They are also used in handling hot molds subsequent to vulcanizing operations.

The type of respirator, named before, is also worn when mixing rubber compound containing a high percentage of hard rubber powder, handling sulphur, sifting powdered shellac and in the performance of other work, where harmful kinds of dust and material are encountered.

A special goggle is used to protect against sprayed or splashed corrosive solutions and irritating liquids.

Undershirts and overalls are also furnished for platers and acid dippers. Protective clothing is laundered weekly.

Rubber gauntlet gloves are worn by those engaged in all plating and dipping operations.

Wooden soled shoes are well known in plating circles. The kind we use, however, are equipped with safety toe caps.

Rubber aprons are worn whenever acid is changed or tanks are cleaned.

All arc welding at Hawthorne is performed inside special enclosures. Welders, helpers, and others in the welding booth are provided with eye and face protection and safety clothing which, with their personal apparel, affords complete protection from the heat and the rays of the arc.

Protective goggles are worn under the helmet. They protect the eyes against an unintentional flash which sometimes occurs while men are arranging their work with the helmet in the up or overhead position.

The arms, hands, body, and feet of welders are protected with such clothing as tanned leather gloves, tanned leather sleeves, chrome leather aprons, chrome tanned leather leggings, jumpers.

Periodic inspection is made of this equipment too. Special precautions are taken with masks to insure that they do not leak light, cover glasses are not broken or cracked, colored lenses are protected by cover glasses, cover glasses are replaced

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if burned or pitted so that vision is affected, and fibre is not bruised nor broken.

In lathe, millings, shaping, and similar machine operations our employees wear the light duty type of goggle. When side protection is required from materials thrown from neighboring machines goggles with side screens are worn.

When acetylene welding or cutting, a goggle with shade No. 8 is generally used. It is also equipped with a cover glass.

Although shoes are not furnished by the company, every effort is made to encourage employees to wear safety shoes. This shoe is equipped with a safety steel toe cap which will withstand 1,950 pounds before deflecting one-quarter of an inch.

Rough chrome soles are worn in our rod mill and other places where drawing compounds or oil are encountered.

Sandblasters wear the same white acid gloves as that worn by platers. Incidentally, we stock and order the right and left as separate items because the right hand glove wears out much faster.

They also wear flame proof sleeves.

On most grinding operations we use a goggle with screened sides. On lighter operations, where no side protection is required we use the light duty goggle.

All men at Hawthorne working at a height of ten feet or more above the floor are required to wear life belts. For seven years not one occasion occurred to bring a life belt into play. In the eighth year, however, a 210-pound apprentice, equipped with a safety belt and life line, was working on a scaffold twenty feet above the ground dismantling a gas holder when one of the hooks failed. His body dropped a matter of inches when his safety belt came into play.

To prevent callouses forming on fingers men who lay out the lines or form the harness for switchboards wear special gloves. To facilitate dexterity the glove fingers are cut off wherever protection is not needed.

We use a cotton flannel glove for removing hot work from plastic material molds and die casting machines.

Rolling mill operators in our copper rod mill wear puttees for protection against hot rod stock. The copper sheathing on the inner side is put on by us. It affords additional protection when men straddle the rod as it comes through the rolls.

Where men lift heavy objects such as pig load from one pit to another or load them on to a truck, foot guards are provided.

Because of the tripping hazard presented by the foot guards themselves, their use is restricted to operations entailing a minimum of walking.

We find coveralls which fit over ordinary spectacles, quite useful on certain jobs where goggles are required less than 50 per cent of the time. However, they are much too heavy for constant use. In cases where goggles are required more than 50 per cent of the time for operators who wear spectacles in every day life prescription lens goggles are furnished free of charge.

I want to go back to the subject of goggles to tell how we sold our employees on goggles. We found that most of the complaints were relative to discomfort. After consulting several optical concerns we found that goggles could be fitted to give as much comfort as a pair of spectacles. So we set up a goggle-fitting section in our storeroom and placed in charge an expert who had been trained by one of the optical companies. Our present practice is for the individual to visit the storeroom himself and have them fitted by this expert. Our complaints now are few.

We ran into another snag when we tried to put goggles on our girls, but here we found that the main objection was appearance. There were some complaints on discomfort too. So, in addition to fitting the goggles we designed a different type. It was made much lighter in weight and a forty-two millimetre lens was used with smaller frames. This goggle has a pleasing appearance and has overcome objections. This goggle could not be assigned to our men operators, however, because the male orbit requires at least a forty-six millimetre lens for adequate protection.

The same safety rules apply to women as to men, keeping in mind that we do not employ women on operations entailing contact with acids, oils, or other materials requiring protective clothing. It is an iron clad rule, however, that they must wear goggles on all jobs where there is the slightest eye hazard present. Women working around any kind of revolving machinery are required to wear hair nets.

ADJOURNMENT