MSA

Bulletin
1000-16

Key Elements of a Sound Respiratory Protection Program

Introduction

Proposed OSHA safety and health regulations could have a major impact on both the users and manufacturers of respiratory protective devices.

During the past two years, OSHA has proposed numerous standards developed under a Standards Completion Project. The purpose of this joint OSHA-NIOSH (National Institute for Occupational Safety and Health) project is to issue complete health standards for the some 400 toxic substances listed in the OSHA regulations. In addition, NIOSH continues to prepare substance criteria documents for OSHA to promulgate as standards.

These efforts closely follow a decision logic system in setting permissible exposure limits and in the selection of respiratory protective devices. The purpose of the decision logic system is to bring some uniformity to the standards setting process.

If adopted in their present form, the proposed standards will affect the NIOSH-MESA (Mining Enforcement & Safety Administration) respirator testing and certification procedures, commonly referred to as 30 CFR, Part 11. The present OSHA regulations governing respiratory protection programs would also be affected.

Hopefully, some clarification of the background and content of the proposed standards and the decision logic system employed in their formulation will help users understand the impact of the requirements on environmental surveillance and respiratory protection programs.

QUESTIONNAIRE
GAS MASK AND RESPIRATOR RECOMMENDATION

NAME AND ADDRESS OF COMPANY SEEKING RECOMMENDATION_____

NAME OF INDIVIDUAL_____

HIS PHONE NUMBER_____

1. Material—
   a. Chemical Name_____
   b. Trade Name_____
   c. Formula_____
   d. TLV or TWA OSHA 1910.1000_____ Current ACGIH_____
2. Form in which it will be used—
   a. Liquid?_____ b. Solid?_____ c. Gaseous?_____
   d. If gaseous, is it an organic vapor?_____ or acid gas?_____
   other?_____
3. Maximum expected concentration—
   a. _____ parts per million, or
   b. _____ milligrams per cubic meter
4. Will material be heated? _____
   a. If so, to what temperature?_____ °F.
5. What is the odor threshold of the material? _____
6. At what concentration is the material considered to be immediately dangerous to life or health?_____
7. Can the substance be absorbed through the skin? _____
8. Irritant to eyes?_____ respiratory tract?_____ skin?_____
9. At what concentration is it an irritant? _____
10. If the substance is known to be flammable, what are the lower and upper flammable limits, in per cent by volume? _____
11. What is the vapor pressure of the material? _____
12. Will material be mixed with other chemicals? _____ If so, give details _____
13. Any possibility of oxygen deficiency?_____
14. Can good ventilation of the area be maintained?_____
15. Will exposure be continuous?_____ or intermittent?_____
16. Will the respiratory device be used for routine exposures, or will it be used as an escape device?_____
17. Provide as much detail as possible concerning exposure conditions. _____

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PLAINTIFF'S
EXHIBIT
AL-1252

Hazard Assessment

The key elements of any respiratory protection program must start with an assessment of the inhalation hazards present in the workplace.

This initial step involves gathering the necessary toxicological, safety, and research data on the substance or substances in the atmosphere.

A simple questionnaire (shown on page 1) can be used to assist in gathering the pertinent information about the air contaminant and the exposure conditions.

Hazard Control and Respiratory Protection

Proper assessment of the hazard is the first step to protection. If exposure concentrations exceed the recommended limits, engineering and administrative controls should be implemented promptly.

If the exposure cannot be reduced below the permissible limit, respirators should be selected on the basis of:

- Toxicity (TLV or TWA)
- Maximum Expected Concentration
- Oxygen Deficiency or Not
- IDLH Concentration or Below
- Warning Properties (adequate or not)
- Sorbent Limitations
- Facepiece Fit
- Mobility Requirements
- Type of Use (routine, escape, or emergency entry)

Permissible Exposure Limits And Action Levels

Permissible exposure limits, time-weighted averages (TWAs), and threshold limit values (TLVs) all mean approximately the same thing. In the latest revision of the OSHA regulations (July 1, 1975), the TWAs are found in tables Z-1, Z-2, and Z-3 of Section 1910.1000. In earlier editions, the TWAs can be found by checking the index for air contaminants. But remember, these exposure limit tables have not been changed since the ACGIH (American Conference of Governmental Industrial Hygienists) TLVs were adopted by OSHA in 1968, so it is a good idea to cross-check the OSHA permissible exposure limit with the current ACGIH TLV.

OSHA feels it is necessary to begin employee exposure measurements and medical surveillance before concentrations reach the TWA or permissible exposure limit, and therefore, OSHA is proposing an action level for each new substance standard. The action level is one-half of the permissible exposure limit. For example, OSHA's TWA, or permissible exposure limit, for 2-butanone is 200 ppm, so the action level would be 100 ppm. OSHA reasons that an action level set well below the permissible exposure limit will provide maximum employee protection with minimum employer burden. Where the results of environmental surveillance show that no employees are exposed to concentrations above the action level, employers are exempt from certain measurement, medical, and training requirements of the standard unless, of course, there is a change in production, process, or control methods that could increase concentrations.

Exposure Determination And Measurement

In conjunction with the action level concept, the exposure determination and measurement sections of the proposed standards are designed in a step-by-step fashion to make compliance easier for those workplaces where only low concentrations are present. There are four steps in the measurement process.

Step 1 — An initial determination of workplace conditions must be taken. This is a simple calculation of exposures and does not require the employer to sample the environment. Normally, this written report covers the size of the workplace, the amount of the regulated substance present, the type of operation performed, the proximity of the workers to the source of emissions, and the ventilation system being used. Such an initial determination must be made even if none of the workers are exposed above the action level, and the initial determination must be made for each operation involving a regulated substance. For example, in dip tank and spray-finishing operations, an initial determination must be made for both operations.

Step 2 — When the initial exposure determination indicates that any employee may be exposed in excess of the action level, the employer must measure the exposure of the employee most likely to have the highest exposure. If the results indicate that the employee is exposed to concentrations in excess of the action level, the employer must measure the exposures of all employees similarly affected.

Step 3 — Exposure measurements of concentrations above the action level, but below the permissible exposure level, must be made every two months. If the results of two consecutive measurements, taken at least one week apart, show that the exposure is below the action level, the surveillance program for that employee can stop. As mentioned before, OSHA's stated intent is to provide adequate protection for employees while minimizing the employer's administrative and financial burden.

Step 4 — If measurements show that an employee is exposed to concentrations above the permissible limit, the exposure must be monitored at least monthly and measures must be taken to reduce the exposure. Monthly measurements are also required even when the employees wear respirators routinely, because the type of respirator selected is determined by the concentration of the regulated substance in the workplace air.

It should be noted that the entire measurement process must begin again, with the initial determination, if there are changes in the production, process, or control measures that could result in new or increased exposures.

Methods of Measurement

The methods of measurement section of the proposed standards does not specify the duration or number of samples to be taken in order to determine individual employee exposures. A combination of long-term or short-term samples would be acceptable, although the proposals require that exposures be calculated on an 8-hour time-weighted average (TWA) basis. The 8-hour exposure can be determined from a single sample or from two 4-hour samples.

Measurement methods are not specified either. However, the method used must meet specified precision and accuracy requirements. This gives the employer some flexibility in selecting the method that best fits his particular situation.

The accuracy requirements are related to the concentration being measured. Above the permissible exposure limit, the accuracy is plus or minus 25%. At or below the permissible exposure and above the action level, the accuracy is plus or minus 35%. At or below the action level, the accuracy is plus or minus 50%. Such accuracy requirements let the employer use NIOSH-certified detector tubes when available, because these accuracy levels are the same as those used by NIOSH when they test detector tubes for a specified compound. Each measurement method must have a confidence level of 95%. This means that out of a long series of tests, 95% must be within 25%, 35%, or 50% of the true concentration.

Methods of Compliance

OSHA's proposed methods of compliance are pretty straightforward. The standards require the use of engineering or work-practice controls to reduce exposures to the permissible limit or below. However, if such controls cannot get exposures down to the permissible limit, they have to be used anyway to reduce the exposure to the lowest level possible. At this point, the controls can be supplemented by respirators.

Naturally, OSHA prefers engineering controls because airborne concentrations are reduced at the source and the controls are not highly subject to human errors. As a check, though, mechanical ventilation systems used as engineering controls must be tested at least once every three months.

Work-practice controls, on the other hand, are only as good as the supervision they get. Good housekeeping may reduce spills, and employees can reduce their exposure by staying out of high concentration areas when work does not require them to be there, but these are not foolproof measures.

Respiratory Protection

OSHA feels that respirators are the least satisfactory means of exposure control, because they provide good protection only if they are properly selected, properly fitted, worn by employees, and replaced when their service life is over. In addition, some employees may not be able to wear a respirator. Despite these difficulties, respirators are the only form of protection available when engineering and work-practice controls are inadequate. The proposed standards also permit respirators to be used to control employee exposure in certain other specific situations, including operations where respirators are needed for not more than 1 hour a day, 1 day a week, or in emergencies. OSHA has not explained why they chose 1 hour per day, 1 day per week.

The new standards list respiratory protection equipment for various concentrations of a substance. This is called the Respirator Selection Guide. To provide additional protection, an employer may always select a respirator prescribed for concentrations **higher** than those found in his workplace. He may not, however, use respirators that are **not** listed. The proposed standards also call for a respiratory protection program as spelled out in Section 1910.134 of the OSHA regulations and ANSI standard Z88.2-1969. Of course, the respirators must be NIOSH-MESA-approved or carry a Bureau of Mines approval still valid under the "grandfather" clause.

Decision Logic

The respirator selection guides are prepared by outside consultants who use the strict guidelines of a decision logic system. The purpose of this decision logic system is to assure that the respiratory protection selection guides for the various substances are uniform. The system works by eliminating, in a step-by-step fashion, respirators that are inappropriate until only those types which are acceptable remain.

To do this, the necessary toxicological, safety, and research information on the substances is assembled in order to answer six basic questions.

1. Skin Absorption — Personal protection requirements for splashes or spills that may cause the substance to be absorbed through the skin are not covered, as respirator selection criteria are based primarily on the inhalation hazard. It is possible that a supplied-air suit may provide both skin and respiratory protection from extremely toxic substances that may be absorbed through the skin. Supplied-air suits, however, are not covered in NIOSH-MESA Approval Regulations, 30 CFR, Part 11, and the data needed to recommend such suits for all types of exposures simply is not available.

Where information indicates systemic injury or death from absorbing a gas or vapor through the skin, the standards say: *"Use of supplied-air suits or other impervious coverings may be necessary to prevent skin contact with the substance when the concentration of the substance is unknown or greater than the IDLH. Supplied-air suits should be selected, used, and maintained under the immediate supervision of persons knowledgeable in the limitations and potential life endangering characteristics of supplied-air suits."*

Irrespective of the use of supplied-air suits, the entry-and-escape-from-unknown-concentrations category of the respiratory protection guides say: *"Self-contained breathing apparatus with a full facepiece operated in the pressure demand or other positive-pressure mode, or a combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in the pressure demand or other positive-pressure or continuous flow mode and an auxiliary self-contained breathing apparatus operated in the pressure demand or other positive-pressure mode."* Translated, this section of the respiratory table means a pressure demand self-contained breathing apparatus or a pressure demand work mask may be used.

2. Warning Properties — Warning properties such as odor, eye irritation, and respiratory irritation that rely upon human senses are not foolproof. However, they do provide some indication to the wearer that the service life of the cartridge or canister is reaching the end, the facepiece is not fitted properly, or there is some other respirator malfunction. Warning properties may be assumed to be adequate when odor, taste, or irritation effects of the substance can be detected and are persistent at concentrations at or below the permissible exposure limit.

If the odor or irritation threshold of the substance is many times greater than the permissible exposure limit, the substance is considered to have poor warning properties, and air-supplied respirators would be specified.

Borderline cases are governed by other rules. This same thinking is reflected in NISOH-MESA approvals for organic vapor chemical cartridge respirators and gas masks which prohibit their use against organic vapors with poor warning properties.

3. Sorbent Efficiency — Where evidence shows immediate or less than three minutes' breakthrough time at or below the IDLH concentration for a chemical cartridge or canister, these air-purifying devices will not be allowed for any use, including escape. Only air-supplied devices are permitted.

4. Eye Irritation — For routine work operations, any perceptible eye irritation is considered by OSHA to be unacceptable. Therefore, only full-facepiece respirators are allowed in concentrations that produce eye irritation. In escape situations, some eye irritation is permitted if it does not inhibit escape or result in permanent injury.

5. IDLH (Immediately Dangerous to Life or Health) — NIOSH-MESA approval regulations define IDLH as: *"Conditions that pose an immediate threat to life or health or conditions that pose an immediate threat of severe exposure to contaminants such as radioactive materials which are likely to have adverse cumulative or delayed effects on health."*

This definition represents a significant change from the previous "Immediately Dangerous to Life" terminology used by the Bureau of Mines. The addition of "or Health" was based on the fact that a worker could escape from an irrespirable atmosphere in the event his respiratory protective equipment failed, but might be affected so severely that his health could be impaired.

Two factors are considered when establishing IDLH concentrations:

1. The worker must be able to escape without losing his life or suffering permanent health damage within 30 minutes. Thirty minutes is considered by OSHA as the maximum permissible exposure time for escape.
2. The worker must be able to escape without severe eye or respiratory irritation or other reactions that could inhibit escape.

If the concentration is above the IDLH, only highly reliable breathing apparatus such as pressure demand is allowed. Since the IDLH limits are conservative, any approved respirator may be used up to its maximum use concentration, as listed in the respirator selection guide, but below the IDLH. Respiratory protection for substances without an IDLH concentration is selected strictly on the basis of the respirator's protection factor and use limitations.

6. Lower Flammable Limit (LFL) and Fire-Fighting — Concentrations in excess of the lower flammable limit (LFL) are considered to be immediately dangerous to life and health. At or above the LFL, OSHA feels that respirators must provide maximum protection. Such devices include pressure demand self-contained breathing apparatus and combination positive pressure supplied-air respirators with egress cylinders (work masks).

ANSI standard Z88.5 defines fire-fighting as immediately dangerous to life, so for fire-fighting, OSHA feels that the only device providing adequate protection is pressure demand self-contained breathing apparatus.

RESPIRATOR PROTECTION FACTORS

Type Respirator	Facepiece Pressure	Protection Factor
I. Air-Purifying		
A. Particulate Removing		
Single-Use, Dust	—	5
Quarter-Mask, Dust	—	5
Half-Mask, Dust	—	10
Half- or Quarter-Mask, Fume	—	10
Half- or Quarter-Mask, High-Efficiency	—	10
Full Facepiece, High-Efficiency	—	50
Powered, High-Efficiency, All Enclosures	+	1,000
Powered, Dust or Fume, All Enclosures	+	X
B. Gas and Vapor-Removing		
Half-Mask	—	10
Full Facepiece	—	50
II. Atmosphere-Supplying		
A. Supplied-Air		
Demand, Half-Mask	—	10
Demand, Full Facepiece	—	50
Hose Mask Without Blower, Full Facepiece	—	50
Pressure-Demand, Half-Mask	+	1,000
Pressure-Demand, Full Facepiece	+	2,000
Hose Mask With Blower, Full Facepiece	—	50
Continuous Flow, Half-Mask	+	1,000
Continuous Flow, Full Facepiece	+	2,000
Continuous Flow, Hood, Helmet, or Suit	+	2,000
B. Self-Contained Breathing Apparatus		
Open-Circuit, Demand, Full Facepiece	—	50
Open-Circuit, Pressure-Demand Full Facepiece	+	10,000
Closed-Circuit, Oxygen Tank-Type, Full Facepiece	—	50
III. Combination Respirator		
A. Any Combination of Air-Purifying and Atmosphere-Supplying Respirator	Use Minimum Protection Factor Listed Above for Type and Mode of Operation	
B. Any Combination of Supplied-Air Respirator and an SCBA		

Protection Factors

Protection factors, a very important part of the decision logic system, are simply a measure of the overall effectiveness of a respirator. The protection factors being used by OSHA are based on fit tests performed at Los Alamos Scientific Laboratory and elsewhere, and in some instances, on professional judgment.

Protection factors are determined by dividing the ambient airborne concentration by the concentration inside the facepiece. The new standards use protection factors that range all the way from 5 to 10,000. This simply means that the maximum use concentration for the respirator is determined by multiplying the TLV of the substance by the protection factor.

Changes to 30 CFR, Part 11

There are certain conflicts between 30 CFR, Part 11, and the decision logic system. OSHA has stated that they plan to make at least five changes to 30 CFR, Part 11, so that it will mesh with the decision logic.

In the first place, 30 CFR, Part 11, does not have protection factor requirements. An amendment is planned that will **include protection factors** for dust, fume, and mist respirators. In the future, amendments are to be planned for other types of respiratory protection.

The second change to 30 CFR, Part 11, would **eliminate approval of Type A supplied-air respirators, commonly known as a hose mask with blower, for IDLH atmospheres.** Although this device is currently allowed for IDLH situations, OSHA feels that an air supply of 50 liters per minute as required in 30 CFR, Part 11, is not enough to maintain a positive pressure in the facepiece under all working conditions. Therefore, OSHA feels this device should have the same protection factor as other air-purifying and atmospheric-supplying respirators with a negative pressure in the facepiece.

The third amendment to 30 CFR, Part 11, will **eliminate the use of gas masks for entry and use in immediately dangerous to life and health atmospheres.** In the decision logic system, gas masks are not allowed in concentrations greater than the IDLH or for entry and escape for unknown concentrations.

The fourth amendment will **eliminate maximum use concentrations from the gas mask approval labels.** The decision logic is consistent with this amendment. However, it's important to remember that canisters approved prior to this amendment will have a maximum use concentration specified on the label. This will not be consistent with most of the proposed standards. OSHA evidently feels that the new standards themselves should control the use of gas masks and that the user should not be made aware of the maximum use concentration limitations associated with such devices.

Finally, 30 CFR, Part 11, does not allow the approval of escape gas masks for acid gases or organic vapors with poor warning properties. A change is planned to **permit the use of gas masks for escape** from these substances regardless of their warning properties.

Current OSHA Respiratory Standard

The OSHA General Industry Safety and Health Regulations, Part 1910.134, state: *"In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible or while they are being instituted, appropriate respirators shall be used pursuant to the following requirements.*

Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protective program which shall include the requirements outlined in paragraph B of this section."

Paragraph B lists the requirements for a minimal acceptable program which include:

1. *"Written standard operating procedures governing the selection and use of respirators shall be established.*

2. *Respirators shall be selected on the basis of hazards to which the worker is exposed.*

3. *The user shall be instructed and trained in the proper use of respirators and their limitations.*

4. *Where practicable, the respirators should be assigned to individual workers for their exclusive use.*

5. *Respirators shall be regularly cleaned and disinfected. Those issued for the exclusive use of one worker should be cleaned after each day's use, or more often if necessary. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use.*

6. *Respirators shall be stored in a convenient, clean, and sanitary location.*

7. *Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use such as self-contained devices shall be thoroughly inspected at least once a month and after each use.*

8. *Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained.*

9. *There shall be regular inspection and evaluation to determine the continued effectiveness of the program.*

10. *Persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician shall determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).*

11. *Approved or accepted respirators shall be used when they are available. The respirator furnished shall provide adequate respiratory protection against a particular hazard for which it is designed in accordance with standards established by competent authorities. The U.S. Department of the Interior, Bureau of Mines, and the U.S. Department of Agriculture are recognized as such authorities. Although respirators listed by the U.S. Department of Agriculture continue to be acceptable for protection against specified pesticides, the U.S. Department of the Interior, Bureau of Mines, is the agency now responsible for testing and approving pesticide respirators."*

It should be noted that NIOSH-MESA is now testing and certifying respirators.

That is the end of the OSHA requirements for a minimal acceptable program and that whole section was picked up from ANSI Z88.2-1969. What was not picked up, however, were the ANSI Z88.2 references that refer you to other sections of the document for additional requirements. For instance, the ANSI paragraph states: *"The user shall be instructed and trained in the proper use of respirators and their limitations, see paragraph 7.4 and* 7.5. "These reference sections specify minimum training and facepiece fit test requirements.

OSHA includes these requirements under paragraph E5 titled "Use of Respirators" and states: *"For safe use of any respirator, it is essential that the user be properly instructed in its selection, use, and maintenance. Both supervisors and workers shall be so instructed by competent persons.*

Training shall provide the men an opportunity to handle the respirator, have it fitted properly, test its facepiece-to-face seal, wear it in normal air for a long familiarity period, and finally to wear it in a test atmosphere. Every respirator wearer shall receive fitting instructions, including demonstrations and practice in how the respirator should be worn, how to adjust it, and how to determine if it fits properly.

Respirators shall not be worn when conditions prevent a good face seal. Such conditions may be a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses. Also the absence of one or both dentures can seriously affect the fit of a facepiece. The worker's diligence in observing these factors shall be evaluated by periodic checks. To assure proper protection, the facepiece fit shall be checked by the wearer each time he puts on the respirator. This may be done by following the manufacturer's facepiece-fitting instructions."

These requirements were obviously meant to be a part of the minimal acceptable program when ANSI published their document, but they became separated when OSHA promulgated Part 1910.

AMMONIA

Respirator	Facepiece	Maximum Use Concentration (ppm)	
		Existing Standard TLV 25 ppm	Proposed Standard TLV 50 ppm "C"
Chem. Cart.	1/2	300	Not Allowed
Chem. Cart.	Full	300	500
Gas Mask	Full	30,000	1,250 (IDLH)
SCBA Demand	Full	Unlimited	1,250 (IDLH)
SCBA Press. Demand	Full	Unlimited	Unlimited

Comparison of Present And Proposed Standards

So a comparison of the present standard to the proposed standards indicates that the present requirements for respirator selection and facepiece-fit testing will be meaningless although still required, and all respirators will have to be selected and used in accordance with the new respirator selection guides.

The new standards appear less complex and somewhat easier to understand, but here are some of the changes they will require, using the proposed Ammonia standard as an example.

The first major difference in the standards is that half-mask chemical cartridge respirators, presently approved for use to 300 ppm, will not be allowed.

Another change is that a full-facepiece chemical cartridge respirator may be used up to 500 ppm instead of the present 300 ppm. However, this conflicts with 30 CFR, Part 11, because the NIOSH-MESA approval limits the cartridge to a maximum of 300 ppm.

Gas masks are downgraded from their present 30,000 ppm status to 1,250 ppm which is the IDLH level proposed by OSHA.

Finally, the demand self-contained breathing apparatus that has been used in emergency rescue and fire-fighting on an unlimited basis for years has been reduced to 1,250 ppm.

Impact of Proposals On Respiratory Protection

This basic example shows that the eye irritation, protection factor, and warning property sections of the decision logic system will result in substantial changes in the types of respirators required in the future. It appears that large numbers of half-mask respirators will have to be replaced with full-facepiece respirators due solely to potential eye irritation that might well be handled by protective goggles.

The protection factors being applied to respirators will require not only the replacement of many half-facepiece respirators but will also require the wholesale replacement of negative pressure respirators with positive-pressure respirators. This includes the bulk of the self-contained breathing apparatus and gas masks in use today.

In the category of adequate warning properties, OSHA and NIOSH consider substances with no published odor or irritation data to have poor warning properties. A review of the Standards Completion Project indicates there are probably more substances with no data available than substances with data. This category arbitrarily eliminates all gas sorbent air-purifying respirators and will require their replacement with air-supplied or self-contained breathing apparatus.

It should be noted that the new standards, if adopted, will take precedence over previous OSHA regulations and will replace the sections of the OSHA regulations covering personal protective equipment, 1910.132 (C); air contaminants, 1910. 1000; eye and face protection, 1910.133 (A); as well as any other provision of Part 1910 not consistent with the new standards.

The ANSI Approach To Protection Factors

Any discussion of facepiece-fit characteristics must recognize that the ideal way to achieve the highest degree of protection, or the least amount of leakage, would be to mold a facepiece to each wearer's face. However, this is not feasible with present technology.

At this time, the best way to determine facepiece-fit characteristics is to individually fit-test each respirator wearer.

The next best method is to fit-test the wearer with several facepieces until it is determined which model provides the highest degree of protection.

As stated previously, the current OSHA regulations require that both supervisors and workers have an opportunity to handle the respirator, have it fitted properly, test its facepiece-to-face seal, wear it in normal air for a long familiarity period, and finally wear it in a test atmosphere.

Because the present standard requires that facepiece-fit testing be performed, the ANSI Z88.2 Committee developed an alternative proposal to the OSHA protection factors. The ANSI test procedures would, in effect, permit users to develop their own protection factors as part of a facepiece-fit testing program.

Maximum Use Limits

The ANSI Maximum Use Limits, or MULs, are based on three types of respirator fit tests. The fitting methods recommended are qualitative, semi-quantitative, or quantitative.

The first consideration in the MUL concept is to determine if the respirator is permitted for use in oxygen-deficient atmospheres or IDLH atmospheres or not.

Depending on the fitting method used (qualitative, semi-quantitative, or quantitative), a Respirator Fit Index is determined. See chart on page 11.

The MUL is calculated by multiplying the Respirator Fix Index by the TWA of the contaminant.

If no fit tests are performed, an MUL of 5 would be assigned. This is considerably more stringent than the OSHA approach and is designed to encourage individual fit testing.

The ANSI Z88.2 Committee feels that proper use of the fit-testing procedures will result in a much higher degree of protection to the respirator wearer than the arbitrary assignment of protection factors based on the poorest fitting respirators tested.

The qualitative fit method determines respirator Maximum Use Limits based on the simplest fit testing. An irritant smoke tube is used in this test and the wearer determines if the respirator leaks by irritation. The Maximum Use Limits from this test are very close to the protection factors proposed by OSHA.

The qualitative fit method can also be performed with a swab containing isoamyl acetate.

The wearer would determine if the respirator leaked by odor of the "banana oil."

The semi-quantitative fit method is based on pre-screening the wearer to determine if 2 ppm of isoamyl acetate can be detected, and then exposing the wearer to a known concentration of at least 400 ppm for a half-facepiece and 2,000 ppm for a full-facepiece in a test enclosure. If the wearer cannot detect the odor, the listed MULs are valid.

The quantitative fit method is based on actual facepiece leakage measurements using DOP (dioctyl phthlate aerosol particles), sodium chloride, halogenated hydrocarbons, or other test means.

The quantitative fit method measures facepiece leakage from inside the facepiece, using a probe, sampling line, and analytical equipment. In this test, Maximum Use Limits would be established for each individual who is fitted.

ANSI Z88.2 PROPOSAL
RESPIRATOR MAXIMUM USE LIMITS

Respirator	Permitted for Use In Atmospheres		MUL Respirator Fit Index According to Fitting Method Used		
	O_2 Def.	IDLH	Qualitative	Semi-Quantitative	Quantitative
1. ¼ or ½ Facepiece Particulate Filter*	No	No	10	200	As Measured on Each Person or MUL-C
2. ¼ or ½ Facepiece Vapor Gas	No	No	Lower of 10 or MUL-C	Lower of 200 or MUL-C.	
3. Full Facepiece Particulate Filter*	No	Yes	100	1000	
4. Full Facepiece Vapor Gas	No	Yes	Lower of 100 or MUL-C	Lower of 1000 or MUL-C	
5. Powered Air-Purifying Any Respiratory Inlet Cover)*	No	No	MUL-C	MUL-C	
MUL-C (MUL of Cartridge or Canister Used) *Use High Efficiency Filters for Particulates with TLV Less than .05 mg/m³					
6. Air-Line (Demand) ¼ or ½ Facepiece	No	No	10	200	As Measured on Each Person
7. Air-Line (Demand) Full Facepiece	No	No	100	1000	
8. Air-Line (Demand) Full Facepiece with Escape Provision	Yes*	Yes	100	1000	
9. Hose Mask Full Facepiece	No	No	100	1000	
10. Air-Line (Pressure Demand or Constant Flow)	No	No	N/A	N/A	N/A
11. Air-Line (Pressure Demand with Escape Provision)	Yes*	Yes	N/A	N/A	N/A
12. Air-Line (Constant Flow with Escape Provision)	Yes*	Yes	N/A	N/A	N/A
*Escape Provision Must Be an Auxiliary Self-contained Air Supply					
13. Demand SCBA (Open or Closed Circuit) Full Facepiece or Mouthpiece	Yes	Yes	100	1000	As Measured on Each Person
14. Pressure Demand SCBA Half or Full Facepiece	Yes	Yes	N/A	N/A	N/A
15. Combination Devices Not Listed	Use Lowest MUL Listed				

Note

This presentation is intended for persons concerned with establishing and maintaining a respiratory protection program. It presents certain basic information for guidance purposes. However, it is not intended to be all-inclusive in content or scope.

Further, this presentation contains simplified interpretations of certain Federal regulations pertaining to respiratory protection and monitoring. While these interpretations convey background information about the regulations, under no circumstances should they be used as the sole basis of a respiratory protection program. In all cases, the current Federal regulations, as published in the *Federal Register*, should be carefully studied, and the rules and procedures in those regulations explicitly followed. Only they define the specific requirements that are in force.

For more complete information on specific problems, the reader is referred to the following publications:

1. *American National Standard Practices for Respiratory Protection, ANSI Z88.2-1969*—Available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

2. *Respiratory Protective Devices Manual*—Available from the Committee on Respirators, P. O. Box 435, Lansing, MI 48902.

3. *Breathing Apparatus for the Fire Service*—Available from the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02110.

4. *Threshold Limit Values*—Available from the Secretary-Treasurer, The American Conference of Governmental Industrial Hygienists, 1014 Broadway, Cincinnati, OH 45202.

5. *Basic Elements of Respiratory Protection*—Available from Mine Safety Appliances Co., 600 Penn Center Boulevard, Pittsburgh, PA 15235.

6. *Code of Federal Regulations, Title 29, Labor, Parts 1900-1917* and *Code of Federal Regulations, Title 30, Mineral Resources, Parts 11-14A* —Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

This presentation contains only general descriptions of several MSA products that can be used to implement a respiratory protection program. While uses and performance capabilities are described, only qualified, trained personnel should use any respiratory protective device. Precautions listed on the labels and cartons must be read, understood, and followed. Only they contain the complete and detailed information concerning the products.

For more complete information about the respiratory protective equipment described in this presentation, contact Mine Safety Appliances Co., 600 Penn Center Boulevard, Pittsburgh, PA 15235.

MSA Mine Safety Appliances Company
600 Penn Center Boulevard
Pittsburgh, Pennsylvania 15235

At your service: 25 branch offices in the United States;
MSA CANADA, Downsview, Ontario (Metro Toronto), Halifax, Montreal, Winnipeg, Saskatoon, Edmonton, Calgary; Vancouver;
representatives in principal cities of the world.
Cable address—"MINSAF" Pittsburgh

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