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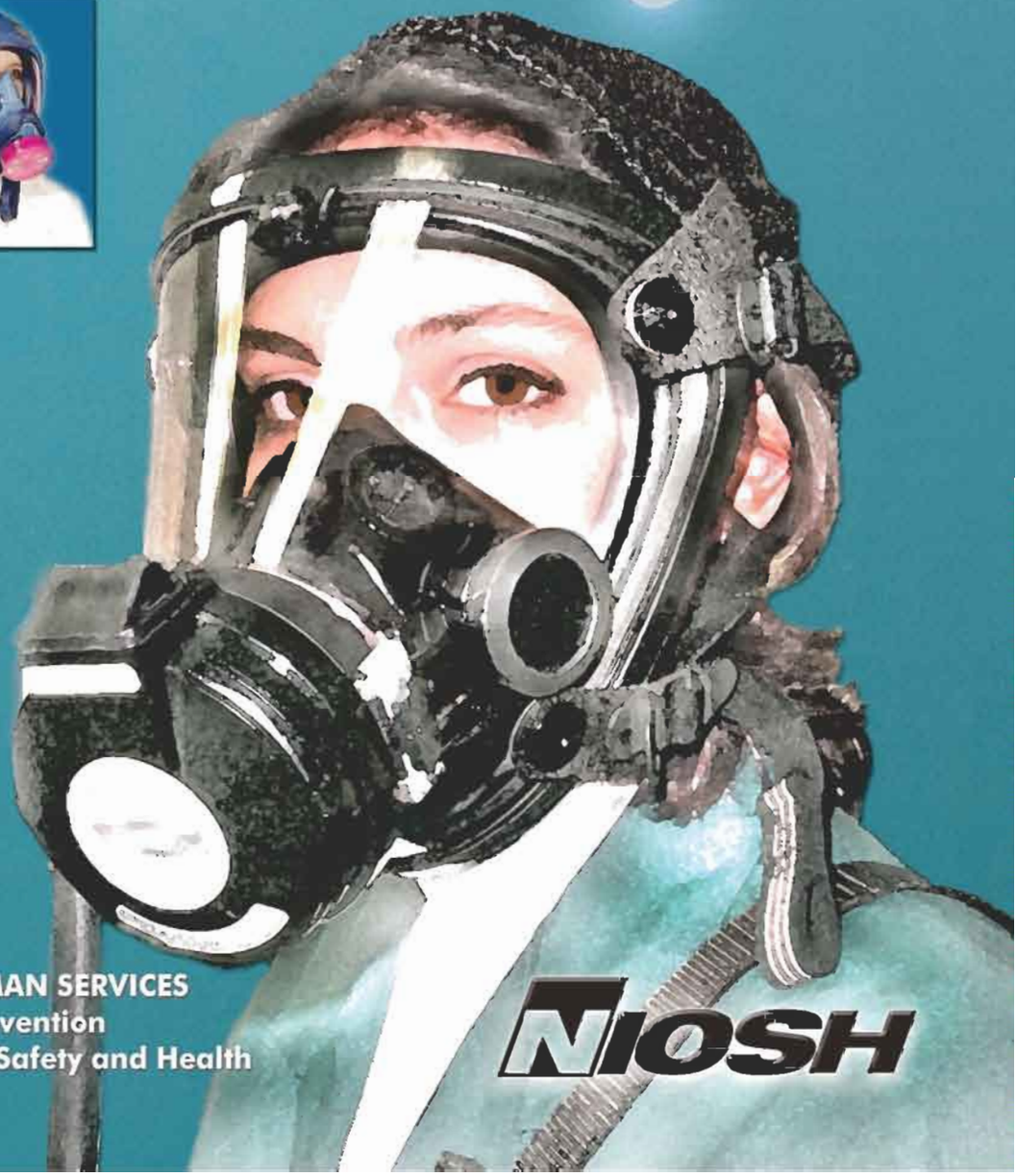
NIOSH Respirator Selection Logic



DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

NIOSH

NIOSH Respirator Selection Logic

2004

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Foreword

The purpose of this Respirator Selection Logic (RSL) is to provide guidance to respirator program administrators on respirator selection that incorporates the changes necessitated by the revisions to the respirator use and certification regulations and changes in the National Institute for Occupational Safety and Health (NIOSH) policy. This RSL is not intended to be used for selection of respirators for protection against infectious agents or for chemical, biological, radiological or nuclear (CBRN) agents of terrorism. While respirators can provide appropriate protection against these agents, the information necessary to use the selection logic is generally not available for infectious disease or bioterrorism agents (e.g., exposure limits, airborne concentration). Similarly, CBRN terrorism events may involve chemicals that can quickly degrade respirator materials or have extremely low toxic levels that are difficult to measure.

In 1987, NIOSH published the NIOSH Respirator Decision Logic (RDL). Since then the Occupational Safety and Health Administration (OSHA) has promulgated a revision to their respirator use regulation (29CFR1910.134 published on January 8, 1998), and NIOSH has promulgated the revised respirator certification standard (42CFR84 on June 8, 1995). In addition, NIOSH has revised its carcinogen policy to recommend the complete range of respirators as determined by this respirator selection logic for those carcinogens with quantitative recommended exposure limits (RELs). Thus, respirators can be consistently recommended regardless of whether a substance is a carcinogen or not.

OSHA recently proposed a rule to establish assigned protection factors (APFs) for various classes of respirators (68FR34036 published on June 6, 2003). When the OSHA standard on APFs is finalized NIOSH intends to consider revisions to this RSL. NIOSH will also modify the certification program to assure that NIOSH certified respirators will be capable of providing the level of protection determined in the OSHA APF rulemaking. NIOSH also intends to periodically update the RSL so that it reflects current OSHA requirements and NIOSH policy.

Sincerely yours,

John Howard, M.D.
Director, National Institute for Occupational Safety and Health
Centers for Disease Control and Prevention

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Table of Contents

I. Background and Purpose

The purpose of this respirator selection logic (RSL) is to provide a process that respirator program administrators can use to select appropriate respirators for the protection of workers in specific workplaces. It is not intended to be used for selection of respirators for protection against infectious agents or chemical, biological, radiological or nuclear (CBRN) exposures associated with terrorism events.*

This RSL contains a series of questions regarding situations which may require the use of respirators. (See Respirator Selection Logic Sequence, page 5.) In answering these questions, the user of this selection logic is assisted in identifying specific classes of respirators, applicable restrictions, and the appropriate respirator selection table to use. When using one of the tables to identify a suitable class of respirators, the user must keep in mind the restrictions identified in the question section of this respirator selection logic.

This RSL identifies the criteria necessary to determine the classes of respirators that will provide the minimum acceptable degree of protection for a chemical at a given concentration. Classes of respirators offering greater protection can usually be used in place of the minimum acceptable class of respirators. Respirator classes are consistent with respirator certification groupings as specified in 42 CFR 84.

The recommendations in this RSL are based primarily on the physical, chemical, and toxicologic properties of the contaminant and on the limitations of each class of respirator, including filtration efficiency, air supply capability, and face seal characteristics and leakage. Thus, this selection logic is limited to identifying classes of acceptable respirators, rather than individual respirator models.

After various classes of respirators are identified as being suitable for a given situation, an evaluation is made of other factors of the particular work environment (e.g., job, task, temperature, mobility, etc.) so that the most appropriate respirator model within the recommended classes can be chosen. In some situations, the selection of a respirator classified as providing a higher level of protection may be advisable.

The assigned protection factors (APFs) used in this respirator selection logic were based on quantitative fit factor data developed by Los Alamos National Laboratories under contract to NIOSH and on field and laboratory data gathered by NIOSH and others. A Notice of Proposed Rulemaking on Assigned Protection Factors was published by OSHA on June 6, 2003. When this regulation is finalized, NIOSH will consider the new standard and revise the RSL as necessary. NIOSH will also modify its certification

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* **Note:** Selection of respirators for infectious disease and terrorism-related exposures requires consideration of additional factors in addition to the traditional exposure assessment approaches described in this guidance. See the NIOSH respirator topic page http://www.cdc.gov/niosh/topics/respirators/ for additional information and guidance on particular infectious disease and terrorism issues.

program to assure that NIOSH certified respirators will be capable of providing the level of protection determined in the OSHA APF rulemaking. Fit factors determined for the individual wearer of a respirator by quantitative fit testing or by any other method used to determine fit should not be substituted for the APF given for each class of respirators. In addition, the fit factor determined through quantitative fit testing must be greater than the APF (10X the APF is generally recommended); otherwise, the respirator cannot be used by the worker.

Note: In order to provide protection at the APF level, respirators must be used in a complete respirator program such as the one required by OSHA in 29CFR1910.134.

II. Information and Restrictions

A. Criteria for Selecting Respirators

To use this selection logic, the user must first assemble the necessary toxicologic, safety, and other relevant information for each respiratory hazard, including the following:

- General use conditions, including determination of contaminant(s);
- Physical, chemical, and toxicological properties of the contaminant(s);
- NIOSH recommended exposure limit (REL), OSHA permissible exposure limit (PEL), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV), State-OSHA exposure limit, American Industrial Hygiene Association (AIHA) Workplace Environmental Exposure Limit (WEEL), or other applicable occupational exposure limit;
- Expected concentration of each respiratory hazard;
- Immediately dangerous to life or health (IDLH) concentration;
- Oxygen concentration or expected oxygen concentration;
- Eye irritation potential; and
- Environmental factors, such as presence of oil aerosols

NIOSH recommends that air sampling be conducted to determine exposure levels found in the workplace. A combination of air sampling and exposure modeling is often used to make reasonable estimates of exposure. Ideally, this determination should be made by a professional industrial hygienist. Also, OSHA offers free consultation to qualifying small- and medium-sized businesses to help recognize hazards, suggest approaches to solving problems and identifying the kinds of help available if further assistance is required. The OSHA website www.osha.gov provides information on compliance assistance and consultation programs.

Obtaining complete information on all criteria needed to use this selection logic may be difficult. When conflicting or inadequate data are found, experts should be consulted before decisions are made that could affect the proper use of this selection logic. In addition, the adequacy of the respirator selected is dependent on the validity of the exposure limit used and the accuracy of the hazard concentration determination. While the selection logic can be used with any exposure limit, NIOSH recommends that the more protective limit of the NIOSH REL or the OSHA PEL, be used in respirator selection. If no REL or PEL exists, other applicable occupational exposure limits such as the ACGIH TLV can be used.

The information obtained on general use conditions for respirators should include a description of the actual job task, including the duration and frequency, location, physical demands, and industrial processes, as well as issues affecting the comfort of the respirators. Some conditions may preclude the use of specific types of respirators in certain circumstances because the individual must be medically and psychologically suited (i.e., not claustrophobic) to wear a given respirator for a given task, particularly if the respirator is a self-contained breathing apparatus (SCBA).

Employers must establish a cartridge/canister changeout schedule which is based on the service life of the cartridge/canister under the conditions of use. The changeout schedule can be determined with the assistance of the respirator manufacturer (changeout software or other tools) or by conducting service life tests. Information obtained on the service life of the cartridge/canister under conditions of intended use must be evaluated regardless of the odor warning properties of the chemicals. These evaluations must be based on all gases and vapors present at the temperature and relative humidity extremes (high and low) in the workplace. NIOSH recommends that when the employer or a representative of the employer conducts service life tests, the challenge concentrations of the gases and vapors should be at least the maximum use concentration (MUC) of the respirator and that a safety margin be applied when evaluating service life data. OSHA provides information on determining change schedules on their website (www.OSHA.gov/SLTC/etools/respiratory/change-schedules.html). In humid workplaces where organic vapor cartridges are used to protect workers from a single volatile source, software (CD-ROM) for predicting service life can be ordered from NIOSH by calling 1-800-356-4674. The software can also be downloaded from the OSHA website at: http://www.osha.gov/SLTC/etools/respiratory/advisor_genius_wood/breakthrough.html. This information can be used to set up cartridge replacement schedules and should be used in conjunction with sensory warning properties.

Although odor should not be relied on for cartridge/canister change out, workers should be trained to exit the contaminated area whenever they detect the odor or experience any irritation symptoms of the contaminant. (See the NIOSH policy statement dated August 4, 1999, in the Appendix (page 27) for a discussion of the OSHA standard and NIOSH's recommendations for change schedules.) If workers are detecting the odor before the end of the change schedule, the respirator program administrator should reevaluate this respirator use; i.e., the change schedule, the workplace concentrations or the other use conditions (relative humidity (RH), work rate, etc.).

B. Restrictions and Requirements for All Respirator Usage

The following requirements and restrictions must be considered to ensure that the respirator selected will provide adequate protection under the conditions of intended use:

1. Workers are not exposed to a single unvarying concentration of a hazardous substance, rather, individual exposures may vary throughout a workshift and between days. The highest anticipated concentration should therefore be used to compute the required protection factor for each respirator wearer.

2. Qualitative or quantitative fit tests must be provided as appropriate to ensure that the tight-fitting facepiece respirator fits the individual. NIOSH endorses the OSHA standard 29 CFR1910.134 for fit testing except for irritant smoke (see the Appendix, page 27). Employees must pass a fit test with the exact model and size that they will wear in the workplace.

3. Respirators with tight-fitting facepieces should not be used when facial scars or deformities interfere with the face seal.

4. Respirators with tight-fitting facepieces (including pressure-demand respirators) should not be used when facial hair interferes with the face seal.

5. The usage limitations of air-purifying elements, particularly gas and vapor cartridges or canisters, should not be exceeded (see NIOSH Certified Equipment List for general limitations at http://www.cdc.gov/niosh/npptl/topics/respirators/cel).

6. Respirators must be certified by the NIOSH. A list of certified respirators can be found at http://www.cdc.gov/niosh/celintro.html.

7. A complete written respiratory protection program must be developed which includes regular worker training; maintenance, inspection, cleaning, and evaluation of the respirator; use of the respirator in accordance with the manufacturer's instructions; fit testing; medical evaluation; and environmental monitoring. Minimum respiratory protection requirements for some contaminants can be found in the OSHA Respiration Protection Standards, 29 CFR 1910.134. Detailed information on respirator programs can be accessed at: http://www.osha.gov/SLTC/etools/respiratory. In addition, the OSHA Small Entity Compliance Guide provides procedures and checklists that can help small businesses comply with the respirator standard. This information can be accessed at: http://www.osha.gov/Publications/SECG_RPS/secgrev-current.pdf.

8. The APFs that appear in this respirator selection logic are based for the most part on laboratory studies. However, a few APFs have been validated and revised as necessary after consideration of data obtained from studies of workplace protection factors (WPFs). OSHA is currently considering setting APFs for respirators.

III. Respirator Selection Logic Sequence

After all criteria have been identified and evaluated and after the requirements and restrictions of the respiratory protection program have been met, the following sequence of questions can be used to identify the class of respirators that should provide adequate respiratory protection. Note that if OSHA has promulgated a substance – specific standard for a contaminant found in your workplace, respirator selection must meet or exceed the respirators required in that standard. (OSHA General Industry Air Contaminants Standard, 29 CFR 1910.1000).

Step 1. Is the respirator intended for use during fire fighting?

a. If yes, only a full-facepiece, pressure-demand, self-contained breathing apparatus (SCBA) meeting the requirement of the NFPA 1981, Standard on Open-circuit Self-contained Breathing Apparatus for Fire and Emergency Services (2002 edition) is required. Information on NFPA 1981 can be found at http://www.nfpa.org.

b. If no, proceed to Step 2.

Step 2. Is the respirator intended for use in an oxygen-deficient atmosphere, i.e., less than 19.5% oxygen?

a. If yes, any type of SCBA other than escape only, or supplied-air respirator (SAR) with an auxiliary SCBA is required. Auxiliary SCBA must be of sufficient duration to permit escape to safety if the air supply is interrupted.
If yes, and contaminants are also present, proceed to Step 3 to determine if the hazard requires the SCBA or SAR/SCBA to meet a specific APF level.

b. If no, proceed to Step 3.

Step 3. Is the respirator intended for entry into unknown or IDLH atmospheres (e.g., an emergency situation)?

a. If yes, one of two types of respirators are required: a pressure-demand SCBA with a full facepiece or a pressure-demand SAR with a full facepiece in combination with an auxiliary pressure-demand SCBA. Auxiliary SCBA must be of sufficient duration to permit escape to safety if the air supply is interrupted.

b. If no, proceed to Step 4.

Step 4. Is the exposure concentration of the contaminants, as determined by acceptable industrial hygiene methods, less than the NIOSH REL or other applicable exposure limit?

a. If yes, a respirator is not required for routine work. For escape respirators, determine the potential for generation of a hazardous condition caused by an accident, spill or equipment failure. See Section IV. Page 17, for a discussion and selection of escape respirators. Proceed to Step 6.*

b. If no, proceed to Step 5.

* If respirators are required by the employer to be worn (even if below the occupational exposure limit), OSHA requires that the employer establish and implement a written respiratory protection program with worksite specific procedures. If an employer provides respirators at the request of employees or permits employees to use their own respirators when exposure levels are below the applicable limits, this is considered voluntary respirator use. OSHA requires that employers provide to their employees the information contained in Appendix D of 29 CFR 1910.134, that they establish and implement those elements of a written program necessary to ensure that any employee using a respirator voluntarily is medically able to wear the respirator (except that medical evaluation is not required for voluntary use of filtering facepieces) and that the respirator is cleaned, stored, and maintained so that it does not represent a health hazard to the wearer.

Step 5. Are conditions such that a worker who is required to wear a respirator can escape from the work area and not suffer loss of life or immediate or delayed irreversible health effects if the respirator fails, i.e., are the conditions not immediately dangerous to life or health (IDLH)? IDLH values for certain compounds can be found in the NIOSH Pocket Guide for Chemical Hazards. This document can be accessed at http://www.cdc.gov/niosh/npg/npg.html. IDLH values for some substances can also be found on the NIOSH internet at http://www.cdc.gov/niosh/idlh/idlh-1.html.

a. If yes, conditions are not considered to be IDLH. Proceed to Step 6.

b. If no, conditions are considered to be IDLH. Two types of respirators are recommended: a pressure-demand, full-facepiece SCBA or a pressure-demand, full-facepiece SAR in combination with an auxiliary pressure-demand, full-facepiece SCBA. The auxiliary SCBA must be of sufficient duration to permit escape to safety if the air supply is interrupted. An auxiliary unit means that the SAR unit includes a separate air bottle to provide a reserve source of air should the airline become damaged. The auxiliary unit shares the same mask and regulator, and enables the SAR to function as an SCBA if needed.

Step 6. Is the contaminant an eye irritant, or can the contaminant cause eye damage at the workplace concentration? Information on eye irritation is included

in the International Programme on Chemical Safety, International Chemical Safety Cards which can be accessed at http://www.cdc.gov/niosh/ipcs/nicstart.html.

a. If yes, a respirator equipped with a full facepiece, helmet, or hood is recommended. Proceed to Step 7.

b. If no, a half-mask or quarter-mask respirator may still be an option, depending on the exposure concentration. Proceed to Step 7.

Step 7. Determine the maximum hazard ratio (HR) by the following:

- Divide the time-weighted average (TWA) exposure concentration for the contaminant determined in Step 4 by the NIOSH REL or other applicable exposure limit. If the exposure limit is an 8 hour limit the TWA used must be on 8 hour average. If the exposure limit is based on 10 hours, use a 10 hour TWA.

- If the contaminant has a ceiling limit, divide the maximum exposure concentration for the contaminant determined in Step 4 by the ceiling limit.

- If the contaminant has a short term exposure limit (STEL), divide the maximum 15 min TWA exposure concentration for the contaminant determined in Step 4 by the STEL.

- For escape respirators, determine the potential for generation of a hazardous condition caused by an accident or equipment failure.

- If a potentially hazardous condition could occur or a hazard ratio greater than 1 has been calculated, proceed to Step 8.

Step 8. If the physical state of the contaminant is:

- a particulate (solid or liquid aerosol) during periods of respirator use, proceed to Step 9;

- a gas or vapor, proceed to Step 10;

- a combination of gas or vapor and particulate, proceed to Step 11.

Step 9. Particulate Respirators

9.1. Is the particulate respirator intended only for escape purposes?

a. If yes, see Section IV (page 17), for a discussion and selection of escape respirators.

b. If no, the particulate respirator is intended for use during normal work activities. Proceed to Step 9.2.

9.2. A filter series (N, R or P) that will provide protection against exposure to the particulate in question is recommended.

a. The selection of N-, R-, and P-series filters depends on the presence or absence of oil particles, as follows:

- If no oil particles are present in the work environment, use a filter of any series (i.e., N-, R-, or P-series).
- If oil particles (e.g., lubricants, cutting fluids, glycerine, etc.) are present, use an R- or P-series filter. ***Note***: N-series filters cannot be used if oil particles are present.
- If oil particles are present and the filter is to be used for more than one work shift, use only a P-series filter.

> ***Note***: To help you remember the filter series, use the following guide:
> N for ***N***ot resistant to oil,
> R for ***R***esistant to oil
> P for oil ***P***roof

b. Selection of filter efficiency (i.e., 95%, 99%, or 99.97%) depends on how much filter leakage can be accepted. Higher filter efficiency means lower filter leakage.

Additional information on selecting the appropriate filter certified under 42CFR84 can be found at http://www.cdc.gov/NIOSH/userguid.html. Proceed to Step 9.3.

9.3. Respirators that have not been eliminated from Table 1 by the previous steps and that have APFs equal to, or greater than, the maximum hazard ratio determined in Step 7 are recommended.[1] Note, however, that the maximum use concentration (MUC) is the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected by a class of respirator and is determined by the lesser of:

- APF X exposure limit
- The respirator manufacturer's MUC for a hazardous substance (if any)

[1] If the respirator is intended for use in an oxygen-deficient atmosphere, only SCBA or SAR with an auxiliary SCBA, can be selected from the Table.

- The IDLH, unless the respirator is a pressure-demand, full-facepiece SCBA or combination pressure-demand SAR with a full facepiece in combination with an auxiliary pressure-demand SCBA.

For multi-component mixtures the MUC can be calculated by:
$C_1/MUC_1 + C_2/MUC_2 + \ldots C_n/MUC_n = 1$

Step 10. Gas/Vapor Respirators

10.1. Is the gas/vapor respirator intended only for escape?

a. If yes, refer to escape respirators Section IV (page 17).

b. If no, the gas/vapor respirator is intended for use during normal work activities. Proceed to Step 10.2.

10.2. An air-purifying chemical cartridge/canister respirator is recommended that has a sorbent suitable for the chemical properties of the anticipated gas/vapor contaminant(s) and for the anticipated exposure levels. Information on cartridges or canisters approved for use for classes of chemicals or for specific gases or vapors can be found in the NIOSH Certified Equipment List http://www.cdc.gov/NIOSH/npptl/topics/respirators/cel/. Proceed to Step 10.3.

10.3. Respirators that have not been eliminated from Table 2 by the previous steps and that have APFs equal to, or greater than, the maximum hazard ratio determined in Step 7 are recommended.[1] Note, however, that the maximum use concentration (MUC) is the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected by a class of respirator and is determined by the lesser of:

- APF X exposure limit
- The respirator manufacturer's MUC for a hazardous substance (if any)
- The IDLH, unless the respirator is a pressure-demand, full-facepiece SCBA or combination pressure-demand SAR with a full facepiece in combination with an auxiliary pressure-demand SCBA.

For multi-component mixtures the MUC can be calculated by:
$C_1/MUC_1 + C_2/MUC_2 + \ldots C_n/MUC_n = 1$

[1] If the respirator is intended for use in an oxygen-deficient atmosphere, only SCBA or SAR with an auxiliary SCBA, can be selected from the Table.

Step 11. Combination Particulate and Gas/Vapor Respirators

11.1. Is the combination respirator intended for "escape only" purposes?

a. If yes, refer to escape respirators on page 17, for a discussion and selection of "escape only" respirators.

b. If no, the combination respirator is intended for use during normal work activities. Proceed to Step 11.2.

11.2 From Table 3, select a respirator type, not eliminated by the previous steps, and have APFs equal to, or greater than, the maximum hazard ratio determined in Step 7. are recommended.[1] Note, however, that the maximum use concentration (MUC) is the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected by a class of respirator and is determined by the lesser of:

- APF X exposure limit
- The respirator manufacturer's MUC for a hazardous substance (if any)
- The IDLH, unless the respirator is a pressure-demand, full-facepiece SCBA or combination pressure-demand SAR with a full facepiece in combination with an auxiliary pressure-demand SCBA.

For multi-component mixtures the MUC can be calculated by:
$C_1/MUC_1 + C_2/MUC_2 + \ldots C_n/MUC_n = 1$

[1] If the respirator is intended for use in an oxygen-deficient atmosphere, only SCBA or SAR with an auxiliary SCBA, can be selected from the Table.

Table 1. Particulate Respirators

Assigned protection[1] factor	Type of Respirator
5	Quarter mask respirator
10	Any air-purifying elastomeric half-mask respirator equipped with appropriate type of particulate filter.[2] Appropriate filtering facepiece respirator.[2,3] Any air-purifying full facepiece respirator equipped with appropriate type of particulate filter.[2] Any negative pressure (demand) supplied-air respirator equipped with a half-mask.
25	Any powered air-purifying respirator equipped with a hood or helmet and a high efficiency (HEPA) filter. Any continuous flow supplied-air respirator equipped with a hood or helmet.
50	Any air-purifying full facepiece respirator equipped with N-100, R-100, or P-100 filter(s). Any powered air-purifying respirator equipped with a tight-fitting facepiece (half or full facepiece) and a high-efficiency filter. Any negative pressure (demand) supplied-air respirator equipped with a full facepiece. Any continuous flow supplied-air respirator equipped with a tight-fitting facepiece (half or full facepiece). Any negative pressure (demand) self-contained respirator equipped with a full facepiece.

1 The protection offered by a given respirator is contingent upon (1) the respirator user adhering to complete program requirements (such as the ones required by OSHA in 29CFR1910.134), (2) the use of NIOSH-certified respirators in their approved configuration, and (3) individual fit testing to rule out those respirators that cannot achieve a good fit on individual workers.

2 Appropriate means that the filter medium will provide protection against the particulate in question. See step 9.2 for information on the presence or absence of oil particulates.

3 An APF of 10 can only be achieved if the respirator is qualitatively or quantitatively fit tested on individual workers.

Table 1. Particulate Respirators

Assigned protection[1] factor	Type of respirator
1,000	Any pressure-demand supplied-air respirator equipped with a half-mask.
2,000	Any pressure-demand supplied-air respirator equipped with a full facepiece.
10,000	Any pressure-demand self-contained respirator equipped with a full facepiece. Any pressure-demand supplied-air respirator equipped with a full facepiece in combination with an auxiliary pressure-demand self-contained breathing apparatus.

1 The protection offered by a given respirator is contingent upon (1) the respirator user adhering to complete program requirements (such as the ones required by OSHA in 29CFR1910.134), (2) the use of NIOSH-certified respirators in their approved configuration, and (3) individual fit testing to rule out those respirators that cannot achieve a good fit on individual workers.

Table 2. Gas/Vapor Respirators

Assigned protection factor[1]	Type of respirator
10	Any air-purifying half mask respirator equipped with appropriate gas/vapor cartridges.[2] Any negative pressure (demand) supplied-air respirator equipped with a half mask.
25	Any powered air-purifying respirator with a loose-fitting hood or helmet equipped with appropriate gas/vapor cartridges.[2] Any continuous flow supplied-air respirator equipped with a hood or helmet.
50	Any air-purifying full facepiece respirator equipped with appropriate gas/vapor cartridges[2] or gas mask (canister respirator).[2] Any powered air-purifying respirator equipped with a tight-fitting facepiece (half or full facepiece) and appropriate gas/vapor cartridges or canisters.[2] Any negative pressure (demand) supplied-air respirator equipped with a full facepiece. Any continuous flow supplied-air respirator equipped with a tight-fitting facepiece (half or full facepiece). Any negative pressure (demand) self-contained respirator equipped with a full facepiece.
1,000	Any pressure-demand supplied-air respirator equipped with a half-mask.

1 The protection offered by a given respirator is contingent upon (1) the respirator user adhering to complete program requirements (such as the ones required by OSHA in 29CFR1910.134), (2) the use of NIOSH-certified respirators in their approved configuration, and (3) individual fit testing to rule out those respirators that cannot achieve a good fit on individual workers.

2 Select a cartridge/canister certified to be used for the specific class of chemicals or the specific gas/vapor found in your workplace.

Table 2. Gas/Vapor Respirators

Assigned protection factor[1]	Type of respirator
2,000	Any pressure-demand supplied-air respirator equipped with a full facepiece.
10,000	Any pressure-demand self-contained respirator equipped with a full facepiece. Any pressure-demand supplied-air respirator equipped with a full facepiece in combination with an auxiliary pressure-demand self-contained breathing apparatus.

1 The protection offered by a given respirator is contingent upon (1) the respirator user adhering to complete program requirements (such as the ones required by OSHA in 29CFR1910.134), (2) the use of NIOSH-certified respirators in their approved configuration, and (3) individual fit testing to rule out those respirators that cannot achieve a good fit on individual workers.

Table 3. Combination Gas/Vapor & Particulate Respirators

Assigned protection factor[1]	Type of respirator
10	Any air-purifying half-mask respirator equipped with appropriate gas/vapor cartridges[2] in combination with appropriate type of particulate filter.[3] Any full facepiece respirator with appropriate gas/vapor cartridges[2] in combination with appropriate type of particulate filter.[3] Any negative pressure (demand) supplied-air respirator equipped with a half-mask.
25	Any powered air-purifying respirator with a loose-fitting hood or helmet that is equipped with an appropriate gas/vapor cartridge[2] in combination with a high-efficiency particulate filter . Any continuous flow supplied-air respirator equipped with a hood or helmet.
50	Any air-purifying full facepiece respirator equipped with appropriate gas/vapor cartridges[2] in combination with an N-100, R-100 or P-100 filter or an appropriate canister[2] incorporating an N-100, P-100 or R-100 filter. Any powered air-purifying respirator with a tight-fitting facepiece (half or full facepiece) equipped with appropriate gas/vapor cartridges[2] in combination with a high-efficiency filter or an appropriate canister[2] incorporating a high-efficiency filter. Any negative pressure (demand) supplied-air respirator equipped with a full facepiece. Any continuous flow supplied-air respirator equipped with a tight-fitting facepiece (half or full facepiece). Any negative pressure (demand) self-contained respirator equipped with a full facepiece.

1 The protection offered by a given respirator is contingent upon (1) the respirator user adhering to complete program requirements (such as the ones required by OSHA in 29CFR1910.134), (2) the use of NIOSH-certified respirators in their approved configuration, and (3) individual fit testing to rule out those respirators that cannot achieve a good fit on individual workers.

2 Select a cartridge/canister certified to be used for the specific class of chemicals or the specific gas/vapor found in your workplace.

3 Appropriate means that the filter medium will provide protection against the particulate in question. See step 9.2 for information on the presence or absence of oil particulates.

Table 3. Combination Gas/Vapor and Particulate Respirators Continued

Assigned protection factor[1]	Type of respirator
1,000	Any pressure-demand supplied-air respirator equipped with a half-mask.
2,000	Any pressure-demand supplied-air respirator equipped with a full facepiece.
10,000	Any pressure-demand self-contained respirator equipped with a full facepiece. Any pressure-demand supplied-air respirator equipped with a full facepiece in combination with an auxiliary pressure-demand self-contained breathing apparatus.

1 The protection offered by a given respirator is contingent upon (1) the respirator user adhering to complete program requirements (such as the ones required by OSHA in 29CFR1910.134), (2) the use of NIOSH-certified respirators in their approved configuration, and (3) individual fit testing to rule out those respirators that cannot achieve a good fit on individual workers.

IV. Escape Respirators

Escape devices have a single function: to allow a person working in a normally safe environment sufficient time to escape from suddenly occurring respiratory hazards. Given this function, selection does not rely on assigned protection factors. Instead, these respirators are selected based on a consideration of the time needed to escape, and the likelihood of IDLH or oxygen deficiency conditions. Escape devices can be separated into two categories: air-purifying respirators and self-contained breathing apparatus.

Air-purifying respirators remove contaminants from the air by sorbent and/or filter media, but because they do not provide air, these respirators cannot be used in an oxygen-deficient atmosphere. Escape capabilities of air purifying respirators can be summarized as follows:

- Air-purifying respirators with particulate filters or chemical cartridges are approved for escape from atmospheres containing specific contaminants in concentrations that are not immediately dangerous to life or health (IDLH) and oxygen content of at least 19.5% by volume. This includes half and full facepiece respirators that are routinely used in many work environments. Mouthpiece-type cartridge respirators (TC-23C) are approved for escape only.
- Air-purifying respirators with canisters (TC-14G) include the escape gas mask (canister) respirator, the gas mask (canister) respirator, and the filter self-rescuer.

The escape gas mask consists of a half-mask or a mouthpiece respirator. The mouthpiece respirator can be used for short periods of time to escape from low concentrations of organic vapor or acid gas. The escape gas mask, which utilizes a half-mask, filters contaminants from the air. These respirators may also be used to escape from low concentrations of organic vapor or acid gas, but not from oxygen deficient atmospheres. Escape gas mask respirators equipped with full facepieces can also be used for escape from IDLH conditions but not from oxygen-deficient atmospheres. These respirators may be used for escape from contaminant concentrations above the IDLH value provided that the maximum use concentration (MUC) for the canister is not exceeded and adequate oxygen (≥19.5%) is present. Note that not all gas masks provide protection against carbon monoxide (CO). Check the certification to determine if the respirator is specifically certified for use against levels of CO that exceed the exposure limit. Gas masks with full facepieces are also acceptable for routine use in *non*-IDLH atmospheres. Gas masks with mouthpieces are for escape only. **No air-purifying device is suitable for escape from a potentially oxygen-deficient atmosphere.** The filter self-rescuer unit is the mouthpiece device, which is designed to protect specifically against atmospheres with not more than 1% carbon monoxide. The filter self- rescuer is normally used in mining.

A new type of air-purifying escape hood that fits over the head and seals at the neck has been developed specifically for escape from chemical, biological, nuclear, or radiological exposures associated with terrorism events. This type is not discussed further here as terrorism-related selection is beyond the scope of this document. See http://www.cdc.gov/niosh/npptl/interesc0404.html for additional information

A self-contained breathing apparatus (SCBA) provides air to the user for escape from oxygen-deficient environments. Escape SCBA devices are commonly used with full facepieces or hoods and, depending on the supply of air, are usually rated as 3- to 60-minute units.

Self-contained self-rescuer (SCSR) devices have been approved by MSHA/NIOSH for escape from mines, but these devices may also have application in other similar environments. SCSRs are mouthpiece respirators that provide a source of oxygen-enriched air for up to 60 minutes. SCSRs are normally stored in mines and used for emergency escape from mine disasters. All SCBA devices can be used in oxygen-deficient atmospheres.

When selecting escape apparatus, careful consideration must be given to potential eye irritation. This consideration is important for determining whether a gas mask or SCBA equipped with a full facepiece should be selected rather than a device equipped with a half-mask or mouthpiece.

The majority of gas masks or escape gas masks can be used in situations involving gases, vapors, or particulates. For escape from particulate-contaminated environments, an air-purifying element must be selected that will provide protection against the given type of particulate.

In addition to contaminants and concentration levels, the time to escape the hazard must be considered. For example, escape SCBA can have rated service lives of 3 to 60 minutes.

NIOSH intends to review the selection criteria for escape respirators and will provide additional guidance in future revisions of the RSL.

V. Additional Information on Hazards and Exposures

The following subparagraphs provide additional information to assist the reader in using the Respirator Selection Logic Sequence:

Subparagraph 1: Oxygen-Deficient Atmosphere

NIOSH defines an oxygen-deficient atmosphere as any atmosphere containing oxygen at a concentration below 19.5% at sea level. NIOSH certification of supplied-air or air-purifying respirators is limited to those respirators used in atmospheres containing at least 19.5% oxygen, except for those supplied-air respirators equipped with auxiliary self-contained breathing apparatus (SCBA).

The minimum requirement of 19.5% oxygen at sea level provides an adequate amount of oxygen for most work assignments and includes a safety factor. The safety factor is needed because oxygen-deficient atmospheres offer little warning of the danger, and the continuous measurement of an oxygen-deficient atmosphere is difficult.

At oxygen concentrations below 16% at sea level, decreased mental effectiveness, visual acuity, and muscular coordination occur. At oxygen concentrations below 10%, loss of consciousness may occur, and below 6% oxygen, death will result. Often only mild subjective changes are noted by individuals exposed to low concentrations of oxygen, and collapse can occur without warning.

Since oxygen-deficient atmospheres are life-threatening, only the most reliable respirators are recommended; the most reliable respirators are the self-contained breathing apparatus or the supplied-air respirators with auxiliary self-contained units. Because a high protection factor is not necessary to ensure an adequate supply of oxygen even in an atmosphere containing no oxygen, any certified self-contained unit is adequate. All aspects of a respiratory protection program must be instituted for these recommendations to be valid.

Subparagraph 2: Exposure Limits

The legal, enforceable exposure limit is the permissible exposure limit (PEL) set by OSHA. NIOSH develops recommended exposure limits (RELs) for hazardous substances. To formulate these recommendations, NIOSH evaluates all known available medical, biological and engineering, chemical trade, and other information relevant to the hazard. Other exposure limits that can be considered in making respirator selections

include State-OSHA exposure limits (e.g., California), ACGIH TLVs, AIHA WEELs, corporate exposure limits, etc. The effectiveness of this RSL is limited to the adequacy of the selected exposure limits in protecting the health of workers. Exposure limits based on a thorough evaluation of more recent or extensive data should be given priority.

For all chemicals that cause irritation or systemic effects but do not cause carcinogenic effects, it is currently believed that a threshold exposure concentration exists such that virtually all persons in the working population (with the possible exception of hypersensitive individuals) would experience no adverse health effects.

Other variables such as the specific situation, worker, or job may influence the selection of the appropriate exposure limit for a given contaminant. For example, the effects of some hazardous substances may be increased due to exposure to other contaminants present in the workplace or the general environment or to medications or personal habits of the worker. Such factors, which would affect the toxicity of a contaminant, would not have been considered in the determination of the specific exposure limit. Also, some substances are absorbed by direct contact with the skin and mucous membranes, thus potentially increasing the total exposure.

Subparagraph 3: Immediately Dangerous to Life or Health (IDLH)

An IDLH exposure condition is one that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment. The purpose of establishing an IDLH exposure level is to ensure that the worker can escape from a given contaminated environment in the event of failure of the respiratory protection equipment. The IDLH is considered a maximum level above which only a highly reliable breathing apparatus providing maximum worker protection is permitted. Any appropriate approved respirator may be used to its maximum use concentration up to the IDLH concentration.

In establishing the IDLH concentration, the following conditions must be assured:

a. The ability to escape without loss of life or immediate or delayed irreversible health effects. (Thirty minutes is considered the maximum time for escape so as to provide some margin of safety in calculating the IDLH.)

b. The prevention of severe eye or respiratory irritation or other reactions that would hinder escape.

Sources of information for determining whether the exposure limit for a contaminant represents an IDLH condition are as follows:

a. Specific IDLH guidelines provided in the literature such as the NIOSH Pocket Guide for Hazardous Chemical Substances (http://www.cdc.gov/niosh/npg/npg.html) and

the American Industrial Hygiene Association (AIHA) Hygienic Guides.

b. Human exposure and effects data, and/or

c. Animal exposure and effects data, and/or

d. Where such data specific to the contaminant are lacking, toxicologic data from analogous substances and chronic animal exposure data may be considered.

Subparagraph 4: Eye Irritation

Eye protection in the form of respirators with full facepieces, helmets, or hoods is required for routine exposures to airborne contaminants that cause any irritation to the mucous membranes of the conjunctivae or the cornea or cause any reflex tearing. Eye protection is required for contaminants that cause minor subjective effects as well as for those that cause any damage, including disintegration and sloughing of conjunctival or corneal epithelium, edema, or ulceration. NIOSH is not aware of any standards for gas-tight goggles that would permit NIOSH to recommend such goggles as providing adequate eye protection.

For escape, some eye irritation is permissible if the severity of irritation does not inhibit the escape and if no irreversible scarring or ulceration of the eyes or conjunctivae is likely.

When data on threshold levels for eye irritation are insufficient, quarter or half-mask respirators can be used, provided that the worker experiences no eye discomfort and no pathologic eye effects develop. Workers should be told that if any eye discomfort is experienced, they will be provided with respirators that have full facepieces, helmets, or hoods and that provide protection equivalent to the quarter- or half-mask respirators.

VI. Glossary of Respiratory Protection Terms

The following definitions are important terms used in the respiratory protection standard and terms that will assist in the understanding and the application of the NIOSH decision logic.

Air-Purifying Respirator: A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

Assigned Protection Factor (APF): The minimum anticipated protection provided by a properly functioning respirator or class of respirators to a given percentage of properly fitted and trained users.

Atmosphere-Supplying Respirator: A respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

Auxiliary SCBA: An auxiliary unit means that the SAR unit includes a separate air bottle to provide a reserve source of air should the airline become damaged. The auxiliary unit shares the same mask and regulator, and enables the SAR to function as an SCBA if needed.

Breakthrough: The penetration of challenge material(s) through a gas or a vapor air-purifying element. The quantity or extent of breakthrough during service life testing is often referred to as the percentage of the input concentration.

Canister or Cartridge: A container with a filter, sorbent, or catalyst, or combination of these items, which removes specific contaminants from the air passed through the container.

Continuous Flow: A respirator that maintains air flow at all times, rather than only on demand. However, it may not maintain positive pressure within the mask at all times. Negative pressure conditions may occur during inhalation involving strenuous activity.

Demand Respirator: A respirator in which the pressure inside the facepiece in relation to the immediate environment is positive during exhalation and negative during inhalation.

Disposable Respirators: A respirator that is discarded after the end of its recommended period of use, after excessive resistance or physical damage, or when odor breakthrough or other warning indicators render the respirator unsuitable for further use.

Emergency Respirator Use Situation: A situation that requires the use of respirators due to the unplanned generation of a hazardous atmosphere (often of unknown composition) caused by an accident, mechanical failure, or other means and that requires evacuation of personnel or immediate entry for rescue or corrective action.

Employee Exposure: Exposure to a concentration of an airborne contaminant that would occur if the employee were not using respiratory protection.

End-Of-Service-Life Indicator (ESLI): A system that warns the respirator user of the approach of the end of adequate respiratory protection; for example, that the sorbent is approaching saturation or is no longer effective.

Escape Gas Mask: A gas mask that consists of a half-mask facepiece or mouthpiece, a canister, and associated connections, and that is designed for use during escape-only from hazardous atmospheres.

Escape Only Respirator: Respiratory devices that are designed for use only during escape from hazardous atmospheres.

Filter or Air-Purifying Element: A component used in respirators to remove solid or liquid aerosols from the inspired air.

Filtering Facepiece: A particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

Fit Factor: A quantitative measure of the fit of a specific respirator facepiece to a particular individual.

Fit Test: Means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual. (See also Qualitative fit test QLFT and Quantitative fit test QNFT.)

Gas: An aeriform fluid that is in a gaseous state at standard temperature and pressure.

Hazard ratio: A number obtained by dividing the concentration of a contaminant by its exposure limit.

High-Efficiency Particulate Air (HEPA) Filter: A filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.

Hood or Helmet: is a respirator component which covers the wearer's head and neck, or head, neck, and shoulders, and is supplied with incoming respirable air for the wearer to breathe. It may include a headharness and connection for a breathing tube.

Immediately Dangerous to Life or Health (IDLH): 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. (See subparagraph 3 on page 20 for more information on IDLH conditions).

Interior Structural Firefighting: The physical activity of fire suppression, rescue or both, inside of buildings or enclosed structures which are involved in a fire situation beyond the incipient stage.

Maximum Use Concentration (MUC): Maximum use concentration (MUC) means the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator, and is determined by the assigned protection factor of the respirator or class of respirators and the exposure limit of the hazardous substance. The MUC usually can be determined mathematically by multiplying the assigned protection factor specified for a respirator by the NIOSH recommended exposure limit (REL), permissible exposure limit, short term exposure limit, ceiling limit, peak limit, or any other exposure limit used for the hazardous substance.

Mist: A liquid condensation particulate.

Negative Pressure Respirator : A tight-fitting respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Orinasal Respirator*:* A respirator that covers the nose and mouth and that generally consists of a quarter- or half-facepiece.

Oxygen Deficient Atmosphere: An atmosphere which contains an oxygen partial pressure of less than 148 millimeters of mercury (19.5 percent by volume at sea level).

Physician or Other Licensed Health Care Professional (PLHCP): Means an individual whose legally permitted scope of practice (i.e., license, registration, or certification) allows him or her to independently provide, or be delegated the responsibility to provide, some or all of the health care services required for medical evaluation to wear a respirator.

Planned or Unplanned Entry into an IDLH Environment, an Environment of Unknown Concentration of Hazardous Contaminant, or an Environment of Unknown Composition: A situation in which respiratory devices are recommended to provide adequate protection to workers entering an area where the contaminant concentration is above the IDLH or is unknown.

Potential Occupational Carcinogen: Any substance, or combination or mixture of substances, which causes an increased incidence of benign and/or malignant neoplasms, or a substantial decrease in the latency period between exposure and onset of neoplasms in humans or in one or more experimental mammalian species as the result of any oral, respiratory, or dermal exposure, or any other exposure which results in the induction of tumors at a site other than the site of administration. This definition also includes any substance that is metabolized into one or more potential occupational carcinogens by mammals (29 CFR 1990.103, OSHA Cancer Policy).

Powered Air-Purifying Respirator (PAPR): Means a device equipped with a facepiece,

hood, or helmet, breathing tube, canister, cartridge, filter, canister with filter, or cartridge with filter, and a blower.

Pressure Demand Respirator: A respirator in which the pressure inside the facepiece in relation to the immediate environment is positive during both inhalation and exhalation.

Qualitative Fit Test (QLFT): A pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

Quantitative Fit Test (QNFT): Means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

Recommended Exposure Limit (REL): An 8- or 10-hour time-weighted average (TWA) or ceiling (C) exposure concentration recommended by NIOSH that is based on an evaluation of the health effects data.

Respirator: Means any device designed to provide the wearer with respiratory protection against inhalation of a hazardous atmosphere.

Respirator Program Administrator: The person responsible for all aspects of the respirator program with full authority to make decisions to ensure its success. The administrator must have sufficient knowledge (obtained by training or experience) to develop and implement the program. Preferably, he/she should have a background in industrial hygiene, safety, health care or engineering.

Respiratory Inlet Covering: The portion of a respirator that forms the protective barrier between the user's respiratory tract and an air-purifying device or breathing air source, or both. It may be a facepiece, a helmet, a hood, a suit, or a mouthpiece respirator with nose clamp.

Self-Contained Breathing Apparatus (SCBA): An atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

Service Life: The length of time required for an air-purifying element to reach a specific effluent concentration. Service life is determined by the type of substance being removed, the concentration of the substance, the ambient temperature, the specific element being tested (cartridge or canister), the flow rate resistance, and the selected breakthrough value. The service life for a self-contained breathing apparatus (SCBA) is the period of time, as determined by the NIOSH certification tests, in which adequate breathing gas is supplied.

Simulated Workplace Protection Factor (SWPF): A surrogate measure of the workplace protection provided by a respirator.

Supplied-Air Respirator (SAR) or Airline Respirator: An atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

Tight-Fitting Facepiece: A respiratory inlet covering that forms a complete seal with the

face.

User Seal Check: An action conducted by the respirator user to determine if the respirator is properly seated to the face.

Vapor: The gaseous state of a substance that is solid or liquid at temperatures and pressures normally encountered.

Workplace Protection Factor (WPF): A measure of the protection provided in the workplace by a properly functioning respirator when correctly worn and used.

Appendix

NIOSH Respirator Use Policy
Approved: August 4, 1999

Background. OSHA's new respiratory protection standard, 29 CFR 1910.134, became effective on April 8, 1998, with complete compliance required by October 5, 1998. The new regulation is an upgrade in many ways and is a significant advance for respirator wearers. The NIOSH Respirator Use Policy (RUP) Workgroup has carefully reviewed the new regulation and determined that it is generally consistent with previous NIOSH policy. The Workgroup identified only five differences between the previous NIOSH policy and the new 1910.134. The Workgroup reviewed these differences to determine if it would be appropriate for NIOSH to modify its policies to be in harmony with OSHA. The consistency between NIOSH and OSHA that would result from such harmonization was considered an advantage to respirator users in that it would tend to minimize confusion in the workplace. At the same time, the Workgroup recognized that the rulemaking process placed restrictions on OSHA that do not apply to NIOSH in making its public health recommendations.

NIOSH Respirator Policy Statement:

NIOSH endorses all provisions of OSHA's 29 CFR Part 1910.134, as published on January 8, 1998, except that NIOSH does not recommend (a) the use of irritant smoke for qualitative respirator fit testing, or (b) unsupervised medical evaluations conducted by health care professionals who are not licensed for independent practice to perform or supervise medical evaluations.

Discussion. Both NIOSH policy and the new OSHA regulation are in fundamental agreement that the primary means to prevent occupational diseases caused by breathing contaminated air is through the use of feasible engineering controls such as enclosures, confinement of operations, ventilation, or substitution with less toxic materials. Only when effective engineering controls are not feasible, or while they are being installed or maintained, should respirators be utilized as the primary means of worker protection.

The differences between the previous NIOSH respirator use recommendations and OSHA's 1910.134 are discussed below along with the basis of the new NIOSH recommendations.

1. Change Schedules. Chemical-cartridge respirators typically use activated charcoal as a sorbent to filter toxic gases and vapors. They are essentially 100% efficient filters until the gas or vapor "breaks through." To use these respirators safely, the user must have some way of knowing when "breakthrough" has occurred and the chemical cartridge has to be replaced. This breakthrough can be identified in three ways. First, if the substance has good warning properties (smell, taste, irritation), the wearer detects breakthrough and knows to replace the cartridge (or canister). Second, an end-of-service-life-indicator (ESLI) for the specific gas or vapor of concern signals the wearer to replace the cartridge. Third, a cartridge "change schedule" is established to assure the cartridge is replaced well before breakthrough occurs. These change schedules must be specific for each workplace situation because the service life of a cartridge depends on many variables including: the contaminant concentration, humidity, temperature, interference from other gases and vapors, patterns of use (continuous or intermittent), and characteristics of each respirator model. Previously, OSHA and NIOSH recognized only the first two methods. The new 1910.134 now recognizes only the second and third (ESLIs and change schedules) and no longer recognizes the first (warning properties). Based on the recommendations of the RUP Workgroup, NIOSH has updated its policy to be consistent with OSHA by recognizing the use of change schedules and by recommending against reliance on warning properties.

Developing cartridge change schedules is a new exercise for most respirator users; because standard approaches to setting a change schedule have not been developed and validated, there is uncertainty about their efficacy. Endorsing the use of cartridge change schedules is done with the full knowledge of the uncertainty and problems associated with this approach. It is believed, however, that the uncertainties of change schedules present less of a public health problem than would the continued reliance on warning properties. Further, the new OSHA regulation will likely, over time, cause the development of improved methods of establishing cartridge change schedules. However, there is the possibility that some employers may develop and follow inadequate change schedules that can result in chronic overexposure. Research to develop and validate clear and practical methods for employers to establish change schedules is, therefore, critically needed.

Reliance on warning properties has long been recognized as problematic. The 1987 NIOSH Respirator Decision Logic described the typical wide variation of odor threshold in the general population (greater than two orders of magnitude). The recommendation made in that publication was for "screening tests for workers who wear air-purifying gas or vapor respirators to determine their ability to detect the odor below the exposure limit for that gas or vapor." However,

NIOSH does not know of any employer who has tried to do this screening nor any established procedures for doing this screening. Even if screening were performed, other problems would remain: shift in odor threshold due to extended low exposures, shifts due to simple colds and other illnesses, failure to recognize odor because of distraction of the workplace competing for worker attention, and inaccuracies in the screening test itself.

Of the five differences between NIOSH and OSHA, this is the only one where following the previous NIOSH recommendation would preclude following the OSHA regulation and would therefore be in violation of OSHA's regulations.

2. Irritant Smoke Fit Testing. This qualitative respirator fit test is conducted by directing the smoke stream from ventilation smoke tubes (intended to study building ventilation systems) at the respirator face seal. An inadequate face seal is indicated by an involuntary reaction (coughing or gagging) of the worker. The involuntary nature of the reaction is the reason many prefer this test over other qualitative fit tests.

NIOSH, in its formal comments to OSHA on the proposed revision of 29 CFR 1910, 1915, and 1926, strongly recommended against the use of this fit test method because of the health risk associated with exposure to the irritant smoke. That recommendation was primarily based on studies conducted as part of a NIOSH HHE (HETA 93-040-2315) and described in Appendix A of the NIOSH comments to OSHA dated May 15, 1995 (docket H-049). NIOSH continues to recommend against the use of irritant smoke fit testing for these same reasons.

A person's involuntary reaction after breathing irritant smoke is caused by a white hydrochloric acid fume produced by ventilation smoke tubes containing stannic chloride. Hydrogen chloride is immediately irritating at air concentrations of 5 parts per million (ppm) or more. Therefore, the NIOSH recommended exposure limit, the OSHA permissible exposure limit, and the ACGIH TLV® for hydrogen chloride are all ceiling limits of 5 ppm. (A ceiling limit is an air concentration that should not be exceeded during any part of a workday.) Air sampling has shown that ventilation smoke tubes can produce highly variable and unpredictable hydrogen chloride concentrations far exceeding 5 ppm. The NIOSH HHE included measurements of the hydrogen chloride concentrations emitted from smoke tubes measured at a distance of 12 inches from the

tube and generated from a single squeeze of an aspirator bulb. These concentrations ranged from near the ceiling limit (1 ppm, 4 ppm, and 9 ppm) in a room with low relative humidity to 100 times the ceiling limit (460 ppm, 520 ppm, and 1700 ppm) in a room with high relative humidity.

NIOSH reviewed the revised protocol for the irritant smoke test in OSHA's final respiratory protection standard and concluded that a risk still exists for overexposure to hydrogen chloride during a facepiece fit test. To check their sensitivity, test subjects are required to breathe irritant smoke both before and after a successful fit test. Generated concentrations to which test subjects are subjected are not measured in the test protocol. A concentration of 5 ppm is the accepted threshold level at which a response is evoked from most persons. A fit test is a failure when a test subject experiences an involuntary cough or irritation. Retesting requires repeating the sensitivity check. In each case, the responses of coughing and irritation are the adverse health effects for which hydrogen chloride's exposure limits are intended to protect against. Consequently, NIOSH maintains its recommendation against the use of irritant smoke as a fit testing agent.

3. Saccharin qualitative fit testing. This test is conducted with an inexpensive, commercially available kit that challenges the respirator wearer with a sweet tasting saccharin aerosol. After previously having been screened to assure that he/she can taste saccharin at the required concentration, the respirator wearer is asked to report if saccharin is tasted during fit testing. If so, the respirator is considered to have an inadequate fit and fails the fit test.

NIOSH has previously recommended against the saccharin fit test because of its classification as a potential carcinogen [NTP 1981; IARC 1987; Niemeier 1991]. However, NIOSH recently re-examined the potential risk to workers that would be posed by saccharin used in fit testing [NIOSH 1999]. Finding that the risk to workers from use of saccharin in respirator fit testing is extremely small and may be zero, and in accordance with the new REL policy [NIOSH 1995], NIOSH recommends both saccharin or Bitrex® for use in qualitative respirator fit testing, consistent with OSHA’s respiratory protection standard (29 CFR 1910.134).

NIOSH intends to include the saccharin fit test in its ongoing research program to assess the efficacy of fit test methods in general. That is, NIOSH plans to evaluate the ability of the saccharin fit test to identify those individuals who will achieve a fit sufficient to assure adequate protection when the respirator is worn in the workplace. NIOSH researchers have conducted, and are conducting, such studies of a variety of fit test methods.

4. Voluntary Respirator Use. Previously, NIOSH recommended, and OSHA required, a full-blown respirator program whenever a respirator was used. Thus, for example, employees having a workplace exposure below the exposure limit but wanting to further reduce their exposure with voluntary respirator use could not do so unless the employer implemented a complete respirator program with all its elements (fit testing, written program, medical evaluation, record keeping,

etc.). This tended to discourage the use of respirators to further reduce exposure to levels well below maximum exposure limits.

The new OSHA regulations require a complete respirator program whenever respirator use is required by the employer. However, when respirators are used voluntarily by employees, the employer needs only to establish those respirator program elements necessary to assure the respirator itself is not a hazard. The exception is that filtering facepiece respirators can be used without any respirator program when used voluntarily. Although there are no known studies of such voluntary respirator use, NIOSH supports OSHA's voluntary use provisions because they provide safe ways not previously available to use respirators to reduce exposure well below established exposure limits.

5. Medical Evaluation Responsible Person. The previous OSHA 1910.134 stated: "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 new 1910.134 states: "The employer shall identify a physician or other licensed health care professional (PLHCP) to perform medial evaluations...." In the definitions section, OSHA states: Physician or other licensed health care professional (PLHCP) means an individual whose legally permitted scope of practice (i.e., license, registration, or certification) allows him or her to independently provide, or be delegated the responsibility to provide, some or all of the health care services required by paragraph (e) of this section."

Thus the new OSHA regulation allows a non-physician, under certain conditions, to be the responsible person who determines medical fitness to wear a respirator. However, the definition in 1910.134(b) of a "physician or other licensed health care professional" does not limit the non-physician responsible person to those who are licensed for independent practice in all the health care services required by 1910.134(e). NIOSH recommends that the only non-physicians responsible for medical surveillance and medical clearance (either conducting the examinations or supervising them) should be nurse practitioners and physician assistants in those states where they are licensed for independent practice.

signed:\ Linda Rosenstock, M.D., M.P.H. August 4, 1999

Director, NIOSH Date

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