



AMERICAN NATIONAL STANDARD

ANSI/ASSE Z88.2 – 2015
American National Standard
Practices for Respiratory Protection

ANSI/ASSE Z88.2 – 2015



AMERICAN SOCIETY OF
SAFETY ENGINEERS

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ANSI/ASSE Z88.2 – 2015

American National Standard

Practices for Respiratory Protection

Secretariat

American Society of Safety Engineers
520 N. Northwest Highway
Park Ridge, Illinois 60068

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American National Standard

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Foreword (This Foreword is not a part of American National Standard Z88.2-2015.)

The purpose of this standard is to help establish, implement and administer an effective respirator program.

Due to the withdrawal of the 1992 version of this standard by ANSI in 2002, this standard is viewed as a new standard rather than the fourth version. The American National Standard, *Practices for Respiratory Protection*, Z88.2-2015 was substantially delayed due to professional disagreements over appropriate assigned protection factors (APFs) for air-purifying half mask respirators and the associated drawn out appeals processes. On December 10, 2010, the ANSI Board of Standards Review Panel denied the final appeal and recommended the review process be started with a new subcommittee. The Z88 committee established a new Z88.2 subcommittee, and directed it to start with the existing draft Z88.2 standard. During the production of this standard, the Occupational Safety and Health Administration (OSHA) revised its Respiratory Protection standard to add definitions and requirements for APFs and Maximum Use Concentrations (MUCs). (See 63 FR 1152; 29 CFR 1910.134; 71 FR 50122, August 24, 2006). OSHA established APFs after thoroughly reviewing available literature, including workplace protection factor studies, comments submitted to the record and hearing testimony. APFs provide employers with critical information to use when selecting respirators for employees exposed to atmospheric contaminants found in industry. Proper respirator selection is an important component of an effective respiratory protection program. Accordingly, the OSHA APFs are necessary to protect employees who must use respirators to protect them from airborne contaminants. [See OSHA Guide, Assigned Protection Factors for the Revised Respiratory Protection Standard, Occupational Safety and Health Administration, U.S. Department of Labor, OSHA 3352-02, 2009].

In addition to OSHA rulemaking on APFs, OSHA also updated Appendix A to §1910.134: Fit Testing Procedures (Mandatory) [63 FR 20098, April 23, 1998; 69 FR 46993, August 4, 2004], and ANSI published the American National Standard, ANSI/AIHA Z88.10-2010 Respirator Fit Testing Methods, approved on December 3, 2010. These rules and standards thoroughly address the topics of APFs and fit testing. Additionally, the Z88 Committee approved the establishment of a Respirator APF Subcommittee, Z88.15, on July 23, 2008. Thus, this Z88.2 standard does not contain details on these topics, but does provide reference to the appropriate OSHA regulations and ANSI/AIHA Z88.10-2010.

This revision of the Z88.2 standard has also updated sections on oxygen deficiency (including an easy to use table indicating what types of respirators are required to work safely in increasingly dangerous oxygen-deficient environments), respirator selection, use of emergency respirators and respirator audits. Also added are new annexes on classification of and considerations for selection and use of respirators, establishing cartridge/canister change schedules, required fit factor value for respirator fit testing, calculating effective protection factors, compliance with compressed air dew point requirements, compressed breathing air equipment and systems and designations of positive-pressure respirators.

The first version of ANSI Z88.2 was approved August 11, 1969 and was a revision of the respiratory protection portion of American National Standard safety code for head, eye and respiratory protection, ASA Z2.1-1959. The second revision of this standard, ANSI Z88.2-1980, entitled American National Standard Practices for Respiratory Protection was approved on May 22, 1980. The third version of this standard, American National Standard for Respiratory Protection, ANSI Z88.2-1992, was approved August 6, 1992.

Revisions: The Z88 Committee welcomes proposals for revisions to this standard. Revisions are made to the standard periodically (usually five years from the date of the standard) to incorporate changes that appear necessary or desirable, as demonstrated by experience gained from the application of the standard. Proposals should be as specific as possible, citing the relevant section number(s), the proposed wording and the reason for the proposal. Pertinent documentation would enable the Z88 Committee to process the changes in a more-timely manner.

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No one but the Z88 Committee (through the Z88 Secretariat) is authorized to provide any interpretation of this standard.

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Appendices/Addenda: Appendices are included in most standards to provide the user with additional information related to the subject of the standard. Appendices are not part of the approved standard.

Committee Meetings: The Z88 Committee meets periodically. Persons wishing to attend a meeting should contact the Secretariat for information.

Standard Approval: This standard was processed and approved for submittal to ANSI by the American National Standards Committee on Respiratory Protection, Z88. Approval of the standard does not necessarily imply (nor is it required) that all committee members voted for its approval. At the time ANSI approved this standard, the Z88 Committee had the following members:

James S. Johnson, Ph.D., CIH, QEP, Chair
Jonathan Szalajda, MSCE, MSIE, Vice Chair
Timothy R. Fisher, CSP, CHMM, ARM, CPEA, Secretary
Jennie Dalesandro, Administrative Technical Support

Organization Represented

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Consolidated Edison of New York
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International Association of Fire Fighters

Name of Representative

Craig Colton, CIH
Geoffrey Betsinger, CIH
Michael Schmoldt, P.E., CIH, CHMM, CPEA

Richard Harley, CSP
Stephen Hedrick
Mark Haskew, CIH, CSP
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Jeffrey Birkner, Ph.D., CIH
Cristine Fargo
Earl Gee
Sander Perle
Bruce Dicey
James S. Johnson, Ph.D., CIH, QEP
Ching-tsen Bien, CIH, P.E.

Roland BerryAnn
MaryAnn D'Alessandro
Richard Metzler, MSIE
Goran Berndtsson
Marty Lorkowski
Stephan Graham, CIH, CSP
Alice Weber
David Weitzman, CIH
Joel Rabovsky
John Steelnack
David Spelce, MS, CIH
Roger Pedersen
Roy T. McKay, Ph.D.
Sarunas S. Mingela, Ph.D., CIH, ROH,
CSP, CRSP, CHMM, CEP

Corresponding (non-voting) members:

Timothy E. Roberts, CIH, CSP
George Gruetzmacher, Ph.D., CIH, P.E.

Subgroup Z88.2 had the following members:

Richard W. Metzler, MSIE (Chair)
Geoffrey Betsinger, CIH
Ching-tsen Bien, CIH, P.E.
Jeffrey Birkner, Ph.D., CIH
Craig Colton, CIH
James S. Johnson, Ph.D., CIH, QEP
Marty Lorkowski
Roy McKay, Ph.D.
Bill Newcomb
Tim Rehak
Irene Richardson
Tim Roberts, CIH, CSP
Natalia Stakhiv
John Steelnack
David Spelce, MS, CIH
William Thomas, CIH, CHP

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AMERICAN NATIONAL STANDARD Z88.2 PRACTICES FOR RESPIRATORY PROTECTION

1. SCOPE AND PURPOSE

1.1 Scope. This standard sets forth minimally accepted practices for occupational respirator use; provides information and guidance on the proper selection, use and maintenance of respirators and contains requirements for establishing, implementing and evaluating respirator programs. The standard covers the use of respirators to protect persons against the inhalation of harmful air contaminants and against oxygen-deficient atmospheres in the workplace. The following are not covered by this standard:

- a) underwater breathing devices;
- b) aircraft oxygen systems;
- c) supplied-air suits;
- d) use of respirators under military combat conditions, and
- e) medical inhalators and resuscitators.

1.2 Purpose. The purpose of this standard is to provide information and guidance on the proper selection, use and maintenance of respirators, which will help safeguard the life and health of respirator wearers. This standard is written for all persons concerned with respiratory protection, but especially for those primarily responsible for establishing and administering an acceptable respirator program. The standard contains requirements recommended for enforcement authorities in establishing regulations or codes for respiratory protection use.

1.3 Exceptions. Users of this standard shall be aware that regulatory agencies may have requirements that are different from this standard.

2. NORMATIVE REFERENCES

The following standards contain provisions that, through reference in this text, constitute provisions of this American National

Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI Z88.6-2006, *Respiratory Protection - Respirator Use - Physical Qualifications for Personnel*

ANSI Z88.10-2010, *Respirator Fit Test Methods*

CGA C-7-2011, *Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers*

CGA G-7.1-2011, *Commodity Specification for Air*

Code of Federal Regulations, Title 49, Part 180, *Continuing Qualification and Maintenance of Packaging*

United States Pharmacopoeia, 2009

National Fire Protection Association (NFPA) 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2014 Edition

National Fire Protection Association (NFPA) 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, 2013 Edition

3. DEFINITIONS

3.1 Abrasive Blasting Respirator. An airline respirator designed to protect the wearer from inhalation of, impact of and abrasion by materials used or generated in abrasive blasting.

3.2 Aerodynamic Diameter. The diameter of a unit density sphere having the same terminal settling velocity as the particle in question.

3.3 Aerosol. Particles, solid or liquid, suspended in air (e.g., dust, fumes, mists or fibers).

3.4 Airline Respirator (Supplied-Air Respirator – SAR). An atmosphere-supplying respirator in which the respirable air is supplied from a hose or breathing tube, rather than being carried by the wearer.

3.5 Air-Purifying Respirator. A respirator where ambient air is passed through an air-purifying element by either inhalation or by means of a blower.

3.6 Ambient Air Pump. A motorized blower used to supply air to a continuous flow airline respirator.

3.7 Approved. A respirator for which a formal certificate was issued by the National Institute for Occupational Safety and Health (NIOSH) or by NIOSH and the Mine Safety and Health Administration (MSHA) in accordance with 42 CFR Part 84 *Respiratory Protective Devices* and is maintained in full compliance with the certificate.

3.8 Assigned Protection Factor (APF). The minimum expected workplace level of respiratory protection that would be provided by a properly functioning and used respirator or a class of respirators to properly fitted and trained wearers when all elements of an effective respirator program are established and are being implemented.

3.9 Atmosphere-Supplying Respirator. A class of respirators that supply a respirable atmosphere, independent of the workplace atmosphere. This class includes airline respirators and self-contained breathing apparatus (SCBA).

3.10 Bioaerosol. A liquid droplet (generated for example by coughing, sneezing) or

a solid particle (generated for example by sweeping, shoveling) suspended in the air that is living or originate from living organisms. Bioaerosols include living or dead microorganisms, fragments, toxins and particulate waste products from all varieties of living things. They are capable of causing infection, adverse or allergic response potentially leading to disease.

Note: Individual bioaerosols most often range in size from 0.01µm to 100µm in diameter.

3.11 Bio-Monitoring. A determination of the concentration of a substance in biological fluids or tissue and used for occupational exposure surveillance.

3.12 Canister (Air-Purifying). A container with (1) gas and vapor removing sorbent or catalyst or (2) gas and vapor removing sorbent or catalyst that remove gases and vapors, and filter that removes particles from inspired air (or air drawn through the unit). Typically attached to a full facepiece either mounted directly to the chin or connected to a breathing tube so the canister may be worn in the front or back of the person.

Note: Respirators with air-purifying canisters are approved by NIOSH as gas masks, and contain an approval number TC-14G-xxxx.

3.13 Canister (Carbon Dioxide Scrubbing). A container filled with a chemical used to remove carbon dioxide from exhaled air before that air is rebreathed in a closed-circuit SCBA.

3.14 Canister (Oxygen-Generating). A container filled with a chemical that generates oxygen by chemical reaction used in closed-circuit SCBA.

3.15 Cartridge. A small container filled with sorbents or catalysts that remove gases and vapors from the inspired air. The cartridge may also have particulate filters that are an integral part or ones that are replaceable.

3.16 Ceiling Limit. The maximum allowable concentration of an airborne contaminant that shall not be exceeded at any time.

3.17 Certified. See “Approved”.

3.18 Change Schedule. A time interval after which a used filter, cartridge or canister is replaced with a new one.

3.19 Confined Space. An enclosed space not designed for human occupancy that has the following characteristics:

- a) restricted entry and exit;
- b) primary function is something other than human occupancy, and
- c) contains potential or known respiratory hazards.

Examples of confined spaces include, but are not limited to; tanks, silos, vessels, pits, sewers, pipelines, tank cars, boilers, septic tanks and utility vaults. See 29 CFR 1910.146 and ANSI/ASSE Z117.1 for more details on permit-required confined spaces.

3.20 Contaminant. A potentially harmful, irritating or nuisance airborne material.

3.21 Continuous Flow Respirator. An atmosphere-supplying respirator that provides a continuous flow of respirable air to the respiratory inlet covering.

3.22 Demand Respirator. An atmosphere-supplying respirator that admits respirable air to the respiratory inlet covering only when a negative pressure is created inside the respiratory inlet covering by inhalation.

3.23 Dust. An aerosol consisting of mechanically produced solid particles derived from breaking up of larger particles.

3.24 End-of-Service-Life Indicator (ESLI). A system or device that warns the wearer of the approach of the end of adequate respiratory protection.

3.25 Escape-Only Respirator. A respirator intended only for use during emergency egress from a hazardous atmosphere.

3.26 Occupational Exposure Limit (OEL). The maximum allowable concentration of a contaminant in the air to which an individual may be exposed over a period of time. Commonly used OELs include OSHA permissible exposure limits (PELs) and ACGIH® threshold limit values (TLVs®). (ACGIH® and TLVs® are registered trademarks of the American Conference of Governmental Industrial Hygienists.) These may be time-weighted averages, short-term limits or ceiling limits.

3.27 Filter. Material used in air-purifying respirators to remove solid or liquid aerosols from inspired air. Some filters are encapsulated in a container and some are not.

N-Series Particulate Filter – The NIOSH classification for particulate filters effective against particulate aerosols free of oil; time-use restrictions may apply.

R-Series Particulate Filter – The NIOSH classification for particulate filters effective against all particulate aerosols; time-use restrictions may apply.

P-Series Particulate Filter – The NIOSH classification for particulate filters effective against all particulate aerosols.

HE Filter – The NIOSH classification for a 99.97% efficiency filters used in powered air-purifying respirator (PAPR) which is effective against all particulate aerosols.

N-, R- and P-series particulate filters are tested at 99.97%, 99% and 95% efficiency levels, referred to as classes 100, 99 and 95 respectively.

3.28 Filtering Facepiece. A negative-pressure respirator where the filter is an integral part of the facepiece or comprises the entire facepiece.

3.29 Fit Factor. A numeric expression of how well a tight-fitting respirator fits a wearer during a quantitative fit test. It is the ratio of the measured challenge agent concentration outside the respirator (C_{out}) to its concentration inside the respirator (C_{in}).

$$(\text{Fit factor} = C_{out} / C_{in})$$

A fit factor resulting from a qualitative fit test has been validated to 100 (Annex A.5).

3.30 Fit Test. The use of a qualitative or quantitative protocol to evaluate sealing surface leakage of a specific tight-fitting respirator while worn by an individual.

3.31 Fume. Aerosols formed by condensation of a vaporized solid.

3.32 Gas. A fluid that has neither independent shape nor volume and tends to expand indefinitely. In contrast, liquids have independent volume, but not independent shape.

3.33 Hazardous Atmosphere. An atmosphere that contains a contaminant(s) in excess of the occupational exposure limit or that is oxygen-deficient.

3.34 Hazard Ratio. A number obtained by dividing the concentration of a contaminant by its occupational exposure limit.

3.35 Helmet. A hood that offers head protection against impact and penetration to the wearer.

3.36 High-Efficiency Particulate Air (HEPA) Filter. HEPA filters are considered N100, R100, P100 and HE. P100 and HE filters are identified with a magenta color.

3.37 Hood. Tight-fitting or loose-fitting respiratory inlet covering that completely covers the head and neck and may cover portions of the shoulders.

3.38 Immediately Dangerous to Life or Health (IDLH). Any atmosphere that poses

an immediate hazard to life or poses immediate irreversible debilitating effects on health.

3.39 Loose-Fitting Facepiece. A respiratory inlet covering that is designed to form a partial seal with the face, does not cover the neck and shoulders and may or may not offer head protection against impact and penetration.

3.40 Mass Median Aerodynamic Diameter (MMAD). The calculated aerodynamic diameter that divides the aerosol particles based on the weight of the particles. By weight, 50% of the particles will be larger than the MMAD and 50% of the particles will be smaller than the MMAD.

3.41 Mist. An aerosol composed of liquid droplets produced either mechanically or by condensation of vaporized liquid.

3.42 Mouthpiece and Nose Clamp Assembly. A respiratory inlet covering that is held in the wearer's mouth and must always be used in conjunction with a nose clamp.

3.43 Maximum Use Concentration (MUC). The maximum atmospheric concentration of a hazardous substance from which a wearer can be expected to be protected, when wearing a respirator, and is frequently determined by the assigned protection factor of the respirator or class of respirators and the exposure limit of the hazardous substance. The MUC can be frequently determined mathematically by multiplying the assigned protection factor specified for a respirator by the required time weighted average occupational exposure limit (OEL), short-term exposure limit or ceiling limit. When no OEL is available for a hazardous substance, an employer must determine a MUC on the basis of relevant available information and informed professional judgment.

3.44 Negative-Pressure Respirator. A respirator in which the air pressure inside

the respiratory inlet covering is negative during inhalation with respect to the ambient air pressure.

3.45 Physician or Other Licensed Health Care Professional (PLHCP). An individual whose legally permitted scope of practice (i.e., license, registration or certification) allows them to independently provide, or be delegated the responsibility to provide, some or all of the health care services required by 29 CFR 1910.134(e).

3.46 Positive-Pressure Respirator. A respirator in which the pressure inside the respiratory inlet covering is normally positive with respect to ambient air pressure (Annex A.6).

3.47 Powered Air-Purifying Respirator. An air-purifying respirator that uses a blower to move the ambient atmosphere through air-purifying elements into the respiratory inlet covering.

3.48 Pressure-Demand Respirator. An atmosphere-supplying respirator in which the pressure inside the respiratory inlet covering, in relation to the pressure surrounding the outside of the respiratory inlet covering, is positive during both inhalation and exhalation.

3.49 Qualitative Fit Test (QLFT). A pass/fail fit test that relies on the subject's sensory response to detect a challenge agent.

3.50 Quantitative Fit Test (QNFT). A fit test that uses an instrument to measure face seal leakage.

3.51 Respirator. Personal protective equipment designed to protect the wearer from inhalation of hazardous atmospheres.

3.52 Respiratory Inlet Covering. That portion of a respirator that connects the wearer's respiratory tract to an air-purifying or atmosphere-supplying respirator. They may be either tight fitting or loose fitting in

design. It may be a facepiece, helmet, hood or mouthpiece/nose clamp.

3.53 Required Fit Factor (RFF). The numeric value established as pass/fail point or acceptance criterion for a quantitative fit test.

3.54 Respirator Manufacturer. An entity that designs and/or manufactures a respirator, or has a respirator designed and/or manufactured for them under their name or trademark.

3.55 Respirator User Instructions. Instructions and information provided by the respirator manufacturer.

3.56 Self-Contained Breathing Apparatus (SCBA). An atmosphere-supplying respirator in which the respirable gas source is designed to be carried by the wearer.

3.57 Service Life. The period of time that a respirator provides adequate protection to the wearer.

3.58 Shall. The word “shall” is to be understood as denoting a mandatory requirement.

3.59 Should. The word “should” denotes a recommendation.

3.60 Sorbent. A material that removes specific gases and vapors from the inhaled air.

3.61 Supplied-Air Respirator. See “Airline Respirator”.

3.62 Tight-Fitting Respiratory Inlet Covering. A respirator component designed to form a complete seal with the face or neck. A half-facepiece (includes quarter masks, filtering facepiece and half-masks with elastomeric facepieces) covers the nose and mouth; a full facepiece covers the nose, mouth and eyes. Tight-fitting hoods seal at the neck.

3.63 User. Person or organization who makes use of the respirator; for example, one involved in selecting, maintaining or wearing the respirator.

3.64 Vapor. The gaseous phase of matter that normally exists in a liquid or solid state at room temperature and pressure.

3.65 Wearer. The person who wears the respirator.

3.66 Wearer Seal Check (a.k.a. User Seal Check). A procedure conducted by the wearer to determine if a tight-fitting respirator is properly donned. See Section 10.

3.67 Written Record. Documentation, either paper or electronic, of any record-keeping requirements and details of the respirator program.

4. RESPIRATOR PROGRAM REQUIREMENTS

4.1 Purpose. This section establishes requirements for using respirators in the workplace. The following requirements are supplemented by recommended practices in subsequent sections of this standard.

4.2 Permissible Practice. In the control of those occupational diseases or injuries caused by breathing contaminated air or oxygen-deficient atmospheres, the primary objective shall be to minimize the workplace exposure. 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 implemented or evaluated, appropriate respirators shall be used according to the requirements of this standard.

4.3 Employer Responsibility.

4.3.1 The employer shall select approved respirators according to the airborne

hazards likely to be encountered in the workplace and provide them at no cost to the employee. The selection process shall include workplace and user factors that are specific and unique to each workplace.

4.3.2 The employer shall be responsible for establishing and maintaining a respirator program that shall include the requirements outlined in Section 4.5.

4.3.3 The employer shall allow a respirator wearer to leave the hazardous atmosphere for any respirator-related cause. Reasons may include, but are not limited to, the following:

- a) respirator fails to provide adequate protection;
- b) respirator malfunction;
- c) detecting air contaminant leakage into the respirator;
- d) increased breathing resistance;
- e) unusual discomfort in wearing the respirator;
- f) illness of the respirator wearer, including: sensation of dizziness; nausea, weakness;
- g) breathing difficulty, coughing, sneezing, vomiting, fever and chills;
- h) to wash their face and the respirator facepiece to minimize skin irritation;
- i) to change the air-purifying elements or other components whenever needed; and
- j) when the respirator reaches the limits of its service life.

4.3.4 The employer shall investigate malfunctions of respirators to determine the cause and to ensure corrective measures are taken. Suspected manufacturing defects should be reported to the manufacturer and the certifying agency.

4.3.5 The employer shall use a respirator equipped with an end-of-service-life indicator or establish a change schedule for filters, cartridges and canisters. Guidance for determining a change schedule is contained in Annex A.1.

4.3.6 The employer shall train the wearer in the proper and effective use of the provided respirators including the proper egress from the hazardous environment before the end of service is reached and during failures of the respirator according to Section 8.

4.3.7 For all tight-fitting respirators, the employer shall ensure that employees perform a wearer seal check each time they put on the respirator using the procedures described in Section 10. Either the positive and negative pressure checks according to the respirator manufacturer's recommended wearer seal check method shall be used. Wearer seal checks are not substitutes for qualitative or quantitative fit tests.

4.4 Wearer Responsibility.

4.4.1 The wearer shall use the provided respirator in accordance with instructions and training received.

4.4.2 The wearer shall guard against damage to the respirator.

4.4.3 The wearer shall immediately leave the contaminated area according to established procedures if the wearer detects contaminant by odor, taste or irritation, if an ESLI indicates end of cartridge service life or if a respirator malfunction occurs. The wearer shall also immediately report the situation to the person designated by the employer in the written standard operating procedures.

4.4.4 The wearer shall report to the person designated by the employer in the written standard operating procedures any physical or medical condition that could impair the ability to properly wear a respirator.

4.4.5 The wearer who uses a tight-fitting respirator shall perform a wearer seal check to ensure that an adequate seal is achieved each time the respirator is put on.

4.5 Minimal Acceptable Respirator Program Elements.

4.5.1 Program Administration. Responsibility and authority for the respirator program shall be assigned to a single person (Section 5). That person shall be identified to all respirator wearers as the respirator program administrator in the written standard operating procedures.

4.5.2 Standard Operating Procedures (SOP). Written standard operating procedures covering the complete respirator program shall be established and implemented (Section 6).

4.5.3 Medical Evaluation. A physician or other licensed healthcare professional (PLHCP) shall determine whether or not an employee has any medical conditions that would preclude the use of respirators, limitations on use or other restrictions.

The program administrator shall advise the physician or other licensed healthcare professional of the following conditions to aid in determining the medical evaluation required:

- a) type and weight of the respirator to be used by the employee;
- b) duration and frequency of respirator use (including use for rescue and escape); typical work activities, and environmental conditions (e.g., temperature and humidity extremes);
- c) hazards for which the respirator will be worn including potential exposure to reduced oxygen environments; and
- d) additional protective clothing and equipment to be worn.

Written records of medical evaluations shall be secured and maintained as medical records.

For additional information on medical evaluations, refer to ANSI Z88.6-2006, *Respirator Use - Physical Qualifications for Personnel*.

4.5.4 Respirator Selection. The selection of the proper type(s) of respirator(s) shall be based upon their capabilities and limitations and respiratory hazards (Section 7).

4.5.5 Training. Each respirator wearer shall be given training and retraining according to Section 8.

4.5.6 Fit Testing. Each wearer shall be fit tested before being assigned a tight-fitting respirator (Section 9).

4.5.7 Maintenance, Inspection and Storage. Maintenance shall be carried out by properly trained individuals according to the respirator user instructions and on a schedule that ensures that each respirator wearer is provided with a respirator that is clean, sanitary and in good operating condition. Each respirator shall be inspected by the wearer prior to its use to ensure that it is in proper working condition. Respirators shall be stored in a convenient, clean and sanitary location according to the respirator user's instructions (Section 11).

5. PROGRAM ADMINISTRATION

5.1 Respirator Program Administrator. An individual shall be assigned responsibility and authority for administering the respirator program. This individual shall have access and direct communication to the site manager for matters impacting worker safety and health. It is preferable that the administrator be in the company's industrial hygiene, environmental, health physics or safety engineering department. A third party entity meeting these requirements may provide this service.

5.2 Respirator Program Administrator Qualifications. Respirator program administrators shall be knowledgeable in respiratory protection and competent in the administration of their duties. Program administrators shall keep abreast of current issues, advances and regulations.

5.3 Responsibilities.

5.3.1 Respirator Program Administrator Responsibilities. The administrator's responsibilities shall ensure that the following components of the respirator program are conducted:

- a) measurement, estimation or review of information on the concentration of airborne contaminant(s) in the work area prior to respirator selection and periodically during respirator use;
- b) ensuring that medical evaluations, training and fit testing are performed;
- c) selection of the appropriate type or class of respirator that will provide adequate protection for each contaminant, present or anticipated;
- d) maintenance of records and written procedures in a manner that documents the respirator program and allows for the evaluation of the program's effectiveness;
- e) evaluation of the respirator program's effectiveness; and
- f) revision of the program as necessary.

5.3.2 Respirator Program Audit. The most comprehensive respirator program is of little value if it is not maintained and implemented as designed and corrected when deficiencies are identified. Therefore, in addition to ongoing surveillance, the program administrator shall annually audit the respirator program to ensure that:

- a) the program procedures reflect the requirements of current applicable regulations and industry accepted standards; and
- b) the program as implemented reflects the written procedures.

To aid objectivity, an additional audit shall be conducted by a knowledgeable person not directly associated with the program, rather than the respirator program administrator. The frequency of this outside audit should be determined by the size and complexity of the respirator program and

previous audit findings. An audit checklist, or equivalent, shall be prepared and updated as necessary.

The audit shall focus, as a minimum, on the following areas:

- a) respirator program;
- b) program administration;
- c) training;
- d) medical evaluation;
- e) fit testing;
- f) air sampling and classification of hazard(s);
- g) selection and issuance;
- h) use;
- i) equipment cleaning, maintenance and inspection;
- j) breathing air quantity and quality;
- k) storage;
- l) emergency preparedness;
- m) special problems; and
- n) corrective action.

Action shall be taken to correct any defects or shortcomings found during the audit. Findings shall be documented, including plans to correct problem areas with target dates for completion and tracking mechanisms to ensure completion.

5.3.3 Medical Surveillance. When applicable, medical surveillance, which may include bio-monitoring shall be carried out periodically to determine if respirator wearers are adequately protected. An occupational health professional (e.g., industrial hygienist, health physicist), in conjunction with a PLHCP, shall determine the medical surveillance program requirements.

6. STANDARD OPERATING PROCEDURES (SOP)

Written SOP shall be established by the employer and shall cover a complete respirator program for routine and emergency situations. Copies of the procedures shall be available for all wearers to read. The procedures shall be reviewed in conjunction

with the annual respirator program audit and revised by the program administrator as necessary.

6.1 Operating Procedure Elements for Respirator Use. Written SOP shall include information necessary, as appropriate, for the proper use of respirators, including:

- a) hazard assessment;
- b) respirator selection;
- c) medical evaluation;
- d) training;
- e) fit testing;
- f) issuance;
- g) maintenance, inspection and storage;
- h) air-purifying element change schedule;
- i) breathing air quality;
- j) monitoring respirator use;
- k) hazard reevaluation;
- l) employer policies; and
- m) program evaluation and auditing.

6.2 Special Considerations for Respirators Used for Emergency Escape. Written SOP shall be developed covering respirators used for emergency escape. Using guidance in Section 7, a hazard assessment shall be performed to determine if, during an emergency, the use of respirators for escape is required and, if so, the appropriate type of respirator for escape shall be selected. Consideration should be given to past emergencies and occurrences that required using respirators for escape as well as conditions that may have necessitated their use, such as equipment or power failures, uncontrolled chemical reactions, fire, explosion or human error.

An adequate number of escape respirators shall be provided and accessible where they may be needed.

6.2.1 Personnel Assigned to Work Areas Where Escape Respirators Are Required. Personnel assigned to areas where respirators may be required for escape shall be enrolled in the complete respirator program, including medical evaluation and

training in the use and limitations of escape respirators.

6.2.2 Visitors and Personnel Not Assigned to Work Areas Where Escape Respirators are Required. Medical approval is not required for visitors and personnel not assigned to work areas where hooded or mouthpiece escape-only respirators are provided for potential emergencies. However, they shall be trained in how to don and use the escape-only respirator according to the respirator user instructions.

For work areas where self-contained breathing apparatus having a tight-fitting respiratory inlet covering, gas masks or other non-escape-only respirators are selected for emergency escape, visitors shall receive medical evaluation, respirator training and fit testing.

6.2.3 Operating Procedure Elements for Emergency Respirator. Written SOP shall be developed for all emergency use and anticipated emergency use.

7. RESPIRATOR SELECTION

Respirator selection for routine and emergency use shall involve:

- a) hazard assessment;
- b) respirator selection of type or class of respirators that can offer adequate protection; and
- c) maintaining written records of hazard assessment and respirator selection (Section 13).

7.1 Hazard Assessment. Perform a hazard assessment including evaluation of potential respiratory hazards (oxygen deficiency or airborne contaminants) and any other hazardous conditions present such as eye and skin hazards, humidity and temperature extremes and other environmental conditions to assist in the selection of an appropriate respirator.

Where the only hazard identified is a bio-aerosol, the guidance in Section 7.2.3 shall be followed.

7.1.1 Hazard Assessment Steps for the Inhalation Hazard. The nature of the inhalation hazard shall be established by determining:

- a) which contaminant(s) may be present in the workplace;
- b) the physical state and chemical properties of all airborne contaminants;
- c) by measurement or estimation, the likely airborne concentration of the contaminant(s);
- d) if the potential for an oxygen-deficient environment exists;
- e) whether there is an occupational exposure limit for each contaminant;
- f) if an IDLH atmosphere exists;
- g) if there is an applicable health regulation or OSHA substance specific standard (e.g., lead, asbestos) for the contaminant(s); and
- h) if the contaminant(s) can be absorbed through the eyes or skin, produce skin sensitization or be irritating or corrosive to the eyes or skin.

7.1.1.1 Determine which contaminant(s) may be present in the workplace. The following factors concerning an operation or process shall be taken into consideration:

- a) operation or process characteristics as they relate to the release of air contaminants through routine or non-routine procedures, malfunctioning of equipment or processes or spills;
- b) materials used, produced or stored, including raw materials, end-products, by-products, chemical reactivity and wastes; and
- c) emergency repair, shutdown procedures, escape and rescue operations.

7.1.1.2 Determine the physical state and chemical properties of all airborne contaminants. The physical states for all airborne

contaminants as they are likely to be encountered shall be identified as follows:

- a) gas or vapor; or
- b) particle.

If the contaminant is a particulate hazard, determine if it is an oil or if an oil aerosol is present along with the particulate contaminant.

Notes:

- 1) Knowledge of the presence of airborne oil is needed to properly select a particulate filter (Section 7.2.2(k) and Annex A.2).
- 2) Examples of activities that are known to produce airborne oil include use of air compressor systems with oil lubricators and operation of motor vehicles.

7.1.1.3 Determine the likely airborne concentration of the contaminant(s). An estimate of the airborne concentrations of contaminants to which persons might be exposed shall be conducted as follows:

- a) air sampling and analysis conducted in accordance with recognized occupational hygiene practices (Ignacio & Bullock, 2006);
- b) mathematical modeling or estimating based on the workplace volume and physical properties (e.g., vapor pressure); or
- c) experience from similar circumstances and materials.

Anticipated exposures should account for variations in process operation, rate and direction of air movement, temperature (ambient or process) and seasonal variations. The workplace atmosphere shall be assessed on a regular basis for respiratory hazards to confirm that the proper type of respirator is being used.

7.1.1.4 Determine if the potential for an oxygen-deficient environment exists. Where the potential for an oxygen-deficient atmosphere exists, the oxygen concentration shall be measured.

Where oxygen concentration is below 159 mmHg (21kPa) (20.9% oxygen at sea level), the cause of the deficiency shall be identified and understood and/or monitored if appropriate.

Where oxygen concentration is confirmed to be below 19.5% (at sea level), the cause of the deficiency shall be determined, and

- a) ongoing monitoring shall be performed (Annex A.3); or
- b) the atmosphere shall be assumed to be IDLH until the cause of the deficiency is understood and controlled to greater than 122 mmHg (16.27 kPa) (16% oxygen at sea level), see Section 7.1.1.6.

Oxygen deficiency is classified as either IDLH or non-IDLH by this document.

7.1.1.4.1 Oxygen-Deficiency IDLH. An oxygen partial pressure less than 122 mmHg (16.27 kPa) (16% oxygen at sea level) shall be considered IDLH.

7.1.1.4.2 Oxygen-Deficiency Non-IDLH. An oxygen partial pressure of equal to or greater than 122 mmHg (16.27 kPa) (16% oxygen at sea level) and less than 148 mmHg (19.73 kPa) (19.5% oxygen at sea level) shall be considered an oxygen-deficient atmosphere that is not immediately dangerous to life.

7.1.1.5 Determine whether there is an occupational exposure limit for each contaminant. Occupational exposure limits shall be identified such as published threshold limit value, permissible exposure limit, derived air concentration (radiological protection limits) or any other available exposure limits or estimate of toxicity for the contaminant(s).

7.1.1.6 Determine if an IDLH atmosphere exists. A location shall be considered to be IDLH when:

- a) the identity or concentration of a contaminant is unknown (e.g., interior structural fire-fighting) or it is an atmosphere known or suspected to have concentrations above the IDLH level for that contaminant (see DHHS (NIOSH) Publication 2005-149 for IDLH values for specific substances);
- b) it is a space that contains less than the normal 159 mmHg (21kPa) (20.9% oxygen at sea level) oxygen, unless the source of the oxygen reduction is understood and controlled; or the oxygen concentration is unknown;
- c) oxygen partial pressure is below 122 mmHg (16.27 kPa) (16% oxygen at sea level);
- d) total atmospheric pressure less than 584 mmHg (77.86 kPa) equivalent to 7,000 ft (2134 m) altitude or any combination of reduced percentage of oxygen and reduced pressure that leads to an oxygen partial pressure less than 122 mmHg (16.27 kPa) (e.g., areas other than sea level) (Section 7.2.4 and Annex A.3); or
- e) any confined space containing less than 159 mmHg (21kPa) (20.9% oxygen at sea level) oxygen, unless the source of the oxygen reduction is understood and controlled (Sections 7.2.4 and 7.2.5). This restriction is imposed because any reduction in the percentage of oxygen present is proof, at a minimum, that the confined space is not adequately ventilated.

7.1.1.7 Determine if there is an applicable OSHA substance-specific standard for the contaminant(s). Determine if there is an applicable substance-specific standard by reviewing applicable standards, e.g., OSHA, MSHA. If so, there may be specific respirators required that will influence the selection process.

7.1.1.8 Determination of other hazards.

7.1.1.8.1 Determine whether the contaminant(s) can be absorbed through the eyes

or skin, produce skin sensitization or be irritating or corrosive to the eyes or skin.

7.1.1.8.2 Determine the nature of other hazards and environmental conditions, which may exist, that would affect respirator selection, such as:

- a) heat, cold, humidity;
- b) head impact hazards;
- c) welding arc;
- d) splash; and
- e) eye impact.

7.2 Respirator Selection.

7.2.1 General Considerations. Proper respirator selection for any situation shall consider the following:

- a) the nature of the hazard;
- b) worker activity and workplace factors;
- c) respirator use duration;
- d) respirator limitation; and
- e) use of approved respirators.

7.2.1.1 Nature of the Hazard. Nature of the hazardous atmosphere shall be determined by the hazard assessment:

- a) IDLH;
- b) non-IDLH;
- c) oxygen deficient; or
- d) bioaerosol.

7.2.1.2 Worker Activity. Worker activity and worker location in a hazardous area shall be considered in selecting the proper respirator. These considerations shall include:

- a) the period of time for which the respirator is to be used, whether the worker is in the hazardous area continuously or intermittently during the work shift;
- b) physical demands made on the worker, whether the work rate is light, medium or heavy;
- c) work area layout;
- d) work activities; and