

Status of ANSI Standards on Respiratory Protection

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"What is the status of Z88.2?" is a question I am asked nearly every week. In this article, I will answer that question and others about the standards published by the American National Standards Institute (ANSI) on respiratory protection.

Background

All of the ANSI standards on respiratory protection are the responsibility of the Z88 committee. These standards are listed in Table 1. The date after the standard number indicates the year in which it was published; those standards without dates are being

written presently for the first time. Under ANSI rules, a standard must be revised at least every ten years. To meet this time limit, a subcommittee must start reviewing and revising the standard about five years after it is published.

Table 1. ANSI respirator standards.

ANSI Z88.2-1980	<i>Practices for Respiratory Protection</i>
ANSI Z88.3-1983	<i>Protection During Fumigation</i>
ANSI Z88.5-1981	<i>Practices for the Fire Service</i>
ANSI Z88.6-1984	<i>Physical Qualifications for Respirator Users</i>
ANSI Z88.7	<i>Identification of Air-Purifying Canisters and Cartridges</i>
ANSI Z88.8	<i>Testing and Certification of Air-Purifying Respirators</i>
ANSI Z88.9	<i>Testing and Certification of Air-Supplying Respirators</i>
ANSI Z88.10	<i>Respirator Fit-Test Methods</i>
ANSI Z88.11	<i>Classification and Description of Respirators</i>
ANSI Z88.12	<i>Respiratory Protection Against Biohazards</i>

ANSI Z88.2

In 1984 the decision was made to separate fit-test methods from the other material in Z88.2 and write a new standard on fit testing, Z88.10, and a revised Z88.2 that will reference Z88.10 for fit testing. Two subcommittees were then formed and have been working since 1984. The Z88.2 proposed standard has been out for public comments twice, and it passed the last time the Z88 committee voted on it. Why then, you may ask, hasn't the revised standard been published? The ANSI process requires that all negative comments made on the proposed revision must be considered. Such comments are studied by the subcommittee that wrote the

revision. Their responses to the comments are then returned to the commenters to determine if they accept the subcommittee's response or if they want to reiterate their negative comment. All continuing negative comments are then sent to the Z88 committee, which has the final say, to determine if any of its members want to change their previous vote. This process is lengthy, but it insures that proper attention has been paid to points of disagreement. ANSI standards are *consensus* standards, which means that most, but not necessarily all, of the parties affected by it agree with the final product.

The topics covered in the proposed revision of Z88.2 are shown in Table 2. Those with an asterisk contain changes that the subcommittee has taken considerable time to discuss and try to obtain a consensus, since it is the *changes* that cause the disagreements. I will briefly review the nature of these changes.

Table 2. Topics covered in the revision to ANSI Z88.2, *Practices for Respiratory Protection*. Items marked with an asterisk have undergone considerable discussion.

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|------|---|
| 1. | Respirator program requirements |
| 2. | Program administration |
| 3. | Written standard operation procedures |
| 4. | Selection, limitations, and use of respirators |
| *5. | Assigned Protection Factors |
| *6. | Potentially IDLH or oxygen-deficient atmosphere |
| *7. | Additional considerations—beards, vision |
| 8. | Training |
| 9. | Respirator fitting tests—QNFT in negative mode |
| 10. | Maintenance, inspection, and storage |
| *11. | Respirable air and oxygen |
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Assigned Protection Factors

For an overview of the changes in the assigned protection factors (APFs), I have constructed Table 3, which compares the APFs in the proposed revision to those in the 1980 version of Z88.2. For further comparison, I have included factors that have been suggested by Mr. Ching-tsen Bien of OSHA in a private communication (note that these are not *official* OSHA factors), and the factors from NIOSH's *Guide to Industrial Respiratory Protection* (September 1, 1987). The topics that caused the most discussion were: whether disposable half masks should have lower APFs than elastomeric half masks, whether the APFs for PAPRs should be lowered so dramatically (especially with the popular loose-fitting facepiece), and whether the APF listing for SCBAs should be changed to a footnote that, more or less, states that one does not always get a protection factor greater than 10,000, so users should be careful. The basis of this change was simulated workplace testing done at Livermore and Los Alamos.*

* The Lawrence Livermore National Laboratory measured 110 fit factors (10 wearers x 11 repeats), finding a mean fit factor of 17,000—but 11% had fit factors below 1000 and the 5th percentile was 360. Similarly, the Los Alamos National Laboratory measured 60 fit factors, also finding a mean fit factor of 17,000, but 5% had fit factors below 1000 and the 5th percentile was 2000–6000.

In addition to changes in the APFs, a change in one selection criterion was made. The present standard states that vapor- and gas-removing respirators should avoid being used in atmospheres where the contaminant lacks sufficient warning properties. The revision specifically allows such usage when precautions are taken to insure safe use, which includes cartridge breakthrough studies and cartridge change schedules.

Concerns have been raised that this is unsafe and against existing NIOSH and OSHA regulations. NIOSH, in 30 CFR 11, has a footnote stating that organic-vapor cartridges are not to be used with materials that lack adequate warning properties; OSHA states that only approved equipment shall be used when it is available.

In substance-specific standards issued by OSHA (e.g., benzene or acrylonitrile), OSHA has recognized that situations exist that will require the use of air-purifying respirators and has allowed their use when data has been presented on cartridge service data. The revision is providing general guidance for such uses for the many other materials that are present in the workplace for which no odor threshold data exists or for those where the data indicates that warning is inadequate.

The American Industrial Hygiene Association respirator committee has written a proposed standard testing procedure for cartridges. This will help employers obtain the necessary data. The AIHA committee did this because of their perceived need for it. This change is opposed by three members; one believes that more safeguards should be put in the standard to make it acceptable. The argument has also been made that all vapor cartridges should be used as suggested above—i.e., enforcing a time/concentration change schedule, without relying upon the worker to detect the odor at the proper concentration.

Oxygen Deficiency

The potentially IDLH or oxygen-deficient atmosphere section caused particular concern for those members working with confined-space hazards, while it pleased those who wear respirators at high altitudes. The current standard defines oxygen deficiency IDLH as a partial pressure of 100 mmHg or less in the freshly inspired air in the upper portion of the lungs, which is saturated with water vapor, 14% oxygen at sea level. Respirators required are an SCBA or airline respirator with escape provisions. Oxygen deficiency, not IDLH, is defined as an oxygen content less than 19.5% at sea level, and requires the use of air-supplied respirators.

Table 3. Comparison of changes in Assigned Protection Factors in ANSI Z88.2.

Respirator	Source			
	ANSI Z88.2		Bien	NIOSH
	1989 (Draft)	1980		
<i>Negative Pressure</i>				
<i>Air Purifying</i>				
Half mask w/QLFT	10	10	5	10
QNFT	10	100	10	10
Disposable QLFT			3	
QNFT			5	
Full-face w/ QLFT	100	100	10	50HEPA
QNFT	100	1000 HEPA	50	50 HEPA
<i>Air Supplying Demand</i>				
<i>SCBA or Airline</i>				
Half mask w/QLFT	10	10	10	
QNFT	10	as FF ^a	10	
Full-face w/ QLFT	100	100	50	50
QNFT	100	as FF ^a	50	50
<i>Positive Pressure</i>				
PAPR Half mask	50	3000HEPA	250	50HEPA
Full face	1000 HEPA	3000HEPA	500	50HEPA
Helmet/Hood	1000 HEPA	3000HEPA	250	25 any filter
Loose-fitting	25	3000HEPA	50	25 any filter
All		100 DFM		
<i>Atmos. Supplying Pos.</i>				
<i>Airline PD w/o escape</i>				
Half mask	50	<IDLH		1000
Full face	1000	<IDLH	500	2000
Full face w/escape		10,000+		10,000
<i>Airline Continuous Flow</i>				
Half mask	50	<IDLH	250	50
Full face	1000	<IDLH	500	50
Helmet/Hood	1000	<IDLH	250	25
Loose-fitting	25	<IDLH	50	25
SCBA w/full face	as FF ^a	10,000+	1000+	10,000

^a as FF = the measured fit factor

In the revision, the committee has changed this to: any reduction below ambient oxygen (20.9%) is IDLH unless the reason for the reduction is known or controlled; oxygen content less than 12.5% (95 mm partial pressure of oxygen) at sea level is IDLH; and if the total atmospheric pressure is less than 450 mmHg, equivalent to 14,000 ft altitude (or any combination of reduced

oxygen content and pressure that leads to a partial pressure of oxygen less than 95 mm) is IDLH. Figure 1 shows a summary of the new requirements on oxygen deficiency and IDLH.

Concerns over these changes basically state that no safety factor is provided for the IDLH level, that a

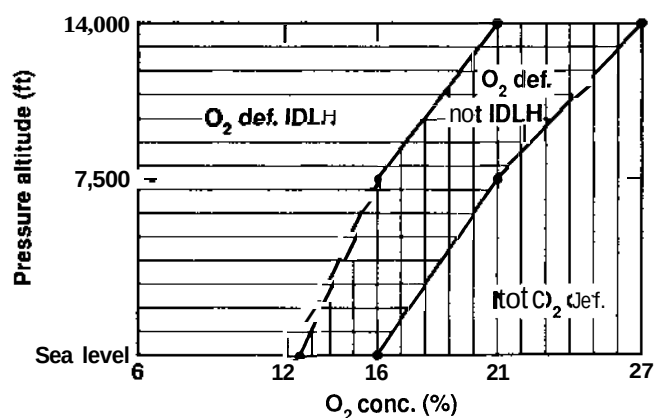


Figure 1. Summary of the new requirements on oxygen deficiency and IDLH.

rapid change from a 20.9% atmosphere to a 13% oxygen level, for example, may incapacitate a person. To address this last supposition, additional instructions for medical qualifications have been added. For most healthy individuals, this change would not cause any problem.

The reasons for these changes were to emphasize that any change in oxygen content needs to be carefully controlled and understood. The major cause of deaths, based on a review of NIOSH investigations into deaths that have occurred, is not reduced content per se, but failure to follow procedures, monitor oxygen content, or enter to assist someone who has already been overcome. Another reason for the change was to base the IDLH level on the physiology of respiration. Reduced oxygen causes little change in the level of oxygen saturation of the hemoglobin until the partial pressure drops below 95 mm, at which point a rapid reduction in saturation occurs. The 1980 and current versions in the IDLH level show little difference (14% vs 12.5%).

A larger difference between the revision and the 1980 version exists in setting the equivalent oxygen content that requires air-supplied respirators. The revision requires supplied air at 95-122 mm partial pressure (equal to 12.5-16% oxygen at sea level) vs the 1980 standard requirement to provide air at levels below 19.5%. This change was made so that people who work at altitudes anywhere in the U.S. are not required to use an air-supplied respirator just to live at that altitude.

Before OSHA, air-purifying respirators could be used down to 15% oxygen. Then the "legal" definition

of oxygen-deficient became 19.5%. The question is, do we blindly follow a "legal" definition, or write a standard that makes technical sense? Although OSHA does not like the new standard, they have not shown the subcommittee, or me, any justification for higher levels of oxygen. I, personally, tried to find justification for the higher levels, but could not.

Beards and Contact Lenses

Under additional considerations, beards are still prohibited but wearing contact lenses is all right if one can wear them in non-work conditions. The survey that provided the basis for this change owes much to the International Society of Fire Service Instructors, the International Association of Fire Fighters, Fire Engineering Magazine, and over 1400 fire fighters for their help in disseminating and completing the survey form.

Carbon Monoxide and Temperature Alarms

Supplied compressed air, carbon monoxide, and temperature alarms was another area of concern. The 1980 standard requires that CO monitors and/or temperature alarms be used with oil-lubricated compressors. The revision has eliminated this requirement and substituted acceptance testing prior to use and periodic confirmation of continued air quality. Concerns have been raised that pointed to incidents where high CO levels have been found due to fire inside the compressor or inadequately maintained equipment. For example, one contractor trying to rent portable compressors had to test several before finding one that could meet the air-quality criteria.

The subcommittee believes that a study done at the Lawrence Livermore National Laboratory, which found no generation of CO when an oil-lubricated compressor was artificially heated, demonstrates that production of CO is unlikely. The requirement to do acceptance testing prior to use and a periodic check to confirm continued acceptable air quality provides the necessary assurances of air quality. In addition, discussions with the manufacturers of compressors established that the temperature alarms are placed on the compressor to protect the compressor itself and have no relation to CO generation. This test requirement applies to systems designed for breathing air, other systems need to be evaluated on an individual basis and may require stricter testing protocols.

Darrel Douglas and Del Tech Engineering expressed continuing concern over the elimination of CO alarm. Darrel Douglas had furnished the subcommittee with an accident report and the aforementioned contractors' problem. Del Tech engineering furnished

a copy of a study that reported dieseling and CO production of very-high-pressure compressors, but the authors of the report had changed employment and could not be found. The author of the Livermore study had also changed jobs.

Other Standards

ANSI Z88.3-1983, *Protection During Fumigation*, is still current and is not under revision.

ANSI Z88.5-1981, *Practices for the Fire Service*, is currently under revision. James S. Johnson is chairing this subcommittee, which has had two organizational meetings thus far. We now need to get Z88 committee approval for the membership of this subcommittee. Dr. Johnson was on the NFPA 1981 committee that wrote the NFPA standard on *Open-Circuit Self-Contained Breathing Apparatus for Fire Fighters*, 1987 Edition, so there should be good coordination between the two standards.

ANSI Z88.6-1984, *Physical Qualifications for Respirator Users*, is current, although a chairperson and new subcommittee members will soon be chosen to start on its revision.

ANSI Z88.7, *Identification of Air-Purifying Canisters and Cartridges*, is a replacement for the old K13 standard that expired in 1989. It is ready for a vote by the Z88 committee and public comment, but I have been holding it up as the one change in this standard is to make it consistent with the revised Z88.2. This change is to drop the restriction on use in atmospheres with less than 19.5% oxygen. Z88.2 will allow use down to 16%, as it was years ago before NIOSH made 19.5% oxygen the IDLH concentration. (I certainly would like to know the technical basis for the NIOSH 19.5% number!)

ANSI Z88.8 and Z88.9 subcommittees were formed to provide an alternative to 30 CFR 11 for the testing and certification of air-purifying and air-supplying respirators, respectively. NIOSH's proposed replacement, 42 CFR 84, met with such opposition that we thought it worthwhile to make a non-governmental proposal. These committees have been active for about two years.

The subcommittee for Z88.10, *Respirator Fit-Test Methods*, formed in 1984. It distributed a preliminary draft of what it might propose for a fit-test standard at the 1989 ISRP San Francisco meeting, and asked for comments on it. The response was not very overwhelming. Of the six responses received, the one that interested me most was that the standard was written backwards—i.e., that the material in the appendix should be in the body and that the material now in the body should be in the appendix. The subcommittee is now regrouping and will take a fresh look at their draft.

A subcommittee has written the proposed ANSI Z88.11, *Classification and Description of Respirators*. The purpose of this standard was to help large contract buyers, mainly the military, to specify respirators accurately and uniformly for the purpose of obtaining bids. However, before the proposal was sent to the Z88 committee for an acceptance, the military changed their purchasing system so that a specific make and model of respirator could be specified. This eliminated most of the need for the standard, and all interest in it was lost.

ANSI Z88.12, *Respiratory Protection Against Biohazards*, is now being formed at the request of workers in the health field. The health risks involved with orthopedic operations on patients with hepatitis B or AIDS were the stimulus for its inception. The proposed chairperson for the subcommittee has been selected, and members are being chosen now. The purpose of this standard will be to provide information and guidance on the proper selection and use of respirators that will safeguard the health and life of the users exposed to infectious or potentially infectious aerosols.

It takes much hard work and dedication to write a consensus standard. We are all indebted to the respiratory protection professionals and their employers who have donated much time to writing these standards.