

The Development of Respirator Protection Factors in the United States

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ABSTRACT

The term "protection factor" was first defined by the Bureau of Mines in 1965 in the respirator approval schedule. Later, the Atomic Energy Commission sponsored a program at the Los Alamos Scientific Laboratory to develop protection factors for various classes of respirators. In 1975, the Occupational Safety and Health Administration and the National Institute for Occupational Safety and Health initiated a Standard Completion Program that provided guidelines on Occupational Safety and Health Administration enforced permissible exposure limits. The respirator decision logic, a part of the Standard Completion Program, lists the assigned protection factors for various classes of respirators, based on the protection factors developed by the Los Alamos Scientific Laboratory. In the early 1980s, the National Institute for Occupational Safety and Health conducted workplace studies on respirator performance during use. Based on the workplace data, the National Institute for Occupational Safety and Health revised the respirator decision logic in 1987. The American National Standards Institute developed consensus standards for respiratory protection and set assigned protection factors for respirators in the ANSI Z88.2 1992 standard. In 2003, the Occupational Safety and Health Administration proposed assigned protection factor revisions. In 2006, the Occupational Safety and Health Administration published final assigned protection factor revisions.

Keywords: Assigned protection factor (APF), Workplace protection factor (WPF), Simulated workplace protection factor (SWPF), Elastomeric facepiece, Filtering facepiece, Powered air-purifying respirator (PAPR)

INTRODUCTION

The term "protection factor" (PF) was first defined by the Bureau of Mines in the Respirator Approval Schedule 21B of 30 CFR 11 in 1965 (Bureau of Mines, 1965). It is a measurement of the degree of protection provided by a respiratory protective device during use, defined as the ratio of the concentration of airborne radioactive material outside the respirator to that inside the facepiece. The term "assigned protection factor" (APF) is defined as the workplace level of respiratory protection that a respirator or class of respirators is expected to provide to employees when the employer implements a continuing, effective respiratory protection program according to the OSHA respiratory protection standard (OSHA, 2006).

$$PF = C_o / C_i$$

$$APF = C_o / PEL \text{ or } TLV$$

Where C_o = Ambient contaminant concentration
 C_i = In mask contaminant concentration
PEL = OSHA permissible exposure limit
TLV = Threshold limit value

Half-mask air-purifying respirators equipped with high-efficiency particulate air (HEPA) filters were approved for APF of 10, i.e., they can be used up to 10 times the exposure limit.

EARLY STUDIES

In 1967, The Atomic Energy Commission (AEC) Directorate of Regulations published a PF table in the Federal Register (AEC, 1967). The APF was 10,000 for a positive pressure self-contained breathing apparatus (SCBA), and APF was 10 for the negative pressure half-mask air-purifying respirator. Later, the table was withdrawn due to lack of adequate QNFT data on all types of devices. To establish universally accepted protection factors for all types of respirators, the AEC Director of Regulation sponsored a respirator testing program at the Los Alamos Scientific Laboratory (LASL) starting in July 1969.

The LASL respirator quantitative fit testing system consisted of an aerosol generator, a test chamber and an analyzing system made from a 5-decade forward light scattering photometer and a recorder. The test was performed inside a test chamber. A second connecting chamber of the same size served as an air lock to keep the test chamber concentration stable. Thermally generated monodisperse DOP aerosol with a size of 0.3 micrometer (μm) was used as the test agent with concentration maintained between 70 and 100 mg/m^3 . A sampling probe was inserted through the facepiece at a point that would not distort the facepiece fit. An 8 liters/min sample of challenge was drawn through a photometer and the recorder was calibrated to 100% on the least sensitive scale (1.0 volt) (Hyatt *et al.*, 1972).

The exercises performed by the test subjects were designed to simulate normal work activities: normal breathing, deep breathing, turning the head from left to right, turning the head up and down, smiling, frowning, reciting the alphabet, reading, running in place, and normal breathing. Each exercise varied from 30 seconds to 2 minutes, the average penetration was calculated from the maximum leakage during the test. Exercises were repeated as necessary and additional activities were performed to aid in locating the source of leakage when it occurred.

Eighty-four fire fighters from the local AEC Fire Department participated in this study comprising a total of 540 quantitative fit tests performed on the self-contained breathing apparatus (SCBA). In addition to the SCBA evaluation study, Hyatt and co-workers conducted QNFT to determine the leakage of five half-masks and six full facepieces respirators equipped with chin style canister or twin cartridge configurations (Hyatt *et al.*, 1972a). All of the respirators used in this study were approved by the Bureau of Mines and equipped with HEPA filters.

The data derived from the above studies was extrapolated in relation to equipment that has not been completely evaluated in developing protection factors. The protection factors for various types of respirators were reported by Hyatt (Hyatt, 1976) and are presented in Table I. In his publication, Hyatt provided the rationales for setting these PFs, the applications and limitations of PFs in the workplace.

In the 1970s, LASL was asked by NIOSH to develop a system utilizing a cold generated polydisperse DOP as test agent since the thermally generated DOP may contain many contaminants with unknown toxicity. The challenge concentration was reduced to 25 mg/m^3 with a mass median aerodynamic diameter (MMAD) of 0.6 micrometer and a standard deviation of two. The sampling rate was also reduced to approximately 1 liter/min (Douglas *et al.*, 1976).

Table I. LASL and NIOSH Assigned Protection Factors

Type of Respirator	Hyatt - 1976	NIOSH RDL - 1987
Air-Purifying		
Single use	5	5
Disposable QNFT		10
Quarter mask	5	5-10
Half -mask includes disposable	10	10
Full facepiece	50	10-50
PAPR - half mask	1,000	50
PAPR - full facepiece	1,000	50
PAPR - Loose fitting	1,000	25
Atmospheric supplying		
Demand SAR - half- mask	10	
Demand SAR - full facepiece	50	50
CF SAR - half mask	1,000	50
CF SAR - full facepiece	2,000	50
CF SAR - hood/helmet	2,000	25
PD SAR - half mask	1,000	1,000
PD SAR - full facepiece	2,000	2,000
PD SAR - full facepiece - escape		10,000
Demand SCBA-full facepiece	50	50
PD SCBA - full facepiece	10,000	10,000

OSHA OCCUPATIONAL SAFETY AND HEALTH STANDARDS

The Occupational Safety and Health Act of 1970 (Act) established OSHA to enforce the law, and NIOSH to conduct research and in support of OSHA's activities. The Act prescribed the standard development process and contents of safety and health standards, also authorized OSHA to adopt existing federal or national consensus standard for enforcement during the three years period following the enactment of the Act. OSHA adopted the safety and health standards published by the American National Standards Institute (ANSI) which included over 20 health standards on air contaminants and one standard on respiratory protection, the Practices for Respiratory Protection, ANSI Z88.2-1969.

NIOSH RDL

In 1975, OSHA and NIOSH initiated a standard completion program (SCP) that provided guidelines on monitoring, personal protective equipment selection, medical surveillance, and training for OSHA enforced permissible exposure limits. The respirator decision logic (RDL), a part of the SCP, lists the assigned protection factor (APF) for various classes of respirators based on the PFs developed by the LASL. OSHA has incorporated these APFs in the agency promulgated health standards such as asbestos, lead, and benzene.

In general, current NIOSH respirator testing and certification regulations require only bench testing. For instance, particle penetration and a face seal tightness tests are performed on negative pressure particulate filter respirators even though these tests may not relate to the respirator performance in the workplace. To determine the performance of respirators during use, NIOSH commissioned several

studies on a variety of devices (Harris, 1974; Blair, 1974; and Toney et al., 1976). The test results indicate that these respirators do not provide the same level of protection as prescribed in the NIOSH RDL.

The first workplace protection factor (WPF) study conducted by NIOSH staff was published in 1983 (Myers et al., 1983). The study was performed on tight fitting powered air-purifying respirators (PAPR) at a silica bagging operation in response to a user complaint. NIOSH determined that the PAPR did not provide an APF of 1,000 and wanted to decertify the device.

NIOSH has also conducted additional workplace studies on approved half-mask negative pressure respirator, half-mask and helmet type PAPRs (Lenhart et al., 1984; Myers et al., 1984; Myers et al., 1984a; Reed 1987) NIOSH found that the helmet type PAPR device did not provide a PF of 1,000. NIOSH used a fifth percentile to determine the workplace protection factor (WPF) that has been widely used as a proposed number for the APF of a given class of respirators ($WPF = GM / (GSD)^{1.64}$; GM = Geometric mean; and GSD = Geometric standard deviation).

Based on the test results of its conducted studies, NIOSH revised the RDL (NIOSH, 1987) with major changes applying to the PAPRs and supplied air respirators (SAR). NIOSH reduced the APF of the half-mask PAPR from 1,000 to 50 and also reduced the APF of supplied air hood and helmet from 1,000 to 25. Since the certification test air flow rate for PAPRs and the SARs are the same, NIOSH also applied the new PAPR APFs to those SARs with the same type of respiratory inlet covering. All tight fitting PAPRs and SARs are assigned an APF of 50. All loose fitting PAPRs and SARs were assigned with an APF of 25. One other change dealt with filtering facepieces (single use, disposable, or maintenance free respirators). NIOSH assigned a PF of 5 for filtering facepieces. An APF of 10 is assigned if the device was able to pass a quantitative fit test. The RDL APFs are shown in Table I. During this time period, many respirator users and manufacturers have conducted workplace studies for approved respirators.

NIOSH issued an update of the Respirator Decision Logic in 2004 (NIOSH, 2005). The major change is to assign a single APF of 10 for the half-mask air-purifying respirator if the wearer has passed the qualitative or quantitative fit test.

SIMULATED WORKPLACE PROTECTION FACTOR STUDIES

After NIOSH began conducting WPF studies, the technical staff of the OSHA decided that, in order to assign appropriate protection factors for different types of respirators, the tests had to be performed under the same controlled test conditions for better correlation. Since respirators are often used under stressful working conditions, such as high temperature, high humidity, and heavy work rate, the test conditions should reflect real use situations. Conducting studies within controlled environmental chamber study would ensure that all respirators are evaluated under the same test conditions, and therefore the results could be compared among different respirators. OSHA and the Nuclear Regulatory Commission (NRC) jointly sponsored a controlled environmental chamber simulated protection factor (SWPF) study that was conducted by the Los Alamos National Laboratory (LANL) (formerly LASL) (Skaggs, 1988).

Seven respirators were selected for this study. The negative pressure respirators consisted of a half-mask and a full facepiece respirator. The positive pressure respirators included a half-mask PAPR, two loose fitting facepiece helmet type PAPR, an abrasive blasting supplied air hood, and a full facepiece pressure demand supplied air respirator (PDSAR). All air-purifying respirators were equipped with HEPA filters. The study was performed in a controlled environmental chamber large enough to allow two test subjects to perform at the same time a variety of exercises that simulate actual work conditions. The test aerosol was di-2-ethyl-hexyl sebacate (DEHS), having an average concentration of 25 mg/m³ and an average mass median aerodynamic diameter (MMAD) of 0.67 micrometer (µm). Three temperature and

two humidity combinations were selected for investigation. They include: 0 °C, 21 °C, 32°C; with 15% and 85% relative humidity. The exercise regimen consisted of five exercises: step up and back down a two-step platform (5 min.); move oiled gravel between two bins (10 min.); pound nails into an overhead board (10 min.); move and lay cinder blocks (10 min.); pound a board with a sledge hammer (5 min.). A five-minute rest period was added between exercises. Twenty-two male and female test subjects participated in this study, but only ten subjects tested each respirator. Test subjects wore hardhat, gloves, safety glasses, safety boots and coveralls during the test.

The test results were in good agreement with WPF studies and the Hyatt data, with the helmet type loose-fitting PAPRs showing low protection and the half-mask PAPR and the PDSAR providing the highest level of protection. The temperature and humidity had less effect on the PAPRs and SARs than the negative pressure respirators. Under high humidity and temperature, it was thought that sweat would cause the facepiece to slide down the nose, downgrading the protection.

WORKPLACE PROTECTION FACTOR STUDIES

Workplace respirator performance studies were begun during the seventies. These studies can be classified into two phases. The first phase consisted of studies sponsored by NIOSH that included several comprehensive evaluations of respirator effectiveness in coal mines, abrasive blasting operations and paint spray operations (Harris *et al.* 1974; Blair, 1974; Toney *et al.*, 1976). The second phase involved studies conducted by NIOSH staff. Subsequently, other respirator users and a few respirator manufacturers also conducted workplace respirator performance studies for a variety of respirators (Grosslink, 1986; Johnston and Mullins, 1987; Colton *et al.*, 1990; Grabory and Burd, 1993; Wallis *et al.*, 1993).

In 1987, NIOSH proposed a revision of the respirator certification regulations stating that respirators would be certified only after achieving a required WPF in workplace tests (NIOSH, 1987a). Respirator manufacturers and other parties opposed the requirement. However, manufacturers preferred to use workplace studies to assign the PFs (NIOSH, 1987a). In 1991, NIOSH sponsored a public meeting to address this issue (NIOSH, 1991). The following agreements were reached after the three-day conference (Ettinger 1991; Hinds, 1991):

1. It was not possible to identify a representative workplace.
2. There was no standard test protocol.
3. Field testing would introduce: uncontrollable test conditions; a high level of uncertainty; and a large number of poorly defined variables.
4. There was insufficient information to implement a test procedure of this type into a formal certification program.
5. Field testing to determine WPF was in a research stage of development.
6. Simulated workplace testing would be preferred over the workplace testing.

NIOSH decided to use simulated workplace testing for respirator certification. The test protocol has not been finalized yet.

ANSI Z88.2 - STANDARDS

Since ANSI requires that each standard must be revised or reconfirmed every 5 years, the Z88.2-1969 standard was upgraded in 1980 (ANSI, 1980). The APFs presented in Table II is not much different from the Hyatt table, although it placed greater emphasis on performing QNFT. A higher PF is assigned for passing a quantitative fit test using high-efficiency particulate air (HEPA) filters. For continuous flow (CF) or pressure demand (PD) type atmospheric supplying respirators, they can be used up to the

immediately dangerous to life or health (IDLH) concentrations, or up to an APF of 10,000 with an escape provision.

Another update of the ANSI Z88.2 standard was published in 1992 (ANSI, 1992). The APF table (see Table II) combined data from the WPF studies and PFs developed in the Hyatt study. The Z88.2 subcommittee decided to use the results of WPF studies to set the APF. However, not all devices listed in the table were tested in the workplace.

Table II. ANSI and OSHA Assigned Protection Factors

Type of Respirator	ANSI – 1980	ANSI – 1992	OSHA - 2006
Air-Purifying			
Filtering facepiece (disposable, single use)		10	10
Quarter mask	10	10	5
Half –mask	10 QLFT Up to 100 QNFT	10	10
Full facepiece	100 QLFT 100-1000 QNFT	100	50
PAPR – half mask	1000	50	50
PAPR – full facepiece	100-3,000	1,000	1,000
<i>PAPR – Loose fitting facepiece</i>	100-3,000	25	25
PAPR – hood/helmet	100-3,000	1,000	25/1000*
Atmospheric supplying			
Demand SAR - half- mask	10 QLFT < IDLH for QNFT	10	10
Demand SAR - full facepiece	100 QLFT <IDLH for QNFT	100	50
CF SAR – half mask	IDLH value	50	50
CF SAR - full facepiece	IDLH value	1,000	1,000
CF SAR – loose fitting facepiece	IDLH value	25	25
CF SAR - hood/helmet	IDLH value	1,000	25/1,000*
PD SAR – half mask	IDLH value	50	1,000
PD SAR – full facepiece	IDLH value	1,000	1,000
PD SCBA - full facepiece	10,000	10,000	10,000

* The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1,000. This level of performance can best be demonstrated by performing a WPF or SWPF study or equivalent testing. Absent such testing, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

The subcommittee decided to use the workplace studies to form the basis for the number assigned (Nelson, 1996). If workplace studies were available, these formed the basis for the numbers assigned. If no such studies were available, then laboratory studies, design analogies, and other information were used to decide what value to assign. Four WPF studies were available for the half-mask respirators. Four NIOSH conducted WPF studies for the PAPRs were available. There was no WPF data for the atmospheric supplying respirators. Hyatt data and analogies were used for assigning APFs for these respirators.

For the air-purifying respirators, the WPF values for the PAPRs are lower than the Hyatt data. However, the WPF values for the half-mask negative pressure respirators are higher than the Hyatt data. NIOSH conducted workplace PAPR studies were selected to assign PFs for these respirators (Lenhart *et. al.* 1984, Myers *et. al.* 1984, 1984a). The loose fitting facepiece PAPRs showed low workplace

performance due to the design limitations. Two of the four half-mask respirator WPF studies were peer-reviewed NIOSH studies. There were two studies for the filtering facepiece and two studies for the elastomeric facepiece respirator (Lenhart *et. al* 1984, Dixon and Nelson 1984, Nelson and Dixon 1985, Reed *et. al* 1987). Based on the estimate of the 5th percentile WPF for the half-mask respirator, the subcommittee assigned the half-mask respirator with an APF of 10. One NIOSH filtering facepiece study reported a WPF of 3 was rejected for using the QNFT. The test data of the asbestos removal operation indicates that the counting fields have been increased from the required 100 to 500. Based on the equation on asbestos fiber concentration calculation in the OSHA asbestos standard (OSHA, 1988), the author believes that the increased counting fields may reduce the in-mask concentration by a factor of five. This also increases the WPF by a factor of five.

In 1996, another ANSI Z88.2 subcommittee was formed to update the Z88.2 standard and APF values. APFs became the most discussed issue at meetings and several changes were made. The APFs for the half-mask continuous flow and pressure demand SARs have been increased from 50 to 250. The APF for the negative full facepiece respirator was reduced from 100 to 50. Also, the APF for the filtering facepiece was reduced from 10 to 5. The Z88.2 standard was confirmed by the parent Z88 committee in 2003. Two appeals were filed for the filtering facepiece APF. Appeal Hearings have not been conducted yet because of disagreements in selecting the Appeals Panel members.

OSHA'S APF ACTIVITIES

The NIOSH RDL assigns all loose fitting SARs and PAPRs an APF of 25 based on the same certification air flow requirement of 170 lpm. However, NIOSH has not conducted workplace studies on the hood type PAPRs and SARs. The OSHA lead in construction standard assigns the abrasive blasting hood with an APF of 25. However, the ambient lead concentration is much higher than 25 times OSHA PEL during blasting operations. OSHA accepted the study sponsored by a hood manufacturer and raised the APF of the blasting hood to 1,000 for use in lead in construction only.

The pharmaceutical industry has sponsored a simulated workplace study to determine the performance of several loose fitting PAPRs and SARs. OSHA accepted this simulated workplace studies and raises the APF for the hood type PAPRs and SARs to 1,000 for use in the pharmaceutical industry. (Cohen *et al.*, 2001).

There was a legal challenge to the OSHA Cotton Dust standard in the 1980s. One respirator manufacturer requested OSHA to raise the APF from 5 to 10. OSHA denied the request (Tyson 1986). The company petitioned the case to the Court, and the Court denied the petition. The Court's decision was that it is difficult to perform a required user seal check (fit check) on the filtering facepiece. This test can be easily performed on the elastomeric facepiece respirators (U. S. Court of Appeals 1987).

OSHA proposed a revision of the respiratory protection standard in 1994. During a hearing in 1995, OSHA held one day meeting to discuss the APF issue. Subjects discussed included difficulties in measuring respirator performance in WPF studies, statistical uncertainties regarding the distribution of data from the WPF studies, and the problems associated with setting APFs for respirators that will protect all potential respirator users across a wide variety of workplaces and exposure conditions.

The revised OSHA respiratory protection standard was published in 1998 (OSHA, 1998) with the APF table in a separate rule. OSHA published the APF proposal in 2003 (OSHA, 2003). In the proposal, OSHA used the WPF and SWPF data to set the APF by using statistical analysis. Many of the APFs are in agreement with the NIOSH RDL. OSHA proposes that the half-mask elastomeric facepiece respirator and the filtering facepiece would have the same APF of 10. The half-mask PAPR and SARs were given an APF of 50. The full facepiece and hood/helmet type PAPR and SAR were assigned an APF of 1,000.

However, there was a restriction on the APF for the hood/helmet type respirators requiring that these devices must maintain a positive pressure during use. The final OSHA APFs are shown in Table II.

OSHA's APF proposal received a mixed review. The filtering facepiece manufacturers and some users are in favor of the proposal. One hood/helmet manufacturer opposed the testing for maintaining a positive pressure during use. Majority of oppositions are concentrated on the APF for the filtering facepiece. Parties raised oppositions consist of employee representatives and professional industrial hygienists. They addressed the following points (OSHA, 2003a):

1. Filtering Facepiece WPF cited studies do not support an APF of ten for 42 CFR 84 Filtering Facepieces. All Studies were performed on respirators which are no longer approved or available.
2. To date, there have been few WPF studies published in peer reviewed journals on 42 CFR 84 approved filtering facepieces to support OSHA proposed rulemaking filtering facepiece APF of 10. Additionally, none appeared in the OSHA statistical analysis.
3. Elastomeric half-mask respirator provides a better face seal than filtering facepieces, since most elastomeric half-mask respirators are made of more pliable silicone rubber that provides a much better seal on the face. In addition, elastomeric half-mask respirators have three sizes with adjustable head straps and a head cradle to improve stability while the majority of filtering facepieces have one or two sizes and the head straps are non-adjustable. However, filtering facepieces with adjustable metal nose band cannot obtain repeatable fit factors.
4. Filtering facepieces come in many configurations such as a rigid form, soft cap, half fold, flat sheet and accordion fold. Some are equipped with an exhalation valve. Some have a metal band to form on the face. Some have an insert, and the shape and material of the insert varies among models. Only a small fraction of the formed cup shape respirators has been tested at the workplace. Therefore, there is limited information as to how well the other untested filtering facepieces models will function in the workplace.
5. Traditionally, OSHA uses studies conducted by independent organizations such as NIOSH, LLNL, or LANL to change compliance policies or developing standards. OSHA selected 19 WPF studies on elastomeric half-mask respirator and filtering facepieces for statistical analysis. However, few of the filtering facepiece studies are published in peer reviewed journals. Test protocol, sampling and analytical methods vary among studies.
6. Many test sites chosen for these studies were selected on availability only. Moreover, key study attributes such as hot and humid conditions, long work hours, and heavy workload were the exception, not the norm for most of the cited studies.
7. A user seal test (fit check) that is a part of the respiratory protection program can be easily performed on the elastomeric facepiece respirators. However, it is difficult to perform an effective user seal test on the filtering facepiece.
8. There is no standardized test protocol for performing WPF studies.
9. Simulated workplace protection factor studies should be used for developing the APFs since all devices are tested under the same test conditions.

The final rule for the OSHA APF standard was published on August 24, 2006 and became effective on November 22, 2006 (Table II). The filtering facepiece received an APF of 10 with two exceptions on its application. It is not allowed to use for protection against asbestos. Also, the APF is only five for protection against cotton dust. It appears that OSHA has followed the Court's ruling on the Cotton Dust standard (U.S. Court of Appeals 1987).

In the final APF standard, OSHA made point-to-point responses to concerns regarding using WPF studies for performing statistical analysis. OSHA concluded that "the Agency has considered the comments addressing the data and study problems identified by commenters, but does not find that these comments merit rejection of the data or analyses. The studies OSHA analyzed were conducted on employees in actual workplaces who were performing their normal job duties. Consequently, the particle sizes, work rates, work times, and environmental conditions varied among these studies. The Agency has

concluded that using data collected under these various conditions presents a more accurate picture of workplace use of these respirators and is a better measure of the protection provided by half-mask respirators than data collected only from SWPF or other highly controlled studies" (OSHA, 2006).

Dr. Kenneth Brown, who performed the statistical analysis for the APF standard, made the following conclusions in his report: "It was concluded that WPF study has limitations as a measure of respirator effectiveness, because of the Co (ambient concentration) effect, and that workplace studies have limitations for comparison of respirator performance because of uncontrolled sources of variability. Improved guidelines for workplace studies are needed to reduce variability and improve comparability across studies, although the heterogeneity of workplace environments would remain a limitation. Chamber studies, or some other assessment methodology with experimental controls, are needed for a baseline test and comparison of respirators, although workplace studies are essential for validation of respirator effectiveness under usage conditions" (Brown, 2002).

States with their own occupational safety and health programs are required to adopt Federal OSHA standards. In January 2007, the California State Division of Occupational Safety and Health (DOSH) held a hearing to consider the adoption of the Federal OSHA APF standard. Two petitions were filed with the California Occupational Safety and Health Standards Board (OSHSB) to lower the APF for the half-mask respirator from 10 to 5. They stated that not all the APFs specified by the Federal OSHA standard were supported by adequate scientific evidence. The data federal OSHA relied upon was incomplete. The California Occupational Safety and Health Standards Board (OSHSB) reviewed the petitions and found the petitions credible. A hearing was held in December 2007. A final decision has not been issued (CALOSHA Reporter 2007).

CONCLUSIONS

The development of the APF has been a contentious issue in respiratory protection. Some safety and health professionals are in favor of using SWPF studies for assigning respirator protection factors. NIOSH has also decided to use SWPF for respirator certification.

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