

program. Under this proposed rule an operator will not be permitted to use PAPRs as a supplementary control without an MSHA approved respiratory protection program which meets the requirements of § 72.710 and incorporates the information required by proposed § 70.210(a)(2).

c. PAPR Protection Factor

The degree of workplace respiratory protection provided to the wearer by a properly functioning PAPR when correctly worn and used depends on the unit's ability to prevent the contaminant from entering the wearer's breathing zone. In general, the protection factor (PF) expresses PAPR performance as the ratio of the respirable dust concentration outside the respirator facepiece to the concentration inside the facepiece. It reflects the effectiveness of a respirator used in conjunction with a good respirator protection program. For example, a PF of 4 means that the particular respirator will reduce the concentration of respirable dust actually breathed to one fourth of the concentration outside the respirator.

In terms of worker health, there are various forms of the PF. One form is the assigned protection factor (APF). Terry Spear, *et al.*, 2000, defined an APF as follows:

APF is a special application of the general protection factor concept, defined as a measure of the minimum nominal anticipated workplace level of respiratory protection that would be provided by a properly functioning respirator or class of respirators to a high percentage (usually 95% or more) of properly fitted and trained users * * *. The maximum specified use concentration for a respirator is generally determined by multiplying the exposure limit for the contaminant by the protection factor assigned to a specific class of respirator.

In the *NIOSH Respirator Decision Logic* (May 1987), based on simulated laboratory tests and some workplace protection tests (none of which replicated conditions in underground coal mines), NIOSH assigned, helmeted PAPRs, properly worn, a protection factor (APF) of 25. NIOSH made the following cautionary statement:

Despite the fact that some of the PF's [APFs] have a statistical basis, they are still only estimates of the approximate level of protection. It must not be assumed that the numerical values of the APF's presented in this decision logic represent the absolute minimum level of protection that would be achieved for all workers in all jobs against all respiratory hazards. The industrial hygienist or other professional responsible for providing respiratory protection or evaluating respiratory protection programs is therefore encouraged to evaluate as

accurately as possible the actual protection being provided by the respirator (NIOSH, May 1987).

Furthermore, in its *Guide to Industrial Respiratory Protection* (September 1987), published after the *NIOSH Respirator Decision Logic*, NIOSH offered an additional caution with regard to the effectiveness of PAPRs:

Until recently, powered air-purifying respirators were considered positive pressure devices. Field studies by NIOSH as well as others, have indicated that these devices are not positive pressure, and that their assigned protection factors are inappropriately high. (NIOSH, September 1987).

There is virtually no positive pressure in the PAPR. Respirable dust may enter the miners' breathing zone through openings along the side and bottom of the visor, even when it is in the full lowered position. The extent to which respirable dust enters a miner's breathing zone, depends, in part, on the velocity of air provided to the MMU and on the miner's work rate and his or her angle of orientation to the airflow.

NIOSH recommended in their 1987 *Respirator Decision Logic* an APF of 25 for all loose-fitting hood or helmet PAPRs. However, the environmental conditions assumed in NIOSH's estimation of an APF for PAPRs are not consistent with those in underground longwall mining operations, where high air velocities for methane and dust control are common. Other, unique conditions of coal mining (obstructed views and difficulty communicating) will compel miners to lift their visors. Once the visor is raised, the respirator is no longer being worn in accordance with conditions required for an APF of 25.

The actual fit or seal of the respirator helmet to the wearer, repeated work-task motions in confined work spaces, raising the visor, and high air velocities along the longwall face all may significantly reduce the actual degree of respiratory protection provided in the workplace. Therefore, it is imperative that such factors be taken into account when estimating the degree of workplace respiratory protection a PAPR provides to the wearer.

According to Spear (2000) a workplace protection factor (WPF) is:

[a] measure of the actual protection provided in the workplace under conditions of that workplace by a properly functioning respirator when correctly worn and used * * * samples [are] taken * * * while the respirator is being properly worn and used during normal work activities. In practice, the WPF is determined by measuring the concentration inside and outside the donned [worn] respirator during the activities of a normal workday.

An effective protection factor (EPF) is another form of estimate of efficacy of a respirator given its typical use.

According to Spear (2000) an EPF is:

[a] measure of the actual protection provided in the workplace under the conditions of that workplace by a properly functioning respirator, defined as the ratio of concentration outside to concentration inside * * * samples [are] taken * * * during normal work activities, while the respirator is being worn and not worn. Because concentration outside and concentration inside are measured during periods of use as well as during periods of non-use, EPFs are considered as estimates of the effectiveness of respirator use policies, rather than of intrinsic respirator performance capability.

A fourth type of protection factor, a program protection factor (PPF) was presented by 3M. In addition to the variables accounted for in an EPF, a PPF reflects factors affecting the respirator programs effectiveness including:

* * * respirator selection, the respirator design, training, maintenance, storage, supervision, program administration and monitoring, and any other variable that affects program effectiveness. If any of these program elements are deficient, the program protection factor will be adversely affected.

An EPF is predicated upon proper fit and maintenance of a respirator, where a PPF is not. Unlike an APF or a WPF, an EPF reflects the degree of respiratory protection provided by a respirator over an actual work shift given specific occupational environmental conditions, such as the velocity of air provided to control methane and respirable dust, and the time when miners must raise their visors to speak or see, given that a miner performs typical work activities and uses the respirator in a typical manner. Based on MSHA experience and miners' testimony, it is not reasonable to expect underground coal miners to always wear the visor down. Due to this eventuality and MSHA's requirement for an approved respiratory protection program, an EPF study or studies, which reflect the conditions on longwall MMUs, such as high air velocities (*i.e.*, exceeding 800 feet per minute (fpm)), would provide suitable data for determining the effectiveness of PAPRs used there.

Although not specifically discussed in the 2000 proposed rule, MSHA had reviewed each of the more than one dozen protection factor studies submitted in Energy West's 1997 petition for rulemaking. The Agency also reviewed the additional relevant studies submitted by commenters in response to the previous proposed rule, as well as studies MSHA identified. A review of the literature identified the fundamental fact that effectiveness of