

mine and on all major DPM emission sources at each mine in addition to spare equipment. The study found that five mines were already in compliance with the interim concentration limit, and another two mines were already in compliance with the existing lower, final concentration limit.

MSHA predicted that eleven of the 31 mines could achieve compliance with both limits through installation of DPM filters alone. Ventilation upgrades were specified for only 5 of the 31 mines in this study, and then only to achieve the final concentration limit. MSHA projected that compliance with the interim and final concentration limits could be achieved without requiring major ventilation installations such as new main fans and repowering main fans. In the existing standard, the agency based its feasibility projections on an average DPM concentration level of over 800  $\mu\text{g}/\text{m}^3$ . MSHA believes that miners' exposures are now much lower, probably as a result of the introduction of clean engines, better maintenance, and the elimination of interferences as confirmed by MSHA's compliance assistance baseline sampling.

MSHA collected baseline samples at most underground mines with diesel powered equipment. Samples were collected in the same manner as MSHA intends to sample for enforcement under the proposed rule. MSHA found the average exposure (based on  $\text{EC} \times 1.3$ ) in the baseline sampling to be 222  $\mu\text{g}/\text{m}^3$  resulting in greater compliance feasibility with the proposed rule.

In spite of the concentrations observed in the 31-Mine Study, the industry parties in the litigation continued to stress that compliance with the existing standard was infeasible in that DPF systems could not be retrofitted properly and could not effectively achieve regeneration. Some operators also noted that they experienced difficulty in ordering and obtaining DPF systems. MSHA could not confirm these statements, but during the 31-Mine Study, the Agency did not find that mine operators were using filtration devices. Moreover, few mine operators actually contacted MSHA to ask for compliance assistance visits, in spite of the Agency's repeated offers to help. Once MSHA initiated its comprehensive compliance assistance work at underground mine sites, the Agency found that most mines did not have complete information on the available control technologies. Accordingly, MSHA stated in its final report on the 31-Mine Study regarding feasibility:

Compliance with both the interim and final concentration limits may be both technologically and economically feasible for metal and nonmetal underground mines in the study. MSHA, however, has limited in-mine documentation on DPM control technology. As a result, MSHA's position on feasibility does not reflect consideration of current complications with respect to implementation of controls such as retrofitting and regeneration of filters. MSHA acknowledges that these issues influence the outcome of feasibility of controls. The agency is continuing to consult with NIOSH, industry and labor representatives on the availability of practical mine worthy filter technology.

Since this finding, however, MSHA and NIOSH have been working with the metal and nonmetal underground mining community and equipment manufacturers to continually refine and improve application of existing DPM control technology. The Agency has made considerable strides in resolving mine operators' concerns with the mine worthiness of DPF systems.

During data collection for the 31-Mine Study, mine operators also questioned the performance of the SKC sampler, especially in light of modifications to it. Additionally, some commenters requested that MSHA revise its internal sampling methodology and analysis for inspectors and laboratory personnel.

MSHA disagrees. One of the objectives of the 31-Mine Study was to examine the performance of the SKC sampler. The Agency is satisfied with the performance of the SKC cassette in collecting DPM while avoiding mineral dust. NIOSH's laboratory and field data show that the SKC cassette collected DPM efficiently. Under a side protocol of the 31-Mine Study, MSHA tested the efficiency of the SKC cassette in avoiding mineral dust at four mines. In these tests, no mineral dust was measured on the filters of the SKC samplers. This finding was confirmed by NIOSH laboratory tests. However, NIOSH discovered that in many cases, the DPM deposit area was irregular in shape, and the shapes varied among samples. Since the DPM deposit area is used to calculate carbon concentrations attributed to DPM, the varied shapes can cause an error in determining DPM concentrations. With the cooperation of MSHA and the technical recommendations and extensive experimental verification by NIOSH, SKC was able to modify the cassette design to produce a consistent and regular DPM deposit area, satisfactorily resolving the problem.

The fact that the deposit area was assumed constant when in fact there were variations in the boundary (shape) and area of deposit of the SKC cassette

samples taken in the 31-Mine Study affects only the reported concentrations of the carbon values (EC, OC, and TC) because deposit area is used in concentration calculation. The results of the inter-laboratory and intra-laboratory studies that compared the analysis of the punches of those (or any) filters from the SKC cassette are unaffected for two reasons: (1) The deposit area does not enter into the calculations (surface densities of carbon in  $\mu\text{g}/\text{cm}^2$  were compared), and (2) the punches were taken from filters inside the boundary of the area of deposits, where the deposits were uniform.

In their comments to the ANPRM, mine operators continued to emphasize the need for more research on control technology. Additionally, NIOSH commented:

In conclusion, various manufacturers offer the particulate filters for diesel engines rated from 15 to several hundred hp. Although on the market for more than a decade, DPF systems have been only sporadically deployed and tested on underground mining vehicles. The DEEP-sponsored evaluation tests at Noranda BM&S and INCO Stobie Mines are based on our knowledge, the best organized attempts to evaluate DPFs in the underground environment. The results from these tests reveal that the DPF systems that have been evaluated on heavy-duty vehicles powered by engines rated over 277 hp and on light duty vehicles powered by 50 hp engines offer promising technology. However, this technology needs significant additional evaluation and some possible re-engineering for underground mining applications. In-use deficiencies, secondary emissions, engine backpressure, DPF regeneration, DPF reliability and durability are major issues requiring additional research and engineering. In addition, it is been found that deployment of most systems, particularly those which require active means of regeneration, require major changes in miners' attitudes toward engine and DPF maintenance. NIOSH's DEEP experienced showed that emission-based engine maintenance, greater discipline on the part of the vehicle operator, and better operational logistics (e.g., multiple locations of regeneration stations for a single vehicle) are imperative for success of DPF technology.

To the contrary, the NIOSH comments in response to the ANPRM include a summary of their experience with retrofitting existing diesel powered equipment. NIOSH acknowledges that although diesel particulate filters have been available to U.S. mines for many years, they have not been extensively used and documented. NIOSH states that in-mine experience with filters is limited, but NIOSH also related their experience with the Diesel Emissions Evaluation Program (DEEP) in Canada. NIOSH stated: