contamination and no information about the potential for fiber release and future air levels. Moreover, the use of air monitoring as an assessment tool involves substantial technical and economic problems which limit its use even for determining current levels of contamination.

As noted in Chapter 1, a list of procedures (protocol) for measuring asbestos in industrial settings has been developed by the National Institute for Occupational Safety and Health (NIOSH) in connection with the OSHA asbestos exposure standard. The NIOSH protocol employs phase contrast microscopy (PCM) for asbestos measurement. The major shortcomings of PCM are that it cannot distinguish between asbestos and nonasbestos fibers or resolve fibers with diameters less than 0.3 micrometers.* In addition, the NIOSH measurement protocol is not designed to count fibers shorter than 5 micrometers. Many airborne fibers in buildings with asbestos-containing materials are likely to have dimensions which fall outside these limits. In addition, fibers from carpets, clothing, hair, paper, books, and many other sources are likely to be present. As a result, PCM analyses of air inside these buildings could be highly misleading.

Methods for measuring small as well as large fibers and for distinguishing asbestos from nonasbestos fibers have been developed and used in various research studies. They use electron microscopy (EM) (specifically, transmission electron microscopy) to measure fibers, and both chemical and crystallographic analyses to identify asbestos minerals.† Air sampling procedures involve sampling at several sites for extended periods and, frequently, collecting several samples at each site. EPA has used these sampling procedures and EM under experimental conditions to establish baseline asbestos levels in various indoor and outdoor settings, and, as discussed above, to validate subjective rating approaches to assessing fiber release. Technical bulletins will be issued by EPA as air sampling and EM protocols are refined. Even then, the difficulty of sampling in occupied buildings and the number of samples needed to detect peak as well as prevalent airborne levels may preclude the use of air monitoring for routine assessment. The cost of EM analysis is high (about $500 per sample), and few laboratories are qualified to perform it. Given these limitations, EPA does not recommend the use of air monitoring for assessment purposes at this time.

3.3 Asbestos Control Measures

Developing and implementing an effective strategy to correct asbestos exposure problems requires detailed information on the applicability and relative costs of alternative control measures. New information on these subjects is presented in this section for each of the four generic approaches to asbestos control: (1) material removal, (2) material enclosure, (3) material encapsulation, and (4) special operations and maintenance practices combined with periodic reassessment of asbestos-containing materials. These approaches are applicable both to material sprayed or troweled on surfaces and to pipe and boiler insulation. However, control problems created by the two categories of asbestos-containing materials are different enough to warrant separate treatment here.

3.3.1 Control Alternatives for Material Sprayed or Troweled on Surfaces

Although each of the four approaches to asbestos control is a distinct alternative, they share several features. The first is the need to conduct a detailed inspection of both the asbestos-containing material to be treated and the underlying surface. Such an inspection should be

*A micrometer is one-millionth of a meter. See Appendix A for a simple discussion of measurement units used to describe and measure asbestos fibers.

†A provisional protocol for EM measurement of asbestos has been developed by EPA (Samudra, et al 1977).

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