Dr. George Guthrie's Preliminary Comments

Chapter 2 provides a discussion of the mineralogical and geological aspects of Libby amphibole. In general, the section can be significantly improved relative to clarity and accuracy.

Section 2.1 is generally sufficient for providing a background relative to historical aspects of the operations.

Section 2.2 needs significant modification. This section should lay a foundation for understanding the nature of Libby amphibole (e.g., mineralogical characteristics such as composition and morphology), information on how the material may vary spatially and temporally (with respect to mining operations), and other factors that may impact exposures. The section does contain much relevant information. However, there are parts of the section that are incorrect and misleading; general suggestions to address these issues include:

- *Adopt a tight and consistent use of terminology associated with particle morphology.* The section mixes a number of terms that address particle morphology, and these are critically important in assessing potential exposures and subsequent impacts. (As an example, "fibers (e.g., acicular…" implies fibrous and acicular are the same, when in conventional usage they are different. See, for example, Veblen and Wyllie, 1993.) A tight use of terms that are defined up front should be followed, recognizing that a lax use of terms may nevertheless exist in the literature cited. A partial attempt is provided in section 2.2.1.2, but it could be expanded and carefully vetted with respect to accepted terminology. The three most important types to lay out clearly are fibrous, acicular, prismatic, and asbestiform. If the report's intent is to note differences in these terms, they should be discussed; if the conclusion is that there are poorly defined distinctions, that could be discussed too. One specific example of inaccurate usage is: prismatic, which by definition is "prism" shaped (meaning <u>parallel</u> sides; it is incorrectly used in multiple places).
- *Double-check all mineral formulae.* There are numerous incorrect compositions in the report; although some of these may be typos (which, of course, should be fixed), some may be incorrectly reported. An example of one incorrect formula is that attributed to vermiculite (which is listed incorrectly as: $[(Mg,Fe,A)_3(Al,Si)_2O_{10}(OH)_2 \bullet 4H_2O]$.
- *Double check that all mineral-species definitions are accepted mineralogical standards.* Mineral species are fundamental terms that describe a material with a specific structure and a specific composition or ranges of compositions; both factors are primary determinants of a material's properties. Indeed, at the heart of this report is the definition of likely exposures to (and risks from) inhaled particles based on the use of mineral species names. The problems in this category are probably most rampant in

section 2.2.1.1, which details amphibole mineralogy (central to the report). For example, anthophyllite is not a Li-amphibole.

Overall, the mineralogy section needs significant technical editing. It presents some irrelevant material (e.g., section 2.2.1, which is a general description of silicate mineral hierarchy), omits some critical information (e.g., section 2.2.1.1 does not provide the mineralogical definitions of key minerals like winchite or richterite), and presents some erroneous and irrelevant (e.g., some of the vermiculite-mineralogy descriptions in section 2.2.2).

In the context of the information on the Libby material, the report is better. One specific observation that could be added is one reported by Sanchez et al. (2008), namely that they observed no correlation between morphology (fibrous vs. prismatic) and major-/minor-element chemistry. In other words, this is consistent with the implication that the large set of compositional data from Meeker et al. (2003) shown in the report reflects the range of compositions associated with inhaled-fiber exposures.

Finally, Figure 2-12 shows morphology data (CDFs) for particles as reported by U.S. EPA (2010). It might be useful to compare these with other morphology data that are cited in report (e.g., Amandus et al. (1987)), which show a different distribution. Have exposures evolved with respect to particle morphology?