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vi 2" Paragraph: "It remains uncertain whether other thoracic-sized EMPs, especially those EMPs with mineralogical compositions similar to the asbestiform minerals, warrant similar health concern."	The Occupational Safety and Health Administration, Mine Safety and Health Administration and the Consumer Products Safety Commission have examined the science and concluded that the nonasbestiform mineral- habits of the asbestos minerals do not present an asbestos-like health concern. Based on the current science and supported by the findings of the agencies listed above, NSSGA believes that there is certainty with respect to the health effects associated with exposure non-asbestiform EMPs. With that said, we are pleased that NIOSH is prepared to re-examine their long-standing position on this issue.	The revised draft *Roadmap* provides a general overview of the state of the science and identifies uncertainties and gaps in the available knowledge. Based on this review, additional research and analyses are appropriate to more fully inform recommendations for worker exposures to nonasbestiform minerals.	No revision
vi 3rd Paragraph: "In 1990, NIOSH revised its recommendation concerning occupational exposure to airborne asbestos fibers. At issue were concerns about potential health risks associated with worker exposures to EMPs with mineralogical compositions similar to those of the asbestos minerals and the inability of the analytical method routinely used for airborne	NOSH does not identify which worker exposures (specific studies) gave it concern about potential health risks to nonasbestiform minerals. The inability to differentiate EMPs from asbestos should not be a reason for treating nonasbestiform minerals as if they were asbestos. The development of more asbestos-specific analytical methods should be a focus of the proposed research.	In testimony to OSHA in 1990, NIOSH stated several reasons for concern about exposure to asbestos fibers and particles from the nonasbestiform analogs of the asbestos minerals (Section 1.5.1.3.1). These included: 1) evidence of respiratory disease among workers exposed to asbestos and other EMPs; 2) experimental animal studies with various minerals in which particle dimension (length and width) where shown to be critical parameters in determining a mineral particle's carcinogenic potential and 3) the inability to adequately distinguish between airborne exposures to particles from asbestiform and nonasbestiform minerals. NIOSH recognizes that the 1990 revision of its REL to explicitly	No revision

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fibers (i.e. phase contrast microscopy (PCM)) to differentiate between these other EMPs and fibers form the asbestos minerals. "		include the nonasbestiform analogs as covered minerals lacked definitive scientific data. Thus, NIOSH was motivated to develop the *Roadmap* with the expectation that a comprehensive and detailed review and assessment of available published scientific literature and other evidence will be undertaken.	
vii 18' Paragraph: NIOSH also wishes to minimize any potential future confusion by no longer referring to particles from the nonasbestiform analogs of the asbestos minerals as 'asbestos fibers: In a clarified REL presented in this Roadmap, NIOSH avoids referring to particles from such nonasbestiform minerals as 'asbestos fibers' and clarifies that particles meeting the specified dimensional criteria remain countable under the REL even if they are derived from nonasbestiform minerals. "	It appears that NIOSH agrees that nonasbestiform mineral analogs of the asbestos minerals are not asbestos but it also appears from the statement above that the distinction will not be deemed relevant for the purposes of determining RELs. The distinction between asbestiform and non-asbestiform particles as it relates to their potential to cause disease is a key issue in this research and should not be presumed until the research is complete.	NIOSH agrees with the commenter's statement that: "The distinction between asbestiform and non-asbestiform particles as it relates to their potential to cause disease is a key issue in this research and should not be presumed until the research is complete." However, NIOSH disagrees with the commenter's assertion that: "It appears that … the distinction will not be deemed relevant for the purposes of determining RELs." In fact, as has been stated in the revised draft *Roadmap* (p. i), results of the research will "provide a sound scientific foundation for future policy development," which would include potential revision of the current REL. It was never the intent that the *Roadmap* itself would establish new or revised policy concerning the current NIOSH REL.	No revision
vii-viii 2nd Paragraph: "More sensitive analytical methods are currently	This effort needs to be a research priority for NIOSH since the current method is counting non-asbestos as asbestos which	As discussed in detail in Section 2.4 of the revised draft *Roadmap*, development and validation of analytical methods is a stated	No revision

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available but these methods will require standardization before they can be recommended for routine analysis. In addition, any substantive change in analytical techniques used to evaluate samples and/or the criteria for determining exposure concentrations will necessitate a reassessment of current risk estimates derived from fiber concentrations based on PCM.	misdirects resources away from true asbestos exposures and will undermine the protection of worker health.	priority.	
viii 2nd Paragraph: ". . .results from epidemiological studies do not provide entirely clear answers regarding potential toxicity of EMPs from the nonasbestiform analogs of the asbestos minerals. Due to various study limitations, NIOSH has viewed findings from relevant epidemiological studies as providing inconclusive as opposed to either positive or negative, evidence regarding health	With respect to mesothelioma, the Homestake Goldmine and New York talc cohorts are extremely strong negative studies indicating an absence of this hallmark asbestos disease even with considerable exposure to amphiboles (cummingtonite-grunerite and tremolite respectively). The published, peer reviewed taconite studies do not have sufficient latency for mesothelioma to be seen and so are less relevant with respect to mesothelioma. The Homestake Goldmine EMP exposure was not inconsequential. The incidence of silicosis and silicotuberculosis deaths and disease in the cohort demonstrates that exposures	The NIOSH rationale for considering the findings from these studies as "inconclusive," rather than negative (or positive), are discussed in the revised draft *Roadmap*. This characterization of the epidemiologic evidence is well justified. The commenter considers the evidence to be convincingly negative. The review article by Gibbs and Gamble reaches a similar conclusion that "the weight of evidence fully supports a conclusion that non-asbestiform amphiboles do not increase the risk of lung cancer or mesothelioma." However, as described in the revised draft *Roadmap* in Section 1.5.1.3.2, the available evidence provides far more	No revision

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hazards associated with exposures to EMPs from nonasbestiform amphiboles."	to the silica-amphibole rich ore deposit was significant for many decades yet there is an absence of asbestos-related disease. A critique of the original NOSH mortality study on Homestake is attached and it clearly shows the exposures to Homestake miners in the early 1900's through the 1970's were significant. The tremolite cleavage fragment exposure of the New York talc workers was also considerable. This level of exposure is evident from the non-malignant dust diseases found in mortality studies of these workers. This deposit contains up to 60% tremolite and yet there are no asbestos-related diseases in the miners and millers. A complete, peer-reviewed published article on the epidemiological differences between asbestos and cleavage fragments by Drs. Graham Gibbs and John Gamble is included in these comments to NIOSH. Based on the studies referenced, NSSGA does not understand the basis upon which NIOSH considers this science inconclusive and would welcome additional dialogue on this issue.	ambiguous results. An excess of lung cancer has been observed in the studies of New York talc miners. Also, a small but statistically significant excess of lung cancer was observed in the most recent update of the study of Homestake gold miners. These findings have been dismissed by some reviewers, primarily because of the lack of an exposure-response relationship between dust exposure and lung cancer in these studies. However, the use of dust exposure (e.g., mppcf) as a dose metric for lung cancer is a poor surrogate for EMP exposure unless dust measurement data can be specifically correlated with measurements of EMP. Adequate exposure data to correlate EMP exposures with dust measurements are not available from studies of RT Vanderbilt. In addition, in the studies of NY talc miners it appears likely that there was misclassification of exposures because miners may have had prior work in other talc mines with higher exposures. This misclassification of exposures may have resulted in a distortion of the exposure-response relationship. Interpretation of the findings from the studies of NY talc miners is further complicated by the presence of asbestiform anthophyllite and tremolite in the mines. Finally, the lack of information on cigarette smoking habits is an important limitation of these studies.	

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		There have been reports of an excess in mesothelioma in the counties where the New York talc mines and the Minnesota taconite mines are located. There is evidence of an excess of mesothelioma among the Minnesota talc miners. There have only been a few mesothelioma cases reported in studies of the South Dakota gold miners. The primary problem with interpreting past studies on mesothelioma is the fact that there was no specific ICD code for mesothelioma until 1999. In regards to the NIOSH mortality study of workers at Homestake, some information exists on the relationship between dust measurements (mppcf) and EMP exposures [Zumwalde et al. 1981]. An industrial hygiene study was conducted to develop a correlation between dust concentrations (mppcf) and EMP exposures (f/cm^3). Impinger samples were simultaneously collected with airborne samples used for asbestos determination (PCM analysis). The correlation developed between dust and EMP concentrations was used to estimate past fiber exposures using dust measurement data that had been collected at Homestake from 1939 to 1974. An increase in fiber concentration was observed with an increase in dust concentrations. However, there is some uncertainty with the interpretation of this correlation since dust	

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		measurement data were based on short-term samples (15-minute) collected at a specific job task and thus may not be representative of longer-term current dust concentrations (mppcf) at that task or past dust exposure measurements. NIOSH anticipates that opportunities for additional dialogue on the epidemiology studies will be available within the study groups proposed in the revised draft Roadmap.	
Page 12 1.5 Components of the NIOSH Recommendation for Asbestos	NIOSH appears to use an arbitrary set of dimensional counting criteria as a definition of asbestos but these dimensions do not define asbestos and do not relate to health effects. The NSSGA respectfully requests NIOSH (and NAS) to research the origins of these counting criteria (Walton 1982) to verify that they do not define asbestos and more importantly do not relate to health risk. Misusing the counting criteria as a definition of asbestos means that all common antigorite, riebeckite, cummingtonite-grunerite, tremolite, actinolite and anthophyllite will be considered to be asbestos unless their rock fragments are less than 5 microns long or have an aspect ratio that is less than 3. This is not consistent with mineralogical or health risk based science and will be less protective of human health because	The purpose of Section 1.5 of the revised draft *Roadmap* is to describe the existing NIOSH recommendations for worker protection as laid out in 1990. Later, in Sections 1.7 and 1.7.1, the many limitations of the analytical counting method are discussed, including that the count from PCM is an index of exposure which is not optimal for protecting workers and does not differentiate between particles of different mineralogy or consistently count particles of known toxicity. The research framework presented in Section 2.5 clearly indicates that any sampling and analytical method chosen to replace the current PCM method will need to represent the known determinants of particle toxicity.	No revision

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	resources will be diverted to address exposures that do not cause disease.		
Page 13 1.5.1 Minerals Covered by the NIOSH REL	NIOSH specifically includes the nonasbestiform analogs of the asbestiform minerals (the serpentine minerals antigorite and lizardite, and the amphibole minerals contained in the cummingtonite-grunerite mineral series, the tremolite-ferroactinolite mineral series and the glaucophane-riebeckite mineral series) in the definition of asbestos without any cellular, animal or epidemiological studies cited as support for this broadening of the asbestos definition. As we have done in the past, NSSGA respectfully requests any reports or articles in support of the broader definition so that we can better understand NIOSH's position on this issue. The following is an excerpt from the OSHA 1990 public hearing: Question: "Now let me turn to the NIOSH definition of minerals to be included as asbestos in your testimony. This definition includes new minerals such as antigorite which have not before been proposed for regulation; is that correct?" Richard Lemen [formerly] of NIOSH 'Yes" Question: *And am I correct in thinking that NIOSH is the only government agency that has made this proposal?" [And it still is]. Richard Lemen: "As far	As discussed in the revised draft *Roadmap* (p. 61), "NIOSH recognizes that its descriptions of the REL since 1990 have created confusion and caused many to infer that the additional covered minerals were included by NIOSH in its definition of "asbestos." For this reason, the revised draft *Roadmap* includes a clarification of the current REL for airborne asbestos fibers and related elongated mineral particles) (underlining added for emphasis), which makes clear that "EMPs included in the count are not necessarily asbestos fibers." However, as it was not the intent of the *Roadmap* to revise existing NIOSH policy, the nonasbestiform analogs remain covered minerals under the clarified NIOSH REL (for asbestos fibers and related elongated mineral particles). Also, while it was not the intent of the *Roadmap* to defend the current REL, the basis for NIOSH's 1990 change in policy to include the nonasbestiform analogs as covered minerals is summarized in Section 1.5 of the revised draft *Roadmap*. The two 1990 NIOSH references cited in Section 1.5.1.3.1 have been made available by NIOSH at http://www.cdc.gov/niosh/review/public/099/pdfs/asbestos_testimony_May9.pdf and http://www.cdc.gov/niosh/review/public/099/	No revision

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	as we know. I can't be certain of that." Question: Would you agree that for antigorite, one of these minerals, that there are no studies showing a positive cancer effect similar to asbestos?" Richard Lemen: That is true. And the reason that they are included is because of cleavage fragments. " Question: "Let me ask you as to a number of other of these. With respect to cummingtonite-grunerite, and riebeckite, would you also agree that there similarly are no studies showing a positive cancer effect similar to asbestos?" Richard Lemen: "This is true."	pdfs/AsbestosTestimony_April%209_1990.pdf. Each of these documents includes a list of the references that NIOSH cited to support explicit coverage under the REL of the nonasbestiform minerals. NIOSH recognizes that the 1990 extension of its REL to explicitly include the nonasbestiform analogs as covered minerals lacked definitive scientific underpinning, and that some relevant subsequent research has been carried out since 1990. Thus, NIOSH was motivated to develop the *Roadmap*. It is anticipated that comprehensive and detailed review and assessment of available published scientific literature and other evidence will be undertaken as part of the research programs proposed in the *Roadmap*.	
Page 14 1.5.1.1 Chrysotile	This discussion regarding chrysotile focuses more on the differences in potency between amphiboles and chrysotile and does not address the differences in asbestos related mortality between chrysotile miners and chrysotile textile workers. In the Quebec chrysotile mines, the primary mineral present is not chrysotile (-5%) but rather antigorite and lizardite (90-95%). In the early studies of exposure to chrysotile miners, the exposure was measured in million particles per cubic meter (mppcf) of air	In Section 1.5.1.1, the revised draft *Roadmap* acknowledges the differences in lung cancer risk reported in worker populations exposed to chrysotile including the Quebec miners and chrysotile textile mill workers. It also discusses a several explanations for these different risks. The commenter suggests that the Quebec miners were exposed primarily to EMPs from antigorite and lizardite (the nonasbestiform analog minerals of chrysotile) and not primarily to chrysotile fibers. The commenter further suggests that this misidentification contributed to a lower dose-	The following sentence was added to the revised draft *Roadmap* "It has also been proposed that the observed differences between the textile mills and the chrysotile mines is that exposures in the textile mills are almost exclusively

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	using an impinger. Most of those particles would have been antigorite not chrysotile, In the conversion of mppcf to fibers per cubic centimeter, this mineralogical fact was not considered therefore much of the antigorite-lizardite was incorrectly counted as asbestos which inflated the "asbestos" dose and resulted in a faulty dose-response relationship for the chrysotile miners. See attached publication: Mineralogy and size of airborne chrysotile and rock fragments: Ramifications of using the NIOSH 7400 method. Wylie and Bailey 1992. The case described above calls into question NIOSH's position that antigorite and lizardite should be regulated as if they were asbestos. This position is not consistent with the fact that very large exposures to antigorite and lizardite "fibers" in the chrysotile miners (much higher than asbestos exposures to the textile workers) resulted in significantly lower asbestos-related mortality,	response slope for the miners compared to the textile workers. The differences in types of particles the workers are exposed to in the textile mills are a potential cause of the observed differences in risk that needs to be investigated. It is anticipated that a comprehensive and detailed review and assessment of available published scientific literature and other evidence will be undertaken as part of the research programs proposed in the *Roadmap*.	to chrysotile asbestos while the exposures in the mines are to a mixture of chrysotile asbestos and related nonasbestiform minerals (Wylie and Bailey 1992)."
Page 15 1.5.1.2 Amphibole Asbestos and Other Fibrous Minerals	The NSSGA supports the inclusion of all asbestiform amphiboles and asbestiform erionite in any asbestos regulation as long as the term asbestiform is applied in its mineralogical definition: Asbestiform mineral populations generally have the following characteristics when viewed by light microscopy: 1. Many particles with	The commenter recommends a definition for asbestiform fibers as determined by light microscopy. The recommendation has some mineralogical merit and may be applicable when attempting to describe a population of mineral fibers. However, its applicability to identifying individual particles on air samples is not clear. However, it has never been	No revision

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	aspect ratios ranging from 20:1 to 100:l or higher for particles > 5 microns in length. 2. Very thin fibrils generally 5 0.5 microns in width 3. In addition to the mandatory fibrillar crystal growth, two or more of the following attributes: a. Parallel fibers occurring in bundles b. Fibers displaying splayed ends c. Matted masses of individual fibers d. Fibers showing curvature The above definition of what asbestiform is mineralogically is found in the 1993 EPA asbestos bulk analysis method and the NIST certificate in its asbestos standards.	intended that the *Roadmap* itself would revise existing NIOSH policy. An important objective of the *Roadmap* is to conduct research to identify the important characteristics (e.g., dimension) of EMPs that are related to a toxicological outcome. If effects are observed based on specific particle characteristics, it is anticipated that appropriate guidance will be developed for describing those particle characteristics as precisely and accurately as possible from a mineralogical perspective.	
1.5.1.3.1 Rationale for NIOSH Policy	The NSSGA does not understand NIOSH's rationale for its position of equating common rock cleavage fragments, based on counting criteria dimensions that do not relate to health risk or mineralogy, to asbestos in light of the overwhelming evidence that there are substantial health differences between these mineral habits or forms. NSSGA is not aware of any science or data that lends support to NIOSH's position and we offer the following in support of our position that exposure to non-asbestiform cleavage fragments or EMP's does not cause the same health effects as exposure to asbestos: These cellular, animal and human studies are very consistent in what they reveal - asbestos and their	While it is not the intent of the *Roadmap* to defend the current REL, the basis for NIOSH's 1990 change in policy to include the nonasbestiform analogs as covered minerals is summarized in the revised draft *Roadmap* (Section 1.5). The two 1990 NIOSH references cited in Section 1.5.1.3.1 have been made available by NIOSH at: http://www.cdc.gov/niosh/review/public/099/pdfs/asbestos_testimony_May9.pdf and http://www.cdc.gov/niosh/review/public/099/pdfs/AsbestosTestimony_April%209_1990.pdf. Each of these documents includes a list of the references that NIOSH cited to support explicit coverage under the REL of the nonasbestiform minerals. NIOSH recognizes that the 1990 extension of its REL to explicitly include the	No revision

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	nonasbestiform analogs are not equal in potency and the findings do not support NIOSH's position on cleavage fragments.	nonasbestiform analogs as covered minerals lacked definitive scientific underpinning, and that some relevant subsequent research has been carried out since 1990. Thus, NIOSH was motivated to develop the *Roadmap*. It is anticipated that comprehensive and detailed review and assessment of available published scientific literature and other evidence will be undertaken as part of the research proposed in the *Roadmap*.	
	Ten epidemiological studies of Homestake gold, New York talc and Minnesota taconite miners and millers that had significant nonasbestiform amphibole exposures meeting the counting criteria of a fiber yet do not show an asbestos-related disease or dose-response relationship. In addition, the chrysotile miners, exposed to significant levels of antigorite and lizardite cleavage fragments (as well as chrysotile asbestos) do not show the same exposure response as other chrysotile exposed cohorts. Since NIOSH's position is that antigorite and lizardite are equally potent to asbestos if the rock fragments fit the counting criteria, one would expect to see this reflected in the published mortality studies of chrysotile miners and millers.	The epidemiologic studies of Homestake gold miners, New York talc miners, and Minnesota taconite miners are discussed in responses to other comments (above). Contrary to the commenter's assertion, these studies do not provide convincingly negative evidence. With respect to the commenter's argument about the studies of chrysotile miners, it is true that, while an excess of mesothelioma and lung cancer has been observed in studies of Canadian chrysotile, the lung cancer exposure-response was much weaker than in the studies of South Carolina textile workers (who were, for the most part, exposed to Canadian chrysotile). The commenter suggests that the Quebec miners were exposed primarily to antigorite and lizardite (the nonasbestiform analog minerals of chrysotile). As stated in a previous response, the reason for the difference in lung cancer risk between	No revision

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		the miners and textile workers is not known. Several explanations have been cited in the revised draft *Roadmap*, including suggestions that the increased risk in lung cancer for the textile workers was a result of longer, thinner chrysotile fibers. The qualitative differences in the particles to which the workers were exposed has been added to the revised draft *Roadmap* as a potential explanation.	
	2. Six animal studies where eight samples of nonasbestiform tremolite and one sample of nonasbestiform actinolite were either injected or implanted in the pleura or instilled in the trachea in either rats or hamsters without causing tumors. This is in contrast to studies where asbestiform tremolite and asbestiform ferroactinolite demonstrate the potent ability to generate tumors in either rats or hamsters by any route of administration, Samples that were mixed asbestiform and nonasbestiform also demonstrated the ability to cause tumors. A complete, peer reviewed literature review of the animal studies relevant to this issue by John Addison and Dr. Eugene McConnell is enclosed with these comments to NIOSH.	The revised draft *Roadmap* has addressed the *in vivo* responses to asbestiform vs nonasbestiform amphiboles in the section entitled "Studies comparing EMPs from amphiboles with asbestiform versus nonasbestiform habits." The literature review presented in this section is considered balanced.	No revision
	There are fourteen in vitro studies or reviews of the science that contrast the toxicological outcome between the	The revised draft *Roadmap* briefly presents *in vitro* data showing positive responses (page 45, line 31) and negative responses (page 46,	No revision

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	asbestiform and nonasbestiform habits of the same minerals. Most of these studies involve chrysotile and its nonasbestiform counterpart, antigorite, crocidolite and its nonasbestiform counterpart, riebeckite and amosite and its nonasbestiform counterpart, cummingtonite-grunerite. These studies were conducted in a variety of species and cell types including hamster tracheal explants, hamster tracheal epithelial cells, rat lung epithelial cells, rat and hamster alveolar macrophages, rat pleural mesothelial cells, sheep.red blood cells, and Chinese hamster ovary cells. All of these studies clearly show a marked toxicological difference between the nonasbestiform and asbestiform habits of the same minerals. A complete, peer-reviewed published article covering the in vitro studies relevant to this issue by Dr. Brooke Mossman is enclosed with these comments to NIOSH.	line 6) to nonasbestiform amphiboles. The *in vitro* section of the revised draft *Roadmap* is presented to review possible mechanisms of action for fiber toxicology. In general, *in vitro* responses to fibers are not viewed as very predictive of *in vivo* response and are not relied upon for risk assessment. Therefore, little would be gained by adding data from additional *in vitro* studies.	
Page 24 Lines 24 - 37	We do not concur with NIOSH in relating a slight increase in lung cancer to exposures at the Homestake mine when there is no exposure-response relationship observed and smoking is not taken into account. NIOSH appears to further understate the importance of the Homestake studies by implying that the dust exposure did not contain enough	There was no intent to imply in the revised draft *Roadmap* that the slight increase in lung cancer risk observed in the Homestake mines was necessarily related to exposures at the Homestake mine. In fact, the revised draft *Roadmap*'s review of the Homestake mine studies concluded that "the studies of Homestake gold miners provide at best weak evidence of an excess risk of lung cancer."	No revision

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	EMPs to see a response. In a critique of the first NIOSH study of Homestake (enclosed) it is reported that NIOSH, citing a 1974 Mining Enforcement and Safety Administration (MESA) fiber survey, states that the average > 5 micron long fiber concentration was found to be 0 -25 fibers/cc with the highest value at 2.8 f/cc. These 1974 data do not represent the historical exposure levels. Homestake mine data from 1937 - 1951 indicate that dust exposures (and concurrent EMF exposures) were 8 times higher than those in 1974 when MESA did its fiber survey. Homestake mine data on ventilation in the mine show that the dust exposures from 1924-1932 were approximately 16 times higher than what was present in 1974 and those for the period 1916 -1 923 were 20 times higher. This is not an insignificant exposure to dust as the silicosis incidence in Homestake studies also indicate. NSSGA believes that the Homestake studies are important and the results should be carefully considered by NIOSH moving forward.	The commenter's assertion that it is difficult to interpret these findings without information on cigarette smoking is consistent with the revised draft *Roadmap*'s review of the Homestake mine studies, which noted that the limited data available suggest that workers may have smoked more than the general population which was used as the referent. In fact, this was one of the major limitations for all of the studies that discussed on page 27 of the revised draft *Roadmap*, in the summary discussion of studies of cohorts exposed to nonasbestiform EMPs. There was no intent that the revised draft *Roadmap* imply, as asserted by the commenter, that "dust exposure [at the Homestake mine] did not contain enough EMPs to see a response," and any inference by the commenter that this is implied is not supported by the content of the revised draft *Roadmap*. As stated in a previous response, NIOSH conducted an industrial hygiene study at Homestake to determine whether it was possible to correlate dust measurement exposures with EMP counts using PCM. The correlation indicated an increasing EMP concentration with increasing dust concentrations (mppcf). However, the accuracy of the correlation was not clear because dust measurement data represented a 15-minute sample for an 8-10 hr job task.	

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Page 27 Lines 1 8-20	What is the scientific basis for the following statement in the NIOSH Roadmap?: "However, dust exposures are a very poor surrogate of exposure to nonasbestiform EMPs in these settings. In a 2005 investigative report by MSHA on a taconite mine (enclosed), the following statement is made following analysis of this relationship: "These regressions indicate that the specific relationship between respirable dust and fiber concentration varies depending on the material being supplied to the plant. However, regardless of the material, the fiber concentration increased as the dust concentration increased."	Historically, the evaluation of exposures in the workplace included the measurement of airborne "dust" by the collection of impinger samples (mppcf) or respirable/total dust samples (mg/m^3). Although these measurement data provide some evidence of "dustiness" in the work environment, the data frequently are incapable of providing the necessary exposure index necessary for conducting risk assessments, especially when the "dusts" contain specific hazardous materials (e.g., quartz, asbestos) of interest. Studies have shown that airborne dust concentrations, as well as the constituents and characteristics (e.g., dimension) of the "dust," can vary by the process or work task in which the dust is generated. Without knowing the specific constituents of the dust at each emission source, it is difficult to assign appropriate exposure indices (i.e., agents of interest) to the specific job or task that are needed to assess risk for a particular group of workers. In studies where the results of "dust" measurements were used with some success to assess worker's risk, supplementary exposure data on substances of interest had also been collected and a statistical relationship developed between the substance(s) of interest and "dust" concentrations. The MSHA 2005 exposure study at a taconite mill illustrates the type of correlation that can be made between	The sentence on page 21: "Although the Honda study was based on reconstructed exposures to respirable dust, these exposure estimates may not be correlated with exposure to EMPs." And the sentence on page 26 "However, dust exposures are a very poor surrogate of exposure to nonasbestiform EMPs in these settings." Have been replaced in the revised draft Roadmap to further explain the potential to attenuate the exposure-relationship by using surrogate data with the following: "Relationships

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		respirable dust concentrations and fiber exposures. Based on the results of samples collected in 6 areas of the mill, a variable, but increasing trend, in fiber concentrations was observed with increasing respirable dust concentrations. Although this observation is based on only 2-days of sampling, the correlation between respirable dust concentrations and asbestos fiber concentrations can provide a means for estimating fiber exposures based on any future measurements of respirable dust that might be taken at these locations in the mill. However, the usefulness of these correlations for assessing the risk of chronic respiratory disease to asbestos is limited and predicated on the availability of historical respirable dust measurement data collected in these same work areas using the same measurement method. The difficulty in using dust measurement data collected at the RT Vanderbilt talc mine and mill for evaluating risk of lung cancer from asbestiform fibers is that historical respirable dust measurement data are based on the collection of very few samples that used different sampling and analytical methods. The inability to correlate contemporary respirable dust measurement data with historical dust measurement data hinders the usefulness of using respirable dust measurements as a surrogate for past asbestiform fiber exposures. In addition,	between health outcomes and exposure to an agent of interest can be attenuated when a nonspecific exposure indicator is used as a surrogate for exposure to the agent of interest [Blair et al. 2007; Friesen et al. 2007]. Thus, when the exposure index used to assess the effect of EMPs is based on a surrogate measure, such as respirable dust, rather than on specific measurement of EMP concentrations, the lack of an exposure-response relationship between the exposure index and the health outcome must be considered

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		relationships between health outcomes and exposure to an agent of interest can be attenuated when a nonspecific exposure indicator is used as a surrogate for exposure to the agent of interest [Blair et al. 2007; Friesen et al. 2007]. Thus, particularly where the composition of a mixed exposure may vary by work area, an exposure-response relationship developed to assess the effect of EMPs must be considered suspect if the exposure index used is based on measurements of dust concentrations and not specifically on measurements of EMP concentrations.	suspect particularly where the composition of a mixed exposure varies by work area. ."
Page 47 Lines 33-41	It is unclear if the "fibers" with minimum aspect ratio of 3:1 were also longer than 5 microns or were they of all lengths. Not knowing the length criteria makes interpretation of the percentages in the different aspect ratio categories difficult.	The comment identifies a real problem with current information (i.e., lack of complete characterization of particle dimensions). This is why the issue of potency of nonasbestiform amphiboles requires more investigation.	No revision
Page 48 Lines 2 - 6	In the Wagner paper there were 47 animals tested with the asbestiform tremolite and 14 mesothelioma tumors were reported for an incidence rate of 30%. The Roadmap says 37 were tested. The authors report that the tumor rate would probably have been higher but the testing period was shortened due to mortality due to infection. The dimensions used in Wagner's paper for "fibers" are not included in the paper and therefore it is difficult to know what constituted a dose of fibers from his Table	Agree	Change page 47 line 2 from "was found in 14/37 animals" to "was found in 14 of 47 animals. The authors speculated that tumor rate may have risen further if the testing period had not been shortened due infection-induced

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	I.		mortality."
Page 49 Lines 1 - 19	The Roadmap cites several animal studies where cleavage fragments of tremolite were used in rats or hamsters. These studies, when contrasted against the results from asbestiform tremolite, tell a great deal about the differences between the potency of the two different mineral habits. The four studies that demonstrate these divergent results are those conducted by Merle Stanton, John Addison and J.M.G. Davis, J. C. Wagner and William Smith. There are twelve tremolite samples used across these four studies. When one looks at the dimensions of the federal fibers (longer than 5 microns, minimum aspect ratio of 3:1, and at least 0.25 micron wide) in each of these samples, it is consistently observed that the higher proportion of tremolite federal fibers with widths less than 0.5 um, the greater the incidence of tumors. Conversely, the higher the proportion of tremolite federal fibers with widths greater than 1.0 urn, the lower the incidence of tumors. In fact, where tremolite federal fibers are predominately greater than 1.0 urn in width, no tumors or insignificant tumors (5-1 2%) are observed. This relationship for these four studies are graphically depicted (Figures 1-4) in Appendix 1 attached to these	As noted in the comment, an issue in interpreting the literature is that so-called nonasbestiform samples often contain some long/thin fibers. The revised draft *Roadmap* states that long/thin fibers are more potent than shorter/thicker structures. However, this does not mean that short/thick structures are benign. As mentioned in the review of *in vitro* results, a working hypothesis for particle activity is that it is driven in part by the generation of ROS. This property is a function of composition. At the extreme, quartz is a sphere not a fiber. It generates oxidants and is fibrotic and is listed as a carcinogen. Therefore, a data gap exists and there is a need for information on well characterized nonasbestiform amphibole samples free of asbestiform fiber contamination. Endpoints for *in vivo* study should include fibrosis as well as cancer.	No revision

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	comments. Figures 5-8 in Appendix 1 clearly demonstrate the biological "inverse" relationship with the composite plots by particle width. Figures 7 and 8 demonstrate the traditional toxicological dose-response association. It can be concluded from this comparison that tremolite federal fibers have different carcinogenic effects (ranging from strong to none) depending upon particle width. Specifically, this comparison shows that tremolite federal fiber dust populations with widths predominately less than 0.5 um, but almost exclusively less than 1.0 urn, are not biologically the same compared to tremolite federal fiber populations with widths predominately greater than 1.0 um, but almost exclusively greater than 0.5 urn in width (see Table 1 in Appendix1). Beyond the dimensional distribution of particles in a single sample, the Roadmap does recognize the importance of exposure dose. Accurately determining dose in any particulate exposure is complicated by the fact that particles vary widely in weight relative to length, width and particle type. Weight alone is therefore not a good predictor of particle dosage. A 10 mg dose of narrow fibers, for example, will obviously contain far more particles than a 10 mg dose of broad particles (lengths		

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	being relatively similar). Bearing in mind the tremolite federal fiber question, the dose issue for some of these same animal studies can be examined from published particle counts expressed in both weight and dimension. This information was available only in the Stanton and Addison/Davis studies and is presented in Table 2 in Appendix 1. Figure 9 in Appendix 1 shows the number of tremolite federal fibers per mg in Stanton's Tremolite 1, 2, and Talc 6 (tremolitic talc) samples. For tremolite federal fibers greater 1 urn in width, there were approximately 2.5 times more in Talc 6 (no tumors) than in Tremolite 1 (1 00% tumors). Talc 6 had 3.7 times more than Stanton's Tremolite 2 sample which also had 100% tumors. - Conversely, the number of tremolite federal fibers 51.0 um and 5 0.5 um in width in Tremolite 1 and 2 vastly outnumbered those in Talc 6. Figure 10 shows the number of tremolite federal fibers per mg for all six of the Addison/Davis samples. The California, Korean and Dornie tremolite samples provide the most important dose information relative to carcinogenic response. The Dornie sample (which authors suggest "is probably harmless to human beings") exceeds both the Korean and California tremolites (97% + tumors		

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	with short survival time) in the number of tremolite federal fibers with a width greater than 1.0 urn. The actual number of tremolite federal fibers per mg was 133 x 1 o5 (Dornie) versus 106 x 1 o5 (Korean) and 81 x 10' (California). All samples which produced prolific tumors and short animal survival time contained massive numbers of tremolite federal fibers with widths below 1.0 urn. Figures 11 and 12 clearly demonstrate a strong, unmistakable, dose response relationship with the number of tremolite federal fibers per mg of test material having diameters less than 1.0 or 0.5 micron. Figure 13 shows that this classic toxicological response does not hold for tremolite federal fibers greater than 1.0 urn in diameter. In Figure 13 there is no association between the number of tremolite federal fibers greater than 1.0 micron in diameter and increased tumor incidence. This fact clearly dispels the position that a "continuum" of carcinogenic response exists for all sizes of tremolite federal fibers. It can be concluded from this comparison that because more tremolite federal fibers with a width greater than 1.0 um existed in samples which produced no clear carcinogenic effect, similarly sized particles in any other sample cannot		

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	reasonably be linked to tumor induction. In a mixed dust exposure it is not logical to indict those portions of the exposure shown to be of lesser risk when tested separately at a higher dose. When this observation is coupled with the proportional particle dimension comparisons, the justification for regulating tremolite federal fibers in the same way vanishes. In addition to the animal studies referenced above, there is a considerable body of literature which addresses both dose and particle dimension. This body of literature provides additional insight into the issue of cleavage fragments and asbestos carcinogenicity. In a series of experiments involving asbestos and other mineral and man-made fibers, Fredrick Pott, demonstrated that "very low doses between 0.05 and 0.5 mg asbestos led to tumor incidences of about 20 to 80% (Pott, 1987). The incidence of tumors in this case was roughly proportional to the dose. This finding strongly suggests that in large doses of dust injected or implanted in animals, small amounts of asbestos in an otherwise non-asbestos dust is sufficient to cause tumors. It is likely that the late tumors observed in the Addison/Davis Italian and Dornie samples were related to an asbestos subpopulation		

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	present in these samples. The Dornie sample had 10% tremolite federal fibers that were less than or equal to 0,5 urn in width. Federal fibers with widths 5 0.5 um are certainly not characteristic of tremolite cleavage fragments. Also, it must be noted that Pott's findings indicate that the use of average or mean dimension in describing a dust sample population can be seriously misleading. Although more than mere dimension is likely involved in particle pathogenicity, certain dimensional characteristics stressed by Dr. Stanton are relevant to the issue of cleavage fragments and asbestos. Beyond the dimensional comparison of Stanton's Tremolite and Talc 6 samples, it is possible to contrast the number of Stanton's critically sized fibers he felt was most associated with tumor induction (L 0.25 um in width and > 8.0 um in length) to the occurrence of such fibers in the animal studies referenced above. Figure 14 in Appendix 1 compares the percent of tremolite federal fibers in each of the animal study samples to Stanton's "critical dimension" particles. Samples which contained Stanton's "critical dimension" particles were all associated with prolific tumor induction while those with no Stanton critical dimension tremolite fibers were not. Stanton's work was reanalyzed		

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	by Dr. Gary Oehlert whose work was published in Environmental Research in 1991 (copy of publication is enclosed with these comments to NIOSH). Basically Dr. Oehlert's analysis reconfirms that the number of critically dimension particles is the primary predictor of tumor incidence. However, fitting separate intercepts and/or slopes to each mineral type resulted in substantial significant improvement of fit indicating the importance of mineral type. This contrast with the "Stanton Hypothesis" which states that dimensional properties alone determine carcinogenicity. Another effort which directly addresses particle dimension and carcinogenicity can be seen in the work of Morton Lippmann. In formulating his conclusions relative to particle dimension and biological effect, Dr. Lippmann addressed the work of Timbrell, Davis, Wagner, Pott, Stanton, Harrington, Holt, Pooley and others. Dr. Lippmann concludes from his dimensional review that "the risk of lung cancer is associated with long fibers, especially those with diameters between 0.3 and 0.8 um, and with a substantial number of fibers > 10 urn in length.. ." In regard to mesothelioma, Lippmann states "that the critical fibers for mesothelioma induction have lengths between 5 and 10		

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	urn," In terms of diameters, Lippmann concludes mesothelioma risk "has been related to fibers with diameters < 0.1 um." Table 3 in Appendix 1 contrasts the percent federal fibers in the animal study samples to Dr. Lippmann's "carcinogenic" size parameters, This comparison demonstrates a reasonable correlation between these size parameters and the carcinogenic effect observed in these studies. Similar to the Stanton critical dimension comparison, tumor incidence is generally proportional to the concentration of fibers which satisfy Lippmann's parameters. Again, as dust exposures contain more particles with widths < 1.0 um and lengths greater than 5 urn, more tumors are observed. The purpose of the above analysis was to test whether or not the existing federal fiber definition is overly broad and includes tremolite particles which do not pose the same health risk as other tremolite particles or "fibers" covered under the same "definition" or counting criteria NIOSH uses for asbestos. In this review, there is indeed a clear difference in biological effect with differently sited tremolite federal fibers. Most everyone would agree that the very thin, long dimensions of asbestos tremolite fibers are carcinogenic in animals and that		

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	federal fiber component in a mixed dust exposure can cause tumor formation. It is also known that in animal injection/implantation studies it does not take many of these fibers to yield tumors. The existing literature in the field clearly demonstrates that federal fibers with a width greater than at least I urn cannot reasonably be associated with a carcinogenic effect. Remarkably, the strongest evidence against a carcinogenic association for common cleavage fragments may well be the very animal studies that NIOSH cites as the reason for treating them as if they were asbestos. It has been shown that on a simple, straightforward dimensional basis alone, these animal studies do tell a great deal about "appropriately sized" fibers and the inadequacy of the simplistic federal fiber definition advocated by NIOSH relative to carcinogenic risk.		
Page 54 1.7 Analytical Methods	We have enclosed with these comments two documents that pertain to the analytical challenge with this issue. The first is an MSHA method by R. L. Clark that was published in 1982 from the proceedings of the NBSIEPA asbestos workshop. The second is a recent published paper titled Differentiating Amphibole Asbestos from Non-asbestos in a Complex Mineral Environment by E)	NIOSH is aware that there are those who purport to have methods which can distinguish between asbestos particles and nonasbestiform mineral particles. However, information in the literature indicates that analysts often come to different conclusions when judging an individual particle in an air sample. Any method which is used to assess worker exposure needs to have been validated. Method development and	No revision

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	Van Orden, K. Allison and RJ Lee. These two publications show that analyzing for asbestos is a straight forward procedure that can be done and is being done.	evaluation are discussed in NIOSH Publication No. 95-117: *Guidelines for Air Sampling and Analytical Method Development and Evaluation*, which can be found at: http://www.cdc.gov/niosh/docs/95-117/ . As stated in Section 1.9 of the revised draft *Roadmap*, "An important need is to identify and develop methods of analysis that can be used or modified to assess exposures to EMPs that are capable of differentiating between EMPs based on particle characteristics that are important in causing disease." The extent to which the commenter's cited methods can be used or can contribute to the development of validated methods (i.e., which meet the stated criteria of differentiating between EMPs based on particle characteristics that are important in causing disease) should be assessed after such particle characteristics are determined.	