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Sent via e-mail only

January 15, 2020

Gary A. Latsha
District Mining Manager
Pottsville District Mining Office
Pennsylvania Department of Environmental Protection
5 West Laurel Boulevard
Pottsville, PA 17901

Re: Transmittal of RJ Lee Group January 14, 2020 Letter
Rock Hill Quarry
Hanson Aggregates Pennsylvania LLC
SMP # 7974SM1
East Rockhill Twp., Bucks Co., PA

Mr. Latsha:

Hanson Aggregates Pennsylvania LLC (Hanson) is providing the attached January 14, 2020 letter from RJ Lee Group (RJLG) regarding the methodology used to differentiate asbestiform amphibole fibers from their non-asbestiform analogs.

Please feel free to contact me at (610) 366-4819 should you wish to discuss this submission.

Regards,

Andrew J. Gutshall, P.G.
Area Environmental Manager

encl: RJ Lee Group letter to Andrew J. Gutshall, P.G. dated January 14, 2020

cc: John Stefanko, PADEP
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January 14, 2020

Mr. Andrew J. Gutshall
Hanson Aggregates Pennsylvania LLC
7660 Imperial Way
Allentown, PA 18195-1040

RE: Regulations of Asbestos Minerals
RJ Lee Group Project Number: LLH901997

Mr. Gutshall,

A request[1] by the Pennsylvania Department of Environmental Protection (DEP) was made on December 4, 2019 for the methodology used by RJ Lee Group (RJLG) to differentiate asbestiform amphibole fibers from their non-asbestiform analogs. This request appears to have been prompted from comments made by B. Erskine related to various analyses performed by RJLG on samples from the Rock Hill Quarry.[2]

Background

Numerous samples of varying matrices (air, water, and bulk) from the Rock Hill Quarry have been analyzed to determine the amount and type of asbestos present in the samples. To date, the only minerals detected that could be asbestos are from the tremolite/actinolite solid solution series.[3] No serpentine minerals have been observed at this deposit. The actinolite occurs in a variety of growth habits, ranging from asbestiform fibers to prismatic, non-asbestos particles.

The Federal government regulated six minerals (one serpentine and five amphibole minerals) as asbestos when they occur in the asbestiform habit. The minerals are listed in Table 1 which is taken from a recommended US Environmental Protection Agency (EPA) analytical protocol (EPA 600/R-93/116):

[1] G. Latsha (2019). Email to A. Gutshall, December 4, 2019.
[2] B. Erskine (2019). Letter to M. Kutney and G. Latsha, December 2, 2019.
[3] B. E. Leake, et al. (1997). "Nomenclature of Amphiboles: Report of the Subcommittee on Amphiboles of the International Mineralogical Association, Commission on New Minerals and Mineral Names", *The Canadian Mineralogist*, 35, p. 219-246. Note: there are more recent publications by this subcommittee (Leake et al 2004 and Hawthorne et al 2012) that update amphibole nomenclature, but these have not altered the tremolite/actinolite definition.

Table 1. The asbestos minerals and their nonasbestiform analogues

Asbestiform	Nonasbestiform	Chemical Abstract Service No.
Serpentine		
Chrysotile	Antigorite, lizardite	12001-29-5
Amphibole		
Anthophyllite asbestos	Anthophyllite	77536-67-5
Cummingtonite-grunerite asbestos (Amosite)	Cummingtonite-grunerite	12172-73-5
Riebeckite asbestos (Crocidolite)	Riebeckite	12001-28-4
Tremolite asbestos	Tremolite	77536-68-6
Actinolite asbestos	Actinolite	77536-66-4

Reproduced from Table 2-6 of EPA 600-R-93/116

As suggested by the above Table, these minerals occur in a variety of growth habits, broadly classed as "asbestiform" and "nonasbestiform". The vast majority of any of these minerals occur as non-asbestos particles (nonasbestiform) and are common rock-forming minerals worldwide.

The asbestiform varieties of these six minerals are regulated by various agencies of the Federal government. Three relevant agencies (EPA, OSHA, and MSHA) regulate the asbestos fibers, describing them as either "asbestos" or "asbestiform". OSHA discussed the literature related to non-asbestos amphiboles in 1992 and concluded that they would not be regulated as if they were asbestos fibers.

Both EPA and OSHA cite to the work by Campbell, et al[4] to describe what is and what is not asbestos. Portions of Campbell are included (copied) in the appendices to OSHA's regulations. Campbell et al defines asbestos as follows:

> Asbestos.--(l) A collective mineralogical term encompassing the asbestiform varieties of various minerals; (2) an industrial product obtained by mining and processing primarily asbestiform minerals.

They further define asbestiform as:

> Asbestiform.--A specific type of mineral fibrosity in which the fibers and fibrils possess high tensile strength and flexibility. The definition of asbestiform minerals includes three aspects: morphology, structure, and chemistry. Morphologically, asbestiform mineral varieties separate into flexible fibers or flexible bundles of fibers.

In 1994, the EPA issued a notice (*Federal Register*, 59, p. 38970-38971) to the analytical community that there was an improved, but not promulgated, PLM analytical method (EPA 600/R-93/116) and recommended its usage. Contained in that method is a definition of "asbestiform":

[4] W. J. Campbell, et al. (1977). "Selected Silicate Minerals and Their Asbestiform Varieties - Mineralogical Definitions and Identification-Characterization", Bureau of Mines, United States Department of Interior, Information Circular 8751.

> "**Asbestiform (morphology)** - Said of a mineral that is like asbestos, i.e., crystallized with the habit of asbestos. Some asbestiform minerals may lack the properties which make asbestos commercially valuable, such as long fiber length and high tensile strength. With the light microscope, the asbestiform habit is generally recognized by the following characteristics:
>
> - Mean aspect ratios ranging from 20: 1 to 100: 1 or higher for fibers longer than 5µm. Aspect ratios should be determined for fibers. not bundles.
> - Very thin fibrils, usually less than 0.5 micrometers in width, and
> - Two or more of the following:
>   - Parallel fibers occurring in bundles,
>   - Fiber bundles displaying splayed ends,
>   - Matted masses of individual fibers, and/or
>   - Fibers showing curvature
>
> These characteristics refer to the population of fibers as observed in a bulk sample. It is not unusual to observe occasional particles having aspect ratios of 10:1 or less, but it is unlikely that the asbestos component should be dominated by particles (individual fibers) having aspect ratios of <20:1 for fibers longer than 5µm. If a sample contains a fibrous component of which most of the fibers have aspect ratios of <20:1 and that do not display the additional asbestiform characteristics, by definition the component should not be considered asbestos."

RJLG used the EPA 600/R-93/116 procedure to analyze various bulk (rock) samples. Because the submitted samples were too large for microscopic analyses (by any microscopic technique), the samples were initially prepared using the grinding procedure described in CARB 435[5]. The ground material was then homogenized using a random-orbital mixer prior to removing any aliquots for analyses.[6]

Differentiation of Asbestos Fibers and Non-Asbestos Particles

The request from the DEP is for the RJLG standard operating procedure (SOP) used in this project to make a differentiation between asbestos fibers and non-asbestos particles. RJLG does not have a formal SOP for this action but relies on more than 40 years of experience analyzing amphibole minerals. Dr. Lee began the initial investigations into amphibole mineralogy back in the 1970's as it was relevant for the taconite mines (related to Reserve Mining) and how that would relate to the mines operated by US Steel. These issues, discussed by the US Bureau of Mines[7,8,9] in their publications from the 1970's-1980's, form the

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[5] Air Resources Board (1991). *Determination of Asbestos Content of Serpentine Aggregate*, California Environmental Protection Agency, Method 435, adopted June 6, 1991.

[6] Air Resources Board (2017). *Implementation Guidance Document: Field Sampling and Laboratory Practices; Air Resources Board Test Method 435: Determination of Asbestos Content of Serpentine Aggregate*, California Environmental Protection Agency, April 2017.

[7] W. J. Campbell, et al. (1977). "Selected Silicate Minerals and Their Asbestiform Varieties - Mineralogical Definitions and Identification-Characterization", Bureau of Mines, United States Department of Interior, Information Circular 8751.

[8] W. J. Campbell, et al. (1979). "Relationship of Mineral Habit to Size Characteristics for Tremolite Cleavage Fragments and Fibers", Bureau of Mines, United States Department of Interior, Report of Investigations 8367.

[9] W. J. Campbell, et al. (1980). "Chemical and Physical Characterization of Amosite, Chrysotile, Crocidolite, and Nonfibrous Tremolite for Oral Ingestion Studies by the National Institute of Environmental Health Sciences"." Bureau of Mines, United States Department of Interior, Report of Investigations 8452.

basis for current Federal regulations. These characteristics were discussed by OSHA in their 1992 rulemaking (see the preamble for the 1992 rulemaking, Federal Register, June 8, 1992).

EPA's recommended procedure (EPA 600/R-93/116) contains a detailed description of "asbestiform" (see above) which provides information on when to count and when not to count a particle as "asbestos". This procedure incorporates two microscopy procedures (polarized light microscopy – PLM and transmission electron microscopy – TEM). Thus, such a definition is not limited to one set of particles but applies to all observable particles.

RJLG personnel have been investigating the characteristics of amphibole minerals for more than 40 years and have published numerous papers related to this research. As noted above, RJLG does not have an SOP that outlines a step-by-step procedure that can be used to make the asbestos/non-asbestos differentiation. Instead, we rely on the more than 40 years' experience for those criteria.

Various publications have detailed these differences between these growth habit, with Langer et al being an example of just such a detailed procedure.[10] In 1984, there was a meeting where principals in the field of mineralogy agreed to a common definition of asbestos.[11] In a simpler form, this definition was adopted into the 1993 EPA PLM method (EPA 600/R-93/116) and into the more recent ISO PLM methods (ISO 22262-1).

RJLG personnel have examined numerous samples of amphibole minerals that can readily be characterized as either "asbestos" or "non-asbestos". These investigations have resulted in several publications that both discuss the differences of the dimensions of such particles[12,13] as well as how the morphological and microscopical differences can be used to differentiate these particles.[14,15,16] Such procedures were approved by the EPA for use in differentiating "asbestos" from "non-asbestos" during the investigation into the possible contamination at the Southdown quarry in New Jersey.[17]

The process used by RJLG is backed by many years of research and experience and is supported by work by other investigators. Differentiation of the amphibole minerals into "asbestos" and "non-asbestos" is not a trivial matter and represents one of the thorny issues for laboratories and investigators whose

[10] A. M. Langer, et al. (1991). "Distinguishing Between Amphibole Asbestos Fibers and Elongate Cleavage Fragments of Their Non-Asbestos Analogues", *Mechanisms in Fibre Carcinogenisis*, p. 253-267.
[11] M. Ross, et al. (1984). "A Definition for Asbestos", *Definitions for Asbestos and Other Health-Related Silicates*, ASTM STP 834, Benjamin Levadie, Ed., American Society for Testing and Materials, Philadelphia, p 139-147.
[12] D. R. Van Orden, et al. (2009). "Width Distributions of Asbestos and Non-Asbestos Amphibole Minerals", *Indoor and Built Environment*, 18, p. 531–540.
[13] D. R. Van Orden, et al. (2016). "Determination of the Size Distribution of Amphibole Asbestos and Amphibole Non-Asbestos Mineral Particles", *The Microscope*, 64, p 13 – 25.
[14] M. S. Sanchez, et al. (2008). "Extinction Characteristics of Six Tremolites with Differing Morphologies", *The Microscope*, 56, p. 13-27.
[15] D. R. Van Orden, et al. (2005). "A Review of the Analysis of Amphibole Fibers", presented at the SME Annual Meeting, Salt Lake City, UT, February 28 – March 2, 2005. Pre-print 05-75.
[16] D. R. Van Orden, et al. (2008). "Differentiating Amphibole Asbestos from Non-Asbestos in a Complex Mineral Environment", *Indoor and Built Environment*, 17, p. 58-68.
[17] D. W. Berman (2003). "Analysis and interpretation of measurements for the determination of asbestos in core samples collected at the Southdown Quarry in Sparta, New Jersey", Report of analysis, Aeolus, Inc., November 12, 2003.

primary experience is with the serpentine minerals which comprise the vast majority of asbestos used in the US as well as the most frequently encountered mineral that can be a naturally occurring asbestos.

If you have any questions concerning these issues, please feel free to contact me. I can provide you with copies of these referenced documents if requested.

Sincerely,

Drew R. Van Orden, PE
Senior Consulting Scientist