BEST PRACTICES

THE VERMICULITE ASSOCIATION

Asbestos Detection and Control Protocol:
Vermiculite Mining and Milling

PROCEDURAL GUIDE

Contents

The TVA Best Practices Program for Asbestos Detection and Control Protocol provides recommended practices based on the collective experience and knowledge of technical personnel. It is not a standard or a specification, nor is it presented as the sole means of asbestos detection or control, or the verification thereof. It is only a guide for use, on a voluntary basis, by firms in the vermiculite industry.

Introduction: Asbestos and Mineral Fibres

Asbestos minerals have been defined as of a group of naturally occurring fibrous silicate minerals, and have been exploited industrially for their useful properties such as thermal insulation, chemical and thermal stability, and high tensile strength. The group includes chrysotile, a member of the serpentine mineral group, and the amphibole minerals amosite, crocidolite, tremolite asbestos, actinolite asbestos, and anthophyllite asbestos.

Table 1 Asbestos minerals and their mineral formulae

Asbestos Mineral	Chemical Formula
Chrysotile	$Mg_3 Si_2 O_5 (OH)_4$
Crocidolite	$Na_2 Fe_5 Si_8 O_{22} (OH)_2$
Amosite	$(Fe, Mg)_7 Si_8 O_{22} (OH)_2$
Tremolite	$Ca_2 Mg_5 Si_8 O_{22} (OH)_2$
Actinolite	$Ca_2 (Mg, Fe)_5 Si_8 O_{22} (OH)_2$
Anthophyllite	$Mg_7 Si_8 O_{22} (OH)_2$

Although many other minerals may occur in fibrous forms and have been used industrially, they are not asbestos. These include minerals such as gypsum, wollastonite, palygorskite, sepiolite, sillimanite, zeolites, and non-asbestos amphiboles, such as tremolite, actinolite, richterite, edenite and winchite. Some of these may be as harmful as asbestos and may need to be treated with the same caution, while others are probably no more harmful than any other low toxicity mineral dust.

Many asbestiform minerals have been identified as potential trace components in vermiculite ore.

These include:

- Amphibole Minerals
  - Anthophyllite
  - Tremolite
  - Actinolite
  - Richterite
  - Winchite
  - Edenite
  - Arfvedsonite
  - Magnesio-riebeckite
  - Magnesio-arvedsonite
- Serpentine Minerals
  - Chrysotile
  - Lizardite
- Fibrous Clays
  - Sepiolite
  - Loughlinite

It is very important that all mining, distribution and end user companies be aware that laboratories offering asbestos analysis have strict conditions attached to their accreditation. They are not permitted to provide a formally accredited report on the identification of any fibre as asbestos, unless the species is a part of their interlaboratory round-robin testing regimen and it is specifically listed in the scope of their accreditation. Of those listed above, only the regulated forms of asbestos are normally listed within that scope (anthophyllite, tremolite, actinolite and chrysotile). This does not mean that laboratories may not identify the remaining minerals, simply that they may not include them in formally accredited reporting.

Definition of Asbestos

The simple definition used above for asbestos is adequate for most practical purposes, and finding a better, more comprehensive and exclusive definition has been controversial and difficult. A simple mineralogical definition of the term asbestos is not easy because it is used for members of two very different mineral families, the serpentines and the amphiboles, both of which are large mineral groups that include many other closely related non-asbestos minerals. There are also distinctions that must be made regarding the habit of the mineral observed. "Habit" is the mineralogical term defined as the external shape of a crystal or group of crystals. Amphibole minerals, and any other mineral, can occur in a variety of habits, asbestos (or asbestiform) being one. However, crystals with an otherwise identical chemical composition can occur as asbestos or non-asbestos, depending on how those crystals formed.

Asbestos identification methods (HSG 248, USEPA 600/R-93/116) use the term ***Asbestiform*** as a mineralogical term that is applied to a range of minerals exhibiting the following properties:

1. capable of separating into very thin fibrils;
2. a range of aspect ratios ranging from 20:1 to 100:1, or higher for fibres longer than 5μm;

And two or more of the following:

1. Parallel fibres occurring in bundles;
2. Fibre bundles displaying frayed ends;
3. Fibres in the form of thin needles;
4. Matted masses of individual fibres;
5. Fibres showing curvature.

Not all fibrous minerals showing these properties are asbestos in the regulatory definition. For example, gypsum can be found in the asbestiform habit but it is never referred to as asbestos.

In addition to these characteristics, ISO 22262-1:2012E defines asbestos as: ***"term applied to a group of silicate minerals belonging to the serpentine and amphibole groups which have crystallized in the asbestiform habit, causing them to be easily separated into long, thing, flexible, strong fibres when crushed or processed."***

Section 7.2.3.7 of ISO 22262-1:2012E discusses the identification of asbestos, as follows:

> *A detailed description for the morphology that is characteristic of asbestos is as follows. This morphology is characteristic of the larger fibres seen in stereomicroscope examinations and of fibres selected from laboratory samples for PLM identification of fibre type.*
>
> *In the light microscope, the asbestiform habit is generally recognized by the following characteristics:*
>
> *a) the presence of fibre aspect ratios in the range of 20:1 or higher for fibres longer than 5 μm;*
> *b) the capability of longitudinal splitting into very thin fibrils, generally less than 0.5 μm in width;*
> *c) in addition, observation of any of the following characteristics for the fibre type under consideration provides additional confirmation that the fibres are asbestiform:*
>
> *1) parallel fibres occurring in bundles,*
> *2) fibre bundles displaying splayed ends,*
> *3) fibres in the form of thin needles,*
> *4) matted masses of individual fibres,*
> *5) fibres showing curvature.*
>
> *In practice, if chrysotile, crocidolite or amosite is identified in a commercial product, the assumption can safely be made that the fibres are asbestiform and that these fibres conform to the description above. This assumption can be made because these three types of asbestos were mined and processed to yield fibres with specific properties for intentional incorporation into products. Some anthophyllite asbestos was used in a few commercial products, but very little was mined and used commercially. Tremolite asbestos has been found in some surfacing and*

fireproofing applications in Japan. However, other than these occurrences, the amphiboles tremolite, actinolite, and richterite/winchite were not generally used in commerce, and their presence in a product is more likely a consequence of naturally occurring contamination of one or more of the major constituents. Accordingly, no assumption can be made as to whether the amphibole is asbestiform or non-asbestiform. Anthophyllite can occur as contamination of other mineral products, and in such situations, no assumption can be made as to whether it is asbestiform or non-asbestiform. In some samples, these amphiboles may exhibit a mixture of morphological types, and quantitative determination of the regulatory status of such samples may require a detailed study of the fibre size distribution that is beyond the scope of this part of ISO 22262.

In general, for this part of ISO 22262, the presence of either the asbestiform or the non-asbestiform analogues of tremolite, actinolite, anthophyllite or richterite/winchite can usually be specified. If the majority of amphibole fibres are longer than 5 µm, have aspect ratios equal to or lower than 5:1, and if the fibres do not exhibit any of the characteristics in c), it can be concluded that the amphibole is probably non-asbestiform, with the degree of certainty increasing with decreasing maximum aspect ratio. If any amphibole fibres longer than 5 µm with aspect ratios in the range of 20:1 or higher are observed, then it can be concluded that amphibole asbestos is probably present, with the degree of certainty increasing with increasing aspect ratio.

> *NOTE. This is intended as guidance for analysts to discriminate between non-asbestiform and asbestiform amphibole populations. It is not intended to override the definition of asbestos as presented in 2.9 nor to override any national regulation.*

It is necessary to appreciate that some samples may still present ambiguities with respect to discrimination between asbestiform and non-asbestiform analogues, and such ambiguities, when observed, shall be reported as part of the results.

Quality Control Systems

The most important feature of any quality control system is the Quality Manual, which covers all the responsibilities and duties of the company in maintaining confidence in the Quality System. An example of a template available for implementation and use as a suitable QM can be found in NISTIR 7028, Type Evaluation Lab etc., July, 2003 (http://accab.org/images/publication/16102014064744.pdf). Alternatively, a template for a general QM may be found at http://www.iso9001help.co.uk/quality-manual-template.html. Such systems are extremely comprehensive but have one overriding principle: full documentation of the details of all aspects of methods, procedures, and the staff involved in testing, including their qualifications, duties and responsibilities.

In addition, most published guidance states that the Quality Manager must have direct access to the most senior management on issues relating to analytical testing quality (for example, by the UK National Accreditation scheme for testing laboratories).

All QM documents will also refer to the maintenance of records of results, sampling methods, internal quality control, repeat testing, laboratory equipment, calibration methods, reference materials, internal and external auditing, in-house training etc.

Management and Technical Training

Management must have adequate knowledge of all aspects of the Quality System, including the mine geology, mineralogy, sampling, analysis, and health and safety, in order to ensure that the System is properly maintained.

The laboratory must be equipped with instruments and scientific equipment appropriate for the operations required. Equally important is the ergonomic design of the workspace, in particular when extended periods are spent in tasks such as microscopy.

The laboratory management must also consider the segregation of different test procedures and the provision of dust cabinets for microscopy to minimize health risks and the possibility of cross-contamination.

Technical staff must have appropriate qualifications or training for their specified tasks. Training in specific fields, such as asbestos identification, can be provided. Training may be in-house if suitable qualified expertise is available, or from third parties (e.g. British Occupational Hygiene Society sponsored training courses, McCrone Research Institute, etc.)

Training should cover the geological, mineralogical and chemical nature of vermiculite and the mineralogical properties of the asbestos minerals and asbestiform minerals insofar as these properties are important in their recognition in hand specimens and stereomicroscopy.

Asbestos testing technicians must have training in the appropriate fibre detection procedures in stereomicroscopy, such as is documented in HSG 248/ EPA EPA/600/R-04/004 (2004) methods.

If Polarized Light Microscopy (PLM) is to be used for formal identification of minerals, training and qualifications must be appropriate.

All technical staff must be trained in the need for accurate and detailed records of procedures carried out and their results, with particular attention paid to the identity of the individual analyst(s) responsible.

Training must also be provided on the health effects of asbestos and other minerals, and on health and safety in the workplace with respect to mineral dusts and asbestos. This training should include the use of personal protective equipment (PPE) in the workplace.

Asbestos Control Procedures

Prior to any mining in any area or working face of the ore body, there must be systematic mineralogical evaluation and sampling and testing for any suspected asbestos minerals. Any such minerals must be identified, reported to senior management, and the site recorded before removal of unsuitable ore from the site. Similarly, any suspected asbestos revealed during mining operations must result in an immediate cessation of work, leading to the sampling and testing procedures as described above.

If stockpiles of crude ore are maintained for blending prior to processing, these should be inspected on a regular basis for the possible presence of asbestos fibres, and sampled and tested as necessary while new material is added to a stockpile.

A comprehensive program of secondary sampling and testing of processed ore concentrate at the plant must be introduced and documented to determine the physicochemical properties and to detect any asbestiform minerals before dispatch or sale.

All tests must be carried out by trained and qualified technicians at the plant, and/or by an accredited experienced commercial laboratory.

All manual handling of samples and disposal procedures of any rejected material must be carried out with full regard to the potential health and safety hazards. These procedures must be fully documented in the QM.

Full records must be retained for a specified period of all customer vermiculite receipts, all sampling and testing results, and dispatched and sold vermiculite.

The producer must retain replicate samples of dispatched batches so that any deviation from the specifications may be investigated.

Internal and external audits of all records should be conducted on a regular basis.

Ensuring any fibrous material is rejected within the mines or pits before it reaches the beneficiation plant is a key step in this protocol. All mining personnel should be trained to look for any potential hazards, and these should be properly investigated prior to vermiculite ore being transported to the beneficiation plant.

Mine Ore Body – Pre-Extraction

Detection of any asbestiform contamination in the ore body ahead of extraction and processing at the mine is one of the primary duties of management.

The vermiculite ore body location should be geologically well-defined, and the mining and extraction area defined before work is started. Any drill-hole samples should be tested for the possible presence of asbestos before the ground is opened for ore extraction. The working face or area must be examined for the possible presence of suspected asbestos minerals, with samples collected immediately for identification as far as is reasonably practical.

In the absence of any suspected asbestos, samples from the ore body should be collected and tested for the possible presence of asbestos minerals in the matrix. For example, analysis of a series of samples collected meter by meter from a horizontal channel at mid-height of the working face could be specified as a means of providing a ‘permit to mine’ from the management.

The mining company should maintain representative examples of all asbestiform and fibrous minerals which could potentially be found in the ore body and adjacent rocks. These should be formally identified (by a third party if necessary) so that they may be used as reference minerals for any future discoveries.

Sampling and testing of the defined areas, should be carried out according to the recommendations noted in this document.

At the minimum, the analysis should include examination and detection by stereo-binocular microscopy, but may extend to the use polarized light microscope analysis for mineral identification.

It is strongly recommended that samples from the mining areas should be submitted regularly (4 per annum) to an experienced accredited asbestos-testing laboratory for quality control purposes and as confirmation of in-house results.

Auditable records of all procedures should be maintained indefinitely.

Processed Vermiculite

Vermiculite production lots should be defined by size and date. Precise definitions of all terminology used must be documented and unambiguous. For example, terms such as batch, bag, lot, load, sample and composite sample must be defined in the QM.

Sampling scheme protocols should be designed to ensure good statistical coverage of all the vermiculite production for the purpose of identification fibres and asbestiform minerals. ASTM D75 provides guidance and could be used as a basis for developing a sampling scheme.

It is recommended that, as a minimum standard, hourly samples of nominally 1 kg be collected from each final product stream. These are then composited into a minimum of one (1) daily composite sample(s) per 24 hours, and delivered to the internal laboratory for analysis. The laboratory will then split the composite sample(s) for the various tests required. The recommended minimum size of the composite sample accumulated per working day will be discussed further on the next page.

Sample splitting must be done using a riffle box or rotary sample splitter.

If testing is carried out on the crude product, the same sampling number and frequency should apply.

Given that different grades of product have different particle sizes, collecting larger sample sizes for the coarser grades will probably be necessary. If there is any doubt about this, reference should be made to relevant guidance (e.g. ISO 14488:2007 Particulate materials -- Sampling and sample splitting for the determination of particulate properties). The recommended minimum composite sample size accumulated throughout the production day should be proportional to the grade size, and the following recommendations are given:

Grade size (mm)	Minimum weight of composite sample per production day
> 10 mm	25 kg
>5 mm but <10 mm	10 kg
<5 mm	5 kg

The QS must ensure the traceability of each bag (or load) by batch or big bag/day/month/year from the records.

Prior to shipment from the mine into the supply chain, representative samples of all vermiculite production will be tested for asbestos fibres following the methods described below. Auditable records of all procedures should be maintained indefinitely.

External Laboratory Testing of Vermiculite Product Samples

Representative vermiculite samples of product sold and ready for shipment should be tested and certified by an external, accredited asbestos-testing laboratory. It is recommended that a minimum of twelve (12) samples per annum should be tested this way to give confidence in the mine laboratory performance. If comparison is to be made between analyses of the same samples by different laboratories, it is critical that the same methods be employed by all laboratories.

Auditable records of all procedures should be maintained indefinitely.

Safe Management, Disposal and Handling

Where asbestiform minerals or suspected asbestos has been found in the examination of proposed working sites in the mine, or discovered during mining, action must be taken to reduce risks to production and to worker's health. The site must be flagged and recorded on the mine plan and reported to senior management. A whole section of the ore body may need to be segregated and excluded from mining activity, or require excavation and removal to a safe disposal site away from the ore body if possible. Alternatively, if the occurrence is minor, the suspect material may be carefully collected and removed for disposal, but the site must be recorded and remain flagged as an indicator of the need for caution.

Procedures must be in place to minimize the spread of the ore from stockpiles and in the plant in order to reduce health risks and possible contamination. Excessive amounts of settled dust should not be allowed to accumulate on exposed flat surfaces for the same reasons.

Sampling and analysis of the settled dust for mineral fibres can indicate that control procedures are not adequate. Close attention must be paid to dust control procedures and the mineral processing must be designed to minimize emissions of airborne dust from the plant site, particularly if there may be risks to the health of the general public.

Analytical Test Procedures

The purpose of the test procedure outlined below is to provide an example of how to determine the percent by weight of asbestiform minerals in a vermiculite ore or concentrate sample. The method outlined below has been developed and tested, and is understood to be accurate and sensitive in regard to the measurement being made. It is also understood to be easily executed with a minimum of specialized technical equipment and training.

Internal laboratory facilities located near mining or processing facilities may have constraints on space and laboratory infrastructure that may require alternate methods to be developed. So long as those methods are shown to be accurate and adequately sensitive and are thoroughly documented they may be employed and results used for decision making in vermiculite processing.

The method employed should be able to identify any asbestos types found in a vermiculite ore or concentrate. It should also be able to accurately measure 0.01 wt % asbestos in a representative sample for the lot or batch being tested.

If an alternate method is developed and utilized, the facility must validate the capability and accuracy of this technique by comparative analysis using an independent accredited testing laboratory. This validation must be repeated whenever changes are made to the alternate methodology. Evaluation of alternate methods is outside of the scope of this guide and if alternate methods are implemented, it is the responsibility of the supplier to demonstrate those capabilities.

Laboratory Equipment (TVA Recommended Method)

Items described in TVA test method 109-99, determination of non-vermiculite matter.

A minimum number of two (2) clean 100mm diameter glass Petri dishes is required, preferably more.

Needlepoint tweezers (preferably reverse action) and dissection probe are necessary for hand picking of suspected asbestos fibres/bundles.

A stereo-binocular microscope capable of variable (preferably zoom) magnification from between 10X and 40X is required, preferably with built-in illumination.

Facilities must be available for thorough cleaning of any equipment used after each test, and for handling and disposal of any residue.

The laboratory balance requirements are:

1. the laboratory balance must be accurate and sensitive to 0.1 mg in order to achieve the desired analytical limit of quantification. The laboratory must have suitable standards directly traceable to appropriate National Standards;
2. the balance should be isolated from any significant source of vibration as this may affect the results;
3. the above equipment needs to be installed in a suitable enclosed room away from the normal laboratory to protect from any airborne dust or interference.

Stereomicroscopy

The non-exfoliating (grit) fraction collected after the laboratory exfoliation of a nominal 50 g vermiculite QA test sample is examined for any suspect fibrous minerals.

The stereo-binocular microscopy examination above is carried out according to the HSG 248/ EPA EPA/600/R-04/004 (2004) methods, which require the test sample to be progressively examined in a shallow Petri dish under a stereo-binocular microscope at magnifications between 10X and 40X to search for any suspect fibrous minerals.

Any suspect fibrous minerals are extracted using fine point tweezers and collected in a separate clean container. Fibre types should be identified using a minimal amount of material, and the remaining extracted material is weighed using a laboratory balance to accuracy appropriate to the required sensitivity (e.g. 0.0005 g for 50 g sample).

It must be acknowledged that there is a risk of losing fine fibres from the grit during the flotation of the expanded vermiculite and the sedimentation of the non-vermiculite grit impurities. It should also be acknowledged that there is a risk of non-fibrous minerals being included with fibrous minerals if the fibrous and non-fibrous crystals are intimately mixed or intergrown.

This method has the advantage that a smaller subsample resulting from the original nominal 50 g of crude vermiculite is examined, and this sub-sample typically concentrates any fibrous contamination present; however, as mentioned above, there is a risk of potentially losing any fine fibres present. Therefore, care needs to be exercised to reduce the risk of losing the finer fibres when handling the non-exfoliating (grit) fraction during the decantation and drying stages. The “grit” fraction should never be “washed” in any way to remove any traces of partially exfoliated vermiculite, or any other matter which may not be deemed as non-exfoliating material. The entire “grit” fraction should be examined after it has been separated and carefully dried.

Sensitivity

Using the example of an approximately 50 g sample of crude vermiculite exfoliated in the laboratory, and the non-exfoliating fraction assumed to have accumulated all of the potential fibrous contaminant that may be present, then by examining this non-exfoliating fraction and weighing any fibrous mineral to a sensitivity of 0.1 mg (0.0001 g), a theoretical sensitivity of 0.0002% or 2 parts per million by weight is achievable. Two factors will influence the uncertainty of this analysis. First, the fibres found may not be asbestos in their entirety and second, some true asbestos fibres may have been missed during the analysis.

Operator Error

The greatest influence on the reliability of these analyses is operator error. The frequency of positive test results should be low if the controls on mining have been effective. This can make performing this test an extremely tedious task for a microscopist, so it is important that the operator has a comfortable and ergonomic posture and environment. This factor also indicates the need to have the capacity to rotate the assignment of the technical staff. It is recommended that no more than 8 samples should be analyzed by any 1 individual analyst in the course of one 8-hour shift. It is also recommended that at least 10% of all samples should be analyzed by a different analyst, as part of the internal QC process.

Fibre Identification

While it is possible for most scientists to attain proficiency in formal asbestos identification, such methods are not necessarily essential in the exercise of Quality Management in vermiculite mining.

Polarized light microscopy (PLM) analysis of mineral fibre is performed if fibres are found during stereo-binocular microscopy (SBM) inspection. PLM is used to determine optical properties such as colour, pleochroism, birefringence, extinction angle and optical sign. The PLM set-up is used to confirm the suggested identity by determination of the exact refractive index of the mineral.

The asbestos mineral types have different characteristic optical properties that are used to identify each asbestos type. Other asbestiform amphiboles may also be identified in-house, but accredited asbestos-testing laboratories may be prevented from providing a formal identification of any unregulated asbestiform amphibole by the scope of their accreditation.

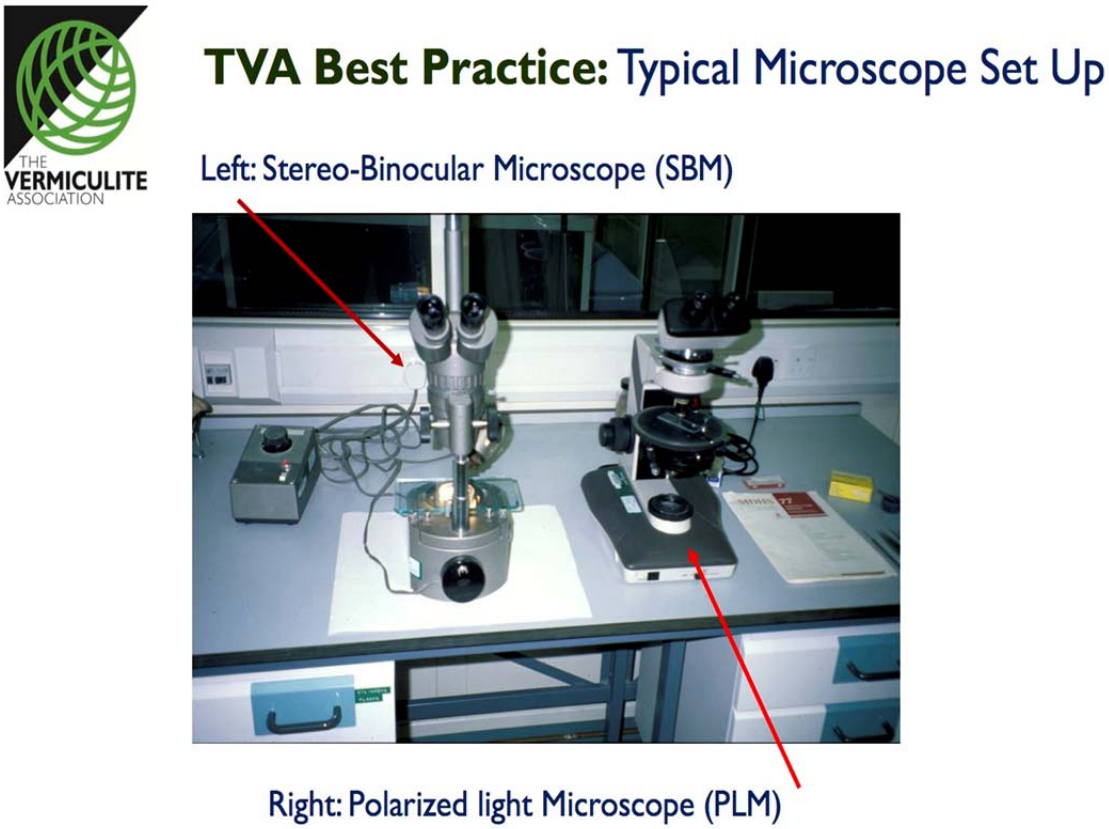
Every accredited asbestos-testing laboratory must hold a reference set of asbestos fibres from the UK Health and Safety Laboratory, Buxton, Derbyshire or the US NIST (or other competent body).

In addition, each vermiculite miner should retain examples of the identified asbestiform minerals found previously in their ore body for future reference.

Vermiculite consumers are recommended to retain as reference materials examples of any asbestiform minerals recovered from shipments, even if they were ultimately within acceptable limits.

Microscope set-up

The image below has been included for illustration purposes to show the two different types of microscopes used in these procedures. The SBM and PLM microscopes should be placed in what is effectively a clean environment, or as clean an environment as feasible.



Pre-shipment Quality Assurance

Vermiculite producers should identify and address QA testing concerns of individual clients. This document may provide adequate assurance for many vermiculite consumers, and if a shipment is shown to contain less than 0.01% as described above, this may be acceptable. However, specific customers may require more stringent or specific testing of vermiculite ore or concentrate which should be addressed on a client by client basis.

It is also important to understand that vermiculite customers of any mine should verify that their actual vermiculite receipts conform to their individual required specifications. This includes review of asbestos test results received from the supplier's laboratory, and any received from accredited asbestos-testing laboratories. It is recommended that any company using significant amounts of vermiculite should have basic in-house asbestos testing facilities available.

It is recommended that customers should perform periodic sampling of incoming vermiculite shipments, correlating to the supplier's production lots, and then dispatching these samples to an accredited laboratory to double check the original results using the same protocols used by the supplier.

Vermiculite consumers are recommended to retain examples of any asbestiform minerals recovered from shipments as reference materials, even if they were ultimately within acceptable limits.

References

Health and Safety Executive (2005). HSG 248, “Asbestos: The analyst’s guide for sampling, analysis and clearance procedures,” HMSO, London.

United States Environmental Protection Agency (1993). EPA/600/R-93/116, “Method for the determination of asbestos in bulk building materials,” USEPA, Washington D.C.

International Standardization Organization (2012). ISO 22262-1:2012, “Air quality -- Bulk materials -- Part 1: Sampling and qualitative determination of asbestos in commercial bulk materials,” ISO, Geneva.

American Society for Testing and Materials International (2014). ASTM D75, “Standard Practice for Sampling Aggregates,” ASTM, West Conshohocken, PA.

International Standardization Organization (2007). ISO 14488:2007, “Particulate materials -- Sampling and sample splitting for the determination of particulate properties,” ISO, Geneva.

NISTIR 7028, Type Evaluation Laboratory Quality Manual Template Developed for U.S. Type Evaluation Laboratories, July 2003.

International Standardization Organization. ISO 9001:2015, “Quality management systems -- Requirements,” ISO, Geneva.

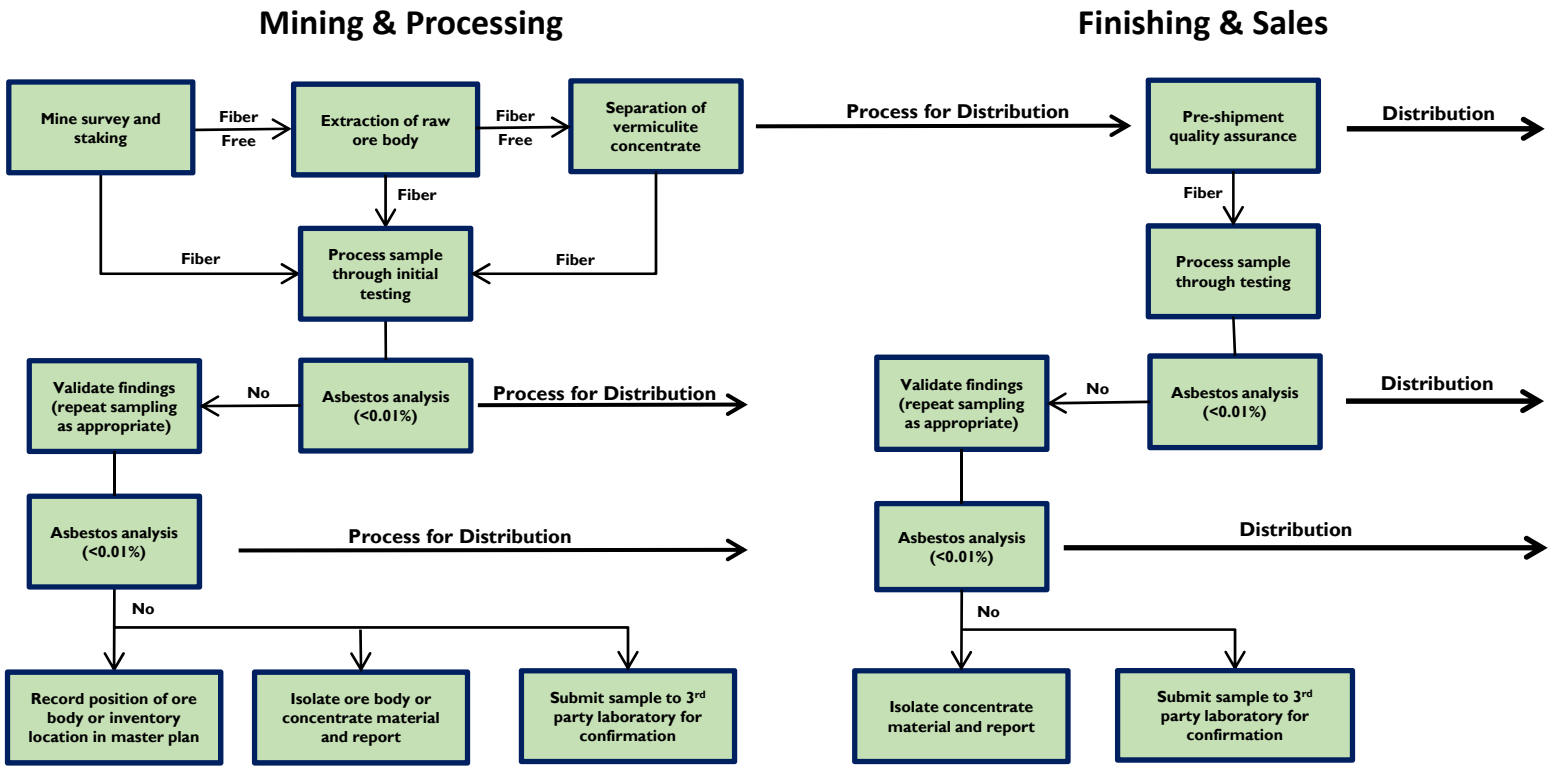
The Vermiculite Association, Test Methods (2001). 109-99, “Determination of Non-Vermiculite Matter,” TVA, Harrisburg, PA.

International Standardization Organization. ISO 10725:2000, “Acceptance Sampling Plans and Procedures for the Inspection of Bulk Materials,” ISO, Geneva.

Procedural Flow Sheets

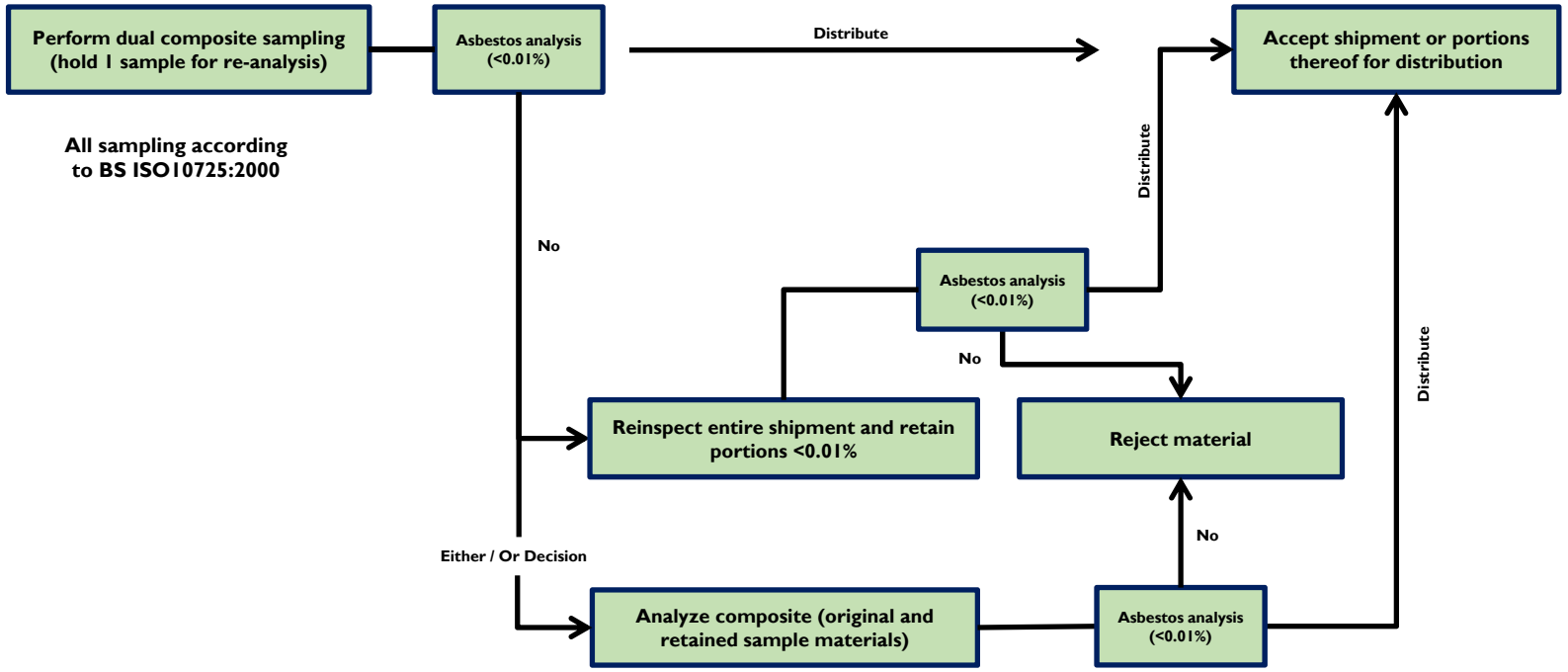
TVA Best Practice

Procedural Flow Sheet - From Mine to Market *(Benchmark Example)*



TVA Best Practice

Acceptance/Rejection Criteria - From Mine to Market *(Benchmark Example)*



Forms

Quality Control Systems
Form TVA – 1

Company Name: _____

Person Completing Form: _____

Contact Phone: _____

Contact Email: _____

Please make note of the following items during your inspection:	Yes	No
Is the Quality Control Manual developed and readily available?	❑	❑
Does the Manual include the following components?		
Testing Results	❑	❑
Sample Methods	❑	❑
Internal Quality Control Procedures	❑	❑
Repeat Testing	❑	❑
Laboratory Equipment Used	❑	❑
Calibration Methods	❑	❑
Reference Materials (ISO, BBB, etc.)	❑	❑
External Audits	❑	❑
In-house Training	❑	❑
Terminology/Definitions	❑	❑
Staff involved in testing, including their qualifications and Job descriptions:	❑	❑
Vermiculite production lots:		
Defined by size and date	❑	❑
Definitions of all terminology used (For example, terms such as batch, bag, lot, load, sample and composite sample must be defined in the QM.)	❑	❑

Comments: _____

_____

_____

_____

_____

Management and Technical Training
Form TVA - 2

Company Name: _____

Person Completing Form: _____

Contact Phone: _____

Contact Email: _____

Please make note of the following items during your inspection:	Yes	No
Geological, Mineralogical and Chemical Training		
Understanding of Vermiculite	❑	❑
Understanding of Asbestos	❑	❑
Understanding of Asbestiform	❑	❑
Asbestos Identification	❑	❑
Health Training		
Health effects of asbestos and other minerals	❑	❑
Health and Safety Equipment (PPE/Asbestos)	❑	❑
Mineral Dusts	❑	❑
Equipment Training		
Laboratory instruments/scientific equipment	❑	❑
Dust Cabinets	❑	❑
Record-keeping		
Internal Procedure Training	❑	❑
Methodology and Techniques Used	❑	❑

Training Details

Please complete the following FOR EACH TRAINING SESSION HELD

Type of Training Conducted (Geological/health/equipment/etc.) _____

Name of Training Session: _____

Who provided training? (Name of company and person conducting training)

_____

Phone number for company providing training or trainer: _____

Date of Training: _____

Location of Training: _____

Proof of Attendance (i.e. certificate) ❑ Yes ❑ No

Asbestos Control Procedures
Form TVA - 3

Company Name: _____

Person Completing Form: _____

Contact Phone: _____

Contact Email: _____

Please make note of the following items during your inspection:	Yes	No
Daily inspection of crude ore for presence of asbestos fibers	❑	❑
Secondary sampling and testing of processed ore	❑	❑
Sign-off of material prior to reaching beneficiation plant	❑	❑
Tests carried out as follows:		
In-house personnel	❑	❑
Training location: _____		
Accredited Laboratory	❑	❑
Name of Laboratory: _____		
Samples of dispatched batches retained	❑	❑
Internal and External Audit s of Records Conducted	❑	❑
Frequency of Audits: _____		

Comments: _____

_____

_____

_____

_____

Mine Ore Body – Pre-Extraction
Form TVA - 4

Company Name: _____

Person Completing Form: _____

Contact Phone: _____

Contact Email: _____

Please make note of the following items during your inspection:	Yes	No
Mining Areas Clearly Defined	❑	❑
Pre-Extraction Testing	❑	❑
Method Used: _____		
Representative Samples		
Obtained and Filed	❑	❑
In-House identification	❑	❑
Third party identification	❑	❑
Sampling and Testing Methodology		
HSG 248/EPA EPA/600/R-04/004 (2004) methods	❑	❑
Stereo-binocular microscopy	❑	❑
Polarized light microscope analysis	❑	❑
Laboratory confirmation of results 4 times/year	❑	❑
Laboratory Used: _____		
Dates submitted: _____ _____		
_____ _____		
Record-keeping of all pre-extraction information	❑	❑

Comments: _____

_____

_____

_____

_____

Processed Vermiculite
Form TVA - 5

Company Name: _____

Person Completing Form: _____

Contact Phone: _____

Contact Email: _____

Please make note of the following items during your inspection Yes No

Particle Sizes and weights are defined as follows:

Grade size (mm)	Minimum weight of composite sample per production day
> 10 mm	25 kg
>5 mm but <10 mm	10 kg
<5 mm	5 kg

For each particle size/grade:

Hourly samples of approximately 1 kg collected ❑ ❑
Daily (every 24 hours) samples delivered to internal laboratory ❑ ❑
Samples split ❑ ❑
Method Used: ❑ Riffle Box ❑ Rotary Sample Splitter
Traceability system to original production lots ❑ ❑
Testing of processed vermiculite by third party lab (12/year) ❑ ❑

Dates Tests Performed:

January _____ July _____
February _____ August _____
March _____ September _____
April _____ October _____
May _____ November _____
June _____ December _____

Laboratory Used: _____

Contact Person at Lab: _____ Phone: _____

Auditable Records on File ❑ ❑

Comments: _____

_____

_____

Safe Management, Disposal and Handling
Form TVA - 6

Company Name: _____

Person Completing Form: _____

Contact Phone: _____

Contact Email: _____

Please make note of the following items during your inspection:	Yes	No
Vermiculite Ore		
If fibrous minerals or suspected asbestos found, did you perform the following actions:		
Flag the site	❑	❑
Record where found on mine plan	❑	❑
Report find to senior management	❑	❑
Internal Processes		
Procedure on file for minimizing spread	❑	❑
Dust Protocol		
Sampling and analysis	❑	❑
Dust control procedures in place	❑	❑
Documentation of processes	❑	❑

Comments: _____

_____

_____

_____

_____

Vermiculite Customer Testing
Form TVA - 7

Company Name: _____

Person Completing Form: _____

Contact Phone: _____

Contact Email: _____

Please make note of the following items during your inspection:	Yes	No
Verify the following items have been provided to customers:		
Pre-shipment samples (monthly)	❑	❑
Quality Control Data	❑	❑
Non-detect asbestos certification from accredited lab	❑	❑
Feedback requested and obtained from customers	❑	❑
Internal procedures developed to respond to customer inquiries	❑	❑

Comments: _____

_____

_____

_____

_____

License Agreement

COMPLETE AND RETURN SIGNED COPIES OF THIS AGREEMENT; BE SURE TO INITIAL EACH PAGE NOTING YOUR ACCEPTANCE OF THE INFORMATION SHARED. A COPY WILL BE SIGNED BY TVA AND RETURNED TO YOU.

TO: TVA Best Practices Administrator
2207 Forest Hill Drive
Harrisburg, PA 17112

We want to begin or maintain our Participant status in the TVA Best Practices Program for Asbestos Detection and Control Protocol: Vermiculite Mining and Milling. Enclosed please find:

- One (1) executed License Application
- A check, payable to TVA in US funds, for our Annual Administrative Fee, which is non-refundable. *To pay by credit card, see below.*

Annual Administrative Fee (non-refundable)	TVA Members	Non-Members
	$ 1,500.00 US	$ 3,000.00 US

BUSINESS ENTITY NAME – PLEASE PRINT _____ EIN NUMBER _____

MAILING ADDRESS (check here ❑ if billing address is same as mailing address) _____

BILLING ADDRESS _____

CITY, STATE, ZIP CODE _____

TELEPHONE NUMBER _____ FAX NUMBER _____

E-MAIL ADDRESS _____ WEBSITE _____

Pay by credit card: ❑ Visa ❑ MasterCard ❑ Discover

Card #_____ Exp. Date_____/_____ Security Code ____

Name on card: _____ Email/Phone for Cardholder:_____

Signature*:* _____ Date _____

LICENSE AGREEMENT

_____, a business entity having its principal offices at

_____

(hereinafter "Participant") hereby applies to The Vermiculite Association (hereinafter "TVA") for a license and authorization to use the TVA Best Practices for Asbestos Detection and Control Protocol: Vermiculite Mining and Milling Logo (hereinafter "Best Practices Logo") on our packaging for vermiculite product manufactured by Participant, and to have its company listed on the TVA Website (www.vermiculite.org), hereinafter "Website") as being a Best Practices compliant company.

By making this application, Participant agrees, if this agreement is accepted, to be bound by the terms and conditions hereinafter set forth, including those set forth in the Procedural Guide for Best Practices Program for Asbestos Detection and Control Protocol: Vermiculite Mining and Milling (hereinafter "Procedural Guide") as amended or revised and distributed to Participant, and the Requirements for Best Practices Program Logo (hereinafter "logo requirements") with respect to the use of the Best Practices Logo, descriptive verbiage, and listing on the Website by Participant and its representatives, sales agents and employees, and agrees further that in the event of any material breach or default of any of the terms and conditions regarding the use of the Best Practices Logo, descriptive verbiage, or being listed on the Website, upon receipt of notice from TVA advising Participant of the breach or default.

By accepting this application, TVA agrees with Participant as set forth herein, and authorizes use of the Best Practices Logo, descriptive verbiage, and listing on the Website according to the terms and conditions set forth herein.

1. DURATION OF AGREEMENT

This agreement shall become effective upon the date of acceptance by TVA and shall be in force from that date until May 31 of the following year, unless the agreement is revoked or terminated for cause as set forth herein, including nonpayment of the annual administrative fee. This Agreement must be renewed after May 31st to be valid through the following 12 month period.

2. PARTICIPANT'S RESPONSIBILITIES

THE PARTICIPANT SHALL:

Comply with all applicable portions of the Procedural Guide, attached hereto and made a part hereof, as may be revised from time to time by, and at the sole discretion of, TVA;

Perform or authorize tests, allow plant inspection by TVA or its mutually agreed upon designee, and allow review of Participant records as requested by TVA;

Provide the information described in the Procedural Guide in determining whether best practices are being followed;

Affix or apply the TVA Best Practices Logo only to Participant promotional materials about the company, and not insinuate that TVA is endorsing or approving any product manufactured by the Participant. The right to affix the TVA Best Practices Logo to Participant's promotional literature is granted solely upon the assurances given herein. Participant alone has the responsibility of ensuring that the material in the packaging to which it affixes the TVA Best Practices logo actually complies with this procedural guide and all other regulations governing vermiculite;

_____

Comply with all applicable portions of the Logo Requirements, attached hereto as "Appendix A" and made a part hereof, as may be revised from time to time, and at the sole discretion of, TVA, and all laws applicable to best practices logos or marks, including notification to TVA of any unauthorized use of the Best Practices logo.

THE PARTICIPANT SHALL NOT:
Affix the TVA Best Practices logo to any products manufactured by Participant, and related sales literature if the Participant is not in compliance with the best practices procedural guide;

Use TVA's name, logo, or any symbol or abbreviation thereof, or any other form of reference which may be interpreted to mean TVA, in any advertising, sales promotions or other communication concerning its product or company, except as outlined in the logo usage guide, or in such manner as is expressly approved in writing by TVA; and

Use, under any circumstances, TVA's name, logo, or any symbol or abbreviation thereof, or any other form of reference which may be interpreted to mean TVA, in any advertising, sales promotions or other communication concerning its product, in such a manner as to indicate that TVA warrants or approves any product; or that TVA certifies that any product complies with specific standard(s); or that TVA makes any other representation or certification with respect to the company to which the Best Practices Logo applies, or in such manner as is expressly approved in writing by TVA.

3. CONFIDENTIALITY

TVA shall not divulge, and shall take all reasonable precautions to safeguard, Participant's manufacturing data, test and inspection reports regarding the product offered, and any other privileged information or information provided in accordance with the terms of this Agreement.

4. FEES

The Participant shall pay the annual TVA Administration Fees (non-refundable) for participation in the TVA Best Practices Program for Asbestos Detection and Control Protocol: Vermiculite Mining and Milling in accordance with the fee outlined. TVA may amend the fee from time to time.

5. BEST PRACTICES LOGO

TVA is the proprietor of the Best Practices logo. Participant acknowledges TVA's exclusive right, title, and interest in and to the Best Practices logo, and will not do anything that will in any way impair, or tend to impair, any part of TVA's right, title, and interest. In connection with the use of the Best Practices logo, Participant will not represent that it has any ownership in the logo or in its registration. Use of the Best Practices logo by Participant will not create any right, title, or interest in or to the Best Practices logo in favor of Participant. Participant will not at any time, either during the term of this Agreement or after it has ended, adopt or use any work or logo that is similar to, or confusing with, the Best Practices logo, without TVA's prior written consent. Artwork for the TVA Best Practices logo will be available only from the TVA Administrator. Upon receipt of artwork for the TVA Best Practices logo, Participant agrees to follow the requirements for proper use (Appendix A).

Immediately upon the termination of this Agreement, for any reason, Participant shall discontinue its use of the TVA Best Practices logo in any form on all products and communications to the satisfaction of TVA, and in compliance with the Procedural Guide.

6. INDEMNIFICATION

Participant agrees to indemnify and hold harmless, TVA, its officers, directors, contractors, staff, and members against and from any and all expenses (including reasonable attorneys' fees), losses, damages, injuries, and liabilities, as suffered or incurred, arising from or related to Participant's participation in, or any statement or representation about, the TVA Best Practices Program for Asbestos Detection and Control Protocol: Vermiculite Mining and Milling, including, but not limited to, use of the TVA Best Practices logo in the manufacture and sale of Participant's products, as well as any actual or alleged deficiency, defect, or fault in Participant's products.

7. LIMITATION OF WARRANTIES; LIMITATION OF LIABILITY

TVA does not make any representations or warranties of any nature, express or implied, in connection with this License Agreement, the TVA Best Practices Program for Asbestos Detection and Control Protocol: Vermiculite Mining and Milling, the Best Practices Logo, or any other matter, including without limitation all warranties of merchantability, title, and fitness for a particular purpose. The limit of liability of TVA shall be the total fees paid by the Participant within the 12 month period immediately prior to the filing of any claim. Under no circumstances will TVA have any liability for lost revenues, lost profits, loss of business, or any indirect, special, consequential, or punitive damages of any nature, or any products liability.

8. DEFAULT AND TERMINATION

Participant shall be in default and TVA may, upon thirty (30) days written notice to Participant, terminate this Agreement should Participant:

a) Fail to pay TVA the annual administrative fee;
b) Fail to indemnify TVA, in a manner satisfactory to TVA;
c) Fail to provide requested documentation requested within the Procedural Guide to prove adherence to Best Practices;
d) Breach or otherwise fail to perform any other term or condition of this Agreement or the Procedural Guide; or
e) Be adjudicated as bankrupt or insolvent, or have a receiver or trustee appointed, or have an order approving a petition seeking reorganization under the Bankruptcy Code, or other similar laws of the United States or any state, or file a petition seeking relief under any of the foregoing, or make a general assignment for the benefit of creditors or instrument similar thereto.

This Agreement shall not be terminated if Participant remedies the default to TVA's satisfaction within the 30-day notice period.

In the event of any revision of the Procedural Guide, Participant shall be given reasonable advance notice of the revision and of the effective date thereof, and Participant, by written notice to TVA, shall have the right to terminate this Agreement as of the effective date of such revision(s).

Termination of this Agreement by whatever means or in whatever manner, shall not affect any obligation of the parties which exists as of the date of termination. Participant's obligation with respect to maintenance of records and indemnification shall not cease, regardless of the termination date, with respect to the best practices for which the TVA Best Practices Logo has been utilized.

9. NOTICE

All notices, reports and other communications permitted or provided for hereunder shall be in writing and shall be delivered in person, electronically or sent by mail, to the address set forth below.

TO TVA: TVA Administrator
2207 Forest Hill Drive
Harrisburg, PA 17112

TO Participant: _____
(Contact person - PLEASE PRINT)

_____
(Business entity name)

_____
(Street address)

_____
(City, state, zip)

_____
(E-Mail)

10. ARBITRATION

TERMS OF ARBITRATION: All claims, disputes, and other matters in question arising out of this Agreement and not otherwise resolved in accordance with the TVA Procedural Guide, shall be submitted to arbitration in Harrisburg, Pennsylvania, in accordance with the Commercial Arbitration rules of the American Arbitration Association then in effect, unless the parties mutually agree otherwise.

EXCLUSIVE REMEDY: A party to this Agreement may not institute a suit at law or equity regarding any dispute under this Agreement. All such disputes shall be settled by arbitration in accordance with this Paragraph.

FINAL AWARD: The award in the arbitration proceeding shall be final and binding on the parties, and judgment on such award may be entered in any court having competent jurisdiction.

FEES AND EXPENSES: Initially, all fees connected with the arbitration proceeding, other than attorney fees incurred by either party, if any, shall be shared equally by both parties. However, the Arbitrator is authorized to award either party a sum to compensate the other party for the time and expense, including reasonable attorney fees, of the arbitration if it is determined that arbitration was demanded without reasonable cause. In such event, the Arbitrator may also assess the costs of the arbitration proceeding against the party that demanded arbitration. In all other cases, the costs of the arbitration proceeding shall be assessed against the party against whom the arbitration award is determined, or against both parties if the determination is against both.

11. MISCELLANEOUS PROVISIONS

NO ASSIGNMENTS: This Agreement may not be assigned in whole or in part by the Participant without the written consent of TVA.

GOVERNING LAW: Regardless of where this Agreement is executed or is to be performed, the interpretation of this Agreement and the performance of the parties hereto shall be governed and construed in accordance with the laws of the State of Pennsylvania.

ENTIRE AGREEMENT: This Agreement constitutes the entire Agreement of the parties and supersedes all prior Agreements, if any, express or implied. There are no warranties or representations other than as provided herein. This Agreement may not be modified or amended except in writing signed by all parties hereto.

SAVINGS CLAUSE: Should any provision hereof be finally determined to be inconsistent with or contrary to applicable law, such provision shall be deemed amended or omitted to conform therewith without affecting any other provision or the validity of this Agreement.

WARRANTY OF AUTHORITY: This Agreement shall be executed for the parties by an officer designated in the parties' governing documents as having the power to enter into contracts. The designated officers warrant that they have acted with authority, and that they may sign this Agreement for their respective entity with the effect that their entity has agreed to and shall be bound by all terms of this Agreement.

Participant: _____

By: _____ _____

Signature of Officer *Title of Officer*

Accepted by: The Vermiculite Association

By: _____ _____

Administrator *Date of Acceptance*

Appendix A – Logo Usage Policy

LOGO REQUIREMENTS AND POLICIES

For more information, visit www.vermiculite.org

The TVA Best Practices Logo refers to TVA's unique and distinctive mark which is approved in connection with the Best Practices Program for Asbestos Detection and Control Protocol: Vermiculite Mining and Milling.

The logo must be clearly linked to a company that successfully follows the processes outlined in the TVA Best Practices program procedural guide and is in good standing with TVA in the program. Good standing denotes that payment is current and that the company has submitted the proper paperwork and received approval from TVA headquarters related to following the best practices protocol outlined in the procedural guide for this program.

The Best Practices Logo is displayed on the cover of the Procedural Guide and is only available from TVA headquarters. At no time may the logo be downloaded from another source or shared with a company that has not successfully completed the TVA Best Practices program. If a participant chooses not to participate in the program following approval by TVA headquarters, or is removed from the program for cause by TVA, it must immediately cease and desist use of the logo on all materials.

TVA has developed the following verbiage for participants when the logo is not being used, but to describe the company's good standing in the program: *(Company name) is a participant in The Vermiculite Association's best practice procedures related to Asbestos Detection and Control Protocol: Vermiculite Mining and Milling. For more information, visit www.vermiculite.org*

The Best Practices logo color scheme may not be altered, but may be produced in black on white background or white on a colored background. The minimum reduction would be that which still allows the words to be read clearly. The original aspect ratio of the logo must be retained.

The logo may be used on the following items:

- General publications and catalogs
- Trade publication advertising
- Media (sales flyers, newsletters, websites, promotional videos, power point presentations, etc.)
- Invoices and Bills of Lading
- Bags and other packaging of ore

For permission to use the logo on other materials, please contact TVA headquarters.

TVA reserves the right to designate another Best Practices Logo or descriptive verbiage to be used in lieu thereof at any time. Should TVA become aware of a violation of the logo requirements and policies, the organization will take appropriate and swift action to protect the brand, up to and including legal action. Non-participants may not use the Best Practices logo or verbiage in any of their materials, publications or communications.