Cnano

Response to "Chemical Information Call-in" requested by DTSC

To Whom It May Concern:

In order to comply with the California EPA requirement of the "Chemical Information Call-in", namely, carbon nanotube-related environmental, health and safety information, we prepared the following response, at our best knowledge, trying to elucidating what we understand and have achieved in our practice.

1) *What is the value chain for your company? For example, in what products are your carbon nanotubes used by others? In what quantities? Who are your major customers?*

Confidential and Proprietary

2) *What sampling, detection and measurement methods are you using to monitor (detect and measure) the presence of your chemical in the workplace and the environment? Provide a full description of all required sampling, detection, measurement and verification methodologies. Provide full QA/QC protocol.*

It is generally perceived that air-borne nanoparticles may pose threat to human through his/her inhalation system. Ingestion or injection is less likely viable pathways for nanomaterials to transport to human body. Therefore, we implemented air quality monitoring policy to sample, detect and measure possible release of carbon nanotubes to our workplace.

The rational behind our air monitoring is to measure air-borne particulates which may contain or are composed of nanoparticles. Nanoparticles are hard to make and hard to maintain in an un-agglomerated state. It is important to understand that a dispersion of nanoparticles in a fluid, i.e., air or water, is thermodynamically unstable. In fact, the challenge is to create, at least briefly, un-agglomerated nanomaterials. Even in the absence of any bulk flow, Brownian motion causes particles to collide, coagulation or agglomeration follows. For mono-dispersed size distributions, one can calculate concentration as a function of time for various particle sizes. These data show that for ideal systems (mono-dispersed spherical particles); only at extreme dilutions of less than 10^6 particles/mL are significant particle lifetimes calculated. In "real" systems, i.e. poly-dispersed distributions, non stagnant fluid and nonspherical particles, these times are significantly reduced. It is notable that the presence of ordinary dust in the air creates just such a poly-dispersed distribution. Thus, an un-agglomerated nanoparticle or other

nanostructure exists only fleetingly from the moment of its synthesis until it encounters other, like or unlike particles with which it associates. These agglomerates quickly grow out of the ultrafine (<0.1 micron) range. It is also notably that once agglomerated, deagglomeration cannot spontaneously take place. Thermodynamics requires that there be a driving force - typically the application of energy - to make this occur. Ordinary handling will not deagglomerate nanoparticle agglomerates.

Due to lack of standard protocol in dealing with nanomaterials, we adopt the method used to monitor air-borne asbestos, and carbon black in workplace. The air sample is collected using a commercial test kit, such as portable air sampling pump manufactured by BGI Inc, Waltham, MA. By placing this test kit in various locations in our workplace for various time periods, we then measure the weight of particulate trapped on the filter membrane and calculate the concentration against total sampled air volume. In a further attempt, some sample will also be transferred from the filter membrane to a microscopic sample grid and examined for possible presence of carbon nanotubes. The goal of spill-free operation is to find zero nanotube through this method, and particulate concentration less than 3.5 mg/mL (OSHA PEL) or 8 mg/mL (Chinese standard).

The protocol is following OSHA's carbon black protocol, and conventional asbestos test method as enclosed as references to this document. In addition, Chinese National Standard on workplace particulates is also enclosed.

The following table demonstrated an example of our workplace air quality evaluation.

Facility Airborne Particle Test Record

Sampling Date	Point	Status	Sampling Time/min	Sampling Flow/L/min	Particle Conc./mg/m3	Allowable Upper Limit/mg/m3
2009.10.27	2F Lab	Operation	30	3	2.2	8
2009.10.29	1F Prepartion	Operation	30	3	3.3	
2009.10.30	1F Lab	Operation	480	5	0.2	
2009.11.21	CNT Mfg	Operation	480	5	0.92	

3) *What is your knowledge about the current and projected presence of your chemical in the environment that results from manufacturing, distribution, use, and end-of-life disposal?*

Carbon nanotubes have long been used in commercial products since late 1990s. Most of the products were seen in automobiles, where front end parts, fuel systems, etc have

adopted CNTs as conductive filler to enable electrostatic painting or dissipate static. Carbon black in tire is another know example of nanomaterials being used widely today. Since nanotubes or nanoparticles such as carbon black are all embedded inside plastics /rubber matrixes, there is no belief that these materials would be release into environment during use, even under severe distortion like brake mark.

Manufacturing these nanomaterials or nano-embedded products, however, presents some challenges in term of EHS concern. Therefore sufficient measure should be implemented in practice to prevent release or spill.

For end-of-life disposal, as we believe, these nano-embedded products can follow traditional recycle method as long as no intentional separation is used to recover the used nanomaterials.

4) *What is your knowledge about the safety of your chemical in terms of occupational safety, public health and the environment?*

Since carbon nanotubes are a new material in the area of environmental, health and safety, we have very limited knowledge about their safety in terms of occupational safety, public health and the environment like many others who are studying and producing these types of materials. However, it is important to define risk from toxicity as we approach the EHS concern. Nanomaterial is a new and exciting class of materials and should be embraced with enthusiasm but also with great precaution when producing and handling. There are a number of raw and intermediate product that are used broadly in today's chemical, pharmaceutical and even food industries have more or less toxic effect to certain degree, and some of them are even extreme toxic. These materials are not banned but instead with great caution when handling, have been proved to be safe in their current applications. Similar effort should also be exercised in dealing with new materials such as carbon nanotubes. Raw product should never enter the consumer product market without proper agglomeration or bondage. In another word, freestanding or free-flowing nanotubes should always be prohibited with no exception.

There are quite a bit of toxicology studies of carbon nanotubes published in the literature. We think there are many mixed reports concerning the toxicology effect from carbon nanomaterials, largely due to their inconsistent material source, sampling procedure and treatment, method of exposure, etc. The reliable conclusion is still not available. Individual study often follows product by process route thus conclusions and results can vary in a great deal among different systems, not to mention contradicting against each other. It is common in the nanotechnology community, where risk is usually represented mistakenly with toxicity. We think it is important to view the risk no matter whether nanotubes are toxic or not. Therefore, we implemented several measures in our

workplace trying to minimize exposure risk of carbon nanotubes to our workers and researchers. These measures are briefed in the following paragraph.

5) *What methods are you using to protect workers in the research, development and manufacturing environment?*

In our corporation, we pursue an internal safety philosophy as "prevent", "contain", and "isolate", which include safety training, good chemical hygiene practice, engineering control and personal protective equipment as the last defense tool.

As highlighted in the attached training presentation, we generally educated our researchers and workers about the potential hazardous risk of carbon nanotubes, importance to a good chemical and personal hygiene, as well as correct ways of checking and wearing protective clothing and masks.

Sufficient engineering controls are in place to prevent release of carbon nanotubes to workplace, and isolate a close environment where carbon nanotubes are packed for shipping.

All lab and production personnel are required to wear lab clothes and gloves in lab and production area, and wear NIOSH approved respirator with N-100 filter.

6) *When released, does your material constitute a hazardous waste under California Health &Safety Code provisions? Are discarded off-spec materials a hazardous waste? Once discarded are the carbon nanotubes you produce a hazardous waste? What are your waste handling practices for carbon nanotubes?*

Whether the discarded off-spec materials are hazardous waste is not clear at the moment, since the toxicological study is still in its very early development stage. However, we view the discarded materials seriously. Our off-spec materials are usually bagged and sent to a furnace to incinerate when enough are accumulated.

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/Enclosures/
Asbestos Test Kit and Method
CNT Safety Training
GB10330-1989 Chinese Workplace Carbon Black Standard
GB16241-1996 Chinese Workplace Asbestos Standard
OSHA-Carbon Black Monitoring Standard-ID196
CNT MSDS

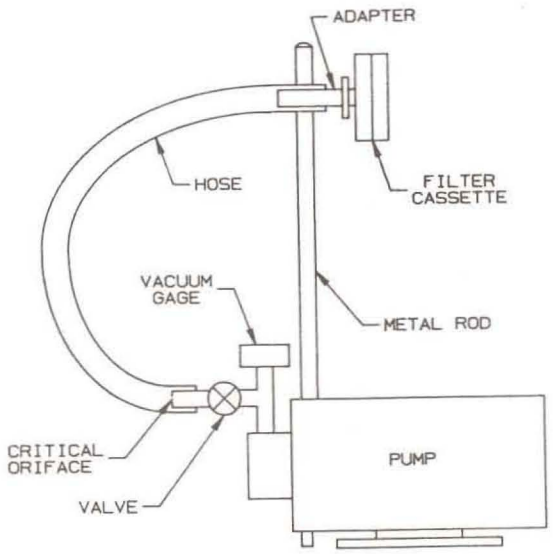
FOR: ASB-II, II-S & III

DECEMBER 1988
FOURTH EDITION

ASBESTOS SAMPLING KITS OPERATING INSTRUCTIONS

INTRODUCTION:

The purpose of this sampling kit is to take large volume air samples over short periods of time. Such a requirement exists in areas where asbestos has recently been removed or removal is being contemplated. Flow rates are controlled to the value of the critical orifice selected and the capacity of the particular size sampling kit purchased. This will vary from 10 to 24 lpm which results in sampling volumes ranging from 600 to 1440 liters per hour. These pumps and orifi have been designed to draw this flow through a 0.8μm membrane filter. This equipment also meets all the requirements for EPA/AHERA sampling with the required special media. For information regarding flow through other media, see the calibration card on the lid of the case, or contact Customer Service.



SCHEMATIC DIAGRAM

EQUIPMENT:

The heart of the ASB is a high capacity, oil-less, rotary vane pump. This pump requires no maintenance for at least 3000 hours. Airflow through the pump is controlled by a critical orifice located downstream of the filter cassette. A needle valve is also fitted for AHERA sampling procedures. The instrument, set up for operation is shown in the photograph and schematic diagram.

BGI INCORPORATED
58 Guinan Street/Waltham, Massachusetts 02154
Telephone: 617-891-9380 Fax No.: 617-891-8151

SAMPLING other than AHERA:

Place the pump on a solid dry surface and plug into a grounded outlet. Screw the extension mast into the threaded hole in the case.

Extend the mast to the desired height and lock in place with the collet locking rings on the mast. (Earlier models utilize 2, ½" diameter threaded rods which are to be screwed together). Install the cassette adaptor to the end of the mast using the thumb screw. This unit has three positions which allow the cassette inlet to be pointed: downwards, horizontally or in the AHERA position, at 45 degrees down from the horizontal. For other than AHERA work, there is some disagreement over which direction to use. In the absence of personal opinion, regulation or other advice, point it downwards.

Use the rubber hose provided to connect the barbed fitting on the front of pump to the barbed fitting on the cassette adaptor. The proper cassette to use will be one of the following five types:

1. 37mm, 0.8μm pore size, mixed cellulose ester membrane.
2. 37mm, 1.2μm pore size, mixed cellulose ester membrane.
3. 25mm, 0.8μm pore size, mixed cellulose ester membrane.
4. 25mm, 1.2μm pore size, mixed cellulose ester membrane.
5. 25mm, 0.45μm pore size, mixed cellulose ester membrane, backed by the 5.0μm MCE (AHERA).

The 25mm cassette *must* be the type provided with a 50mm long conducting, extension cowling. The most commonly used filters are Nos. 3 and 5. For background and clean air sampling we recommend No. 3 as shorter sampling times may be used to obtain a valid sample.

Each of the four cassettes listed above is of 3 piece construction. The blue cap is on the *inlet* end and the red cap is on the *outlet.* The filter itself consists of two layers. The thin (top) membrane and a support pad. This filter assembly is sandwiched between the exhaust end of the cassette (red plug) and the middle ring. No. 5 has two layers of membrane.

Remove complete, ⅓ of cassette body that contains the blue inlet plug by using a coin, inserted in the groove between the pieces and twist, to release cassette body pieces. This should leave the filter held between the exhaust end (red plug) and the cassette center piece, exposing the whole surface of the filter. Remove the red plug and place the cassette on the tapered nipple using the hole that previously contained the red plug. There is also a more recent cassette design available which is identical to those described above, but which screws together instead of a taper fit.

Prepare label indicating:

Sample No.
Date
Location
Flow Rate Setting
Start Time of Sample
Stop Time of Sample

Place label on cassette–wrap around body, sealing exhaust end piece to center piece of cassette body. Switch on pump, noting time and writing it on the label.

Run pump for sufficient time to collect 1800 liters of air. With a flow rate of 10 lpm, run pump for 1800/10 = 180 minutes, i.e. 3 hours. These flow rates are the EPA maximum figures for a 25mm filter cassette. If another flow rate is used be certain to sample long enough to obtain a statistically valid sample. Guidelines for this calculation may be found in the NIOSH/OSHA 7400 Method.

NOTE: Length of time is not critical other than it exceeds the time necessary to collect 1800 liters. What is important is to note the exact time of switching on and off the pump so that the amount of air collected is known and can be used by the laboratory to calculate the fiber concentration of the air passed through the filter.

Note the time the pump is switched off and write it on the label. Place the inlet cap, with blue plug, over the end of the cassette and push in place. Remove the cassette from the pump and replace the red plug. Check label that it contains the following information:

- Sample No.
- Date
- Location of Sample
- Flow Rate of Pump
- Start Time of Sample (Note: Use 2400 hour system, *not* AM/PM).
- Stop Time of Sample

Alternatively, place a numbered label on the cassette and record the information on a data sheet.

SAMPLING, EPA AHERA

At the present time AHERA Regulation sampling relates only to clearance testing conducted in school buildings. Nevertheless an increasing number of building owners are calling for testing to be done to these standards. The difference between routine area sampling and AHERA sampling may be summarized as five points.

1. Analysis to be by TEM (transmission electron microscopy), which requires a new filter. The new item is the 25mm cassette with conductive cowling. The filters comprise a 0.45μm MCE followed by a 5.0μm MCE followed by a backer pad.

As an alternate, the first filter may be a 0.4μm polycarbonate.

Check with your TEM laboratory before making a selection.

2. The filter head must be held at a 45 degree angle (down from horizontal).
3. The only connection between the pump and the filter must be via the suction hose. In other words the extension rod must **not** be connected to the pump.
4. The maximum flow rate (25mm cassette) is 10 lpm.
5. The sampling volume is 1200 to 1800 liters of air. Again, consult your TEM analyst before selecting a sampling time.

Because of the very highly resistive filter pack mandated under AHERA the maximum flow rate attainable is 9.5 to 10.5 lpm. This limit has nothing to do with the size of the pump but the limiting flow condition occurring in the filter pores. More powerful pumps will not pull more air through the filter.

Because of this limiting condition it is not possible to utilize a critical orifice for flow control. However, under the regulations, the flow must not exceed 10 lpm. Since the natural critical values of commercial filters fall across the 10 lpm figure, a valve has been incorporated for throttling purposes.

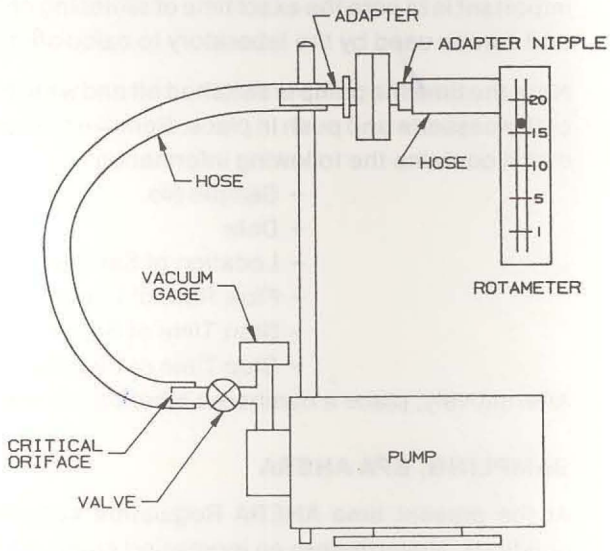
Set the equipment up as shown in Figure 1. Be certain there is no critical orifice installed in the system and the valve is fully open. Plug a rotameter into the front of the cassette, as detailed below under calibration. Turn on the pump. If the flow indicated on the rotameter exceeds 10 lpm close the valve until this flow rate is achieved. Remove the rotameter and filter cap and proceed with the sampling. Note the filter number and flow rate. When the sampling period is concluded, while the pump is still running, loosen the thumb screw and detach the entire sampling head from the extension rod. Orient the cassette vertically upwards and reinstall the inlet cap (blue plug) then shut the pump off. This maneuver is intended to prevent fibers from falling off the filter, according to the regulation. Replace the outlet plug (red) and record the appropriate data.

NOTE: When a normal 0.8μm MCE filter pack is used install a critical orifice and **open the valve,** all the way. Under no circumstances should you use the valve when a critical orifice is installed.

CALIBRATION CHECKING:

The procedure for field confirmation of the original orifice calibration value is to select the same type filter cassettes originally used. (See calibration card on lid of carrying case). In this instance the top portion of the cassette is not removed. Simply take out the red and blue plugs and install the cassette as if a normal test were to be conducted.

A rotameter is now plugged into the hole in the front of the cassette and hand held while the pump is switched on. Check that the vacuum gage is reading at least 16 inches of mercury (Hg). (Rotameters of a suitable type, complete with plug in fittings are available as our part No. **RM-67** or **RM-69**). The rotameter is read by observing the line closest to the **CENTER** of the meter ball. Finer values between lines are estimated by eye. If the value observed is not within ±5% of the calibrated value a fault exists and must be corrected. These faults could include:



SCHEMATIC DIAGRAM - CALIBRATE

Faulty pump – insufficient vacuum.
Cracked or leaking hose.
Missing "O" ring on orifice.
Cracked boss around hole of cassette.
Cassette suffering from internal/external leakage or both.
Incorrect media in cassette.

More precise calibrations of the orifice can be performed in the laboratory using ±1% rotameters Wet test meter, Bubble meter, Spirometer, or the Mini-Buck Calibrator.

APPLICATION NOTES:

While this instruction manual equally applies to the ASB-II, II-S and III, there are special cautions to be noted with the ASB-II-S unit. In this particular "silent" model a fan has been fitted to the pump box as the unit is designed to run with the box closed. This fan provides adequate air movement over the pump for adequate cooling up to ambient temperatures of 100°F. Under no circumstances should the ASB-II-S be operated in environments exceeding this temperature. The pump will not be damaged in any way but the automatic thermal overload switch will turn the pump off and prevent its operation until the unit cools.

FILTER CASSETTES:

We can not caution too strongly against reusing filter cassettes as an economy measure. Several problems can arise. First they must be thoroughly cleaned and dried in a clean room. When recompressing the plastic parts repeatedly the plastic expands and takes a permanent set. This leads to external leakage. Some have attempted to cure this leak by wrapping the cassette with tape or by the use of air dry, shrink bands. While this may stop external leakage it does not cure internal or filter bypass leakage. The shrink bands can make this problem worse. As they contract they can actually draw the tapered surfaces apart and create bypass leakage. This can be observed during a calibration test as excessively high flow due to elimination of the filter resistance.

CNT Safety

www.CNanotechnology.com

CNT Safety

- Suspect of Asbestos hazard- “pneumonokoniosis”, but some reports claimed it to “straight and short” CNT
- Require more in-depth study on the CNT hazard
- CNano received US EPA PMN in August, 2009
- CNano committed to participate in in-depth program of “Nanoscale Materials Stewardship”

Control in Practice ....

Purpose

- Prevent adverse health effects (physiological and psychological) attributable to work
- Help maximise workforce availability (Healthy, Happy and Here)

Control in Practice ....

- What For- *prevent harm*
- When- *today or tomorrow*
- Which- *engineering or procedure*
- How- *management*

Safety Measures

- Engineering control
- Management control

Engineering Control

- HEPA or Water Scrubber-LEV (Local Exhaust Ventilation)
  - Collect CNT by filtration before dumping waste water to city sewer
- Compartment
  - Confine CNT powder working place
- Ventilation
  - Collecting hood around handling opening

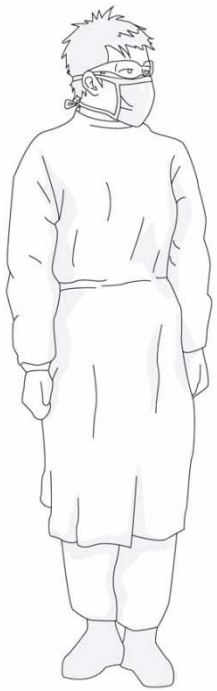
Management control

- Minimize exposure (operators, time, space)
- Changing clothing, shoes in work place
- “Wet” cleaning spill-soap water mopping
- Waste disposal-cremation advised
- Respirator “Fitness Test”
- Annual physical examination for workers
- Regular airborne particle measurement

PPE is the last tier of protection

- Air respirator: NIOSH approved, Filter cartridge N100/P100/R100
- Chemical proof glove, clothing

How to fit and remove personal protective equipment in the correct order

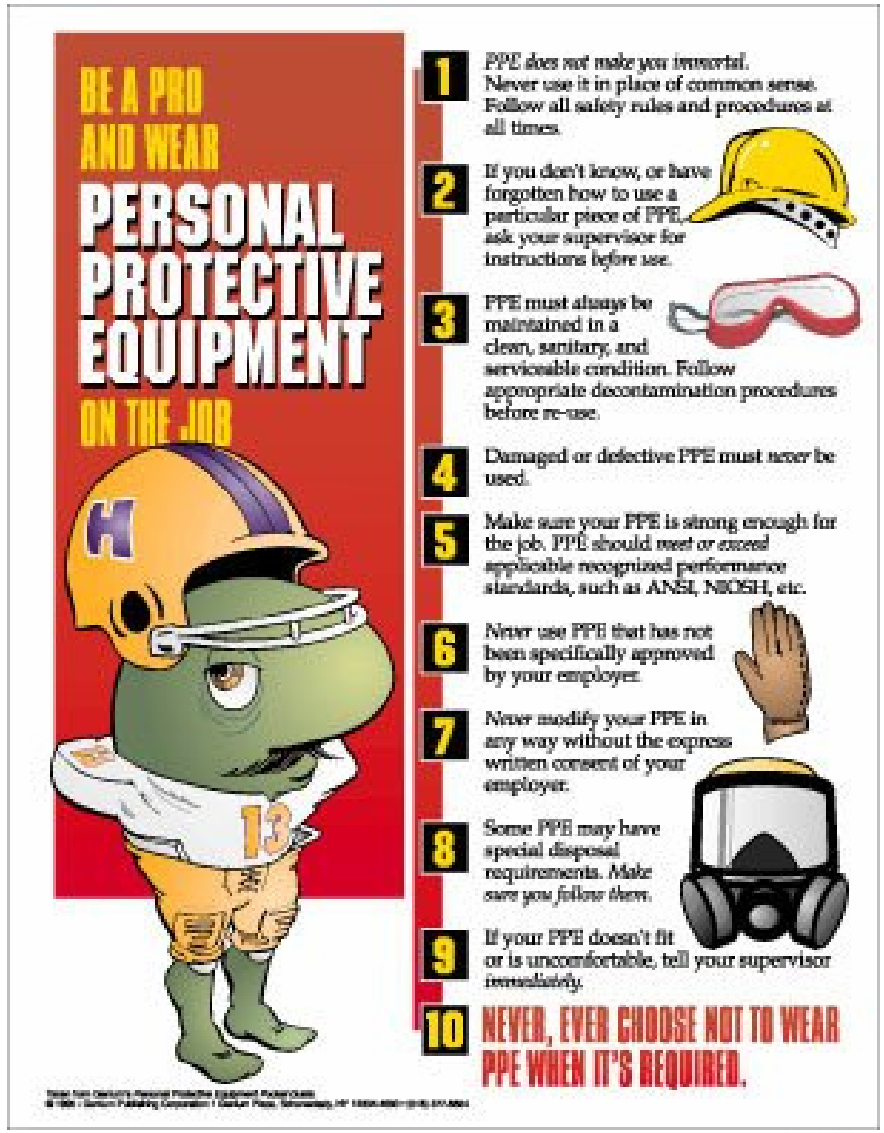


Fit in this order

- Wash hands or use alcohol-based rub
- Respirator
- Goggles
- Gown
- Gloves

Remove in this order

- Gloves
- Wash hands or use alcohol-based rub
- Goggles
- Gown
- Respirator
- Wash hands or use alcohol-based rub



During removal of personal protective equipment, hands should be washed immediately after removing any item which is visibly soiled.

An Australian Government Initiative

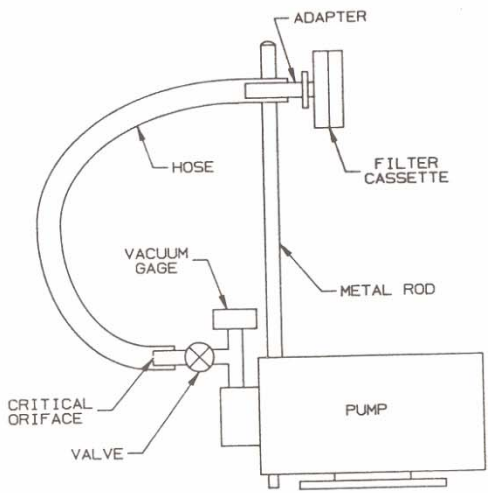
Cnano

Fitness Test

- Individual test and record
- Every year

Airborne particle measurement

- Work place regular measurement
- Asbestos sampling



SCHEMATIC DIAGRAM

Facility Test

Facility Airborne Particle Test Record

Sampling Date	Point	Status	Sampling Time/min	Sampling Flow/L/min	Particle Conc./mg/m3	Allowable Upper Limit/mg/m3
2009.10.27	2F Lab	Operation	30	3	2.2	8
2009.10.29	1F Prepartion	Operation	30	3	3.3	
2009.10.30	1F Lab	Operation	480	5	0.2	
2009.11.21	CNT Mfg	Operation	480	5	0.92	

中华人民共和国国家标准

UDC 628.511
:661.666

车间空气中炭黑粉尘卫生标准

GB 10330—89

Hygienic standard for carbon black dust in the air of workplace

本标准规定了车间空气中炭黑粉尘的最高容许浓度及其监测检验方法。

本标准适用于生产和使用炭黑的各类企业。

1 卫生要求

车间空气中炭黑粉尘的最高容许浓度为8 mg/m^3。

2 监测检验方法

车间空气中炭黑粉尘浓度、游离二氧化硅含量的测定按 GB 5748《作业场所空气中粉尘测定方法》执行。

3 监督执行

各级卫生防疫机构负责监督本标准的执行。

附加说明：

本标准由卫生部卫生防疫司提出。

本标准由中国预防医学科学院劳动卫生与职业病研究所、四川省劳动卫生职业病防治研究所负责起草。

本标准主要起草人符绍昌、张素琼。

本标准由卫生部委托技术归口单位中国预防医学科学院劳动卫生与职业病研究所负责解释。

中华人民共和国卫生部1989-02-27批准　　1989-09-01实施

中华人民共和国国家标准

车间空气中石棉纤维卫生标准

GB 16241—1996

Health standard for asbestos fibre in the air of workplaces

1 主题内容与适用范围

本标准规定了车间空气中呼吸性石棉纤维的最高容许浓度、时间加权平均容许浓度及其监测检验方法。

本标准适用于除石棉矿山的采矿作业外的生产、加工、运输和使用石棉及石棉制品的各类企业。石棉矿山的采矿作业暂仍沿用原定 $2mg/m^3$ 的最高容许浓度。

2 引用标准

GB 2544 手术刀片

GB 5748 作业场所空气中粉尘测定方法

3 术语

3.1 石棉 本标准所泛称的石棉主要指温石棉。其他品种石棉如青石棉、铁石棉、透闪石、直闪石、阳起石等在其卫生标准未制定前，亦可使用本标准。

3.2 呼吸性石棉纤维 能被吸入并沉着在肺泡内的石棉纤维，其条件是：宽度小于 3μm，长度大于 5μm，长宽比大于 3∶1。

3.3 石棉纤维浓度 悬浮在空气中的呼吸性石棉纤维数量，即每毫升空气中含呼吸性石棉纤维的根数(f/mL)。

4 卫生要求

车间空气中石棉纤维的最高容许浓度为 1.5f/mL。

车间空气中石棉纤维的时间加权平均容许浓度为 0.8f/mL。

5 监测检验方法

本标准的石棉纤维浓度监测检验方法见附录 A(补充件)。

国家技术监督局1996-04-03批准 1996-09-01实施

附 录 A
车间空气中石棉纤维计数浓度测定方法——滤膜/相衬显微镜法
（补充件）

A1 主题内容与适用范围

本方法规定了车间空气中石棉纤维计数浓度测定方法的原理、仪器、试剂、采样、样品制备、计测及计算方法。

本方法适用于车间空气中各类石棉纤维计数浓度的测定。

A2 原理

经滤膜抽取一定体积含有石棉纤维的空气，使纤维阻留在滤膜上、滤膜经透明固定后，在相衬显微镜下计测石棉纤维，根据采气量计算出每毫升空气中石棉纤维的根数(f/mL)。

A3 方法灵敏度

本法检出下限为 0.1f/mL。

A4 仪器

A4.1 滤膜：采用硝酸纤维素酯和醋酸纤维素酯混合滤膜(孔径为 0.8μm)，或测尘滤膜(过氯乙烯纤维滤膜)。当滤膜夹采用与 GB 5748 中所用的相同时，滤膜直径为 40mm。

A4.2 滤膜夹、滤膜贮存盒及运输携带箱。

A4.3 粉尘采样器：用定点或个体粉尘采样器时，要求采样流量为 2L/min，转子流量计的刻度应能显示 0.1L/min。

A4.4 相衬显微镜

A4.4.1 显微镜至少应具有 10×及 40×两个相衬物镜，明相衬或暗相衬均可使用；目镜可采用 10×或 15×，均应能放入目镜测微网。总放大倍率应为 400～600×。

A4.4.2 显微镜要带有 X-Y 方向移位的推片器。

A4.5 专用目镜测微网：使用在显微镜下既能测量纤维长度和宽度，又能给定测量面积的各种目镜测微网。常用的有 Porton 型测微网(网格图形见图 A1)，或改进 Beckett 型测微网(网格图形见图 A2)。

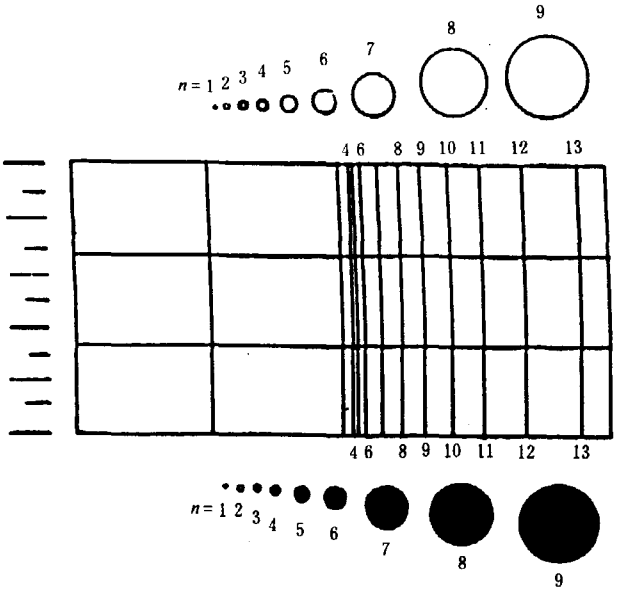


图 A1 纤维计测用 Porton 型目镜测微网

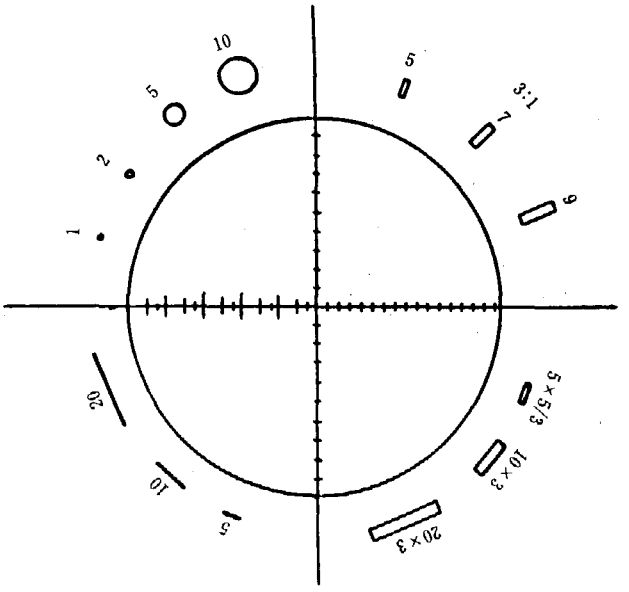


图 A2 改进 Beckett 型目镜测微网

A4.6 物镜测微计(每个刻度的间距为 10μm)。

A4.7 载物玻片(25mm×76mm×0.8mm)及盖玻片(22mm×22mm,厚度:0.17mm)。

A4.8 无齿小镊子、剪刀或手术刀,在刀柄上插入 22 号刀片(参见 GB 2544)。

A4.9 计时器或秒表。

A4.10 丙酮蒸气发生装置。可使用为液化滤膜专用且能喷出足够量丙酮蒸气的各种装置。常用的一种装置如图 A3,使用此装置时,要在通风良好的场所或在通风橱内操作,以避免引起火灾或对人体健康产生危害。

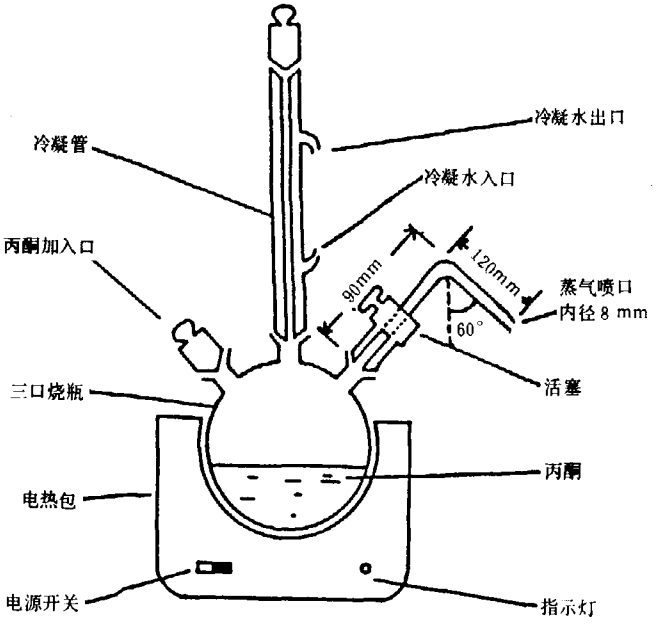


图 A3　丙酮蒸气发生装置

A4.11　结核菌素注射器及皮内针头。

A5　试剂

A5.1　采用微孔滤膜时需用试剂为丙酮 CH_3COCH_3(AR)及甘油三醋酸酯$(CH_3COO)_3C_3H_5$(AR)。

A5.2　采用测尘滤膜时需要邻苯二甲酸二甲酯(AR)和草酸二乙酯(AR),将它们按 1∶1 的容积比配成混合溶液,再按每升溶液中含 0.05g 洁净滤膜的比例加入测尘滤膜碎屑,配制成透明溶液,配制后摇匀,溶解 24h 后离心去杂质,取其上清液放在有盖玻璃瓶中备用,是为苯-草透明液,配制后的溶液宜在一个月内使用。

A6　采样

A6.1　采样地点的选择:按照 GB 5748 有关内容进行。

A6.2　采样流量:以 2L/min 的流量采样。

A6.3　采样时间:采样的持续时间应根据采样时作业场所空气中石棉纤维浓度的高低及滤膜上能采集到适于在显微镜下计测的纤维量而定,在一般情况下不应少于 15min。

最佳采样时间可按式(A1)计算:

$$t=\frac{A}{a}\times\frac{L}{C_P}\times\frac{1}{r}\times\frac{1}{1000} \quad \cdots\cdots (A1)$$

式中:t——最佳采样时间,min;

a——计数视野面积,mm^2;

r——采样流量,L/min;

A——滤膜有效采尘面积,mm^2;

L——滤膜应达到的负荷量,一般为 0.5～5 根/视野;

C_P——采样时的预期浓度,f/mL。

当预期浓度在最高容许浓度附近,滤膜负荷量为 0.5 根/视野时,推荐采样时间为 40min。

A6.4　采样步骤

A6.4.1　滤膜的准备:在实验室内将已编号的清洁滤膜放在滤膜夹中备用。

A6.4.2 在采样现场将滤膜夹放在采样头里，拧紧顶盖，放在支架上进行采样。

A6.4.3 在采样过程中要经常观察及调准流量。流量变化值应不大于±5%，并记录采样的持续时间。

A6.4.4 采样时应记录样品的编号、采样地点、采样时的劳动条件及防护措施等。

A6.4.5 采样结束后，小心地取下采样头，取出滤膜，使受尘面向上放在滤膜贮存盒中，不可折叠或迭放，带回实验室进行计测。在运输过程中避免振动以防止石棉纤维落失。

A7 滤膜的透明固定

采有石棉纤维的微孔滤膜用丙酮蒸气法透明固定。采有石棉纤维的测尘滤膜用苯-草透明液固定。滤膜透明化操作应在清洁的实验室内进行。

A7.1 在制备样品的整个过程中要避免纤维性粉尘的污染。载物玻片及盖玻片使用前应放在无水乙醇中浸泡，用蒸馏水冲洗后用绸布擦干备用。

A7.2 用无齿小镊子小心的取出采集有石棉纤维的滤膜，使集尘面向上，置于干净的玻璃板或白瓷板上，用手术刀沿滤膜半径小心滚动刀刃，从滤膜切取 1/6～1/8 的扇形小块(如图 A4)，放在清洁的载物玻片上。如使用测尘滤膜时，可用剪刀剪成扇形小块备用。

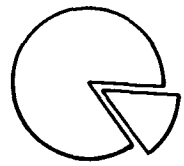


图 A4 从滤膜上切取扇形切片

A7.3 丙酮蒸气透明法的操作步骤(适用于微孔滤膜)

A7.3.1 按所用丙酮蒸气发生装置的使用说明，将载玻片上的扇形滤膜液化。如使用图 A3 的装置时，先加热至发生丙酮蒸气，打开蒸气喷口活塞，将载有扇形滤膜的玻片置于丙酮蒸气之下，由远至近移到丙酮蒸气出口 15～25mm 处，熏制 3～5s，使滤膜透明。同时频频移动载物玻片，使滤膜全部透明为止，不要使丙酮蒸气过多或液滴滴到滤膜上，以免弄皱滤膜。

A7.3.2 用结核菌素注射器通过皮内注射针头立即向透明的滤膜上加 2～3 滴甘油三醋酸酯，小心盖上盖玻片，操作时先将盖玻片的一边与载物玻片接触，然后与液滴接触，使之扩散，再小心地放下盖玻片，避免产生气泡。

A7.3.3 用记号笔在载玻片背面画出扇形滤膜轮廓，以免镜检时找不到随后将完全溶解透明的滤膜边缘。同时写好样品编号。

A7.3.4 如透明效果不理想时，可将载玻片放在 50℃的烘箱中加热 15min，以加速透明过程。

A7.3.5 样品处理后先关闭丙酮蒸发器的电源，再关闭活塞。

A7.4 透明溶液法的操作步骤(适用于测尘滤膜)

A7.4.1 用滴管加 2～3 滴苯-草透明液于载物片的中央，将滤膜的集尘面向上放在透明溶液上，此时滤膜逐渐溶解并透明，30min 后在透明的滤膜上放一盖玻片，此时要避免产生气泡，如产生气泡可用小镊子在盖玻片上轻轻加压排除。但用力不要过大，避免使滤膜的面积扩大。

A7.5 滤膜清洁度的检查：在每盒滤膜(50 张)中任意抽取一张空白滤膜，用与处理样品同样的方法透明和计测。在 100 个视野中不超过 3 根纤维时，认为是清洁滤膜，此盒滤膜方可应用。

A8 石棉纤维的计测

A8.1 用相衬显微镜计测石棉纤维：按所用相衬显微镜的使用说明书调节好显微镜。

A8.2 目镜测微网的校准：按所用目镜测微网的使用说明书，利用物镜测微计对目镜测微网的刻度进

行校准，算出计数区面积(mm^2)及各标志的实际尺寸(μm)。

A8.3 将样品先放在低倍镜下(10×)对准焦点，然后换成高倍物镜，用40×物镜观察计测。

A8.4 石棉纤维的计数规则

A8.4.1 计数符合下列条件的纤维：长度大于5μm，宽度小于3μm，长度与宽度之比大于3∶1的石棉纤维。

A8.4.2 一条纤维完全在计数视野内时计为1根，只有一端在计数视野内计为1/2根，纤维在计数区，而两端均在计数区之外者计为0根，但视野数应计算。

A8.4.3 不同形状和类型的纤维按下列规律并参照图A5的各分图进行计数。其中，每个例图右下角的数字为应计数的根数。

A8.4.3.1 单根纤维按A8.4.1的规定并参照图A5-1进行计数。

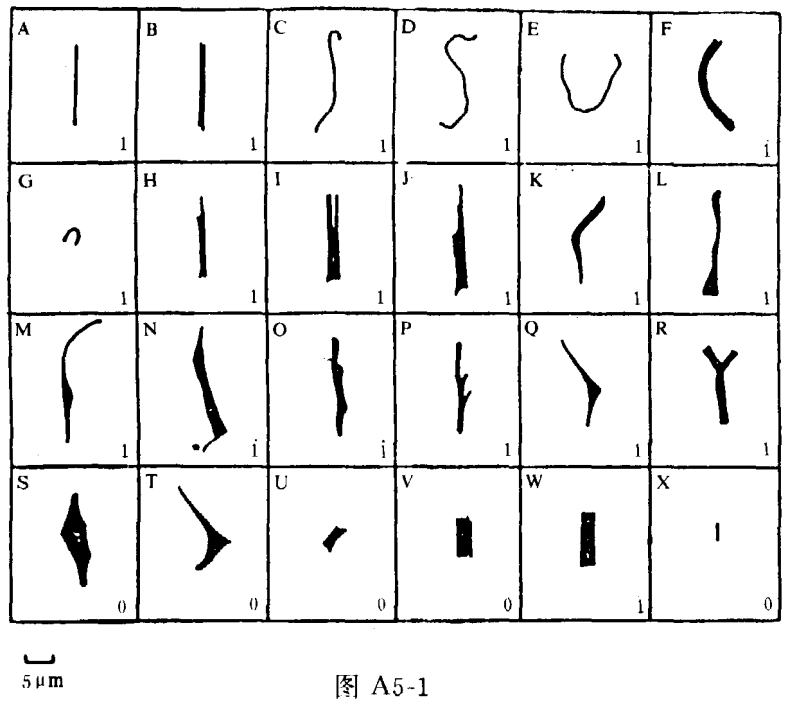


图 A5-1

A8.4.3.2 分裂纤维原则上按1根计数(参照图A5-2)。

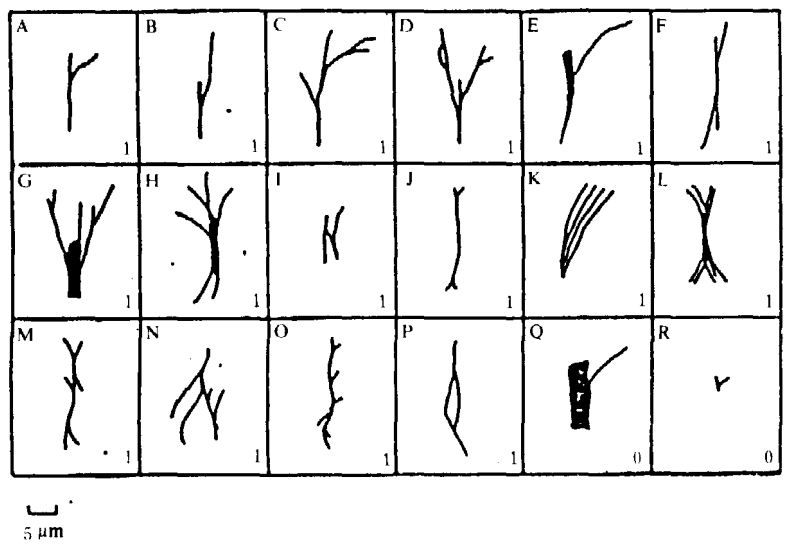


图 A5-2

A8.4.3.3 交叉纤维或成组纤维：如能分辨出单根纤维者按单根计数原则，分不出者按一束计，束的宽度小于 3μm 者，按 A8.4.1 的规定计数，大于 3μm 者不计(参照图 A5-3)。

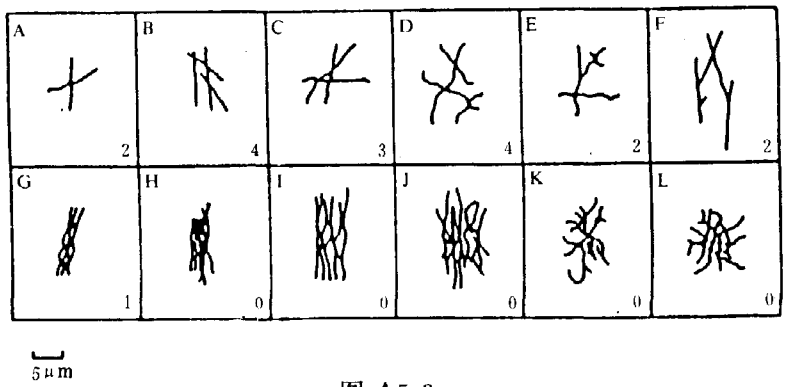


图 A5-3

A8.4.3.4 纤维附着尘粒，如尘粒的直径小于 3μm 者计为 1 根，大于 3μm 者不计(参照图 A5-4)。

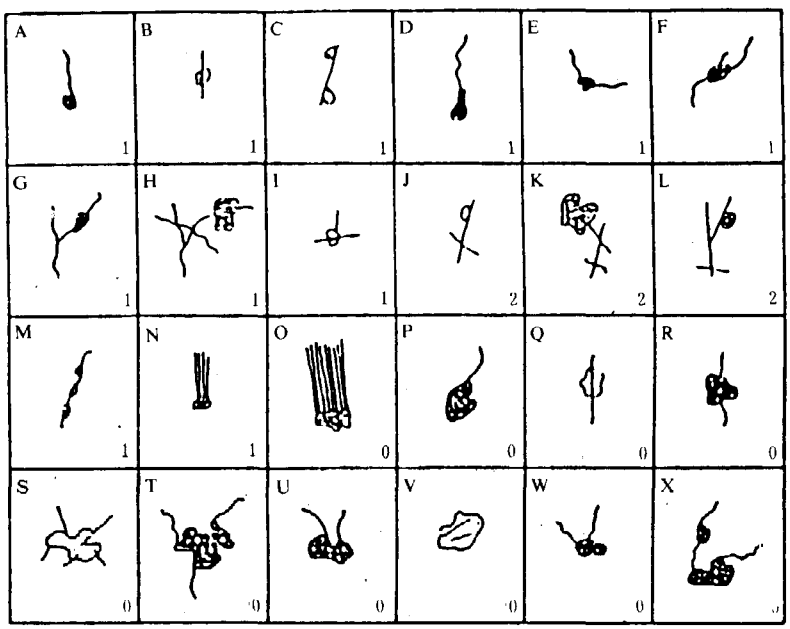


图 A5-4

A8.5 计数指标：当计数到 20 个视野以上时，纤维数如已达到 100 根，即可停止计数，如纤维数不足 100 根，则应计数到 100 个视野。

A8.6 计数完一个视野后，移动推片器找下一个视野，移动时应顺序按行、列推动，不应有意挑选，而要随机停留，以避免重复计数和减少系统误差。

A8.7 计测时滤膜上纤维的分布数量应合适，每 100 个视野中纤维的数量不应低于 20 根，在每个视野中应不多于 10 根。

A8.8 如滤膜上的纤维数不符合于 A8.7 的规定时，应重新制备样品计测；如仍不符合时，应重新采样进行计测。

A9 石棉纤维浓度的计算

空气中石棉纤维浓度按式(A2)计算：

$$C=\frac{A\cdot N}{a\cdot n\cdot r\cdot t\cdot 1000} \quad \cdots\cdots (A2)$$

式中：C——石棉纤维浓度，f/mL；

N——计测的总纤维根数，f；

n——计测的总视野数；

t——采样时间，min；

A——滤膜上采尘面积，mm^2；

a——目镜测微计的计数视野面积，mm^2；

r——采样流量，L/min。

A10 计数误差的衡量

A10.1 本方法的误差，用变异系数（CV）来衡量，在本法中，变异系数与计数的纤维总数有关。当计数纤维数达 100 根时，最好的 CV 为 0.115，而总纤维数为 10 根时，最好的 CV 为 0.41。

A10.2 计测人员应定期对同一滤膜标本按本标准要求计数 10 次以上，求其各次读数的均数及标准差，并计算变异系数，应小于等于 0.23，愈接近 0.115 愈好。如变异系数大于 0.23，应检查各项操作过程中选成误差增大的原因，切实改正后，再进行衡量。

附加说明：

本标准由中华人民共和国卫生部提出。

本标准由上海医科大学预防医学研究所、中国预防医学科学院劳动卫生与职业病研究所、四川省劳动卫生职业病防治研究所负责起草。

本标准主要起草人黄建权、朱惠兰、符绍昌、沈国安。

本标准由卫生部委托技术归口单位中国预防医学科学院劳动卫生与职业病研究所负责解释。

Carbon Black in Workplace Atmospheres

Method no.:	ID-196
Control number:	T-ID196-PV-02-0709-ASD
Matrix:	Air
OSHA PEL:	3.5 mg/m^3
Procedure:	Samples are collected by drawing a known volume of air through pre-weighed 37-mm diameter low-ash polyvinyl chloride (PVC) filters. Sample filters with gravimetric results greater than the PEL are dissolved in tetrahydrofuran (THF). The residue is redeposited on THF-rinsed quartz fiber filters. The quartz fiber filters are heated at 150 °C and then cooled and weighed. The filters are reheated at 600 °C and then cooled and reweighed. Weight lost after heating at 600 °C is reported as carbon black.
Recommended sample volume:	480 to 960 L
Recommended sampling rate:	2 L/min
Analytical procedure:	Gravimetric
Status of method:	Partially validated. This method is presented for information and trial use.
Detection limit:	0.1 mg (administrative)

January 1982 — Alan Peck
Revised September 2007 — Robert Douglas

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1. Introduction

1.1. Scope

This method is used for the measurement of airborne carbon black particulates to assess carbon black exposure in workplaces where carbon black is known to be used.

1.2. History of the method

1.2.1. A previous method for the analysis of carbon black was gravimetric. All dust present in an atmosphere known to contain carbon black was reported as carbon black (Ref. 6.1.).

1.2.2. In 1975, ignition was used at the OSHA Laboratory to eliminate interference from particulates that do not lose significant weight upon ignition, i.e. minerals.

1.2.3. In 1979, scanning electron microscopy was used to distinguish between carbon black and other organic substances. With the current procedure, scanning electron microscopic analysis is no longer required.

1.2.4. The method was tested at the OSHA Salt Lake Technical Center (SLTC) in 2007 and the currently available glass fiber filters were found to have high and somewhat inconsistent gravimetric blank levels after heating at 600 °C. This rendered them unsatisfactory for use in the method. Quartz fiber filters were tested, but were found to also have high blank levels. The material causing high blanks was not identified, but it was found to be soluble in tetrahydofuran (THF). Quartz fiber filters were selected for use in this method because glass fiber filters were observed to have melted after heating at 600 °C. The blank issue was circumvented by prerinsing the filters with THF. Evaluation data to support these changes are presented in Appendix 1.

1.3. Principle

Organic chemicals and the filter are dissolved with THF and carbon black is re-deposited on a quartz fiber filter. Carbon black is determined as weight difference after heating at 150 °C and then reheating at 600 °C.

1.4. Classification and properties

Carbon black may also be classified as lampblack, channel black, furnace combustion black, and thermal black. Each form is produced by the partial combustion or thermal decomposition of liquid or gaseous hydrocarbons. It is composed of more than 85% elemental carbon in the form of near-spherical colloidal aggregates. The properties of carbon black commonly evaluated for control and classification purposes are usually based on particle size, surface area, structure, and surface chemistry.

1.5. Uses

Carbon black is used as a reinforcing agent in rubber and as a black pigment in printers ink, coatings, paper, and plastics. Ninety-five percent of carbon black is used in the rubber industry, predominantly as a pigment and reinforcing agent in tires.

2. Recovery

The average recovery of carbon black based on weight loss after heating at 150 °C and then reheating at 600 °C was 104.4% (Appendix 1). This recovery was within acceptable limits of uncertainty.

3. Interferences

3.1. Source

3.1.1. The most probable sources of interferences are chemicals used in the rubber-processing industries that are released as dusts with carbon black during the weighing, conveying, and mixing operation. These airborne particulates will contribute to the total weight of carbon black samples. Particulates (other than carbon black) that are insoluble in THF and that lose weight after heating at 600 °C are interferences in this method.

3.1.2. Rubber-processing chemicals are usually grouped into accelerators, antioxidants and stabilizers, antiozonants, and miscellaneous materials (Ref. 6.2.). These chemicals are defined by the U.S. Tariff Commission as "organic compounds that are added to natural and synthetic rubbers to give them qualities necessary for their conversion into finished rubber goods" (Ref. 6.3.). Most of the commercial organic chemicals used in the rubber industry are listed in Tables of the Encyclopedia of Chemical Technology (Ref. 6.4.).

3.2. Controlling interferences

Chemicals or substances are eliminated as potential interferences in this method according to the following physical constants:

1. Those that vaporize at 150 °C.
2. Those that are soluble in THF.
3. Those that are weight stable at 600 °C.

THF is the preferred solvent extractant because of its unique solvent properties and wide miscibility. It is a saturated cyclic ether $(CH_2)_4O$ and is a good solvent for high-molecular weight polyvinyl chloride, polyvinylidene, resins, and other organic materials. THF is miscible with most organic solvents and with water in all proportions (Ref. 6.5.).

Other solvents can be used for the removal of organic chemicals insoluble in THF. The efficacy of each should be pre-determined in tests with bulk samples.

4. Sampling

Note Some carbon blacks may contain significant amounts of polynuclear aromatic hydrocarbons (PAH) such as:

Anthracene/Phenanthrene
Pyrene
Chrysene
Benzo [a] Pyrene

If PAHs are suspected to be present, the following additional steps and analyses can be performed:

A. Provide a bulk sample.
B. Take separate personal air samples on glass fiber filters following OSHA Method 58 (Ref. 6.6.) or other suitable method.
C. Take area samples on glass fiber filters following OSHA Method 58 (Ref. 6.6.) or other suitable method.

The bulk sample and glass fiber filters can be analyzed for PAH content using parameters established in OSHA Method 58 (Ref. 6.6.) or other suitable method.

4.1 Apparatus

4.1.1. Pre-weighed (tared) 37-mm diameter low-ash 5-µm polyvinyl chloride filter contained in a polystyrene cassette. OSHA personnel can obtain this filter and cassette from SLTC.

4.1.2. Personal Sampling Pump: A calibrated personal sampling pump whose flow can be determined within ±5% at the recommended flow rate. The pump must be calibrated with a filter holder and filter in the line.

4.2. Procedure

4.2.1. Immediately before sampling, remove the top and bottom plugs from the cassette.

4.2.2. Attach the cassette to the sampling pump so that it is in an approximately vertical position with the inlet facing down during sampling near the worker's breathing zone. Position the sampling pump, cassette, and tubing so it does not impede work performance or safety.

4.2.3. Air being sampled should not pass through any hose or tubing before entering the cassette.

4.2.4. After sampling for the appropriate time, remove the sampler, and replace the top and end plugs. Wrap each sample end-to-end with a Form OSHA-21 seal.

4.2.5. Submit at least one blank sample with each set of samples. Handle the blank sampler in the same manner as the other samples except draw no air through it.

4.2.6. Record sample volume (in liters of air) for each sample, identify the type of operation, and identify any potential interference.

5. Analytical Procedure

Samples are first gravimetrically screened for carbon black following OSHA Method PV2121 (Ref. 6.7.) or other suitable method. Samples with results greater than 3.5 mg/m^3 (the PEL for carbon black) are then further analyzed as described below.

5.1. Apparatus

5.1.1. Muffle furnace capable of maintaining temperature at 600 °C.

5.1.2. Drying oven capable of maintaining temperature at 150 °C.

5.1.3. Balance accurate to at least 0.1 mg.

5.1.4. Filtering assembly and vacuum system.

5.1.5. Quartz fiber filters (37-mm) without organic binder. Millipore quartz fiber filters (lot R6MN83955) were used to gather additional evaluation data. These filters are rinsed by placing them in a small beaker containing about 10 mL of THF for about 10 min. The beakers are swirled several times. The filters are air dried in a hood before use. See Section 5.3., Safety Precautions, for handling THF.

5.1.6. Centrifuge tubes (50 mL).

5.1.7. Ultrasonic bath.

5.1.8. Filter holder (for quartz fiber filters) and accessories with a vacuum source and a cold trap for collection of THF.

5.1.9. Quartz crucibles. Fisher Scientific Fisherbrand Self-Sealing 10-mL Quartz Crucibles (catalog 10-490-4) were used to gather additional evaluation data.

5.2. Reagents

5.2.1. Tetrahydrofuran [CAS no. 109-99-9]. Sigma-Aldrich tetrahydrofuran, 99+%, A.C.S. reagent (lot 17769T0) stabilized with 250 ppm BHT was used to gather additional evaluation data.

5.2.2. Carbon, Lampblack [CAS 1333-86-4]. Fisher Scientific, 100% (lot 061965) was used to gather additional evaluation data.

5.3. Safety precautions

5.3.1. Care should be exercised in using THF. It is extremely flammable and the vapor is harmful. It should be used only with adequate ventilation and contact with the skin should be avoided. Other dangers are listed on the reagent label.

When using THF, work in a well ventilated hood and wear protective gloves to avoid skin contact.

5.3.2. Usual precautions in working near high temperature furnaces or ovens and fumes should be observed. Protective gloves and tongs should be used in the transfer of samples to and from the high temperature apparatus.

5.4. Laboratory quality control samples

Quality control samples are prepared by placing weighed portions of carbon black, PVC filters, and 15 mL of THF into a 50-mL centrifuge tube. The carbon black is weighed to the nearest 0.1 mg. The weighed amounts of carbon black corresponding to 0.5, 1.0, and 2.0 times the PEL are 1.7, 3.4, and 6.8 mg based on a 960 L air sample.

5.5. Sample analysis

5.5.1. The air sample filters and 15 mL of THF are placed in a 50 mL centrifuge tube and sonicated for 10 minutes to dissolve the PVC filter and organic interferences.

5.5.2. The samples are transferred (filtered) onto rinsed quartz fiber filters. The filtered THF is captured with a cold trap. The quartz fiber filters are washed 3 times with 2 to 3 mL of THF.

Occasionally, a carbon black sample has a very large amount of material that will not allow the THF to pass through the filter. To facilitate filtration, the pre-filtrate sample material can be portioned onto one or more additional filters (as many as needed) so as to allow for smaller amounts of sample material per each filter. The result for each of the filters for that sample is added together to obtain the correct level of carbon black in the original heavily loaded sample.

After the final wash, immediately remove the quartz fiber filter from the filtering assembly in order to prevent its adherence to the assembly. Place each filter in a separate quartz crucible.

5.5.4. The crucibles with the filters are dried in an oven at 150 °C for 30 minutes, cooled to room temperature in a desiccator and weighed (W1) to 0.1 mg.

5.5.5. The crucibles with the filters are placed in a muffle furnace at 600 °C for one hour.

5.5.6. The filters are cooled to room temperature in a desiccator and reweighed (W2).

5.6. Calculations

The amount of carbon black is determined by subtracting W2 from W1. Average the results for blank samples and identify the average as W3. Subtract the average blank result, W3, from the carbon black result. This value in milligrams is divided by the sample air volume in m^3 and reported as mg/m^3.

$$\text{carbon black, } {}^{mg}\!/_{m^3} = \frac{[(W1 - W2) - W3]}{m^3}$$

where: W1 is the weight after heating at 150 °C
W2 is the weight after heating at 600 °C
W3 is the average weight loss for the blanks
m^3 is the sample air volume in cubic meters

6. References

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6.2. Kirk, Othmer, Encyclopedia of Chemical Technology, 2nd Edition, Vol. 17, 509 (1968).

6.3. U.S. Tariff Commission, U.S. Production and Sales of Synthetic Organic Chemicals for 1966, Aug. 11, (1967).

6.4. Kirk, Othmer, Encyclopedia of Chemical Technology, 2nd Edition, Vol. 17, p. 512 - 539 (1966).

6.5. Kirk, Othmer, Encyclopedia of Chemical Technology, 2nd Edition, Vol. 10, p. 249, (1966).

6.6. Burright D., Coal Tar Pitch Volatiles (CTPV), Coke Oven Emissions (COE), Selected Polynuclear Aromatic Hydrocarbons (PAHs), http://www.osha.gov/dts/sltc/methods/organic/org058/org058.html (accessed 9/21/2007).

6.7. Methods Development Team, Gravimetric Determination, http://www.osha.gov/dts/sltc/methods/partial/pv2121/pv2121.html (accessed 9/21/2007).

Appendix 1
Additional Evaluation Data

Three samples were prepared by weighing aliquots of carbon black (Section 5.2.2.) into 50-mL centrifuge tubes, and adding 15 mL of THF (Section 5.2.1.) and a PVC filter (Section 4.1.1.) into each of the tubes. The centrifuge tubes were sonicated for 10 min and each sample was filtered separately through a THF-rinsed quartz fiber filter (Section 5.1.5.) as described in Section 5.5.2. of this method. The quartz fiber filters were heated to 150 °C for 30 min and then placed in a desiccator to cool to room temperature. The filters were weighed to 0.1 mg and then heated to 600 °C for one hour. The filters were returned to the desiccator to cool and again weighed to 0.1 mg. The weight difference was divided by the sample weight and then multiplied by 100 to calculate percent loss which is defined as percent carbon black. The data show that the blank issue was resolved and that carbon black recovery was excellent.

Table 1
Additional Evaluation Data

sample	carbon black (mg)	crucible weight (g)	weight after 150 °C (g)	weight after 600 °C (g)	weight loss after 600 °C (mg)	blank corrected (mg)	carbon black (%)
cb	9.6	6.8551	6.9546	6.9446	10	9.9	103.1
cb	3.1	7.1915	7.2838	7.2804	3.4	3.3	106.4
cb	5.4	6.8894	6.9815	6.9758	5.7	5.6	103.7
blk	0.0	7.1980	7.2885	7.2883	0.2		
blk	0.0	7.0736	7.1622	7.1621	0.1		
blk	0.0	7.1769	7.2676	7.2676	0.0		

MATERIAL SAFETY DATA SHEET

MSDS No. 0001
Rev. 1.1
Issued Date: 03/8/2008
Revised Date: 09/17/2008

Multi-Wall Carbon Nanotubes

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Multi-wall Carbon Nanotubes (MWCNT)

Product Code: FloTube 9000

Company: CNano Technology Limited

Tel: +86-10-67892366 Fax: +86-10-67892846

Emergency Telephone Number: +86-10-67892366

2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredient(s)	CAS Number	% (by weight)
MWCNT	7440-44-0	>95%
Other inorganic substance	-	<5%

3. HAZARDS IDENTIFICATION

Potential Health Effects

General Overview

Product is in the form of odorless black powder and is not expected to cause environmental hazard under good industrial hygiene plan.

Dusts from handling or processing may cause eye, skin and respiratory tract irritation when exposed.

Product contains small amount of metal oxides and consequently may produce an allergic reaction.

Wear appropriate personal protective equipment. Keep the product handling in confined space. Proper air ventilation system is advised in handling the product.

Eye

Contact with the eyes may cause irritation due to abrasive action of the dust. Not expected to cause prolonged or significant eye irritation.

Skin

There is no known hazard, but may be mildly irritating to the skin. It is not expected to cause prolonged or significant irritation, even at high concentration. Not expected to be absorbed through the intact skin.

Inhalation

The dust from this material may cause respiratory irritation.

Ingestion

No known hazards. The product is not expected to be harmful if swallowed.

Acute and Chronic Health Effects

High concentration of dusts may be irritating to eyes, skin, mucus membranes and respiratory tract. No applicable chronic information at this moment, but none of the components is known to be a carcinogen or a suspected

carcinogen.

Target Organ Effects

No data

Developmental Information

There are no data available for assessing risk to the fetus from maternal exposure to this material.

4. FIRST AID MEASURES

General

Remove all contaminated clothing immediately.

Eyes

Hold the eyes open and rinse with water for a sufficiently long period of time (at least 10 minutes). Obtain medical attention if pain, blinking or redness persists.

Skin

In case of skin contact, rinse thoroughly with soap and plenty of water. Obtain medical attention if irritation persists.

Inhalation

If dusts are inhaled, move the person into fresh air, keep warm and allow to rest. If breathing is difficult, oxygen may be administered and medical attention should be obtained

Ingestion

Rinse mouth with water and obtain medical attention.

5. FIRE FIGHTING MEASURES

Flash Point

Not applicable

Explosive Limit

No data

Auto ignition Temperature

No data

Hazardous Products of Combustion

Carbon oxide, small quantity of metal oxides

Fire and Explosion Hazards

No special fire hazards are known to be associated with this product

Extinguishing Media

Water, Carbon Dioxide, Dry Chemical, or Foam

Fire Fighting Instructions

Wear a self-contained breathing apparatus for fire fighting

6. ACCIDENTAL RELEASE MEASURES

Personal precautions

Equip cleanup crew with proper protection. Ensure adequate ventilation.

Environmental precautions

Prevent entry to sewers and public waters

Spill Procedures

Sweep or vacuum according to normal housekeeping practices

7. HANDLING AND STORAGE

General

Keep in closed container. Additional sealing may prevent accidental dust release

Precautions in handling and storage

Good ventilation of the workplace required. Contact with the skin and the eyes as well as inhalation of dusts must be avoided

Storage

Keep only in the original container in a dedicated place

Handling

Handle in accordance with good industrial hygiene and safety procedures

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Eye Protection

Chemical goggles, safety glasses or full-faced shields

Skin Protection

Suits, gloves and other items of protective clothing. Protecting gloves including, for example: nitrile, latex, and rubber

Respiratory Protections

Wear suitable respiratory equipment with High Efficiency Particulate Air Filter (HEPA), such as NIOSH P100 filter, or air-supplied respirators when directly exposed or handling the powder

Engineering Controls

Provide sufficient mechanical (general and/or local exhaust) ventilation for dust

Exposure Guidelines

In case of contact, ensure prompt removal from eyes, skin and clothing. Wash hands and other exposed areas

with mild soap and water before eat, drink or smoke and when leaving work

9. PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point：Not applicable	**Appearance**：Black Powder
Specific Gravity：>1 @ 77 F	**Soluble in Water**：Insoluble
Melting Point：No data	**Odor**：Odorless

10. STABILITY AND REACTIVITY

Stability

Thermal decomposition or combustion may produce smoke of carbon oxide and metal oxide

Incompatibility

Avoid contacting strong oxidizing and reducing agents. No hazardous reaction when used as directed.

Conditions to avoid

Avoid excessive heating (above 400 C) in oxygen rich atmosphere

11. TOXICOLOGICAL INFORMATION

Rat oral LD50 [mg/kg]

No data

Rabbit dermal LD50 [mg/kg]

No data

Rat inhalation LC50 [mg/l/4h]

No data

Health Hazard Data

Experimentations performed on reconstituted human epidermis have shown no sign of toxicity of even very large doses (full skin coverage for 24 hours) of carbon nanotubes (results to be published). However, preliminary reports, based on pre-studies on rats which were instilled with severe, high-level doses of carbon nanotubes material, indicate that, if inhaled in large quantities, carbon nanotubes are potentially toxic for humans. Such an exposure scenario is however unrealistic. Nevertheless it is recommended that respiratory protection should be used to prevent inhalation exposure to carbon nanotubes.

12. ECOLOGICAL INFORMATION

The product is not expected to present environmental hazard.

MATERIAL SAFETY DATA SHEET

Multi-Wall Carbon Nanotubes

13. DISPOSAL CONSIDERATION

Disposal

As prepared the product is considered as non hazardous. It can then be either disposed in an approved landfill or destroyed by incineration. Volatile dust must be collected during incineration. Liquids containing significant amount of carbon nanotubes must be filtered before being released to the sewer.

14. TRANSPORT INFORMATION

Not regulated. Use precaution during transport in order to prevent accidental spill. Not dangerous cargo. Keep separated from foodstuffs.

15. REGULATORY INFORMATION

Symbol(s): None

R Phrase(s): None

S Phrase(s): S22 Do not breathe dust

S29 Do not empty into drains

S36/37/39 Wear suitable protective clothing, gloves, eye/face protection

Regulations

This product is listed in TSCA (US Toxic Substances Control Act)

Canadian Domestic Substances List (DSL)

European Inventory of Existing Commercial Chemical Substances (EINECS)

Korean Existing Chemicals List (ECL)

Australian Inventory of Chemical Substances (AICS)

Philippines Inventory of Chemicals and Chemical Substances (PICCS)

Swiss Giftliste 1 Inventory of Notified New Substances

This product is not regulated in Japan and excluded from the Japanese Chemical Substances Control Law according to the Japanese Ministry of Economy, Trade and Industry, formerly the Ministry of International Trade and Industry (MITI)

16. OTHER INFORMATION

Further information: None

The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances.