This fact sheet answers the most frequently asked health questions (FAQs) about synthetic vitreous fibers. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

**HIGHLIGHTS:** Synthetic vitreous fibers are manmade fibrous materials used for thermal and sound insulating purposes. Short-term exposure can cause reversible skin, eye, and lung irritation. Workers from factories making synthetic vitreous fibers used in home insulation showed no increased rates of lung problems. Some refractory ceramic fiber workers showed changes in their chest x-rays, but these changes are not associated with breathing problems. There is no clear association between exposure to synthetic vitreous fibers and cancer in humans. Synthetic vitreous fibers have not been detected in any of the 1,647 National Priorities List sites identified by the Environmental Protection Agency (EPA).

**What are synthetic vitreous fibers?**
Synthetic vitreous fibers are a group of fibrous, inorganic materials that contain aluminum or calcium silicates, and are made from rock or stone, clay, slag, or glass. They do not occur naturally in the environment, but are widely used for thermal and sound insulating purposes and to reinforce other building materials. There are three categories of synthetic vitreous fibers: 1) glass fibers (fiberglass), including glass wool and continuous filament glass, 2) mineral wool, which contains stone wool and slag wool, and 3) refractory ceramic fibers.

Insulation that is used in homes and buildings is composed of synthetic vitreous fibers. Refractory ceramic fibers are not widely used for building insulation. They are used to insulate furnaces, in replacement of asbestos.

**What happens to synthetic vitreous fibers when they enter the environment?**
- Synthetic vitreous fibers can enter the air, water, and soil from the manufacture, use, and disposal of fiber-containing materials.
- Synthetic vitreous fibers are generally not broken down in the environment.
- Synthetic vitreous fibers do not dissolve in water or move through soil.

**How might I be exposed to synthetic vitreous fibers?**
- When insulation materials containing synthetic vitreous fibers are disturbed, fibers can be suspended in the air and inhaled. Installing your own fiberglass insulation in your home may expose you and your family to synthetic vitreous fibers.
- Workers who install or remove insulation or who are involved in building maintenance or repair are expected to have the highest levels of exposure to synthetic vitreous fibers.

**How can synthetic vitreous fibers affect my health?**
When synthetic vitreous fibers are suspended in air they can cause irritation of the eyes, nose, and throat, and lung. When these fibers contact the skin, they may also cause irritation. These effects are reversible and disappear shortly after exposure stops.

Animal studies show that repeatedly breathing air containing a lot of synthetic vitreous fibers can lead to inflammation and fibrosis of the lung. If pulmonary inflammation continues over a long period of time, a slow build up of scar tissue may occur in the lungs and in the membrane.
surrounding the lungs called the pleura. This effect is called pulmonary fibrosis or pleural fibrosis. Glass fibers commonly used in home insulation materials did not cause fibrosis in animals, but refractory ceramic fibers did. You are unlikely to develop long-term pulmonary inflammation or pulmonary fibrosis from synthetic vitreous fibers, unless you are exposed to very dusty conditions daily for many years. Studies of workers from factories that make synthetic vitreous fibers used in home insulation materials did not find abnormal numbers of cases of long-term pulmonary inflammation, breathing problems, or changes in chest x-rays. Some workers who made refractory ceramic fibers showed changes in chest x-rays that are called pleural plaques, but their ability to breathe was normal. Pleural plaques are small areas of scarred pleural tissue.

**How likely are synthetic vitreous fibers to cause cancer?**

You are unlikely to develop cancer from breathing in air with small amounts of synthetic vitreous fibers. Studies of workers from factories that make synthetic vitreous fibers have not found increased rates of lung cancer or cancer of the pleura, called mesothelioma. Animals exposed for life to air containing refractory ceramic fibers showed increased rates of lung cancer and mesothelioma, but animals exposed to insulation glass wools and stone wools did not. The International Agency for Research on Cancer (IARC) determined that insulation glass wool, stone wool, and slag wool, and continuous filament glass are not classifiable as to carcinogenicity to humans because of the inadequate evidence of carcinogenicity in humans and the relatively low biopersistence of these materials. IARC determined that refractory ceramic fibers are possibly carcinogenic to humans because of their relatively high biopersistence and the findings of cancer in animals that repeatedly breathed in high levels of refractory ceramic fibers. The EPA has classified refractory ceramic fibers as a probable human carcinogen.

**How can synthetic vitreous fibers affect children?**

There are no unique exposure pathways to synthetic vitreous fibers for children. It is likely that children exposed to these types of fibers will experience the same effects as adults, such as eye, skin, and upper respiratory tract irritation. There are no studies that examined whether exposure to synthetic vitreous fibers affect the developments of the fetus, infants, or young children.

**How can families reduce the risk of exposure to synthetic vitreous fibers?**

Insulating material in attics or walls is the most common source of synthetic vitreous fibers in a home. Avoid disturbing or contacting these materials. If you install your own insulation, wear protective clothing, respiratory protection, and eye protection, and follow recommendations provided by the manufacturer for installing this material. If you are exposed to these fibers at work, you may carry fibers home on your skin, clothes, or tools. You can avoid this by showering, and changing clothing before leaving work. Your work clothes should be kept separate from other clothes and laundered separately.

**Is there a medical test to show whether I’ve been exposed to synthetic vitreous fibers?**

There are currently no tests specific for synthetic vitreous fibers. A chest x-ray is a common method to determine if you have certain conditions, such as pleural plaques, lung or pleural fibrosis, or mesotheliomas.

**Has the federal government made recommendations to protect human health?**

The Occupational Safety and Health Administration (OSHA) has set a limit of 5 milligrams of synthetic vitreous fibers as inert or nuisance dust per cubic meter (5 mg/m³) of air for the respirable fraction and 15 mg/m³ for total dust. The voluntary limit for fiberglass and mineral wool is 1 fiber per cubic centimeter.

**Reference**

GLASS FIBER AND HEALTH COMPLAINTS

What is Glass Fiber?

The term “glass fiber” as used here refers to any rigid, vitreous fiber, mineral or organic. “Glass” is a physically defined state of matter and not a product with a specific chemical composition\(^1\). To cause health complaints it must be large enough to be trapped by the upper respiratory system\(^2\). Crystalline fibers, such as the asbestos minerals and other fibrous minerals and vitreous fibers that are small enough to penetrate deeply into the lung are not included here because they do not result in complaints at the time of exposure. All “glass fibers” function the same way on the body but the response of any given individual will differ from that of other individuals for a variety of reasons that include medical condition, sensitivity, and other recent or associated exposures. Environmental glass fiber is often associated with other materials, such as allergens, whose adverse effects may be enhanced by the association with glass fiber.

There are many different names for commercial glass fiber. Some of these names indicate chemical composition and some indicate the manner of manufacture, but in the upper respiratory system they are all the same. These names include Rock Wool, Mineral Wool, Glass Wool, Slag Wool, Navy Wool, Man Made Vitreous Fiber (MMVF), Ceramic Fiber, Glass Fiber, Synthetic Vitreous Fibers (SVF), Silica Fiber, Mineral Fiber, Glass Silk, E-Glass, S-Glass, Glass Mat, Banrock, Rocktex, Fiberfrax, Dyna-Flex, and many others. They are all “glass” fiber and they are all irritants to the respiratory system and the eyes. Many of these terms are very loosely defined and they are often applied arbitrarily. Aspect ratio is not a critical consideration with regard to how glass fiber irritates the nasal passages or eyes. Aspect ratios, length to diameter, as low as 1.5 seem to be as irritating as much longer fibers.

What are Its Sources?

**Thermal Insulation** Glass fiber is used widely in construction, as thermal insulation, as sound-proofing, for filters, and as reinforcing. As thermal insulation it is commonly used in walls and ceilings. It has also been used inside large ventilation ducts as thermal insulation. It is either in “blankets”—glass fiber mats bound in a loose, open pattern by a phenolic resin—or as blown-in insulation—short glass fiber wool without binder. Only the blanket form is use in ventilation systems as thermal insulation. It is also used in a spray-on form in which the glass fiber is mixed with vermiculite or perolite, calcite, and other materials with a gypsum binder and sprayed onto steel I-
beams. In this application its primary function is as a reinforcement to hold the thermal insulation together.

**Sound-Proofing**

As a sound-proofing agent it is used in acoustic ceiling tile, office or cubicle dividers, hallway liners, and in ventilation systems as “soundboard” just down stream from the main fans. Much more binder is applied to the glass fiber in these applications than in the case of thermal insulation. Acoustic ceiling tiles come in many formulations. Visually they are typically either a grayish mat or a yellow mat panel in a standard 2 by 4 foot size. These panels are suspended in a T-bar network over the classroom or office space. The yellow mat panel is covered on the front face by a plastic film and the mat itself is an open network of resin bonded glass fiber. The panel is somewhat rigid with open, unprotected edges. The gray mat tiles come in much greater variety, from very rigid ceramic formulations to very loose, airy mats that crack easily. The gray mats are often a blend of many different materials along with the glass fiber. The edges of these gray mat panels are generally unprotected. Vibration of the T-bar framework or sudden changes in room pressure cause the tile to rub against the T-bar. Glass fibers are broken free from the tile and then rain down onto the occupants and surfaces below. Any movement of the tiles in the T-bar frame creates glass fiber.

The soundboard in ventilation systems is typically a stiff glass fiber mat bound with a phenolic resin and often painted black on the open side facing the air stream. These materials breakdown over time and begin releasing glass fiber into the air stream. The soundboard panels cover only a small part of the air duct down stream of the fans.

**Office Dividers**

The panels used as office or cubical dividers and as hall liners are often glass fiber mats covered with cloth in a metal frame. The glass fiber is typically bound with a phenolic resin and is similar in composition to the yellow mat acoustic ceiling tile. The cloth covering acts as a filter, but over time the phenolic resin begins breaking down and the glass fibers can begin working through the cloth. Penetration of the cloth by pins or mechanical damage to the divider can increase the rate of glass fiber release from these surfaces.

**Reinforcement**

Glass fiber is used in gypsum wall board, in drywall tape and joint compound, in fiberglass/resin construction, and in plaster. Construction or remodeling activities often release glass fiber from these materials and introduce it into the environment. The glass fiber from these sources tends to be uniform in diameter and straight.

**Manufacturing Processes**

Plastic molding processes may use inorganic glass fiber as a raw product that can be released into the environment and/or may create plastic glass fibers in the process that can then be released. Many molded plastic parts are reinforced with short glass fiber. These glass fibers can be released into the environment prior to their being mixed with the plastic or may be released during the trimming of a plastic part. Recycling of the plastic may also release glass fiber. There are a number of cases where the “glass fiber” involved in the health complaint is in fact a stiff plastic fiber. One extensively studied case involve the use of a thermoplastic molding process in which the excess plastic bleed out onto surfaces that had not been treated with mold release. Fine “strings” of clear plastic were created when the mold pulled apart. These fine strings broke into short stiff fibers that traveled with the molded parts and airborne, resulting in health
complaints over a large area of the factory and the adjoining office areas. Controlling these plastic fibers eliminated all complaints. A brief relaxation of controls resulted in a new outbreak of complaints even though those complaining were not aware of the revised practice that increased exposure to these fibers. Over a three year study a consistent correlation of complaints to fiber concentration on surfaces was established.

**How Does Glass Fiber Affect Environmental Perception?**

Glass fiber irritation has been implicated as a significant agent correlated to the sick building syndrome and to health complaints. The complaints associated with exposure to short glass fiber (less than five hundred micrometers in length) includes sinus congestion, sinus headache, dry-irritated eyes, sore throat, tight lungs, nausea, and skin rashes. A general fatigue often accompanies these symptoms. The documented correlation of health complaints to low levels of short glass fiber exposure goes back to at least the early 1960’s. This laboratory has extensive records and case histories correlating the relationship between glass fiber on surfaces and health complaints going back to 1973. All of this data is “clinical”, symptoms were present when glass fiber was present above a certain concentration, disappeared when the glass fiber dropped to low levels, and reappeared when the glass fiber increased above a certain level.

Glass fiber longer than five hundred micrometers has long been associated with contact dermatitis. This is also a common problem with carbon fiber composite debris. In the three year study mentioned above the likelihood of complaints of contact dermatitis increased rapidly after a concentration of 4 fibers per square inch of surface area was reached. This level has seemed to be a reliable predictor of complaints over a broad range of environments in the twenty-five years since that study. The correlation to glass fiber has been often demonstrated by visually observing the fiber protruding from the skin at the site of irritation.

Short glass fiber complaints are less obviously related to the symptoms but a consistent pattern has emerged over the last forty-plus years of observation. Short glass fibers have been collected from irritated eyes of individuals known to be exposed to glass fiber. The Materials Safety Data Sheet (MSDS) for glass fiber products warn that breathing dust from these materials “may cause a scratchy throat, congestion coughing, eye irritation, and rashes”. Brief publications by NAIMA (North American Insulation Manufacturers Association) in 2003 and 2004 correctly assessed current data as to the lack of evidence for a correlation to cancer but acknowledged the problem of “irritation”. The studies by Thriene, et al and Hedges document case histories similar to hundreds of others not documented in the literature that the author is personally familiar with. In many of these cases the “official” explanation was mold or

**Symptoms That May be Caused by Glass Fiber Exposure:**

- Eye Irritation
- Contact Dermatitis
- Rashes
- Bloody Nasal Discharges
- Sinus Congestion
- Sinus Headache
- Sore Throat
- Chest Tightness
- Nausea
- Fatigue
volatile organic compounds (VOC’s) but the complaints didn’t stop until the glass fiber in the environment disappeared.

Lower respiratory complaints are also mentioned on occasion and there has been some concern regarding those who suffer from asthma. A link between nasal irritation and lower respiratory response may be related to the release of neuropeptides in the nasal passages due to the stimulation of the fifth cranial nerve\textsuperscript{21,22}. The neuropeptides are aerosolized by breathing and then constrict the lung in an effort to reduce the inhalation of the irritant. This can trigger an asthmatic episode or a “tightness” of the chest in a non-asthmatic individual.

The inevitable question is ‘at what exposure level might health complaints be expected?’ Data suggests that this is a moving target\textsuperscript{23,24}. The recognition of the effect of sensory clues on perception and physiological responses suggests a learned physiological response on a subconscious level, the body actually becomes sensitive to lower levels of exposure. Perception of the exposure not only becomes more sensitive on the cognitive level but also triggers a physiological preparation for those consequences. In a different sensory environment the same level of exposure may not trigger the same physiological response. The level that in this laboratories experience tracks best with the initial complaints is 13 short glass fibers per square inch of relevant surface. A relevant surface is any surface representative of those that the individual in question contacts in association with the symptoms. A detailed discussion of these surfaces is the subject of another article to be written in the future\textsuperscript{25}.

**How is Exposure to Glass Fiber Measured and Why?**

Repeated studies of surface concentration and airborne concentration of glass fiber in the environment have shown that health complaints correlate well with surface concentrations but not with airborne concentrations\textsuperscript{6,12,26}. That has also been the experience of this author over more than 30 years and many thousands of investigations. Some who have failed to find that correlation have failed because they failed to collect a proper surface sample or to analyze the sample correctly after sampling. Adhesive tape has been a standard collection technique for surface particles since the 1920’s. It was a standard technique for collecting crime scene evidence from the 1930’s on. In the 1960’s it was demonstrated to be the most effective surface sampling technique for radioactive particles. It has been a standard for assessing cleanliness in the Aerospace industry since at least the early 1970’s and was finally made into an ASTM standard, as E 1216-87, in 1987. It has been documented as being at least six times better than any other standard current method as recently as 1998\textsuperscript{27}. It is essential to sample using a tape having a plastic film that can be easily removed after sampling without significantly altering the particles collected or their relative position with respect to one another. One tape that satisfies these requirements is Scotch 3M Brand Magic Tape. There is a more detailed discussion of surface sampling in PARTICLES AND HEALTH: ENVIRONMENTAL FORENSIC ANALYSIS\textsuperscript{25}.

The path from surfaces to the upper respiratory system seems to involve both resuspension and mechanical transfer. The unique airflow pattern over the body and the way the nose samples that
volume contribute to the concentration of these particles in the upper respiratory system. This pattern can not be duplicated by any combination of air sampling techniques other than direct sampling of the nasal cavity itself. Particles on surfaces are resuspended by mechanical disruption of the surface or by transference to the hands or clothing of the individual or individuals affected. Convective flow and the Coanda effect over the body combine to focus particles into the tidal airflow of the upper respiratory system. Direct contact between the hands and face carry glass fiber into the nasal airflow. All currently standard air sampling techniques are intentionally designed to eliminate the glass fibers that cause health complaints from the sample stream.

The quantification of the glass fiber requires polarized light microscopy and the scanning of at least one square inch of the sampled surface. This involves the scanning of tens of thousands of particles per sample to identify the few glass fibers that may be present. That requires the use of oblique illumination in order to create the contrast necessary for rapid discrimination of the glass fibers among the background of often thousands of other non-glass fibers. No other analytical technique is capable of examining thousands of particles and reliably identifying the glass fibers within a reasonable time frame. Analyzing a smaller surface area will not result in reliable results. Electron microscopy has been used in many studies in the literature. This is not an acceptable method because the glass fibers can not be characterized elementally and the examination of thousands of fibers in a square inch area by electron microscopy would be economically prohibitive.

What is the “Normal” Exposure (Baseline)?

Glass fiber has become ubiquitous in the environment at large. Urban environments have a background of about 1 glass fiber per square inch of surface area with a total particle loading (obscuration) of 15%. Total surface obscuration is a measure of time since last surface cleaning. There are some interesting parallels between formaldehyde exposure and glass fiber exposure. The formaldehyde in a “New Car” is an enjoyable experience for many people who respond differently to formaldehyde in the home. The same is true with the “New Home” experience and exposure to glass fiber in the office. Glass fiber levels in a new home are often above the 13 per square inch of surface area. That level often drops to less than 1 per square inch over a couple of years without any complaint. If the level of glass fiber stays high over a couple of years complaints become more common. The same high level of glass fiber is often true of other new buildings but the occupants tend not to be tolerant of the exposure.

How Can Exposure be Controlled?

Exposure to glass fiber in the environment is a function of the rate of accumulation and the frequency of cleaning. Exposure can be controlled either by increasing the frequency of cleaning or by decreasing the rate of generation. Literally millions of offices and classrooms are full of glass fiber sources but do not have a glass fiber exposure problem. The difference between problem
areas and non-problem areas is the result of these two parameters. Vibration is the most frequent case for problems with acoustic ceiling tile. In the absence of vibration the rate of generation is so low that standard cleaning frequencies remove the accumulating glass fibers before they become a problem. In many schools where acoustic ceiling tile glass fiber has become a problem, it has been because of the use of the T-bar as hangers for school art work. The added load on the T-bar resulted in vibration between the T-bar and the acoustic ceiling tile. In these schools the problem is often isolated to only a few classrooms. In many offices and classroom the problems appear only after the cleaning frequencies were extended as a budget cutting item.

There is a limit to the ability of an increase in the cleaning frequency to mediate the problem. If the rate of generation is too great the only acceptable approach is to reduce the source. That generally requires the removal and replacement of the source material. The replacement should not be a source of glass fiber though it may contain glass fiber. There are many glass fiber containing materials that are sealed and should not cause an exposure problem.

Are There Long Term Health Consequences?

There do not seem to be any long term health consequences resulting from exposure to glass fibers in the upper respiratory system other than a possible increased sensitivity to glass fiber exposure. This is an assumption based on very limited data. Though the author has been involved in many hundreds of these cases and has been able to follow up on some of them there have been a few individuals that report an increased in sensitivity to a number of other environmental factors. They attributed this “new” sensitivity to the glass fiber exposure. That has not been supported by any reliable objective measurements. The medical data prior to exposure to glass fiber is always missing. There is so little understanding of the complex response to environmental factors that it is difficult to characterize these sensitivities in any objective fashion.

References and Notes

2. Particles too small to be captured by the upper respiratory system do not cause rapid physical discomfort unless the airborne concentration is quite high. High concentrations of airborne dust are hazardous regardless of the nature of the dust.
10. Rindel, A., C. Hugod. E. Bach, N. O. Breum, "Effect on health of man-made mineral fibers in kindergarten ceilings", IARC, Scientific Publication, pp. 449-453, 1990. (This study examined a number of kindergarten classrooms with glass-fiber-containing ceiling tiles compared to classrooms without ceiling tiles. Airborne concentrations in the two types of classrooms were similar. In rooms with health complaints surface glass fiber concentration correlated with the complaints but airborne concentrations did not. Their overall conclusion was that the presence of ceiling tiles did not correlate with health complaints because there were health complaints in classrooms without ceiling tiles where surface glass fiber was also found.)
20. The MSDS for glass fiber containing materials cite nasal congestion, sore throat, cough, eye irritation, and skin rashes as symptoms of exposure.
22. Shusterman, Dennis, Elizabeth Matovinovic, and Andrew Salmon, “Does Haber’s Law apply to human sensory irritation?”, Inhalation Toxicology, vol. 18, pp 457-471, 2006. (Haber’s Law states that prolonged low level exposure is equivalent to single high level exposures. The relation is much more complex than that—the Physiologically Based
PharmacoKinetic {PBPK} model—but the implication may be correct in the case of many irritants at exposures above some threshold, including glass fiber.)


24. This pattern has been seen in multiple environmental studies of glass fiber exposure by this author. The sensitivity to glass fibers in the environment did plateau well above background levels but below the level typical of initial health complaints.


26. Schneider, Thomas, Ove Nielson, Per Bredsdorff, Peter Linde, “Dust in buildings with man-made mineral fiber ceiling boards”, Scand. J. Work Environ. Health, vol. 16, pp 434-439, 1990. In this paper health effects are not addressed but the correlation of the presence of ceiling tile to surface glass fiber was much better than that to airborne glass fiber. Other papers referenced in this paper by Schneider do address the health effect and surface concentrations. Those papers will be added here after I have reviewed them.


28. There are many more references to be added. They will be added on a “time available” basis.

Signed: ____________________________

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