Indoor Air Quality Investigation Review

JFK LIBRARY

EASTERN WASHINGTON UNIVERSITY

September 11, 2018

Terracon Project No. 81187124

Prepared for:
Eastern Washington University
Facilities and Planning
Cheney, Washington

Prepared by:
Terracon Consultants, Inc.

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September 11, 2018

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Attn: Shawn King
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Re: Industrial Hygiene Consulting Services
Indoor Air Quality Assessment, JFK Library
Terracon Project No. 81187124

Dear Mr.: King

Terracon Consultants, Inc. (Terracon) is pleased to present our report for our third-party review of an ongoing indoor air quality investigation at the JFK Library on the Eastern Washington University campus. This review was conducted in accordance with our Proposal P81187124, dated March 8, 2018.

Terracon appreciates the opportunity to provide services to you. If we can provide any additional environmental, occupational health, or safety-related services, please contact Kathie Lavaty at 425.697.1124.

Sincerely,
Terracon Consultants, Inc.

Kathie A. Lavaty, CIH, CSP
Senior Industrial Hygienist

Rush Bowers, CIH, CSP
Senior Industrial Hygienist

EXECUTIVE SUMMARY

Kathie A. Lavaty, CIH, CSP, of Terracon Consultants, Inc. (Terracon), conducted a third-party review of an ongoing indoor air quality (IAQ) investigation at the JFK Library on the Eastern Washington University (EWU) campus in Cheney, Washington. The review was performed in general accordance with Terracon's proposal P81187124, dated March 8, 2018. These indoor air quality consulting services were provided in response to a request from Mr. Shawn King, of EWU Facilities and Planning Services. The ongoing IAQ investigation is being conducted by EWU Environmental Health and Safety (EHS).

The general objective of the review was to provide an external assessment of the means and methods employed in the investigation, including indoor air monitoring and sampling results and management responses to those results, and to offer recommendations, as applicable, for additional actions.

Terracon reviewed the EHS letter reports of the sampling and analytical data conducted over the course of the IAQ investigation and, in general, concurs with EHS's findings that health complaints are believed to be related, at least to some extent, on glass fiber concentrations in settled dust. Terracon also concurs with the EHS recommendations to perform cleaning at the JFK Library.

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REVIEW OF INDOOR AIR QUALITY INVESTIGATION
JFK Library, Eastern Washington University
Cheney, Washington
Terracon Project 81187124
September 11, 2018

INTRODUCTION

Kathie A. Lavaty, CIH, CSP of Terracon Consultants, Inc. (Terracon) provided a third-party review of an ongoing indoor air quality (IAQ) investigation at the JFK Library on the Eastern Washington University (EWU) campus in Cheney, Washington. The review was performed in general accordance with Terracon's proposal P81187124, dated March 8, 2018. These indoor air quality consulting services were provided in response to a request from Mr. Shawn King of EWU Facilities and Planning Services. The ongoing IAQ investigation is being conducted by EWU Environmental Health and Safety.

PROJECT INFORMATION

Terracon understands that prior to 2018, there had been a limited history of indoor air quality concerns from occupants in the JFK Library, including administration, faculty and employees, but the number and severity of IAQ-related health concerns increased significantly starting in January 2018, and that the concerns appeared to be centered in the U02 and M04 Suites and U06 conference room. The health concerns reported by occupants include headaches, burning, itchy eyes and skin, skin rashes, respiratory issues (chest tightness, congestion, sneezing, itching and sore throats) and general allergy-like symptoms. Terracon also understands that some persons have been relocated to work spaces in other buildings because they were unable to occupy their regular offices due to the severity of their symptoms.

EWU reported to Terracon that the number and severity of reported symptoms may be associated with adjustments to the building HVAC system during the summer of 2017, which resulted in increased air volume to locations affected by the modifications. Symptom reports may also have increased due to increased shedding of glass fibers from ceiling tiles dues to abrasion from suspended ceiling T-bars related to purported supply duct vibration from inadvertently closed fire dampers. Terracon understands that occupant reports of vibration noise from HVAC equipment correlated with a sudden increase in the number and severity of IAQ complaints from building occupants; it should be noted that EWU EHS did not directly observe the reported vibration noise.

In response to concerns from building occupants of symptoms believed to be associated with indoor air quality in their work areas, EWU Environmental Health and Safety (EH&S) initiated an indoor air quality investigation.

Due to the scope and continuing escalation of health complaints associated with indoor air concerns at the JFK Library, Administration officials requested that an external consultant be engaged to review the ongoing investigation.

Scope of Services

The general objective of Terracon's review of the JFK IAQ investigation is to provide an external assessment of the means and methods employed in the investigation, including review of indoor air monitoring and sampling methods, review of the monitoring and sampling results and management responses to those results, and to offer recommendations, as applicable, for additional actions.

The scope of services provided in this review included several telephone conversations with Mr. Shawn King and Mr. Chad Johnson, Manager of EWU EH&S, a site visit by Ms. Kathie Lavaty on March 14, 2018, and a review of monitoring and sampling results, as reported in three letter reports by EWU EHS; Terracon's scope did not include performing or directing the IAQ investigation activities.

Standard of Care

This investigation was conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions in the same locale. The results, findings, conclusions, and recommendations expressed in this report are based on information provided for this review, and conditions observed during out site visit. Many factors, such as weather conditions, building occupancy, ventilation patterns, and seasonal variations in fungal concentrations, can affect the conditions observed. The information contained in this report should not be relied upon to represent conditions that existed prior to or after this investigation. Terracon does not warrant the services of regulatory agencies, laboratories, or other third parties supplying information that may have been used in the preparation of this report.

Reliance

The report has been prepared on behalf of and exclusively for use by Eastern Washington University for specific application to their project as discussed. No other individual or entity may rely on this report without written of Terracon and Eastern Washington University. Reliance on this report by Eastern Washington University and all authorized parties will be subject to the key understandings and limitations stated in the proposal, this report, and Terracon's Agreement for Services. The limitation of liability defined in Terracon's Master Services Agreement is the aggregate limit of Terracon's liability to Eastern Washington University and all relying parties.

SITE VISIT

Terracon conducted a limited visual inspection of the areas of concern in the JFK Library and the air handling units (AHUs) that service those areas as part of our site visit to the EWU campus on

March 14, 2018. Terracon did not observe evidence of moisture intrusion and no unusual odors were noted. AHUs appeared to be well maintained.

Terracon met with Mr. Shawn King, Mr. Chad Johnson and Mr. Jerry Page, Safety Officer 1 with EWU EHS, to discuss the investigation background and results, which at that time had identified high dust loading in the areas of concern, based on the forensic analysis of surface tape-lift samples. Specific constituents of settled dust included allergens (dust mite allergen and pollen) and short and long glass fibers.

INDOOR AIR QUALITY SAMPLING REPORTS

Terracon reviewed the following letter reports of sampling conducted by EWU EHS:

Report dated March 2, 2018

This report discusses results of bioaerosol, volatile organic compound, airborne particulate and settled dust sampling and analysis.

Mold and bacterial sampling and analysis

EHS reported that Anderson samples for viable fungi and bacteria were collected in the JFK Library, but the report does not include the specific locations in the building where samples were collected. Samples were analyzed by EMLab P&K of Phoenix, Arizona. According to the EHS report, viable mold spores were not detected and airborne bacteria concentrations were less than the action level of 500 colony-forming units per cubic meter (CFU/m^3) and less than 200 CFM (sic)/m^3 for gram–negative bacteria. The EHS report does not include a citation for the bacteria air sampling results and Terracon is not aware of an established standard for evaluating the number of colony forming units cultured from airborne bacteria.

Terracon reviewed the EMLab P&K report of spore trap air samples collected from four locations in the JFK Library on January 31, 2018. Total fungal spore concentrations ranged from 110 to 230 spores per cubic meter of air.

High variability in airborne fungal spore concentrations can exist in different geographic locations, during different seasons, and weather patterns, and over the course of a given day. As a rule, indoor air fungal spore concentrations in an HVAC-supplied building are typically less than, but qualitatively like, fungal spore concentrations found in the outside environment. Per the sampling protocols provided in the EMLab P&K spore trap sampling guide, typical sampling locations include problem areas, an indoor non-problem area if available, and at least one representative outdoor area (more are preferred). Terracon's protocol for spore trap sampling, based on the accepted standard of care for airborne spore trap sampling, includes collecting at least two outdoor air samples for comparison to the area of concern to evaluate whether airborne spores found indoors are representative of the types and concentrations of spores present outdoors.

Terracon understands that EWU EHS collected outdoor samples for all spore trap air sampling conducted after those collected on January 31, 2018.

Real-Time Measurements of Volatile Organic Compound

EHS reported using a RAE systems ppbRAE 3000 to perform real-time measurement of volatile organic compounds in the UO2/UO6 and MO4 suites and in L23. According to the report, VOCs were not detected in the UO2/UO6 suite, VOC concentrations in the MO4 suite were well below the 500-microgram-per-cubic-meter (µg/m^3) action level and monitoring in L23 indicated a single spike over 600 µg/m^3, which fell rapidly to 300ug/m^3.

The report does not state the reference or source for an action level of 500 µg/m^3 total VOCs and Terracon is not aware of a standard or guideline that establishes such an action level for total VOCs in indoor air measured by real-time photo ionization detectors.

Size-Specific Airborne Particulate

EHS reported using a Lighthouse 3100 particle counter to measure and data-log real-time analysis of airborne particulate by 0.3, 0.5, 1, 2.5 5, and 10-micron particle size. The average concentration of particulate in the 0.3-micron size was less than 5000 counts per 0.1 cubic foot of air (0.1 ft^3) and ranged from 2554 to 4468 counts per 0.1 ft^3 in areas of concern, and from 3170 to 6032 counts per 0.1 ft^3 in control locations. By comparison, 0.3-micron particle counts during smoky outdoor air conditions, such as from wildfires, have been measured as high as 400,000 particles per 0.1 ft^3.

Tape-lift Sampling and Analysis

EHS collected two sets of tape-lift samples on February 1, 2018, from Suites U and M, and submitted the samples to Microlab Northwest for forensic particle analysis.

EHS concluded that tape-lift sample results offered the best information as to a possible source of indoor air quality complaints. These results indicated elevated levels of glass fibers, dust mite allergen and pollens.

Report dated March 2, 2018

Tape-lift Sampling and Analysis

Twelve tape-lift samples were collected from office suites L, U and M on March 1 and 2, 2018, and submitted to Microlab NW for forensic particle analysis. Microlab's report found that many of the samples were overloaded with particles, resulting in lower collection efficiency and the introduction of an under-reporting error due to the entire layer of particulate not being collected. The laboratory concluded that tape lifts from L03, L23, M14, M18a, U04, 08, U12A, U18a, U18b and U18c contained glass fiber above the level associated with health complaints. Most of the glass fiber is assumed to be from acoustic ceiling tiles. These tiles have the potential to release

glass fibers from unsealed edges and from air movement in the adjacent open return air plenum above the suspended ceiling tiles.

Vacuum Dust Sample

EHS collected settled dust samples on March 1, 2018, from rooms L03, L23, M04D, M04, M23, U04, U06, U12A and U12B, by collecting dust onto a filter cassette using a HEPA vacuum. Samples were analyzed by Indoor Biotechnologies for dust mite allergen. According to the laboratory report, results for all seven samples were below the laboratory reporting limit. Per the EHS report, this indicates that the presence of dust mite allergen in the sample locations is below that expected to cause allergy symptoms.

Report dated April 17, 2018

This report discusses the results of forensic particle analysis of tape-lift samples, carbon dioxide data logging and real-time analysis of airborne particulate by 0.3, 0.5, 1, 2.5, 5, and 10-micron particle size. Tape-lift sampling and carbon dioxide monitoring were conducted in areas of concern in the JFK Library. Airborne size-selective particle count monitoring was conducted in JFK and other campus buildings for comparison between complaint and non-complaint buildings.

Tape-lift Sampling and Analysis

The report discusses the sampling and analytical results of tape-lift samples collected in rooms U06, U02C and U02 following cleaning in these locations. Forensic particle analysis found that all tape-lift samples were very clean and glass fiber found on the samples was within “the range for background”..

Carbon Dioxide (CO_2) Monitoring

Carbon dioxide concentrations were measured and data logged over six days in three locations (U06, U02C and M04) from April 7 through April 13, 2018. The graphs of logged data indicate peak levels of CO_2 around 500 parts per million (ppm), presumably at times of highest occupant load in these locations, while the average concentrations were around 400 ppm. Outdoor CO_2 concentration measurements were not provided but the EHS report indicates that ambient concentrations are around 400 ppm. ASHRAE Standard 62.1-2016 recommends that indoor CO_2 concentrations be maintained at less than 700 ppm above outdoor concentrations as a surrogate measure of adequate fresh air ventilation. These results indicate that adequate outdoor air ventilation was provided to the monitored locations during the monitored period.

Size-Specific Airborne Particulate

Indoor particle counts in the JFK Library building were higher than in three comparison buildings and lower than in three others. Indoor particulate concentrations were all significantly lower than outdoors concentrations, an indication that the building HVAC systems were providing effective filtration of outdoor air.

DISCUSSION OF EWU IAQ INVESTIGATION

Mold and Bacteria Sampling and Analysis

Terracon is unable to comment on the viable mold and spore trap sample results provided in the March 2, 2018 report in the absence of outdoor comparison samples. Because airborne fungi are nearly always detected in some concentration in typical indoor environments, Terracon does not normally recommend conducting airborne fungal sampling and analysis in buildings that do not have a history of moisture intrusion, or as a screening method when conducting IAQ investigations. In general, Terracon relies on visual inspection of buildings for evidence of moisture intrusion, such as water staining or elevated moisture content in building materials, as indication of the potential for indoor fungal growth on building materials, although spore trap sampling is often conducted to confirm the findings of our visual inspection. When spore trap samples are collected, standard protocol involves collecting at least two outdoor comparison samples. Terracon understands that, other than the spore trap air samples collected on January 31, 2018, all subsequent spore trap air sampling included outdoor comparison samples, and that EWU follows this protocol for all spore trap air sampling.

Likewise, Terracon does not typically conduct air sampling for airborne bacteria as a screening method in IAQ investigations, due to the ubiquitous nature of airborne bacteria. Terracon does conduct surface bacterial swab sampling when the source of a water intrusion event involves sewage-contaminated water as an indication of the need for remediation of water impacted locations, in accordance with the S500 Standard and Reference Guide for Professional Water Damage Restoration, published by the Institute of Inspection Cleaning and Restoration (IICRC).

Glass Fiber Exposure

Based on the results of multiple tape-lift samples collected in areas of concern at the JFK library, it is reasonable to conclude that glass fiber contamination, likely resulting from the abrasion of acoustic ceiling tiles, is associated with at least some of the health complaints reported by building occupants. Acute skin, eye and respiratory irritation from fibrous glass exposure is well documented; however, the relationship between glass fiber exposure and lower respiratory symptoms is less well established. Terracon is not aware of any published standards or guidelines for glass fibers in settled dust in buildings below which irritation symptoms are not expected, other than the study cited by Microlab NW in their paper titled “Glass Fiber and Health Complaints” (Appendix A), which states that at a concentration greater than 4 long (greater than 500 micrometers) fibers per square inch of surface area, the likelihood of complaints of contact dermatitis increased rapidly. The author states that, in Microlab’ s experience, a level of 13 short glass fibers per square inch of surface area “tracks best” with initial complaints.

CONCLUSION AND RECOMMENDATION

Conclusion

Forensic analysis identified significant dust loading in tape-lift samples collected from horizontal surfaces in areas of concern at the JFK Library. Specific constituents of settled dust included allergens (dust mite allergen and pollen) and short and long glass fibers well above proposed levels that trigger complaints of contact dermatitis. Tape-lift samples collected following cleaning in those locations indicated very low levels of glass fibers.

Acoustic ceiling tiles are the likely source of glass fibers in the library. There is some anecdotal evidence that adjustments to the building HVAC system, sometime during the fall of 2017, resulted in increased vibration of supply ducts from inadvertently closed dampers, which in turn increased shedding of glass fibers from ceiling tiles due to abrasion from suspended ceiling T-bars. Reports of vibration noise from HVAC equipment correlated with a sudden increase in the number and severity of IAQ complaints from building occupants.

EWU has increased custodial staffing in the library from two to three full-time persons and conducted extensive cleaning in the original concern locations and is planning to close the library during summer break in June to conduct a thorough cleaning of the entire library.

Recommendations

- Terracon recommends that EWU develop a standard protocol for conducting and documenting IAQ investigations, such as the Environmental Protection Agency's IAQ Building Education and Assessment Model (https://www.epa.gov/indoor-air-quality-iaq/iaq-building-education-and-assessment-model-ibeam-diagnosing-and-solving).
- To prevent accumulation of glass fibers on surfaces, regular cleaning with HEPA filtered vacuums and wet wiping of readily accessible horizontal surfaces should be continued along with occasional cleaning of elevated horizontal surfaces. Cleaning should be conducted at a frequency sufficient to prevent reports of adverse health effects, including eye irritation, upper respiratory tract irritation, sinus congestion and headaches, and rashes associated with exposure to short glass fibers.
- If cleaning is not sufficient to reduce symptoms to some level deemed acceptable by EWU administration and building occupants, EWU may want to consider removing carpet and all other upholstered furnishings from areas of concern as they that can serve as reservoirs for settled particulate, including glass fibers.

APPENDIX A Glass Fiber and Health Complaints, Microlab Northwest, May 2008

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Rev. Date: May, 2008

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.

"Glass Fiber" is any rigid, vitreous fiber, mineral or organic. To cause health complaints it must be large enough to be captured in the upper respiratory system.

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. When a supplier is ask if their product contains glass fiber they may answer that it does not because they don't call it glass fiber. Asking for the types of fiber in their product can be more helpful. The types of fiber can then be compared to the list presented above. 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

Sources:

- ***Thermal insulation***
- ***Sound-Proofing***
- ***Office Dividers***
- ***Reinforcement***
- ***Manufacturing Processes***

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 Implicated As a Major Cause of the Sick Building Syndrome (SBS)

Glass fiber irritation has been implicated as a significant agent correlated to the sick building syndrome and to health complaints[3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18]. 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. The Finish study[18], conducted over a period of four years, added a number of subjective complaints to this list of physical symptoms that correlated to glass fiber exposure, which included dry air, unpleasant odor, and perception of dust and dirt. A general fatigue often accompanies this body of symptoms. The documented correlation of health complaints to low levels of short glass fiber exposure goes back to at least the early 1960's[13]. 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. These "clinical" observation are now supported by much more controlled studies[18,] in terms of the causality but in all cases the analytical method used for quantification has been poor done.

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***
- ***Phantom Malodor***
- ***Dry Air Sensation***

Glass fiber longer than five hundred micrometers has long been associated with contact dermatitis[9]. 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" [19,20,21]. The studies by Thriene, et al[14] and Hedges[6] 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 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[22,23]. 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[24,25]. The recognition of the effect of sensory clues on perception and physiological responses suggests a learned physiological response on a sub-conscious 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 laboratory's experience tracks best with the initial complaints is 13 short glass fibers per square inch (2 per square centimeter) 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[26]. T. Schneider, using a similar analytical technique in Denmark, suggests that 19 per square inch (3 per square centimeter) may indicate a glass fiber problem[29].

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[6,12,27]. 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[28]. 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

Only tapelifts of surface particles correlate to health complaints.

discussion of surface sampling in PARTICLES AND HEALTH: ENVIRONMENTAL FORENSIC ANALYSIS[26].

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[26]. 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 because the techniques are designed to eliminate particles that are effectively trapped in the upper respiratory system.

Quantification requires oblique, polarized, light microscopy.

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[18,27]. 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)?

The urban environment background is about 1 glass fiber per square inch of surface or less.

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 are 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.

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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 cause 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.

Glass fiber can be controlled by reducing the generation rate or by increasing the cleaning frequency.

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.

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

Signed: _____
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