HVAC/IAQ Building Evaluation
25 Sigourney Street
Hartford, Connecticut

REPORT COVERS SITE WORK
10-06-05 THROUGH 11-18-05

DECEMBER 2005

TURNER BUILDING SCIENCE, LLC

TURNER GROUP

MECHANICAL ENGINEERS • BUILDING SCIENTISTS • IAQ CONSULTANTS

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December 28, 2005

Mr. Jonathan Holmes
Department of Public Works
Facilities Management
165 Capitol Avenue – Rm G-4
Hartford, CT 06106

SUBJECT: Final Report: Building Evaluation Regarding:
HVAC, IAQ, Building Science (Moisture) &
Current Occupant Health Concerns
25 Sigourney Street
Hartford, Connecticut
TBS# S0588-01

Dear Mr. Holmes:

In accordance with our approved scope of work, we are pleased to offer this report on our observations and limited testing concerning the 25 Sigourney Street Office Facility. We proposed to evaluate the building and systems compared to applicable guidelines established by ASHRAE, OSHA, ACGIH, US EPA, and the State of Connecticut. The focus of this work effort included a general evaluation of the current adequacy of the indoor air quality being provided to the occupants of the facility in accordance with the accepted scope. Our determination of adequacy of the indoor air quality is based on our general knowledge of ASHRAE Standard 62-1999 and 55-1992, and Good Engineering Practice, ACGIH publication *Bioaerosols: Assessment and Control*, and OSHA Technical Manual (TED 1-0.15A), as these guidelines apply to mixed-use, office-type occupancy. It was requested that we address the specific concern in this facility of reported historical and current health symptoms (allegedly related to occupancy in the building), and assist with a rapid decision concerning the safety of continued occupancy.

Our findings and corrective action recommendations made herein are based primarily on our observations and measurements collected in limited representative areas while on-site, and a review of others' historical data as applicable. The enclosed report is of a technical nature; therefore, the reader will need to have some technical knowledge of the facility to properly evaluate the findings and recommendations.

We are pleased to serve as professional consultants to The State of Connecticut, Department of Public Works. Please contact us if there are any questions on subjects presented here that need further clarification. You can reach me or our Certified Industrial Hygienists in our Harrison, Maine office at (800) 439-3446.

Sincerely,

TURNER BUILDING SCIENCE, LLC

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1.0 INTRODUCTION AND EXECUTIVE SUMMARY

1.1 Executive Summary

At the request of the State of Connecticut, Department of Public Works (DPW), Turner Building Science, LLC (TBS) was contracted to assist in the directive from Governor Rell in determining whether 25 Sigourney Street is suitable for continued use and to support that recommendation by scientific findings and defensible expert opinion.

Turner Building Science, LLC has conducted an initial HVAC and IAQ evaluation of limited representative areas, including several locations within the 20 story, mixed-use office facility located at 25 Sigourney Street. Continuous IAQ monitoring of multiple environmental parameters was conducted from October 10, 2005 until November 11, 2005 in selected areas. The monitoring included near continuous monitoring of Carbon Dioxide (CO_2) (as an indicator of ventilation rate), testing for Carbon Monoxide (CO), temperature, relative humidity, and monitoring for inhaleable, respirable, and fine-fraction dusts (particles). We also conducted appropriate, limited, technical observations with respect to representative suspect mold, dust, and pollutant sources, limited pollutant pathways diagnostics, and a limited moisture intrusion evaluation. We have interviewed representative occupants with expressed health concerns, and contracted with a health professional (Dr. Michael Hodgson, M.D., M.P.H.) for a limited review of the current medically reported health concerns. This report concludes all currently approved observations and measurements as outlined in our approved scope of work and budget.

Conclusion: Based on relatively large volumes of high quality representative, current, and recent historical common environmental measurements, exposure to the air currently provided inside the facility would be considered similar to typical office buildings located in an urban setting. Additionally, the building often provides shelter from multiple urban pollutants that originate outside the building. The building does experience some moisture incursion in ways that may differ from typical office buildings.

Given this scientific data, it can be concluded that the building is habitable for the general population who have not developed disease during previous occupancy of the facility. However, this building also contains a number of sources of air contaminants that have been shown to potentially contribute to indoor air quality problems (as part of a multi-factorial analysis), and to building-related illness, consistent with the health issues in this building.

Further, the majority of the locations within the facility where high speed printing and copying occur do not meet current recognized engineering guidelines for HVAC design.

Thus, in addition to listing the sources, we have recommended corrective actions for modifying the HVAC design and mitigation to reduce the identified sources, in order to reduce the environmental conditions that might trigger symptomatic responses.

Our medical review (Summarized in Section 1.2.2 & 4.14) concurs with the current habitability of the building for the general population. However, we also advise that based on the medical review, that the building is not habitable for occupants who are currently exhibiting clinically diagnosed disease during their occupancy of the facility.

1.2 Current Habitability of the Facility:

1.2.1 Environmental Monitoring Data

There is a reported concern regarding the past and current incidence of occupant reported disease. Whether the building is safe to continue occupying is a question that we understand State Government Officials, DPW, and Union Representatives would like us to answer. Clearly, a review of recent historic, multiple environmental measurements of the concentration of various possible airborne pollutants by The National Institute of Occupational Safety and Health (NIOSH) and others would lead one to conclude that exposures to unsafe or hazardous levels of the contaminants, as measured within the facility during normal occupancy, are very unlikely to occur.

Our measured environmental data (Oct./Nov. 2005) is very similar to other source's recent historical data, with a few exceptions. We would agree that as previously reported, the measured environment inside the building, during the normally occupied periods, is not much different than the 100 random office buildings studied by US EPA in the B.A.S.E. office building study, as referenced in two Environmental Health and Engineering reports funded by NIOSH (Report #11767, dated May 5, 2004, and Report #11767, dated February 2, 2005). In fact, much of our continuously logged environmental monitoring data and short-term sampling data suggests similar conclusions to the EH&E Reports. In general, based on significant collected data, the air inside the building (when the HVAC systems are operating) offers shelter from multiple types of outdoor pollutants that are almost always at higher levels in the environment outside the building. TBS data is presented in detail in the body of this report in Section 4.0 and in the Appendices.

As noted in the Executive Summary, this building also contains a number of sources of air contaminants that have been shown to potentially contribute (as part of a multi-factorial analysis) to indoor air quality problems and to building-related illness consistent with some of the symptoms reported for this building. Thus, in addition to listing these sources, we have recommended actions for reducing these identified sources, in order to reduce the environmental conditions that might trigger symptomatic responses.

1.2.2 Summary of Current Medical Review Results and Recommendations

Dr. Michael Hodgson reviewed 27 medical files from the University of Connecticut (Drs. Eileen Storey and Ken Dangman), reviewed correspondence summaries from Dr. John Santilli, and discussed their current clinical strategies with Drs. Santilli, Storey, and Dangman. More details are found in Section 4.14 of this report.

The State of Connecticut asked whether:

- The criteria used to diagnose disease, relative to the building represents current standard and good medical practice.
- Whether other possible causes could be excluded.
- Whether there is evidence that something in the building is still causing adverse health outcomes.
- Whether any individuals should be removed.

UCONN relied on a standard approach to make diagnoses of building-related illness. Review of the records suggests careful documentation of symptoms, their onset, duration, and patterns. In addition, careful documentation of lung function changes documenting physiologic responses to presence in the building followed recommendations from the National Institute for Occupational Safety and Health and professional societies. A range of patterns was seen, from ongoing lung function changes suggesting active asthma and hypersensitivity pneumonitis related to work in the building, the presence of such diseases in the past with ongoing symptoms but no persisting decrements, resolved symptoms, and the question of newly worsening disease since January 2004. Dr. Santilli's use of allergy testing follows current standard allergy practice, though it carries less power to actually link disease to the building or exclude associations.

For building occupants with symptoms and lung function changes related to presence in the building, some form of exposure in the building is likely the cause. The best way to identify the true cause is to intervene sequentially, and evaluate carefully, whether these interventions resolve health complaints. The best first step is to focus on VOC exposures associated with high-speed printing. Until those exposures are resolved, it will be impossible to determine whether ongoing moisture incursion is related to health issues. If health issues persist after resolution of the printing exhaust, then additional intervention on moisture is necessary not just for engineering, but also for health concerns.

Two categories of disease rely on less reliable linkage, and leave other possible explanations besides moisture. Sinusitis and rhinitis in the presence of allergies to fungi documented in the building, chronic disease such as sarcoidosis, and usual interstitial pneumonitis may have additional causes besides moisture in the building. The simple presence of those risk factors renders the inability to exclude others. Potential causes include the high-speed printing exhaust recirculated throughout the building and moisture-associated factors.

Individuals with lung function changes related to the building should be removed as soon as possible to prevent the development or worsening of underlying lung disease. Once printing exposures are resolved, they can be sent back into the building under careful observation. Such a strategy may work best if an on-site health unit is able to follow symptoms, symptom severity, and lung function changes at work through the presence of a local spirometer.

1.2.3 Indoor Sources of Possible Irritants and Building Design Deficiencies

Based on the parameters measured by TBS and other sources, the building is habitable; *however*, we have identified several current indoor sources of specific materials that could potentially contribute to some occupant reported irritation.

The term irritants is used to describe levels of contaminants well below classic enforceable health based exposure limits, at levels that may pose a mucous membrane, and lower respiratory irritation for some sensitive individuals. As requested, we have summarized these sources below in a likely order of priority, and we have recommended specific corrective actions (as they can be determined from our current limited scope of work) within the body of this report. Additionally, we have summarized ongoing building design/operational deficiencies that likely contribute to ongoing reported occupant discomfort and irritation. Most of the issues presented are not unique to 25 Sigourney Street. They are conditions often found in problematic buildings, including some of the buildings in the US EPA B.A.S.E study.

Summary Opinion: *Indoor Air Quality concerns are almost always part of a multi-factorial situation that is often addressed in stages. It is our opinion that, in general, historical efforts have properly placed a high priority to focus on fixing the obvious moisture intrusion that impacted this facility. The addition of hospital-grade filters to capture any particle that could be related to microbial growth or outdoor sources was also a very appropriate improvement.*

Based on reports made to us, and current observations, the amount of moisture intrusion has drastically been reduced, but not eliminated. There still could be some microbial activity associated with the perimeter water intrusion that remains. However, our *current measurements do not indicate exposure to spores within the breathing air, and the installed air filters have proven to be very effective at cleaning the air when the HVAC is running. Their effectiveness is limited to particulate sources upstream of the filter location (including re-circulated air), and is not effective for sources within the HVAC ductwork downstream of the filters.*

It is our understanding of the historical health data that the rate of some of the confirmed occupant diseases associated with the facility has also decreased since improvements in recent years have been accomplished.

Based on all of our observations and analysis to date, it is our opinion that volatile emissions associated with the high volume of printing and copying that are allowed to migrate and mix throughout the breathing air in the upper floors of this facility are a very high priority to address.

Additionally, removing the newly observed mold growth within short sections of the supply ductwork is a very high priority. It is our opinion that reducing the likelihood of Volatile Organic Compounds (VOC's) exposures associated with the high volume of printing/copying, and possible emissions of VOC's or proteins from the observed limited mold growth within the short sections of the supply ductwork, within the mechanical rooms, are the first two highest priority items that need to be accomplished ASAP, along with continued further reductions in envelope moisture intrusion. There could be a significant reduction in the number of sources of possible irritants potentially present within the facility after these first two tasks are accomplished.

As requested, we have attempted to list the items that need to be addressed in this facility in an order of priority. It remains our professional opinion that all of the items we have identified need to be addressed to move the facility more into the realm of a healthy, energy efficient building design.

Possible irritant sources and building deficiencies in likely order of priority:

1. **Address Medical Recommendations:** Medically based recommendations are summarized above and presented in this report. They should be addressed as one of the Highest Priorities.

2. **Highest Priority:** Photocopier/printer emissions. Emissions from ten (10) high-speed, often high-use photocopier/printers, eight of which are not under sufficient physical isolation and negative pressure, are achieved by exhaust from the rest of the facility. Tracer gas testing confirmed the existence of pathways leading to exposures to irritants from these commercial-type machines on the upper floors, including the 17th, 18th, and 19th. In some cases, the tracer testing revealed more potential for exposure on the uppers floors than on the floors where the equipment is located.

   Remediation: The high-speed printing/copy equipment should always be isolated from the rest of the facility and exhausted out of the building. As an alternative, the operations could be moved out of the facility. If the option of physical isolation and negative pressure is pursued, evaluation of its effectiveness should be validated.

3. **Highest Priority:** Cladosporium and Penicillium Species Mold Growth. Mold growth downstream of the hospital-grade air filters and individual air handler cooling coils was confirmed in all air handlers, growing on dirt deposited on porous fiberglass duct liner, and in one perimeter VAV box. Both mold species are very common molds often found both indoors and outdoors. Airborne monitoring for mold spores was performed (as a surrogate for biological exposure) as a precaution in several representative locations in the office space on three (3) different days. No elevated spore levels were present during three (3) periods of testing in the occupied space. Outdoor levels were much higher than indoors, which is consistent with past spore and culture data. However, under certain circumstances, a possibility exists that some low level exposure may occur. Although some portion of responses to Cladosporium represents allergies to specific antigens, other exposures associated with moisture and biological growth include endotoxin or entrained fragments of cell wall, such as bataglucans, represent alternatives. **Note:** Airborne sampling was not performed during repeated periods of high outdoor humidity and hot weather. We do not know if very humid and hot weather would cause additional growth and dissemination to occur.

   Remediation: Growth of any kind in the air handling equipment of this building must be addressed. Corrective actions should be to remove the mold and porous surface that it has grown on, and reduce the moisture levels that are present in the supplied outside air (See #4 below).

4. **Highest Priority:** Limited possible reoccurring sources of mold within perimeter walls where ongoing moisture incursion has persisted. An infrared inspection was performed on all floors during and after a major rain event that occurred in October 2005. Forty-eight (48) areas of suspected moisture incursion were identified. These areas must be investigated and corrected permanently. Mold will grow within these exterior wall cavities if they stay wet long enough, and therefore, pose a potential exposure situation if not addressed properly. Inadequate humidity control may delay drying of moisture within wall cavities. The DPW believes that the water-sealing contractor has identified the probable cause of much of the potential water incursion areas to be due to face seal leakage at cracked window caulking. Further investigation will be required to address all current leakage sites. This building relies primarily on face sealing and four miles of caulk of dissimilar materials to keep wind driven rain out, and will continue to experience some ongoing moisture incursion. We recommend that until all water leakage is stopped that an aggressive program of observation and infrared inspection be undertaken after every significant rain event. Additionally, routine inspection of the building façade to identify failing joints may be warranted. There is a strong movement in recent years in the construction industry to not construct buildings that rely primarily on face sealing, but rather to install a continuous, redundant drainage plane.

   Remediation: We have confirmed with the Architect who designed the envelope repairs that this building was built in accordance with standards at the time of construction that did not include a continuous drainage plane. Our current opinion is that a redesign of the exterior envelope to one that provides for continuous and redundant drainage planes (as has been done in other buildings) will likely provide the most acceptable long-term moisture intrusion fix. It is also our professional opinion that the balconies serve no useful purpose, will always pose potential leakage problems, and should therefore be considered for elimination or be completely redesigned as part of the long-term fix.

5. **High Priority:** Excess humidity during certain weather conditions. This facility, by original design, brings large quantities of raw, unconditioned outdoor air into two air shafts, and distributes it to each floor. By original design, the moisture is only removed from the supply air if the twenty-nine (29) cooling coils in the individual air handlers are "on" and "continually cold", which is not always the case during long periods of normal operation. This situation can result in longer periods of time when the surface conditions within the fan chamber falls below the dew point temperature,

leading to the presence of condensation, or humidity levels that can allow mold growth to occur at these locations. Also, this design situation will result in some floor areas receiving high levels of moisture if continuous intense cooling is not needed during any time period when it is very humid or raining outdoors. We are aware of locations on the 10th floor with valid reports of very elevated humidity levels during certain weather conditions.

Remediation: In the short-term, further investigation into the relatively new energy management system controls, outside air damper settings, and relief damper operation is advised. For a longer-range corrective action, redesign of the HVAC system to include dehumidification of the outdoor air prior to distribution is likely necessary. With today's energy costs, this would normally be achieved most economically with enthalpy energy recovery from ganged building exhaust. This approach could significantly improve IAQ and comfort, reduce the size of the dehumidification equipment needed, and reduce energy costs.

6. **High Priority:** Inefficient ventilation air delivery. Despite there being a confirmed total of 2-3 times the minimum ventilation air (as currently recommended by ASHRAE) pumped into this facility from the rooftop, many areas effectively receive only slightly more than the ASHRAE recommended amount of ventilation air. On most floors above the 8th floor, this ventilation air also likely includes byproducts from fugitive VOC emissions from large-scale printing and photocopier activities found within various locations within the facility.

   Remediation: In the short-term, we have recommended isolation and exhaust of the high-use printing machines. Additionally, efforts should be expended to further understand the current controls which determine the amount of outside air that is being pumped into the facility and the position of the relief dampers when the building is under pressure control. Re-entrainment of relief or exhaust air could explain part of the difference. In the long-term, upgrade of the failing pneumatic VAV boxes and controls to a modern DDC (Direct Digital Control) standard, and the ability to automatically reset supply air delivery temperatures based on North and South zonal conditions, will help to provide continuous distribution of adequate outdoor air supply throughout the facility.

7. **High Priority**: Dirt covered porous materials stored in unconditioned spaces moved into office areas. It is reported and observed by TBS, that paper materials and other materials are stored in unconditioned storage areas in rooms adjacent to the parking levels. We observed an accumulation of dirt (which always contains mold spores) on products contained in this storage area, and on materials stored in caged areas of the

parking garage space. It is our understanding that these materials and areas are not routinely cleaned or heated above the dew point of the outdoor air.

Remediation: This situation can be readily remediated with proper routine cleaning via HEPA vacuuming, and the use of storage areas that are routinely cleaned and heated above the dew point of the outdoor air.

8. **High Priority**: Temperature control issues; failing VAV Controls compounded by perimeter radiant heat loss. A 1987 Due Diligence Report conducted for the previous Owner notes that by design, the facility has large areas of external glass with no perimeter convective radiant heating, which is rather unusual for this climate. It is unlikely that the fan powered VAV boxes in the perimeter can be an acceptable substitute to correct this radiant heat loss situation. Additionally, these fan powered VAV units and associated ductwork potentially release some very low level of fiberglass into the air during operation, and also have been observed to not securely hold their filters in place. Testing has confirmed levels of fiberglass to be very low and not at a level where remedial clean-up action would necessarily be recommended. TBS in-space temperature data confirms periods of poor temperature control in most zones, likely from failing VAV box controls that have reached their useful life expectancy.

   Remediation: The VAV boxes and all controls can readily be upgraded to a modern, fully DDC control system. It may be most cost effective to add a radiant perimeter heating system for improved occupant comfort, and to permanently eliminate noise and potential fiberglass dissemination from the fan powered perimeter VAV heating system during this renovation.

9. **High Priority**: Contaminated paper concerns. There exists unresolved concerns' regarding the possibility of settled dusts on paper or other materials leading to skin irritation. It is beyond our scope to further look into the reported issue of possible rashes from contact with certain paper. This issue clearly is reported in ongoing concerns by occupants.

   Remediation: As a precaution, it would be prudent to remedially clean all materials that will be disturbed or moved to any other location with HEPA vacuuming to remove accumulated, settled dusts. This includes ceiling tiles that are disturbed during any renovation that have been in place for years. This is also particularly important for the tops of books and other items that likely collect settled dusts. We understand that both the DHS and DSS computer rooms were recently professionally cleaned, with reports of improvements in the quality of the air. It is also prudent to provide this level of cleaning when large-scale moves of workstations or other materials occur.

10. **Lower Priority:** Tobacco smoke within building grounds. Currently, tobacco smoke odors are reported to sometimes be noted within the facility. While on-site, TBS noted this experience on several occasions. It is reported that this situation has triggered at least one asthma attack that required hospitalization and lost work.

    Remediation: Removing tobacco smoke from all areas of the building and parking areas, and strictly limiting tobacco smoke to the perimeter of the grounds, most readily accomplishes this situation.

11. **Lower Priority:** Low levels (typically 3% or less) of fiberglass fibers found in accumulated dust samples. Based on the binder color of the glass fibers, the fibers appear to be from damaged duct liner in air handlers and ductboard located downstream of all VAV boxes. The fiberglass was found not on normal work surfaces, but in accumulated dust from hard to reach areas, on carpets at the perimeter of workstations, and from a filter in a perimeter fan powered VAV box. This material has likely been accumulating over months. Fiberglass lined duct and ductboard is a common HVAC material, and nearly impossible to clean without significant potential fiber release.

    Remediation: This acoustical ductliner and ductboard situation can only be corrected by removing the failing duct liner and ductboard. In the interim, remedial cleaning (with HEPA vacuuming) of all significant settled dust deposits throughout the building should be undertaken.

12. **Lower Priority:** Dust mite growth, dog allergen, and mouse urine, in low to moderate levels, has been confirmed in limited accumulated dust samples. The samples were taken from one area immediately adjacent to partitions, where routine vacuuming with existing equipment does not clean the extreme perimeter of the workstation areas. Dust mites are common in humid climates and bedding where skin scales can accumulate and stay damp. Nearly every home, school, and office building contains some level of dust mites. The levels found in this building generally do not present an elevated risk to the most sensitive individuals, although the mechanism by which aerosols are generated may influence the actual exposures. If individuals have documented allergies to dust mites, some portion of the asthmatic responses seen in those individuals may be to mites.

Remediation: This situation can be corrected by careful one time remedial cleaning (with HEPA vacuuming) of all significant settled dust deposits throughout the building, as well as improved humidity control throughout the building (See #4 above). The performance of the existing routinely used vacuum cleaners do not currently achieve this level of absolute particle capture, as particle sampling has shown elevated airborne particle counts in association with the use of this equipment. It would be advisable to clean the area adjacent to the partitions where normal vacuuming does not reach once per year, or to change the type of equipment used to facilitate routine vacuuming up to the partition edge and edge of all walls.

13. **Lower Priority:** Consider kitchenette/walk-up photocopier odors within agency spaces. It is reported that kitchenette areas are not located within designated enclosed spaces with dedicated exhaust, which is the ideal situation in new construction. Additionally, it is reported that there are some areas with high-use, walk-up photocopiers. Cooking and high-use photocopying activities emit odors that should ideally be exhausted out of an office facility to improve IAQ.

    Remediation: This situation should be considered for remediation with the development of dedicated, exhausted kitchenette areas on each floor adjacent to restrooms. Locations of high-use, walk-up photocopiers within these areas or in adjacent exhausted areas should also be considered to improve IAQ.

1.3 Recommended Corrective Actions for Continued Habitability for 20-30 Years

It is our understanding that the State would like us to address continued occupancy (habitability) of the facility for the next 20-30 years (foreseeable near-term future). In recent years, clearly the State has invested significant funding with very good faith efforts to significantly reduce reported historical moisture intrusion, and to improve overall HVAC functioning to make the building more comfortable for the occupants.

It has been our experience over the past 30 years in this field, that in addition to the question of safety or habitability, other considerations for office buildings are critical. These considerations include avoiding long-term irritation, occupant discomfort, and maintaining occupant productivity. These considerations are also important for reducing complaint levels and restoring confidence in a building where a history of health concerns has existed.

Our experience shows that facilities fall somewhere on a continuum between an "unhealthy" or "sick" building, and a modern, healthy building design, such as a LEED

(Leadership in Energy and Environmental Design) rated healthy building design. In addition to the efforts that have already been made to keep the occupants safe, we have identified multiple remaining issues that need to be addressed to continue to improve conditions, and to move the facility from just being a visually attractive office design (with some deficiencies) towards a more modern and healthier building design.

We strongly recommend that the corrective actions be addressed if the State plans to remain in the facility for another 20 to 30 years. Proper implementation of these corrective actions would be expected to:

A. Prevent occupant exposures to identified potential irritant sources currently located within the building.

B. Reduce continued thermal discomfort complaints.

C. Stop intrusion of wind driven rain.

We have outlined these corrective action items below, which are presented in detail in the body of the report, with supporting scientific data located in the Appendices.

We fully expect and realize that properly implementing these corrective action recommendations will involve a relatively large sum of money. Further, because of the heightened IAQ concern levels present in this building, it may only be feasible to accomplish the recommended renovations by vacating major portions, or the total building during the renovations, and by performing all renovations within this facility with active construction dust containment as described by SMACNA (Sheet Metal and Air Conditioning Contractors National Association).

Many of the issues that this building faces are not unique, and may be common with this vintage facility. A 1987 Due Diligence Report performed for the previous Owner dated March 16, 1987, describes the facility generally as an aesthetically pleasing building of reasonable quality, and notes building deficiencies concerning the exterior envelope and HVAC systems. A 1992 report conducted for the State of Connecticut suggests that various components of the HVAC system will by now be close to the end of their useful life.

We understand that the State has already taken some actions to reduce the reported VAV box failure. However, the temperature and air delivery control could be much improved by moving to a completely interfaced DDC system. It is also our opinion that the continued moisture intrusion can only be adequately stopped by moving away from a primary face sealed envelope design (created prior to changes in the Brick Institute of America design guidance), to a more modern, post-1987 design, with a continuous, redundant drainage plane. There are proven methods for retrofitting a continuous drainage plane from inside the facility without removal of the exterior brick. There may be other methods that should be considered.

It is our opinion that properly addressing these corrective action items should bring the facility up to the level of a more modern, healthy building design. Additionally, the renovations recommended would be expected to significantly improve both the Indoor Air Quality and the current reported poor energy efficiency.

1.3.1 Summary of Corrective Action Recommendations in Suggested Order of Importance: (Note: All recommendations should be addressed),

(See Section 4 of Report for Specific Details of Each Recommendation)

1. Address Medical Recommendations Presented in Report. (Section 4.14)

2. Isolate and Exhaust all High Volume Printing/Photo Copying. (Rec. #3, Section 4)

3. Abate Mold Growth Located on Porous Liner in all Air Handlers, and Short Sections of Air Handler Supply Ducts up to the Noise Attenuating Section. (Rec. #1, Section 4)

4. Further Investigate Outdoor Air Delivery and the Need for Primary Dehumidification of Outdoor Air, in Order to Allow the HVAC Systems to Provide Reasonable Ventilation, and Allow it to Maintain Recommended Humidity Levels within the Building. (Rec. #7, Section 4)

5. Rigorously Manage Current Moisture Intrusion and Evaluate a Redesign of the Exterior Envelope of the Facility to More Permanently Stop Rain Intrusion with a Redundant, Continuous Drainage Plane/Air Barrier/Insulation Layer System. (Rec. #8, Section 4)

6. As a Precaution, Remedially Clean all Materials that will be Disturbed or Moved to Any Other Location. Consider Further Evaluation of the Issue of Alleged Paper Contamination. (Rec. #14, Section 4)

7. Evaluate the Current Storage Situations. Alter to Prevent Dirt Accumulation, Condensation and Mold Growth. (Rec. #11, Section 4)

8. Evaluate the Current Cleaning Procedures. Alter to Remove Accumulated Visually Observable Settled Dusts. (Rec. #12, Section 4)

9. Replace all VAV Box Controls with Reliable Digital Controls. (Rec. #5, Section 4)

10. Remove Deteriorating Fiberglass Liner and all Duct Board in Air Supplies. (Rec. #2, Section 4)

11. Evaluate the Need for Redesign of the Upper Floors of the Structure to Eliminate Balconies. (Rec. #9, Section 4)

12. Continue Excellent Air Filter Type and Maintenance. (Rec. #13, Section 4)

13. Install Perimeter Radiation and Consider Eliminating 2/3 of Exterior Glazing. (Rec.#6, Section 4)

14. Further Isolate Tobacco Smoke Away from the Building, so that the Interior of the Building is Never Impacted with Odors. (Rec. #4, Section 4)

15. Consider Eliminating Odors from Cooking in Kitchenettes, Provide for Scheduled Maintenance of Walk-up Copiers, Fax and Printers, and Evaluate Possible Relocation of Heavy-Use Office Equipment. Consider a Kitchenette Area on Each Floor with 100% Exhaust to the Outside to Improve IAQ. (Rec. #10, Section 4)

1.4 Limitations of TBS Study:

1.4.1 Environmental Monitoring Limitations

The professional opinions and recommendations contained within this report are based on an intense, short-term monitoring and diagnostic effort by TBS to address multiple, significant building factors. We have worked within a short timeline to conduct the building diagnostics, produce the data, analyze the data, and make the recommendations contained in our report. Our analysis is in some cases based on somewhat limited sampling, conducted over short time periods. This testing was often specifically conducted in areas with known possible sources, or in areas reported by occupants to sometimes exacerbate irritation symptoms. We believe all of the test data to be accurate, and likely representative of much of the overall conditions in the facility during our evaluation period. However, it is impossible to know if it is a good representation of all of the various zones or areas within the facility.

Intrusive disassembly of the suspect continued moisture intrusion locations has not been performed as part of this study. These areas warrant continued investigation and follow-up with a very responsive technical program put in place to assure that microbial growth in repeatedly wet perimeter areas is not currently occurring and being disseminated until routine wind driven rain water intrusion, or other water leakage is proven to be eliminated.

Our study included limited intensive surrogate spore trap monitoring in specific representative areas to further explore the sources of irritants that were identified in our study. It may be prudent to conduct more monitoring in very specific areas to further determine if any likely biological exposures are occurring due to ongoing rainwater intrusion events. Additionally, it may be prudent to work with medical professionals to conduct very specific monitoring in an area where any ongoing symptoms are reported.

We have stated in several cases that some unknown factors may remain to be evaluated, but we believe we have identified the most prominent and likely conditions that have contributed to this problematic building.

1.4.2 Medical Review Study Limitations

The primary goal of reviewing medical records was to determine whether standard approaches were used and whether some form of problem likely persists. Additionally, the goal was to determine whether new-onset disease had developed since January 2004, after building remediation. Records on 27 of the between 140 and 190 individuals with complaints (i.e., less than 25% of records), were actually reviewed. Treating physicians at UCONN identified records for review, and had planned to send the most severe cases. Still, there is no assurance for certainty of that strategy in the absence of systematic review.

As importantly, because of the way the initial questions were formulated, complete records were collected only from after January 2004; older records on individuals with current problems were not reviewed. At least one individual was identified with current documented lung function changes during work in the building, with resolution after leaving, who had prior symptoms, and reportedly, no lung function abnormalities despite very aggressive testing. Therefore, such cases preclude categorical statements about building acceptability.

Because of time and economic constraints, no formal review of the allergy records was undertaken. Dr. Santilli saw approximately 20 of the Sigourney Street employees, conducted skin testing, and made diagnoses of building-related sinusitis and rhinitis, based on a symptom pattern that worsens at work. These cases may, at least theoretically, represent underlying allergic disease with mucosal irritation during active exposure rather than only active allergic disease. Only intervention on the printing offgassing will show the consequences.

Finally, linkage of chronic diseases such as sarcoidosis and usual interstitial pneumonitis to a building relies on history taking and documentation of similar exposures, by history, to those identified in epidemiologic studies. Those are unable to exclude other causes. In fact, both mentioned forms of chronic lung disease have been associated with both bioaerosols and with organic solvents. Other known causes include silica and metal grinding, and yet other agents such as viruses remain suspect causes. These causes cannot be excluded.

2.0 APPROVED SCOPE OF WORK

2.1 General Scope

As stated in our approved proposal dated September 29, 2005 (based on discussions of September 15, 2005), we proposed to initiate direct communication with NIOSH project officers, medical professionals, and union representatives. The goal of our efforts was to further understand medical concerns, and to determine if there were any existing building issues that could be scientifically correlated to current reported occupant health concerns.

As soon as we understood the factual information that was available regarding the current building situation, the current and past medical concerns, and the employee/union concerns, we had proposed to proceed with a team-oriented problem identification and solving approach.

In our original proposal, we did not propose to duplicate any evaluation work/testing that has been historically conducted in a comprehensive manner. We expected to need to conduct limited HVAC observations in order to validate the most recent reports of existing conditions, conduct some building interstitial space observations, and conduct limited building diagnostic testing, as warranted, for parameters that had not been evaluated.

Any detailed observations and testing were primarily undertaken after we had communicated with NIOSH, medical, DPW, and union officials. All on-site work and communications were coordinated with DPW officials. Any intrusive disassembly or inspection work within the facility was coordinated with contacts that were conveyed to us by the DPW.

Services were provided in a technical manner based on our existing contract with the State of Connecticut (contract number 03PSX0375). As required in our State Contract, all site work was followed-up with verbal reporting, describing our observations and general recommendations for any short or long-term improvements, and/or further evaluation if warranted.

Based on our area of building science expertise, industrial hygiene, mechanical engineering and building operations, we have formulated and offered opinions regarding the conditions in the building and its suitability for continued occupancy. As requested, we have subcontracted a review of the current medical data to a qualified, board certified, occupational health professional experienced with disease and health issues in non-industrial settings, Dr. Michael Hodgson, M.D., M.P.H. Dr. Hodgson was approved by the State before joining our efforts. He has formulated and offered his medical opinion regarding current reported building related occupant health issues, and the building's suitability for continued occupancy.

Any recommendations for corrective action or improvements to the building have been developed based on the results of our analysis of the building science information, and any apparent relationships to current occupant health concerns, and medically reported information made available to us. Our building science and medical opinions have been scientifically based following the review and analysis of current data, reports, interviews, industry standards/guidelines, and TBS's observations and building diagnostic evaluations/test results.

Our work has focused on trying to identify all current factual information with regard to any building related items that may need corrective action to bring them in line with a normal standard. We proposed to work in cooperation with designated health officials to further clarify the health status of the current occupants with regard to their occupancy of the facility, based on the building science and medical information that has been made available.

2.2 Proposed Due Date and Specific Task Items:

1. Due Date: The target completion date and submittal of a preliminary draft report is December 15, 2005.

2. Initial Meetings: Initial meetings with appropriate personnel after communication with medical personnel were conducted. We also planned and executed a meeting with the union representatives, medical, and State personnel to further identify the general scope of concerns, clarification of responsibilities, communication channels, and goals of services. (We communicated with Dr. Storey of the University of Connecticut as soon as we were authorized.) Additional meetings were scheduled as needed.

3. Report Review: We obtained limited appropriate technical reports and general medical information that was released (not patient records, unless warranted and released) pertaining to the current concerns. We obtained and reviewed detailed current moisture reports and laboratory data as warranted, as the information was made available.

4. Further On-Site Meetings and Visual Observations: We met with the Client's authorized representative on-site to walk the facility, and met with union officials to clarify any details of evaluations proposed.

5. Limited HVAC Observations, Interstitial Space Observations and/or Testing: Once we better understood the current available information, we conducted limited diagnostic/problem solving evaluations. These included the operation of a continuous laser particle counter to determine potential combustion related impacts, or other diagnostic procedures, which were determined to be useful and approved. The analysis is listed in Section 3 of this report.

6. Moisture Intrusion - Visual Observations, Limited Intrusive Disassembly, and Representative Samples: After reviewing recent and current Infrared Moisture Reports conducted by DPW contractors, we received approval to have additional Infrared Diagnostic work conducted. We have reviewed sketches and drawings as warranted. Also, we proposed and conducted visual assessments and representative samples at specific locations in HVAC systems and ductwork. Additional evaluation work and scope was recommended to the State, and approved on a case-by-case basis. We recommended and conducted a further study of the HVAC systems after visually suspect mold was identified. We did not conduct exploration in building wall assemblies, and have recommended further follow-up of areas where continued water leakage was observed. DPW personnel, without intrusive disassembly of areas, also checked suspect areas revealed by Infrared Survey for dampness with a moisture meter.

7. Additional Scope: As proposed, this work was conducted as an interactive approach. That is, during the course of the work, items were identified which warranted the development of an additional scope for approval, and upon authorization, we altered our scope to address the items on a time and materials basis in accordance with the agreed upon standard State Contract rates.

8. Reporting: With this report, we are conveying the results of our work and offering recommendations as they pertain to current guidelines for office-type occupancy, or as they may relate to the medical condition of employees.

9. Results and Recommendations: At the conclusion of this project, TBS has developed this report to provide a scientifically supportable and expert opinion on whether 25 Sigourney Street is suitable for occupancy. Our report includes, as warranted, corrective actions suitable for any short-term or long-term issues that we have been able to define from the results of the assessments. Additional testing or evaluation procedures have also been recommended, as results or observations warranted.

The scope of work did not include the design of corrective measures, nor the surveying or testing for asbestos fibers, or any other pollutants not identified in the proposal. If requested and agreed to, as part of an additional scope of work, our firm can perform additional testing, monitoring during reintroduction, mitigation design, cost estimates, or provide others services as may be allowed within our State Contract.

We have submitted verbal progress reports and one written addenda request during the project. A preliminary draft report was issued for accuracy and clarification review, prior to the issuing of this current Final Report.

3.0 TESTS PERFORMED TO EVALUATE THE BUILDING IAQ/HVAC

3.1 Carbon Dioxide Concentrations in Buildings

Results: Levels of Carbon Dioxide measured near continuously in several different locations within the facility over four (4) weeks generally confirm delivery of outdoor ventilation rates in accordance with current ASHRAE guidelines of 20 CFM per person.

The current ventilation design in areas where heavy duplicating and printing is conducted in this facility would not meet current ASHRAE Standard 62 design guidance. We have elaborated on this is Section 4.2 of the report.

Recorded measurements of CO_2 concentrations in this facility as measured from October 6, 2005 to November 11, 2005 are found in Appendix D5 of this document. Further discussion of the data collected is presented in Section 4.6.

Testing: As part of our HVAC/IAQ evaluation, we measured Carbon Dioxide (CO_2) in occupied spaces to identify if there was potentially inadequate ventilation. Measurements were collected during normal occupied and unoccupied times. Measurement of the CO_2 concentration in the air is one way to measure the amount of ventilation Outdoor Air (OA) delivered to a space. CO_2 concentration in the indoor air of a typical occupied space is a mixture of the CO_2 introduced to the occupied spaces from outdoor sources and from the occupants breathing. CO_2 is a byproduct of the metabolic process involved with respiration; i.e., people release CO_2 into the environment by exhaling.

Outdoor Air, as ventilation, is provided to the occupied spaces of this facility by two means. The first and most prominent is the mechanical ventilation system, which operates during occupied times, and should introduce a preset quantity of OA for ventilation; and, second, from infiltration, which is air leaking into the building through cracks in the building envelope via air pressure differences, or operable windows. Areas where air leaks into the building include the crack area between walls and windows (or doors) and the crack area at the wall roof interface.

Clean OA will normally have a CO_2 concentration of 375 PPM (Part Per Million) +/- 25 PPM, and the concentration of CO_2 in air exhaled by human occupants exceeds 35,000 PPM. Our measurements of CO_2 in the occupied space are the result of the combined sources, occupants and OA. By applying normalized occupant density factors (from ASHRAE) and typical occupant respiration rates, we can determine the quantity of OA introduced into the space.

Carbon Dioxide was monitored in the occupied space with a TSI Model 8551 portable CO_2 gas monitor, Serial #30253.

The concentration of CO_2 typically found in office spaces (375 PPM to 3,000 PPM) is not known to present a health hazard to occupants. OSHA has set a limit of 5,000 PPM as the maximum allowable in an occupied workspace. The OSHA limit, however, is not to be confused with ASHRAE or NIOSH guidelines used to evaluate indoor settings. Published data from ASHRAE and NIOSH indicate that CO_2 concentrations more than 600-800 PPM in occupied spaces, when the ambient (outdoor) conditions are in the range of 350 PPM, and indoor population densities are greater than seven (7) people per 1,000 sq. ft., can be expected to result in an increased incidence of reports of poor indoor air quality from the occupants of the space. Carbon Dioxide concentration in excess of 1,000 PPM under normalized measuring conditions may be an indicator that ventilation rates are less than current ASHRAE recommendations (typically 15-20 CFM per occupant in an office environment).

3.2 Carbon Monoxide within Occupied Spaces

Results: We observed no periods of time during our entire four (4) week study when the CO concentrations were above zero (0), thus we have not included that data in this report. We rechecked the calibration of the CO monitor a second time after the study was completed to further confirm its accuracy and the reliability of the data.

Testing: Carbon Monoxide (CO) is a harmful byproduct of the combustion of fossil fuels. Fossil fuel burning equipment located within a building space must be properly vented to the ambient (outside) to limit the spillage of CO and other byproducts into the occupied spaces. Additionally, to prevent CO from tailpipe emissions from entering the building, vehicles must not be allowed to idle in close proximity to the building. NFPA (National Fire Protection Association) publishes guidelines on the proper installation of fossil fuel appliances with respect to CO emissions.

The following list of limits of Carbon Monoxide exposure has been set by each of the listed agencies for specific environments.

- The American Conference of Governmental and Industrial Hygienists (ACGIH)
- The Occupational Safety and Health Administration (OSHA)
- The National Institute of Occupational Safety and Health (NIOSH)

Exposure limits, Threshold Limit Value (TLV) for Carbon Monoxide in an industrial setting:

- 35 PPM Time Weighed Average (TWA -10 Hr) NIOSH
- 50 PPM Time Weighed Average (TWA -8 Hr) OSHA
- 200 PPM Ceiling Limit, NIOSH

(OSHA, 29 CFR 1910.1000, Table Z-1, C-12)

The above limits are considered industrial workplace guidelines, and are considered extreme upper limits to be applied to work areas where occupants are expecting to receive some exposure to CO fumes. The limits are also intended for workplaces where the airborne concentrations are monitored and controlled to prevent unsafe conditions.

The US EPA National Air Quality Standards

- 9 PPM as a limit for an 8-hour average
- 35 PPM as a limit for a 1-hour average

(EPA, 40 CFR 50.8, C9)

The above guidelines are intended to protect the general public.

The World Health Organization (WHO)

- List concentrations greater than 5 PPM for more than one (1) hour as a concern.

  We collected data utilizing TSI Q-Trak data loggers, Model 8551 (Serial #30253), with a CO sensor in multiple areas over a four (4) week period. The sensor was calibrated at the beginning of the study and validated at the end.

3.3 Building Temperature and Humidity Testing

Results: Temperatures and Relative Humidity levels in general would meet ASHRAE thermal comfort overall guidelines. Of concern in many of the thermal trend logs is the drifting of temperatures with time over the course of a day, and the inconsistencies of temperatures in different locations.

See Appendix D5 through D10 for graphs of the temperature and humidity conditions monitored in the spaces, inside air handlers, and outdoors. See Section 4.4 for discussion and recommendations concerning thermal comfort conditions.

Testing: Space air temperatures and humidity were monitored in the selected locations within the occupied area in the vicinity of the occupant's desk area, within some air handlers and outdoors. The thermometer and humidity sensor in the TSI Model 8551 IAQ monitor (Serial #30253) was used to measure the space dry bulb temperatures and relative humidity values. We also used calibrated Onset Instruments Hobo data loggers.

ASHRAE (American Society of Heating, Refrigeration, and Air-conditioning Engineers) provides guidelines for thermal comfort in office environments. The recommended temperature and relative humidity ranges are based on the type of activities typically performed within the environment. These guidelines are a subset of the acceptable temperature and humidity conditions for human occupancy, as presented in ASHRAE Standard 55-1992 "Thermal Environmental Conditions for Human Occupancy". The ASHRAE recommended temperatures and humidity of office and classroom spaces are provided in Chapter 3 of the ASHRAE 2003 "HVAC Applications" and are summarized in Table 1 "General Design Criteria". ASHRAE recommends temperatures in the range of 70 to 74°F based upon a humidity range of 20 to 30% in winter seasons, and 74 to 78°F based upon a humidity range of 40 to 50% during the summer season.

As with most office facilities, this building has no humidifiers and high ventilation rates, therefore, low relative humidity (less than 20%) in the winter months could be expected during cold weather. Also, there are no enthalpy energy recovery devices in the ventilation system of the facility, thus no moisture in the exhaust air is captured to minimize dryness during cold weather. Additionally, high humidity can be expected during damp weather (i.e., the indoor dew point will track closely with the outdoor dew point, unless the air conditioning coils are actively cooling with chilled water in the range of 44°F).

During our study, we also used HOBO data loggers to monitor temperature and humidity in representative air handlers and at supply diffusers.

3.4 Inhaleable Particle Concentrations in Buildings

Results: It is unlikely that the levels of airborne respirable particulate we recorded are posing any significant health exposure (as nuisance dust) to the majority of occupants in this building. See Appendix D3 for trend graphs. Further discussion pertaining to the particle data collected can be found in Section 4.11.

Testing: A calibrated, real-time Dustrak Inhaleable Particle Monitor Model #8520, Serial #22564 was employed to collect airborne Inhaleable particle size (PM-10) data for the period of our site work. The particle counter was set in a noise reduction box, with a sampling tube extended out of the box in the occupied zone, and an air circulation fan located within the box. The particle counter used in this sample series counts the total number of particles in the air stream passed through the counting chamber that are smaller than 10μ (microns) in aerodynamic diameter.

We do not use this device to assess OSHA limits for dusts in offices. It is used to look for patterns in particle levels, to compare levels over a period of time. Periods with elevated levels over background indoor particle counts typically are indicative of occupant activity within the rooms. Spikes of extreme elevation above background indoor particle counts typically suggests that housekeeping or other activities are re-suspending settled materials from the floors or other horizontal surfaces.

Increases in particle counts during occupied times when people are moving about can most often be attributed to activities in the space, or in rare cases, possible entrainment of combustion related fumes. To some degree, the quantities of particulate indicated by the particle counter that cannot be attributed to ambient air conditions, or local sources of combustion (from cigarette smoke, fossil fuel combustion, etc.), may be an indication of large reservoirs of settled particulate matter that might be removed from increased and more effective cleaning efforts of the horizontal surfaces.

For comparison purposes, typical inhaleable sized particle concentrations in schools not found to have IAQ complaints associated with dusty conditions are in the range of 50 micrograms per cubic meter or less. Offices are often much cleaner. It is important to note that this equipment does not indicate the composition of recorded particle concentrations. In some cases, a small concentration of a particular known contaminant may result in reports of poor IAQ and occupant-related symptoms. The identification of these particles cannot be established by the particle counter, and would need to be identified by other means, including observation, occupant interviews regarding activities that occur within the space, or unusual odor occurrence with lab analysis of samples.

3.5 Airborne Mold Sampling

Results: Airborne testing on three occasions detailed in Section 4.1.3 of this report indicate that indoor testing always indicates that low levels of common types of outdoor mold were identified. Levels indoors were always lower than levels outdoors and similar in type.

Testing: There are essentially no nationally accepted standards for airborne mold levels inside facilities. All current guidelines direct that the data be viewed with regard to respective indoor and outdoor levels, type of molds, time of year, and observed conditions at the time of sampling. TBS personnel conducted spore trap sampling for airborne mold spores during repeated 10 minute intervals on three (3) occasions. Discussion of airborne mold data is found in Section 4.1.3 Laboratory Results, found in Appendices C1 and C2.

3.6 Laser Particle Counting

Results: Extensive laser particle counting was conducted near continuously over a four (4) week period. In general, levels inside the building remained low during occupied periods. Based on the data collected, and the lack of any Carbon Monoxide being indicated within the facility, there is no reason to suspect combustion particles to be significantly impacting the facility on a routine basis. The graphed results of the particle data are presented in Appendix D4. Discussion is found in Section 4.11 of this report.

Testing: Calibrated, real-time particle counters (Climet model CI-4100) were employed to collect airborne particulate concentrations within selected occupied spaces over the monitoring period. The particle counters were set in the selected spaces to establish peak particle loading and the time of day of peak occurrences. One unit was run indoors for approximately four (4) weeks in various locations. A second unit was set-up sampling the outdoor air for an additional period of sampling.

The data collected by the counters are presented in two size fractions, 1) particles larger than 0.5 microns (0.5μ) and 2) larger than 5.0 microns (5.0μ). The respirable size fraction is the 0.5μ count minus the 5.0μ count. These particles are small enough to pass uninhibited through our respiratory system filters (mucus membranes), and are then available for deposition within the depths of the lungs.

The increased number of airborne particles larger than 0.5μ (micron) during occupied times can be attributed to activities in the space, such as the introduction of combustion particles from cigarette smoke, or from the migration of similar combustion particles from another location, such as exhaust from auto and bus engines. It is our experience that typical particle concentrations in buildings not found to have IAQ complaints associated with dusty conditions are in the range of 30,000 to 60,000 particles per cubic foot larger than 0.5µ. It is important to note that the particle counter does not determine the composition of recorded particle concentration. We have found that in some cases a small concentration of some known contaminants may result in reports of poor IAQ and occupant related symptoms. The identification of these particles cannot be established by this device, and will need to be determined by other means including observation, sampling, and occupant interviews.

As part of our scope of work, we also collected particle data using a TSI Dust Trak model 8520 (described in Section 3.4). This device measures the number of particles smaller than 10 microns and converts this count into a concentration in micrograms per cubic meter ($\mu g/m^3$), based on data from standard dust size and weight distributions. The instrument was calibrated prior to initiating the recording.

3.7 Fine Particles as an Indicator of Combustion

Results: As noted above in Section 3.6, extensive laser particle counting was conducted near continuously over a four (4) week period inside the facility, and for one week inside and outside the facility. In general, levels inside the building remained low during occupied periods. Based on the data collected, and the lack of any Carbon Monoxide being indicated within the facility, there is no reason to suspect combustion particles to be significantly impacting the facility on a routine basis. The graphed results of the particle data are presented in Appendix D4. Discussion is found in Section 4.11 of this report.

Testing: A calibrated, real-time laser particle counter, as would normally be used in clean room monitoring, was used to detect the level of 0.5 micron and larger particles inside the building (as described above in Section 3.6), and at the air intake during the end of our monitoring dates November 12th through November 18th. The particle counter was set-up to sample, located just outside the air intake filters on the air handling unit located within the penthouse. The particle counter used in this sample series counts the total number of particles in the airstream passed through the counting chamber that are larger than 0.5 microns in aerodynamic diameter. High fine particle counts measured by this device typically suggests that combustion emissions are impacting the unit.

See the end of Appendix D4 for trend graphs. Discussion is found in Section 4.11 of this report.

3.8 PM-2.5 Particles, Gravimetric and Elemental Analysis

Results: Levels of respirable particles were in general, lower indoors than outdoors, or nearly the same during the daytime periods or nighttime unoccupied periods. Results of the elemental analysis of the collected particles indicate somewhat different compositions of the indoor particles vs. the outdoor ones for some elements. There are no health implications for this small data set. All levels of all materials identified are extremely low. It is unknown what materials used within the facility (such as photo duplicating) would influence the minor differences between the indoor and outdoor elements. Results of this analysis are reported in Appendix D2, PM-2.5 Lab Data. Discussion is located in Section 4.11.1.

Testing: TBS conducted an evaluation and sampling of airborne respirable PM-2.5 dusts, utilizing Impactor size separation technology that was originally pioneered at Harvard School of Public Health for sampling very low levels of indoor particles. We conducted particle sampling and elemental analysis on two days during occupied and unoccupied times, in order to determine the elemental makeup of the particles.

We assessed the levels of materials during a 6 to 8 hour sampling period at a flow rate of 20 liters per minute through Teflon filters. Filters were submitted for elemental analysis of 48 elements, via X-ray techniques (XRF), through the services of Chester LabNet, located in Tigard, Oregon. These samples were collected on two occasions, October 19, 2005 and January 26, 2005, during normal daytime hours with the HVAC on, and during evening hours with the HVAC system off. Results of this analysis are reported in Appendix D2, PM-2.5 Lab Data. Discussion is located in Section 4.11.1.

3.9 Occupant Interviews

Results: As can be seen from the summary table in Section 4.13, the respondents who came forward during interviews are distributed fairly uniformly throughout the vertical profile of the building. Temperature control concerns as well as health concerns were frequently verbalized by most participants.

Testing: As a result of initial meetings with various departmental representatives from the building and union representatives, it was decided that TBS should allow for an interviewing time period where anyone could come forward and provide us with information regarding their occupancy of the building. A sample interview form is attached below. Non-confidential results are summarized in Section 4.13 of this report.

CONFIDENTIAL IAQ INTERVIEW FORM   INTERVIEWER: DATE: TIME:

In response to concerns about the quality of indoor air and comfort provided, we are collecting information on individual experiences to better understand conditions in this building under our review.

1) Floor and Grid Location [1A] ___-[1B]___-[1C]___ Zone [1D] ___ Department [1E] ____
Floor Letter Number

2) We understand that you are here because you have current health or comfort concerns about the quality of indoor air currently provided in this building that you associate with being in this building?
Health [2A] Y / N , Comfort [2B] Y / N , Other [2C] ___________
If comfort, too hot [2D] Y / N , too cold [2E] Y / N , too humid [2F] Y / N , too dry [2G] Y / N .
When? Time of day [2H] ___ am pm, Time of year [2I] Summer, Fall, Winter, Spring

3) Can you list the body area impacted by any symptoms or discomforts that you associate with being in this building: Upper respiratory (nose, throat, sinus) [3A] Y / N , Lower respiratory (chest tightness, bronchitis,) [3B] Y / N , Irritation of the eyes [3C] Y / N , Irritation of the skin, [3D] Y / N ,
Do you wear contact lenses? [3E] Y / N
Other/more details: [3F] ______________________

4) When do these symptoms occur? [4A] ___ am pm. When did they start? [4B]

5) Do they go away after leaving the building? [5A] Y / N, How long after, [5B] ___ hours

6) Do you associate the onset of these symptoms with any event in the building, any location in the building, or a change in the season/weather? [6A]

7) How long have you been experiencing these symptoms, [7A] ___ weeks / months / years
How long have you worked here [7B] months / years
Has your location in the building changed over time? [7C] ___ Where did you work in the building before ? floor and grid location ___-___-___, zone_____, department____________

8) Have you reported any symptoms to a physician? [8A] Y / N. If so, what was their response? [8B]
____

9) Do you have any allergies that you are aware of? [9A] Y / N [Details: [9B]]

10) Can you briefly describe your work activities? [10A] ______________________
What percent of your time involves paper handling [10B] %
Video Display Terminal   Cathode Ray Tube   Liquid Crystal Display
11) Do you use a video display screen (VDT) [11A] Y / N : CRT [11B] Y / N or LCD [11C] Y / N,
If so for how many hours a day? [11D] ___, or a percent of your time [11E] ___%

12) Do you have any observations or comments about building conditions that might be relevant or might help explain your symptoms? [12A] ______________________
____

Thank you.
DWB revised 10-23-05

3.10 Settled Dust Sampling

Results: Elevated levels that would cause concerns for potential daily exposures to allergens, mold, or fiberglass during routine activities within the facility were not found. Remediation of long time accumulated settled dusts are recommended as a precaution in this facility, given the historic symptomology of the occupants. Discussion of the data in this report, and the location of the laboratory data in the appendix is located as noted below, under each category of evaluation.

Testing: TBS conducted three types of settled dust analysis in order to attempt to quantify any potential for allergen exposure, mold exposure, or possible fiberglass exposure from settled dusts. The studies are identified as follows:

1. **Settled Dust Evaluation for Allergens:** Vacuum dust samples were collected using samplers supplied by DACI Reference Lab at John Hopkins University School of Medicine. Four (4) vacuum samples were collected (in one workstation) and submitted for analysis. Results are located in Appendix G1, DACI Lab Allergen Report, and dated November 28, 2005. Discussion of results is located in Section 4.10.

2. **Settled Dust Evaluation for Molds:** In addition to the four DACI lab vacuum dust samples collected for mold culturing, we obtained seven (7) tape samples for microscopic analysis taken from areas on the 15th, 17th, 18th, and 19th floors, where interviewees had complained of visible dust within their work areas or behind their computers. The tape samples were conveyed to EMLabs for analysis, and the data is contained in Appendix G2, EMLabs Report #185879, dated November 16, 2005. Discussion of results is located in Section 4.10.

3. **Settled Dust Evaluation for Microscopy Analysis of Materials and Fiberglass:** To further understand the composition of the settled dusts within the facility, thirteen (13) micro-vacuum dust samples were collected for analysis by Polarized Light Microscopy, by the Severn Trent Labs in Billerica, MA. Five (5) samples were taken from a workstation located on the 10th floor where the allergen samples were collected, and seven (7) were collected from areas on the 15th, 17th, 18th, and 19th floors, where interviewees had complained of visible dust within their work areas or behind their computers. One sample was taken from an air filter, which had recently been removed from a perimeter fan powered VAV box after a normal year in use. The samples were conveyed to Severn Trent Billerica Labs for analysis, and the data (including photos) is

contained in Appendix G3, Severn Trent Billerica Report #230758, dated November 2, 2005. Discussion of results is located in Section 4.10.

3.11 Pollutant Pathway Diagnostics

Results: Tracer gas testing revealed gross migration of air from high-use photo-processing areas to upper floors. Results are contained in Appendix C3. Discussion is in Section 4.2. Corrective action recommendations have also been made in this report.

Testing: Pollutant pathway diagnostic testing and evaluation is typically accomplished in two phases. Phase one involves the introduction of an inert tracer gas into a location, and testing for that unique gas to find out where it moves to and how fast. This diagnostic procedure was conducted on November 11, 2005, with releases in three (3) suspect locations within the facility, to find out where high volume printing and copying emissions would be expected to migrate to from their generation point. Once tracer gas testing reveals the locations that the tracer gas moves to, very detailed pressure testing (mapping) and data logging, as needed, can be undertaken to determine the predominant pathways for the pollutant migration. Conducting this level of evaluation and testing is currently beyond this scope and is likely unwarranted if our recommendations for corrective action are followed.

3.12 Moisture Intrusion Diagnostics

Results: Infrared Thermography indicated forty-eight (48) suspect sites of limited moisture intrusion after a wind driven rain event. DPW moisture meter readings confirmed the majority of these sites were damp or wet. Results are contained in the report located in Appendix F1. Discussion is included in Section 4.7 of this report.

Testing: When current wetting in wall or roof assemblies is suspected, powerful infrared cameras can be used to look for patterns of temperature change created by evaporating moisture or changes in conductive temperatures driven by moisture. Infrared diagnostic techniques were used in this facility after significant rain events to attempt to locate any current wind driven rainwater intrusion in the exterior wall envelope. Work was conducted on October 10, 2005 by a certified infrared operator contracted by TBS.

3.13 Review of Possible Impact of Steam Plant Emissions

Results: In order to better understand the possible impact of the steam plant stack plume on the building, we obtained the wind data from our month of monitoring, and developed a wind rose for the month. Based on the wind rose data and fine particle data recorded at

25 Sigourney Street by TBS, it is unlikely that the steam plant stack plume impacts the facility as any type of a routine event. Results are reported in Section 4.13 of this report. Further investigation of this issue is currently beyond our scope.

Evaluation: To further investigate this possibility, contact was made with John Drennan (860-293-1990) acting Steam Plant Manager, to potentially review any stack dispersion modeling efforts that might be available. The response we received however was that due to many changes in ownership for this facility, he might not be able to readily locate any documentation with respect to this issue. He suggested that it might be easier to track down any studies by contacting the DEP. To pursue this issue further, DPW personnel then identified a contact number of 860-424-3038, for the Department of Compliance and Field Operations. Pursuing this effort is beyond our current scope.

In order to evaluate our own collected data, the wind speed and direction data we obtained from the airport was plotted and placed on a local map of the area. Results are reported in Section 4.13 of this report.

Further investigation of this issue is currently beyond our scope.

3.14 Current Medical/Health Record Review

Results: Medical Records and Diagnostic procedures were reviewed as requested. Results are reported in Section 4.14.

Scope: Medical records were requested from the University of Connecticut and Dr. Santilli, professionals that occupants have been known to visit. Materials were reviewed for objective clinical diagnosis. Results are reported in Section 4.14.

4.0 OBSERVATIONS AND CORRECTIVE ACTION RECOMMENDATIONS

4.1 Air Handler/Duct Observations, Results and Recommendations

Members of the TBS team conducted observations of all of the air handling units serving the facility on October 10, 2005, shortly after our contract was approved. As described previously in reports prepared by EH&E for NIOSH Report #11767, dated May 5, 2004, and again Report #11767, dated February 2, 2005, we observed that the building continues to be served by multiple air handlers located on each floor of the facility. Two units on each floor are set-up to serve a primarily North or South exposure, although each Air Handling Unit (AHU) delivers conditioned air to a continuous supply air duct loop that is common to both units, for emergency backup.

TBS observations of the current HVAC discharge temperature control logic suggest that separate discharge temperature setpoints are not determined on a North and South basis, but appear to be averaged. It is our understanding that this TBS observation is not in accordance with the current sequence of operation, and therefore should be carefully reviewed to determine exactly how the controls are currently working to set discharge temperatures in the North and South zone of each floor. There are two outdoor air supply fans at the roof level that feed raw (unconditioned) outdoor air to each air handler on each floor. A computer controlled system to control floor pressures with respect to the outdoors and to monitor Carbon Dioxide has been added as part of the building improvements since 2004. Separate ganged exhaust fans serve the restrooms, a building relief system, and smoke exhaust systems.

4.1.1 Air Handler Observations

Without exception, the air filter sections appeared in excellent condition with hospital-grade (MERV 20), multi-pleat air filters as has been reported by others in the past. These filters were added to improve the indoor air quality within the facility.

Our observations of the fan housing (downstream of the air filter, heating coils, and cooling coils) revealed a situation very different than what had been described in previous reports. Specifically, on October 10, 2005, TBS observed visual signs of suspect microbial amplification (growth) on the dark fiberglass acoustical liner in the fan housings, in all but one of the air-handling units that serve the facility.

Representative tape samples of six (6) of the visually suspect areas were sent to EMLabs (Environmental Microbiology Laboratory) for microscopy analysis. All six (6) tape samples (from six different units) sent for microscopy analysis at EMLabs revealed mold growth with the predominant organisms, at the time being Cladosporium and Penicillium species. (See Appendix A1, EMLab Report ID# 179074, dated October 13, 2005, for data.)

Results: Based on the visual signs in all of the air handlers, it is reasonable to conclude that there is mold growth in all air handlers downstream of the hospital-grade air filters. This situation warrants the removal of all acoustical liners showing signs of mold growth under negative air containment conditions. Also indicated, is dehumidification of the incoming outdoor air to prevent future elevated humidity conditions in these locations from promoting mold growth to reoccur. It is unknown whether the current observed mold growth in the air handlers or short section of supply ducts is a recent occurrence, and we know of no way to determine the age of the organisms that are growing. It is possible that the growth in the air handlers on the acoustical liner and in the liner within the initial sections of the supply ducts is recent (during the past cooling season), and that it has occurred since the 2004 evaluations. It is also possible that it is the result of increased outdoor air supply to improve pressure control within the facility. Corrective action recommendations are made below.

4.1.2 Duct Observations

Given the visually suspect observations made in the air handlers, access was gained via contracting with Cochrane Ventilation (a professional Inspection/Duct Cleaning Firm) to the duct liner downstream on 6 floors (12 units) on October 12, 2005. Access doors were installed on floors #6, #10, #12, #17, #18, and #19. Duct camera inspections were conducted and photos taken. Twenty-five (25) tape and bulk samples were taken from suspect duct liners and submitted to EMLabs for microscopy analysis.

(See Appendix B1 for Cochrane Ventilation Report #8473, dated October 12, 2005, with photos, and Appendix B2, EMLabs Report ID# 179909, dated October 18, 2005.) Additional samples of outdoor air intake shafts were taken by TBS and submitted on November 11, 2005, along with settled dust samples. The results are contained in Appendix B3 EMLabs Report ID# 185879, dated November 16, 2005. (See TBS photos #8, #9, #10, #13, #14, #15, #16, #18, #19, #20, #21, #22, #23, #24, #25, #26, #27, #34, #35, and #36 in Appendix B3).

Results: Ductwork. Results of the duct camera inspections revealed that most supply ducts are in a reasonably good state of repair, but also that there were some loose and deteriorating fiberglass acoustical liners in some of the supply ducts. Laboratory analysis of representative bulk samples confirmed mold growth on all suspect porous liner samples submitted between the cooling coil areas and in the short section of duct, up to the perforated sheet metal of the double-wall, sound attenuation sections on the twelve (12) units evaluated. This is approximately the first thirty (30) feet of supply ductwork at its largest cross section, just downstream of the supply fan housing. Corrective action recommendations are made below.

Some dirt build-up was observed in most of the unlined sections of supply duct, as well with the quantity of dirt decreasing away from the air handler. Some dirt was observed to be darker in color, possibly indicating moisture or condensation in the ducts. Cleaning of the main supply duct trunks is warranted.

Results: Fan Powered VAV Boxes. Twelve (12) representative fan powered VAV units at the end of each duct run were also evaluated. Few VAV fan powered boxes showed any visual signs of mold growth. Only one fan powered VAV box was found with confirmed minimal mold growth. All VAV boxes in the entire system are reported to have fiberboard "ductboard" construction downstream of all VAV boxes, (as designed) with yellow binder fiberglass which is very commonly used for this type of application. Also, some fan powered VAV boxes had filters that had fallen away from their intended location in the airstream.

Note: See sample floor plan in Appendix B5 with color coding and grid lines, identifying representative areas of ductwork with acoustical liner and ductboard.

Results: Outdoor Air Fans. Outdoor air supply ducts at the penthouse level on the 20th floor revealed severely damaged and disintegrating fiberglass liner at the top of the shaft, just past the fan (See photos #1-#7 in Appendix B3). However, laboratory analysis confirmed that no mold growth was observed in this area. It does not appear that there is acoustical liner in the shafts lower than the 20th floor level. Inspection of the shafts is beyond our scope.

4.1.3 Airborne Mold Assessment

Given the observations of mold growth within the air handlers and limited areas of the supply ducts, TBS has conducted multiple mold spore trap evaluations in limited locations to determine if there is any evidence of airborne mold being released from the supply ducts and showing up in the air inside the facility. On three occasions, multiple 10-minute spore trap samples had been collected in several areas to determine airborne concentrations as an indicator of mold spore release from the observed growth, or potential exacerbated health risk from this source. The three (3) testing periods are described in the following sections.

4.1.3.1 HVAC Start-up Airborne Mold Assessment #1

Our first airborne mold HVAC assessment was on October 18, 2005, as a likely suspect worst-case scenario. The purpose of this airborne testing was to determine if there was any change in airborne spore concentration in the occupied space, when the air handlers started-up in the morning after an evening off. Airborne testing was conducted on floors #10, #17, #18, and outdoors. A total of twenty-eight (28) samples were collected, three (3) outdoors, and twenty-five (25) indoors during a typical early morning start-up. Data is located in Appendix C1, EMLab Report ID# 180605, dated October 21, 2005.

Results: Airborne spore levels in all indoor locations remained very low before, during, and after start-up. Levels of Cladosporium and Penicillium species remained extremely low indoors in all samples. Outdoor mold levels remained very elevated, approximately 150 times higher outdoors than indoors (normal for October in the Connecticut climate), while indoor levels were extremely low.

From this data set, we concluded that mold spores were not being released into the air stream from the acoustical liner during morning start-up activity, and that occupancy of the facility under the measured conditions provided shelter from the elevated levels of outdoor molds occurring at the time of measurement.

4.1.3.2 Routine Operation Airborne HVAC Mold Assessments #2 & #3

Our second airborne assessment of mold was conducted on November 16th and it was repeated a third time on November 18, 2005. The purpose of these airborne tests was to further determine if there was any change in airborne spore concentration in the occupied space after a short period of damp, humid weather had occurred, which might be more representative of summer conditions. Sampling was conducted on November 16, 2005 in the afternoon when the HVAC systems were on, and in the evening when the systems were off. The sampling was repeated on November 18th with the HVAC systems on. Airborne testing was conducted on floors #6, #10, #12, #16, #17, #18, and outdoors during this two day time period. A total of thirty-four (34) spore trap samples were collected, four (4) outdoors, and forty-two (42) indoors during this sampling period. Data is located in Appendix C2, EMLab Reports ID# 187040 and #187468, dated November 22nd and November 23, 2005.

Results: Again, airborne levels in all indoor locations remained very low during the testing period. Outdoor levels remained elevated, approximately 10 times higher outdoors than indoors, (normal for November in a Connecticut climate), while indoor levels were low. Compared to other airborne data we have collected in this facility, in this data set there is a very slight increase in Penicillium and Cladosporium-type species indoors after humid weather has occurred. However, the levels are still essentially the same or lower than outdoors, and do not reveal an increase in exposure indoors over outdoor levels.

From all three airborne data sets, we concluded that mold spores were not likely being released into the air stream, and that occupancy of the facility under the measured conditions typically provided shelter from the elevated levels of outdoor molds occurring at the time of measurement. We do not know if release of spores may occur during heavy periods of elevated humidity.

Recommendation #1: Abate Mold Growth Located on Porous Liner in all Air Handlers, and Short Sections of Air Handler Supply Ducts up to the Noise Attenuating Section. Analysis of duct liner revealed mold growth from the cooling coils downstream to the sound attenuating sections (with perforated duct), that start at the fire rated wall of the air handler room. These materials are located downstream of the hospital-grade filters that are capable of capturing materials that could be released from mold growth activity. To eliminate the possible source of exposure to microbial activity originating indoors, all the porous liner from the cooling coils up to the sound attenuating (perforated duct) sections should be removed under conditions of professional negative air containment, and the units and ductwork externally insulated before the onset of the 2006 cooling season. All remaining fan powered perimeter VAV boxes should be inspected and bulk samples submitted for mold analysis.

Recommendation #2: Remove Deteriorating Fiberglass Liner and all Duct Board in Air Supplies. Duct camera inspections have revealed all known acoustical fiberglass liner close to supply fans to be in various states of minor deterioration, and most liner to contain some mold growth. We have recommended its removal above. During this abatement period, the short sections of severely damaged liner just downstream of the outdoor air supply fans in the penthouse on the 20th floor should also be abated.

The ductboard that forms the downstream section of the VAV boxes should eventually be removed, along with the perimeter fan powered VAV boxes, when they are removed. It would be advisable to provide heat to the perimeter with a VAV box with a heating coil and supplemental hydronic radiation, preferably located below the glass. Reduction in glazing area or improved insulation could alter the amount of heat needed. Determination of a corrective design is beyond our scope.

4.2 Photocopier/Printer and Computer Room Tracer Gas Study Results, Observations and Recommendations

There are ten (10) high-speed photocopier/printers located within the building, eight of which are not maintained in areas that are under isolation, or any type of effective exhaust. Four are located within the DSS mail/duplication room on the 8th floor, three within the 9th floor DSS computer room, two located (with dedicated room exhaust) in the DRS old offset printing room on the 16th floor, and one within the DRS computer room on the 16th floor.

Three of the four units located in the mail/duplicating room have dedicated machine exhausts installed, however they merely dump exhaust directly to the return air plenum. (See photos #3 and #4, Appendix G4.) Volatile organic emissions release from melting toner and bond to paper representing a possible significant VOC source located within the building that is distributed throughout many areas. It is our limited understanding that the machines used by DRS often utilize high metallic content toners and stronger bonding agents to facilitate the automated reading of checks in banks.

By simple observation, the eight machines as installed likely do not meet the ASHRAE Standard 62 recommended practices for HVAC design in printing and duplication areas. These guidelines specify a minimum of three (3) air changes per hour (outdoor air) with positive exhaust and pressure control to prevent dissemination of materials. As we understand the current HVAC system of the building, the building as a whole receives a maximum of one (1) air change per hour (mostly evenly distributed to each floor). The only area with positive exhaust capacity is the old offset printing room. A detailed engineering analysis is beyond our scope. We have conducted a detailed tracer gas study to determine where the emissions would currently move to, which is explained in the following section. The current air exchange rate was also confirmed by our tracer testing.

Review of NIOSH Data For VOC's: Reviewing the results of VOC testing involving SUMMA canisters in accordance with protocols specified in EPA Method TO-14 from Table 2.4 of the EH&E Report #11767 of February 2, 2005, is suggestive of possible elevated VOC levels compared to other office environments. (It should be kept in mind that these very low levels of VOC's do not come anywhere close to approaching health based limitations, so the significance of the levels found is not understood.) Specifically, the results for Acetone had a maximum value of 140 $\mu g/m^3$ in this building, as compared with a maximum from the EPA B.A.S.E. study of only 92 $\mu g/m^3$. The maximum results for Acetonitrile were 180 $\mu g/m^3$ in this building, as compared with none reported in the EPA B.A.S.E. study. The maximum reported value for Ethanol was 210 $\mu g/m^3$ in this building, as compared with a maximum from the EPA BASE study of only 108 $\mu g/m^3$. For comparison purposes, the health based limitation for the compounds are acetonitrile, ACGIH 20 ppm twa, osha 40 ppm twa, for acetone osha -1000 ppm twa, ACGIH -500 ppm twa.

Possible VOC Sources: VOC's could be coming from a number of sources that include:

1. Sources of mold in the fiberglass lining of the supply air ductwork.
2. Sources of mold in the fiberglass lining of the fan chambers on most of the floors.
3. Possible sources of mold in the perimeter wall cavities behind the drywall that communicate with the plenum above the suspended ceiling.
4. Emissions from the duplication activities on the 8^{th} and 9^{th} floors that are not captured and removed.
5. Proximity of the building to Interstate Route 84.
6. Having a parking garage at the base of the building.
7. Proximity of the building to a Steam Plant stack and cooling towers.

Further Testing Approved: As a means to further understand the distribution of VOC's from high volume printing and photocopy machines located within this facility, (as a likely source), we proposed and received authorization to conduct a tracer gas study related to the rooms where printing and duplicating is currently processed. Results are reported in Section 4.2.1.

Additionally, TBS was questioned if it would be valuable to test for VOC's from the duplicating processes. At present, we do not know which component of copier/printer toner or emissions would be important to test. Qualitative analysis makes sense from a scientific perspective if 1) criteria levels are known, 2) the active causal agent is identified, 3) detection limits are clear, and 4) sampling strategies exist. Separately, sampling may serve to seek an explanation, but must follow traditional rules of scientific work, with careful definition of goals, study design, and techniques. In addition, failure to identify pertinent results generally reflects selection of incorrect elements, rather than a "negative" study. Thus, in general, it is our opinion that funds are better expended on remediation of the HVAC systems, which do not meet current ASHRAE Std. 62 guidelines for the current use. Testing for VOC's is not recommended and beyond our scope.

4.2.1 Tracer Gas Testing

To better understand where the emissions would disseminate from the plenum space in the rooms without dedicated exhaust discharging to the outdoors, we conducted a detailed limited tracer gas study for one day that involved tracer releases at three (3) different locations. The purpose of this study was to assess whether any pathways existed from these source locations to other occupied locations in the building. This study was to answer the question of where the printer VOC emissions would migrate to and how fast. For the tests, a tracer gas was released within the return air plenum where the exhaust from these machines is discharged on the 8th, 9th and 16th floors. Testing was conducted by TBS on November 11, 2005 (a state holiday with the HVAC systems altered to run under normal weekly operational settings).

Results: The tracer testing confirmed the greatest potential exposures to known irritants from the four machines located within the mail/duplicating room area on floor #8, and the machines in the computer room on floor #9, however the potential exposures are not on the floors the machines are located on, but in the core areas on the floors above, specifically the Elevator Lobbies and Zipper areas on floors #17, #18, and #19. That is, the tracer gas released in the plenum very quickly showed up on upper floors at high concentrations, confirming rapid migration of the material.

(See figures #1 and #2, in the detailed Tracer Gas Report conducted by TBS Appendix C3, TBS Tracer Gas Report, dated November 11, 2005.) The term irritants is used to describe levels of contaminants well below classic enforceable health based exposure limits, at levels that may pose a mucous membrane and lower respiratory irritation to some sensitized individuals. For more information on low-level VOC irritation effects see Appendix C4, LBNL Report #51570, dated October 16, 2002.

The computer rooms located on the 8th and 16th floors are somewhat unique in that they have a high output printing/photocopier located within them, as well as specialty computer systems. The copying/printing machines located in the computer rooms are very similar to the machines in the copying and mailing facility on the 8th floor, but do not have optional machine exhaust installed, and therefore discharge their emissions directly to the room. Computer rooms in general would typically be designed to have relatively low ventilation rates (outside air delivery rates) and specific types of dedicated cooling and humidity control equipment for controlling the computer room environments.

Placing the high volume copying/printing machines within the computer room environment is effectively similar to placing an industrial-type process inside the computer room. It is reported that during some time periods, both computer room printing facilities, DSS and DRS, use multiple cases of paper during lengthy printing sessions on some weeks of the year.

Based on TBS past research, all high volume printers/copiers work on the same general principle of melting toner and fusing it to paper. Toner is a mixture of iron powder and carbon black, with a bonding agent such as styrene monomer or other plastics. It has been reported by US EPA pollution prevention researchers that the levels of emissions from one batch of toner to another can vary widely, and that the emission levels are not generally predictable. Technical papers authored by Xerox researchers have conveyed that they have eliminated carcinogenic materials from the carbon black in their toners. It is also reported that the plastic agents used to bond the carbon black to the paper are proprietary to the manufacturer and constantly being reformulated. The byproducts of high volume printing/photocopying include fugitive gaseous emissions of the plastics that bond the carbon and iron powder to the paper, possibly ozone as a byproduct of a high intensity lamp, and fugitive toner. Dr. Hodgson, our medical reviewer, has conveyed to us that exposure to copying emissions has been reported in the medical literature to exacerbate known Asthmatic conditions under research conditions.

It is our professional opinion that all high-use printers/copiers should be equipped with the optional heat extractor (exhaust fan and duct) when they are available, and the exhaust should be ducted directly to the outdoors. Additionally, they should be located in a room within a room, that is also exhausted based on the first principal of industrial hygiene engineering controls, i.e., local exhaust is the most cost effective approach for exposure reduction. This approach is in accordance with ASHRAE Standard 62 recommended practice. Thus, the air from the room the machines are located in should be exhausted directly to the outdoors and discharged out of the aerodynamic wake of the building, to prevent the capture of this exhaust, and allow the recirculation of contaminated air back into the general HVAC systems that serve other zones outside of the copying/printing areas.

Recommendation #3: Isolate and Exhaust all High Volume Printing/Photo Copying. Observations and the tracer gas study results revealed that known irritating emissions generated from the high volume photocopier/printer operations in three (3) areas are spread throughout the floor that they are located on, and confirmed that they are very rapidly moved to other floors. This dispersion is a very undesirable situation, and one that could lead to reports of mucous membrane irritation, exacerbation of airway irritation, and to reports of exposures to chemical odors. We strongly recommend that all large, high volume printing/copying machines be equipped with any exhaust features that are available from the manufacturers, and that the dedicated exhausts are conveyed to the outdoors. Additionally, the isolation rooms (room within a room) that the machines are located in should be proven to be isolated from the general HVAC system, and they should be exhausted to the outdoors, i.e., air from the copying/printing room should not be re-circulated to other parts of the facility. This recommended approach is in accordance with ASHRAE Standard 62 guidelines for printing and duplicating areas. After corrective renovations are made, it is advisable to confirm the effectiveness of the containment with a tracer gas study.

4.3 Reported Tobacco Smoke Odors, Observations and Recommendations

It is our understanding that current smoking activity occurs on the rooftop and in various locations within the parking garages. During our occupant interview sessions, some occupants expressed concerns for tobacco smoke smells within the core of the facility, and on at least one occasion reported the triggering of an asthma attack, requiring a hospital visit. During on-site testing periods in October, on several occasions, TBS personnel smelled the very distinct odor of tobacco smoke within core areas of the facility. Given the current known building pressurization of the facility, the only logical explanation for tobacco smoke smells would be due to smoking activity on the roof of the facility (where the air intakes are), (See photo #1, Appendix G4) or in garage locations close to an elevator shaft, or door that is open and temporarily acting as an air intake. In order to prevent the occasional exposure of occupants to secondhand smoke, which is currently regarded as a carcinogenic material, and may trigger serious asthma attacks, these occasional exposures must stop.

Recommendation #4: Further Isolate Tobacco Smoke Away from the Building, so that the Interior of the Building is Never Impacted with Odors. The emissions from tobacco smoke are periodically noted within the facility. In order to prevent the occasional exposure of occupants to secondhand smoke within the facility, causing possible asthma attacks, smoking areas should be moved off the rooftop and to ground level areas, at least a recommended 50 feet away from any building feature, or to the property line, as has been done in other state facilities.

4.4 Aging Variable Air Volume Zone Controls, Observations and Recommendations

The variable air volume controls that supply both appropriate fresh air distribution and provide temperature control to a given area are severely aging, sometimes perform poorly (are outdated), and are reported to be unpredictable and frequently failing, such that a preventative replacement plan has been implemented by the State DPW. (See photos #11 and #12, Appendix B3). Given that they are reported to fail in either the closed or open position (providing no air flow or too much cooling), and their failure is not predictable, it is our opinion that the continued use of this reportedly failing system in this modern office space, with no provisions for natural ventilation (no operable windows) is not suitable. Additionally, the current control system does not offer the ability to automatically reset discharge temperatures to keep the supplied air-flows above minimums.

A frequent complaint of respondents in our occupant interviews was uneven temperature control throughout floors, unpredictable temperatures, often too cold, and sometimes too drafty. The temperature, humidity, Carbon Monoxide, and Carbon Dioxide data collected near continually by TBS over a four (4) week period is located in Appendices D5 through D10. The in-space temperature data in Appendix D7 reveals some fluctuation in daytime temperatures depending on the location. Control points appear to vary from 70 to 76°F. In general, the measured temperatures for this time of year would meet ASHRAE criteria. However, it is clear that the temperatures are not very uniform as reported by the occupants. The effect of nighttime setback is very clear in the data, and should be further evaluated during cold weather.

Review of the Carbon Dioxide data in Appendix D5 reveals that the current VAV system controls appear to deliver an adequate supply of ventilation air sufficient to meet or exceed ASHRAE guidelines of a minimum recommended 20 CFM per person.

The condition of the zonal VAV controls is not a new issue, and the preventive replacement program was conveyed to us at the start of the project. If the State is to remain in the facility, we recommend that VAV boxes and controls be upgraded with fully integrated Direct Digital Control (DDC) boxes with flow readouts, and fully integrated DDC controls, in order to get beyond the current unreliable control issues.

Additionally, during redesign we recommend that the DDC control system be equipped with supply temperature reset controls based on zonal needs and box position indicators. The boxes should also be sized and balanced in accordance with current general occupancy needs. Recent studies by Dr. Allen Hedge, Ph.D., CPE at Cornell University suggest that often temperatures in the range of 72 to 74°F without drafts is the most productive temperature for VDT users (computer operators), and the temperature at which errors are most reduced.

Recommendation #5: Replace all VAV Box Controls with Reliable Digital Controls. As noted above, the zonal VAV boxes are outdated, failing unpredictably, and in some cases, are reported by the occupants to provide significant occupant discomfort, and lack of reliable temperature and ventilation delivery control. Given the age and condition of the equipment, the VAV boxes and controls should be upgraded with fully integrated DDC boxes with flow readouts, and fully integrated DDC control loops. As noted above, the system should be equipped with supply temperature reset controls based on zonal needs and box positions, and should be sized and balanced in accordance with current occupancy needs. The impact of nighttime setback on space temperatures should be further evaluated in cold weather.

4.5 Lack of Perimeter Radiant Heating and Large Glass Area, Observations and Recommendations

The original 1987 Due Diligence Report performed for the previous Owner notes that the facility has large areas of exterior glazing with insulated glass, and no perimeter radiation. The original design utilizes somewhat noisy, fan powered, variable air volume boxes that attempt to counter the problem of excess radiant heat loss to large, cold, glass surfaces in winter with increased space temperatures and heat supply. The reported two-mode linear diffusers that distribute air in these zones are not continuous in all areas where glass exists, and are at best, a poor attempt to counter cold draft issues in speculative office space, and at worst, a maintenance headache and continuous source of occupant discomfort and complaints.

As noted earlier, the ductwork that serves all areas downstream of the VAV boxes is fiberglass ductboard (not metal) that cannot be cleaned, and is subject to fiber erosion. Noted in a later part of this report, the fiberglass in the settled dusts found within the facility has yellow binder, the same color as the ductboard. As referenced in the 1987 report, the ductboard was a common economical solution at the time of design.

We know of three (3) possible solutions that can be considered for the perimeter areas and corner offices, either in combination with one another or as stand-alone items.

A. Significantly reduce the window area with well insulated infill.

B. Supplement the perimeter areas with near continuous perimeter hydronic radiation, either above or preferably below the windows.

C. Replace the fan powered boxes with a standard VAV box with a coil, and hydronic radiant perimeter heat.

Eliminating the fan powered box and replacing it with a coil and continuous ceiling, or below glass radiation, eliminates:

1. The need for local recirculation of air.

2. The noise and maintenance associated with a fan and filter.

3. The electricity used in unoccupied hours, moving air to keep the area heated.

Whatever is done, careful consideration should be given to the long-term 20-30 year life cycle costs of eliminating 2/3 of the current exterior glazing, and replacing it with insulated infill. Energy simulation is beyond our scope.

> **<u>Recommendation #6</u>: Install Perimeter Radiation and Consider Eliminating 2/3 of Exterior Glazing.** As noted above, the perimeter heating system in this facility has been marginal or inadequate since it was constructed. Careful consideration should be given to the long-term, best solution for eliminating the fan powered VAV boxes and ductboard, and replacing them with DDC boxes with heating coils, and perimeter radiation plumbed. Careful consideration should be given to the long-term 20-30 year life cycle costs of eliminating 2/3 of the current exterior glazing and replacing it with insulated infill. This would be expected to save significant energy and to improve occupant comfort and reduce complaints.

4.6 Excess Original Outdoor Air Supply Design, Inefficient Outdoor Air Distribution, and Current OA Operation, Observations and Recommendations

Based on our drawing reviews and recent NIOSH reports, we understand that the original design minimum outdoor air supply to the facility was achieved by pumping in the range of 63,000 CFM of OA into the facility. Currently, it is reported that the energy management system delivers in the range of 52,000 to 63,000 CFM of OA. See Appendix E1, Outdoor Air Delivery EMS Supply Plots. This air is raw outdoor air delivered by two large fans to two vertical air shafts, with no opportunity for moisture management or energy recovery before it enters the facility.

This design approach is clearly a speculative HVAC 1980's office design, and grossly energy inefficient in comparison to today's standards with today's energy costs. At an occupancy rate of 1,200 people, the outdoor air supply quantity is currently in the range of 40 to over 50 CFM of outside air per person. This is significantly above the ASHRAE minimum recommended amount of 20 CFM per person. Based on the current Carbon

Dioxide (CO_2) readings obtained by TBS during October and November, (See Appendix D5), this outdoor air supply cannot be effectively delivered to some of the occupied spaces, or the Carbon Dioxide levels could not reach the levels that they are observed to routinely reach. (See CO_2 data in Appendix D5.) In most cases, the ventilation rate based on the TBS in-space CO_2 readings would be expected to be in the somewhat reasonable range of 15 to 30 CFM per person, despite nearly twice that amount being pumped into the facility and conditioned (heated and cooled) at the air handling units on individual floors.

To date, we have not conducted an analysis of where all the outside air being pumped in at the rooftop level is going. However, it is likely based on CO_2 readings, that in the range of 50% of the outdoor air entering the facility is not serving the intended purpose of being delivered to the occupants breathing zone to dilute indoor sources, and the situation is wasting significant energy during peak heating and cooling periods. During humid weather in the cooling season, this excess quantity of damp air places a large moisture (latent energy) load on the mechanical equipment that is unnecessary, and during dry winter weather, a large heating load, that will contribute to excess dryness.

We have not conducted an analysis of just how the current building pressure control logic works, or the design objectives, as to why it is set-up the way it is attempting to achieve a 0.20 (inches water) pressure on each floor, as reported in the EH&E Report and confirmed by TBS observations. This rather high pressure may be an attempt to reduce the impact of wind driven rain leakage, or to reduce the suction effect of the return plenums on pulling wind driven rain into the perimeter plenum areas. It is currently beyond our scope to understand the current control logic of the pressure control system, or to determine specific engineering recommendations to correct the situation that we have not fully defined.

It is reasonable to assume that whatever the situation, the outdoor air design could be altered to provide in the range of 20 CFM per person building wide, once the photocopier/printers emissions have been exhausted outdoors using ASHRAE recommended transfer air for makeup air, in the areas where printing and copying occur.

Also, the addition of enthalpy energy recovery to building wide exhausts would provide much better year round humidity control, better moisture management during rain storms, vastly reduce coil size for dehumidification, and improved occupant comfort. This redesign would also drastically reduce long-term energy operating costs. It is likely that new penthouse space would need to be created to accommodate the addition of energy recovery and outdoor air drying equipment, in order to improve the IAQ and comfort within the facility. Design of a fix is beyond our scope.

<u>Recommendation #7</u>: Further Investigate Outdoor Air Delivery and the Need for Primary Dehumidification of Outdoor Air, in Order to Allow the HVAC Systems to Provide Reasonable Ventilation, and Allow it to Maintain Recommended Humidity Levels within the Building.

As noted above, the minimum outdoor air delivery rate of approximately 40-50 CFM per person designed into the facility is very high by today's standards, and very energy inefficient. Careful evaluation of the situation should be conducted, and consideration should be given to the most appropriate short and long-term solution for eliminating the observed excess outdoor air supply to the air-shafts, and improving the proper delivery of outdoor air to the occupants after the printer exhausting has been achieved. A detailed engineering analysis of this situation and corrective action recommendations are beyond our current scope. Enthalpy energy recovery should be considered as part of a long-term solution for improving occupant comfort and indoor air quality.

4.7 Building Envelope Design and Moisture Intrusion Observations and Recommendations

In recent years, efforts at redesign and repair of the building exterior have been conducted to stop rainwater intrusion through the exterior envelope with significant success. Based on occupants' and managements' reports to TBS, drastic improvements have been made in reduced wind driven rain intrusion. In a recent Infrared Moisture Scan conducted for TBS after a significant rain event on October 10, 2005, approximately forty-eight (48) potential areas of moisture intrusion were identified. (See Appendix F1, Monroe Infrared Technology Report, dated October 18, 2005, and TBS photos #12, #17, #30, #31, #32, and #33 in Appendix B3.) Dampness in these locations was also reportedly confirmed by DPW with a moisture meter. A contractor working for DPW reports that several areas identified in the report may be associated with failed caulking that may have been overlooked during the recent building envelope repair.

We understand based on our drawing reviews (and discussions with the Architect that recently designed improvements and repairs for the facility) that the current building envelope relies primarily on face sealing at the outer skin to reduce wind driven rain entry. That is, the building uses spray-on brick sealants and elastomeric caulk in the vertical joints between the window assembly and the brick veneer as the primary means to keep wind driven rain out of the structure. Being a normal pre-1987 design (when brick veneer design details were changed to more waterproof), there is apparently no continuous, redundant drainage plane behind the brick veneer to keep rainwater from penetrating into the facility.

It is our training and professional opinion, that unless the facility has a near continuous drainage plane behind the extensive face seal assemblies in this building, it will continue to be prone to wind driven moisture leakage. In the interim, it is prudent to minimize the water intrusion with detailed and repeated inspections of any suspect intrusion sites after any significant rain event. Additionally, the exterior façade should be periodically inspected to identify and repair deteriorated areas before they can cause problems.

Based on a drawing review, we currently estimate in the range of 20,500 lineal feet four (4) miles of sealed seems between dissimilar materials on the outer face of this facility, and over 125,000 sq. feet of perimeter surface area, 58% of which is non-brick. This is a lot of seams for potential long-term management to prevent wind driven rain leakage. Periodic thermal imaging could also be employed to assist in maintaining the building façade until a more permanent long-term fix is completed.

It is our opinion, based on information currently available to us, that in order to fully stop water leakage from wind driven rain suitable for a 20 to 30 year fix, a redundant, continuous drainage plane in front of or behind the exterior surface will need to be created. We are aware of remedial efforts that can be conducted from the interior without removal of exterior brick. The approach also vastly improves the overall building insulation system, building shell tightness, and occupant comfort near the perimeter. This type of long-term repair should be further investigated and considered for the facility. It is beyond our scope to conduct energy simulations, or to calculate a payback in energy savings for this and other approaches, to improving the ventilation moisture control we have suggested.

Recommendation #8: Rigorously Manage Current Moisture Intrusion and Evaluate a Redesign of the Exterior Envelope of the Facility to More Permanently Stop Rain Intrusion with a Redundant, Continuous Drainage Plane/Air Barrier/Insulation Layer System, Installed from the Interior.
As noted above, the current exterior wall system contains an estimated four (4) miles of linear caulking, and continues to allow rain penetration into the facility in multiple areas. It is our professional opinion that a long-term, alternate, permanent solution needs to be explored as opposed to simply making repeated efforts to improve the exterior sealing system to be near-perfect, and attempting to keep it that way. Careful evaluation of the situation should be conducted, and consideration should be given to the most appropriate, long-term solution for eliminating the persistent rainwater intrusion, and likely improving the energy efficiency of the envelope at the same time. A detailed engineering analysis of this situation and corrective action recommendations are beyond our current scope. We recommend that a further envelope moisture mitigation evaluation be

conducted (through TBS or others) utilizing the expert services of a nationally recognized building shell moisture expert.

4.8 Balcony Design and Moisture Intrusion Observations and Recommendations

As conveyed in the 1987 Due Diligence Report for the previous Owner, the upper level balconies serve no useful purpose for office occupancy. Their existence makes these stories very prone to long-term moisture entry at doors, and multiple joints of dissimilar materials. We understand that recent efforts have been somewhat effective at reducing moisture intrusion at these levels. It is our professional opinion that these balconies will continue to be a long-term liability regarding moisture intrusion. It is our opinion, based on information currently available to us, that in order to stop water leakage from wind driven rain suitable for a 20 to 30 year fix, consideration should be given to eliminating the balconies by converting them to usable space, or via other alterations, such as a pitched roofing system.

Recommendation #9: Evaluate the Need for Redesign of the Upper Floors of the Structure to Eliminate Balconies.
As noted above, the current design of the upper floors with multiple level balconies will in the long run, likely continue to allow rain penetration into the facility in multiple areas. It is our professional opinion that a long-term, alternate, permanent solution needs to be pursued regarding the elimination of the balconies or other suitable fixes. Careful evaluation of the situation should be conducted, and consideration should be given to the most appropriate, long-term solution for eliminating the persistent rainwater intrusion and likely excessive energy consumption, caused by the excess glass in these areas, and multiple, leaky door gaskets. A detailed engineering analysis of this situation and corrective action recommendations are beyond our current scope.

4.9 Kitchenette Cooking Emissions, Local Walk-up Photocopiers, and Observations and Recommendations

It is our understanding that use of microwaves and local walk-up photocopiers are allowed throughout the facility. This situation allows emissions of (sometimes odiferous) cooking odors, and photocopier byproducts to be released and distributed directly into the office breathing air. In general, ASHRAE Std. 62 Ventilation Rate guidelines for offices are intended primarily to dilute water-soluble, bio-effluents from people, not specific point source pollutants from routine use of cooking and high-use duplicating equipment. Specific exhaust guidelines exist for ventilation design for duplicating areas. Ideally, a healthy building design that minimizes the need for excess general ventilation (and the subsequent consequence of dry air in the winter time and wasted energy), and maximizes the potential for energy conservation, would include an exhausted kitchenette area (near restrooms) on each floor with no recirculation from the area. This area would also be an ideal area to locate any locally heavy-use, walk-up photocopiers in.

<u>Recommendation #10</u>: Consider Eliminating Odors from Cooking in Kitchenettes, Provide for Scheduled Maintenance of Walk-up Copiers, Fax and Printers, and Evaluate Possible Relocation of Heavy-Use Office Equipment. Consider a Kitchenette Area on Each Floor with 100% Exhaust to the Outside to Improve IAQ.
Ideally, a healthy building design that minimizes the need for excess general ventilation (and the subsequent consequence of dry air in the winter-time), and maximizes the potential for energy efficiency would warrant an exhausted kitchenette facility (located near restrooms) on each floor for microwave use. Additionally, walk-up, high-use photocopiers (more than a package of paper a day) should also be located in this facility, and not dispersed randomly where localized exposure to fugitive copier emissions can occur.

4.10 Settled Dust Analysis Observations and Recommendations

During occupant interviews, occupants repeatedly raised concerns regarding the settled dusts located within the facility, regarding its content, and its potential to cause irritation or health effects if exposures to the settled dusts occur. In the past, NIOSH has studied culturable mold levels from occupant's chairs, and reported that they related the culturable mold levels to allergy symptoms. Due to these reported concerns, an analysis of settled dusts in limited areas was undertaken. These areas are reported on below in Sections 4.10.1 and 4.10.2.

4.10.1 Storage Area Observations

TBS observed the conditions in both the indoor storage room and caged parking lot areas used for paper and equipment storage, located on the parking lot levels. In general, it is conveyed that these areas are not routinely cleaned, have experienced some water intrusion in the past, and that no effort is made to keep the contents above the dew point temperature during storage.

Results: We observed conditions representative of this above information. Most horizontal surfaces in the storage areas had a clearly visible accumulation of dirt. Outdoor dirt always contains significant quantities of naturally occurring mold spores. If this dirt layer is frequently placed in conditions of dampness, with the temperature of the surface below the dew point temperature for the outdoor air, a layer of condensed moisture will occur. After repeated cycles, mold growth will occur.

<u>Recommendation #11</u>: Evaluate the Current Storage Situations. Alter to Prevent Dirt Accumulation, Condensation, and Mold Growth.
The current storage situation indoors and in the caged area fosters the accumulation of dirt layers (which contain mold spores) and possible mold growth. All porous materials must be kept clean and at heated temperatures above the dew point temperature of the air in the storage area. Some type of suitable plan needs to be implemented for routine cleaning of storage areas and temperature control to keep all stored porous materials clearly above the dew point temperature of the outdoor air, or alternately, to dehumidify the air in the storage area to lower the dew point.

4.10.2 Office Space Settled Dust Sampling and Testing

TBS conducted <u>three (3) types</u> of settled dust analysis in order to attempt to quantify any potential allergen exposure, mold exposure, or possible fiberglass exposure from settled dusts. The studies and results are listed as follows.

4.10.2.1 Settled Dust Evaluation for Allergens

Vacuum dust samples were collected using samplers supplied by DACI Reference Lab at John Hopkins University School of Medicine. Four (4) vacuum samples were collected (in one workstation) and submitted for analysis. This workstation was located on the 10th floor where an interviewee complained of extreme dust allergies leading to health effects, and obvious dust deposits at their worksite. Photos #5 through #9 of the area are contained in Appendix G4.

One sample (ID left) was taken of the left band of carpet immediately adjacent to the dividing partitions where routine vacuuming does not remove the deposited cloth fibers, paper dust, skin scales, and tracked in dirt. Another sample (ID right) was taken from the right band. Additionally, two samples were taken from the center of the cubical, one in the front where it would be easily vacuumed (ID center F), and one in the back (ID center B) where the occupant's chair would be located. The samples were evaluated for allergens related to Dust Mites (Dep p 1) and (Der f 1), Cats (Fel d 1), Dogs (Can f 1), Cockroach (Bla g 2), Mouse Urinary Protein, Viable Mold Spore Counts, and Rat Urinary Protein.

Results: Results of the four samples (from one workstation) from the DACI lab work are contained in Appendix G1, DACI Lab Report dated November 28, 2005. Ranges of generally acceptable levels for each parameter are also conveyed in the DACI lab reports. In all four samples, the mold cultures were low, along with most other parameters. <u>Of particular interest in the four samples is the difference between the cubical perimeter band samples where vacuuming cannot readily occur (with the type of vacuums used), and the</u>

center areas where vacuuming appears to be done readily. Dust mite levels were reported as moderate in the two perimeter samples, and low in the center samples. It is our understanding from discussions with Dr. Hamilton at the DACI lab that even at the moderate levels of Der f 1 dust mite allergen found, the concentration of materials is very low, and not anywhere near levels that would be found in occupant's bedding where dust mite allergics are normally triggered. What is significant about the dust mite levels are that they are much lower where normal vacuuming is reaching. This data would also suggest that on some occasions the humidity within the building is elevated to the level of 70% RH or more. This is the humidity required for dust mite proliferation.

4.10.2.2 Office Settled Dust Evaluation for Molds

In addition to the four DACI lab vacuum dust samples collected for mold culturing from the 10th floor, which yielded low levels as noted above, we obtained seven (7) tape samples for microscopic analysis taken from areas on the 15th, 17th, 18th, and 19th floors, where interviewees had complained of visible dust within their work areas or behind their computers. The tape samples were conveyed to EMLabs for analysis and the data is contained in Appendix G2, EMLabs Report #185879, dated November 16, 2005.

Results: In all cases, the tape sample analysis for molds revealed few spores present, and the ones that were present (are noted by the lab) to be of normal outdoor types, with no signs of mold growth. In all but one sample, heavy background debris (dirt and dust) levels were also reported indicative of accumulated dust levels.

4.10.2.3 Settled Dust Evaluation for Microscopy Analysis of Materials and Fiberglass: To further understand the composition of the settled dusts within the facility, thirteen (13) micro-vacuum dust samples were collected for analysis by Polarized Light Microscopy, by the Severn Trent Labs in Billerica, MA. Five (5) samples were taken from the workstation located on the 10th floor where the allergen samples were collected, and seven (7) were collected from the general areas on the 15th, 17th, 18th, and 19th floors where interviewees had complained of visible dust within their work areas or behind their computers. One sample was taken from an air filter, which had recently been removed from a perimeter fan powered VAV box after a normal year in use. The samples were conveyed to Severn Trent Billerica Labs for analysis and the data, including photos, is contained in Appendix G3, (Severn Trent Billerica Report #230758, dated November 2, 2005).

Results: In most cases, the analysis revealed the majority of the samples to contain primarily paper, cotton dust, other biological materials (such as skin scales, pollen, and spores), and dirt (mineral grains). These levels are considered normal for offices where lots of paper is handled. In all but one sample, the dusts contained low levels of glass fibers (fiberglass) in the range of 3% or less, which is not unusual for a building insulated with fiberglass batts. However, this facility does not have fiberglass batt insulation within the perimeter walls. It does have fiberglass insulated pipes, acoustical liner in supply ducts, and exposed fiberglass composition ductboard in all VAV box distribution systems. Based on the binder color associated with the microscopic analysis of the majority of the glass fiber dusts, the most likely source is the acoustical liner and ductboard that are found in the supply air ducts downstream of the VAV boxes. The levels are generally low (except in the air filter taken from a fan powered VAV box), and do not warrant a remedial clean-up solely for the purpose of removing the deposited glass fibers.

In general, fiberglass dust is regarded as a heavy, boulder-type dust particle and does not become airborne unless disturbed. Disturbed glass fiber dusts can show up as skin irritation where the fibers deposit. The elevated level of fibers on the air filter taken from the perimeter fan powered VAV box may be an indicator of the ductboard releasing fibers. Testing has verified that fiberglass levels are very low and below a level where clean-up would typically be recommended. In general, fiberglass fibers are almost never found in the air (without active disturbance) as they quickly settle after any release occurs, and remain settled until physically disturbed.

<u>Recommendation #12</u>: Evaluate the Current Cleaning Procedures. Alter to Remove Accumulated Visually Observable Settled Dusts.

This situation of the accumulation of significant quantities of visually observable settled dusts can be corrected by <u>careful remedial cleaning (with HEPA vacuuming)</u> of all significant visual deposits of settled dust throughout the building. Allergen test data demonstrate that where vacuuming is occurring, significant possible irritants accumulation is <u>not</u> occurring. Additionally, some type of suitable plan needs to be implemented for routine cleaning of horizontal desks and other work surfaces (beyond dusting) that do not re-release settled materials into the air.

The routinely used vacuums within this facility should not be used for a detailed specific remedial cleaning, as the performance of the existing vacuum cleaners do not currently achieve a level of (HEPA) rated particle capture, and in combination with the beater bar activity, has shown elevated airborne particle counts in association with the use of this equipment. (See Appendix G5, for TBS vacuuming test data.) The current equipment is likely fine for routine cleaning of trafficked areas.

4.11 Airborne Particles (Inhaleable, Respirable Dust, and Fine Fraction), Elemental Analysis, Observations and Recommendations

Routine daytime and off-hours operation assessment for Inhaleable PM-10, Respirable PM-2.5, and Fine Fraction ≥0.5 micron (combustion size) dusts was conducted utilizing three different methods of evaluation as outlined in Sections 3.4, 3.6, and 3.7. Results are presented and discussed in the following three sections.

4.11.1 PM-2.5 Particles, Gravimetric and Elemental Analysis

TBS conducted an evaluation and sampling of Airborne Respirable PM-2.5 dusts, utilizing Impactor size separation technology that was originally pioneered at Harvard School of Health for sampling of very low levels of indoor particles. We assessed the levels of materials during a six to eight hour sampling period for elemental analysis of forty-eight (48) elements, via X-ray techniques (XRF), through the services of Chester LabNet, located in Tigard, Oregon. These samples were collected on two occasions, October 19, 2005 and October 26, 2005, during normal daytime hours with the HVAC on, and during evening hours with the HVAC system off. Results of this analysis are reported in Appendix D2, PM-2.5 Lab Data. (See representative photos #10, #11, and #12, Appendix G4.)

Results: The gravimetric concentrations in micrograms per meter cubed ($\mu g/m^3$) are presented in the first graphs in Appendix D2. From this data, it can be seen that the levels are typically for a clean office or residential setting, very low, and typically lower inside than outside the facility. This likely demonstrates that the hospital-grade (MERV 20) filters are continually cleaning the breathing air, such that it generally remains cleaner inside than outside.

Additional results of elemental analysis are presented in subsequent graphs in Appendix D2. Specifically, it can be seen that being inside the facility typically offers shelter from the Sulfur (as an indicator of combustion) that is found in the air outside the facility.

Of interest (but of no known health significance) are the subsequent graphs for other elements including metals. It appears that on some occasions, there are a greater variety and level of elements detected inside of the facility than outside. All of these concentrations are very low, and do not constitute a known elevated health risk. We do not understand the role of duplicating toner, or its prime, fine particle ingredients to comment on whether it could be contributing to any of the elements detected. The primary information to be gained from this data is that the indoor and outdoor concentrations are low, and sometimes dissimilar in nature indicating the likely existence of some inside sources. Further analysis is beyond our scope.

4.11.2 PM-10 Particles and Laser Particle Counts

TBS conducted an evaluation and sampling of airborne inhaleable PM-10 particles and Laser Particle Counts (LPC) on a near continuous basis, during a four (4) week time period in several locations. All of the data is presented in Appendices D3 and D4, organized by location and data type. Both sampling devices use light scatter as a means of counting particles. The Dustrak (DT) device converts the particle counts to a calculated gravimetric number based on a calibration to Arizona Road Dust.

Results: There are interesting patterns that can be observed from both types of instruments, especially when used together. It is clear from both data streams that the air inside the facility is always very clean, as evidenced by low >5.0 micron particle counts. Additionally, it can be seen that the 0.5 micron LPC data is only somewhat elevated during the daytime from normal occupant activity, along with the DT data.

Given how the Dustrak instrument works, its data is susceptible to producing artificially inflated PM-10 levels during any periods of extreme elevated fine particle presence in the range of 0.5 microns and smaller particles as indicated by the LPC. In the data we collected, this situation occurs on several evenings where we originally thought that cleaning activity might be stirring up evening PM-10 dust levels, but there is no rise in 5.0 micron (large particle) on the LPC data. During these time periods, there is an evening rise in LPC 0.5 micron data, indicating likely penetration of the outdoor urban aerosol, related to combustion from traffic, and other urban long distance transport materials. Of particular interest is the last week of LPC data November 12th through the 18th, where we supplemented the indoor data with an outdoor monitor. (See photo #2, Appendix G4.) It is clear from the comparison of these two data sets that the outdoor levels vary widely, and are almost always higher outside than inside.

Results: The laser particle count data and corrected Dustrak data always indicate that dust levels stay very low indoors most of the time. They also show that normal activities within the facility during daytime occupancy slightly stir-up the larger sized settled dusts that are almost non-existent at night when the HVAC system is off and cleaning is occurring. From this data, it can be seen that the levels are very low inside, and lower inside the facility than outside. This likely demonstrates that the hospital-grade (MERV 20) filters are continually cleaning the breathing air, such that it generally remains cleaner inside than outside when the HVAC is running. The perimeter HVAC components are possibly suspect in this regard however. These perimeter units, intended to recycle warm air from plenum space above the suspended ceiling and deliver it back to the occupied portion of the room, have been observed to have the filter fallen out of position in one observation, and frequently exhibit accumulated dirt on the adjacent ceiling tiles.

<u>Recommendation #13</u>: Continue Excellent Air Filter Type and Maintenance. The gravimetric and elemental analysis of respirable particle data indicates that the air inside the building is generally equal to, or cleaner than outside. We recommend that the excellent grade filters that are used in the facility be continued, given the urban location and the closeness of the facility to a very busy highway. Additionally, so long as the perimeter fan powered VAV boxes remain installed, a means of assuring perimeter fan powered VAV box filters remain installed needs to be devised.

4.11.3 Settled Dust and Paper Contamination

In interviews, occupants expressed concerns regarding the possibility of settled dusts on paper or other materials leading to a rash. NIOSH has previously studied paper from various locations within the facility. During our evaluations, TBS undertook a close look at fiberglass in settled dusts because it was indicated in trace quantities in the NIOSH paper study. What we know from our work to date is that large accumulations of historically settled dusts likely contain some measurable level of fiberglass, but not at a level high enough to warrant a full-scale clean-up of all settled dust surfaces within the facility. It is beyond our scope to further look into the reported issue of possible rashes from contact with certain paper.

<u>Recommendation #14</u>: As a Precaution, Clean all Materials that will be Disturbed or Moved to Any Other Location. Consider Further Evaluation of the Issue of Alleged Paper Contamination. The reported issue of some materials possibly triggering a rash in occupants remains unclear, as far as we are aware. If occupants and their belongings will be moved during renovations within the facility, <u>we recommend that as a precaution,</u> all objects that have any signs of settled dusts should be remedially <u>HEPA vacuumed</u> if they are porous, and either HEPA vacuumed or damp wiped if they are non-porous, before being moved to a new location. This recommendation includes any ceiling tiles that will be disturbed during maintenance or renovations that have been in place for years. This is also particularly important for the tops of books and other items that likely collect settled dusts that are stirred-up during normal activity within the facility. We understand that both the DHS and DSS computer rooms were recently professionally cleaned with reports of improvements in the quality of the air. It is prudent to provide this type of level of cleaning when large-scale moves of workstations or other materials occur.

4.12 Steam Plant and Associated Cooling Towers Located Nearby

To analyze any obvious possible impact on the fine particle levels (0.5 microns and larger) as conveyed by our laser particle counter data collection during the monitoring period, we compared the wind direction and speed data for the entire time period to the ≥0.5 micron data. Reviewing the data, it appears that elevated fine particle levels can occur within the building at night with the HVAC off, with winds from the Southwest and Northeast. Our knowledge of New England air quality data suggest that elevated levels from the Southwest would be expected to be related to long distance transport of upwind combustion in the Northeastern United States. This is commonly referred to as haze during summer periods. It is possible that the few incidences of elevated levels from the Northeast, with moderate winds, could be related to the plume from the stack of the steam plant. Detailed evaluation of the impact of the steam plant plume is beyond our scope. Given typical wind data for the area, it is unlikely that the plume routinely impacts the building.

Results: Elevated fine particles do not show up inside the facility during the daytime. At this point, we do not have enough data or research to offer any opinion or make a recommendation regarding the Steam Plant plume. It is likely from the geometry of the elevation of the stack, and normal wind rose data for the region, that the stack plume would not frequently impact the building or the air quality within it, especially with the high quality of the air filters currently within the facility. Further evaluation of this situation is beyond our scope.

4.13 Results of Occupant Interviews by TBS

Compilation of the results from the collection of interview questionnaires was undertaken. One of the first steps was the creation of a visual assessment of the locations in the building where the people who came forward are situated. This is presented below.

Results: As can be seen from the following summary table, the respondents who came forward are distributed fairly uniformly throughout the vertical profile of the building. A very small number of people who came forward at this time did report that they currently experienced no adverse health symptoms that they associated within the building.

Percentage of Interview Respondents by Floor

Floor	Respondents	Population	% of Floor
5	3	20	15.0%
6	21	94	**22.3%**
7	11	116	9.5%
8	5	83	6.0%
9	6	93	6.5%
10	15	131	11.5%
11	5	140	3.6%
12	9	84	10.7%
14	8	98	8.2%
15	8	102	7.8%
16	0	81	0.0%
17	15	121	12.4%
18	13	88	**14.8%**
19	7	59	11.9%
20	0	7	0.0%
ALL	126	1317	9.6%

About 10% of the people working in this building came forward, as a whole. There were some differences by floor, with 22% participating on the sixth floor, and 15% participating on the 18th floor. The distribution on each floor was also spread across the entire floor plate, with occasional concentrations showing up, but typically random across the floors.

4.14 Medical/Health Review Results and Recommendations

Dr. Michael Hodgson, M.D., M.P.H. reviewed clinical records from Drs. Eileen Storey and Kenneth Dangman at the University of Connecticut, correspondence from Dr. John Santilli, and discussed strategies and cases with the three physicians. For timing and efficiency reasons, he reviewed 27 of the almost 200 individuals' cases and focused only on visits since January 2004, after building remediation. The request was specifically to answer a series of questions. The professional opinion expressed is based on a review of a total of 27 current medical records, of which several were still undergoing diagnostic testing.

4.14.1 What is your professional opinion based upon the records you reviewed of the methods used by physicians to diagnose a health condition as specifically work related?

<u>Health Condition: Asthma</u>

Asthma is defined as variable airways narrowing, airways hyper-reactivity ("twitchiness") based on several different underlying mechanisms with several forms. It is an obstructive disease, i.e., represents difficulty pushing air out of the lungs. Asthma may present with immediate onset, i.e, within one hour, or delayed-onset, with symptoms and lung function decrements occurring only after six to eight hours. Allergic, pharmacologic, and irritant mechanisms each rely on different strategies for documentation. Traditional approaches to documenting allergy in the work place, as defined initially by NIOSH/CDC, rely on a well-known algorithm and on specific criteria. Symptoms at work, with new-onset in the work place, and documentation of changes at work based on spirometric changes at work, peak expiratory flow rate changes consistent with work, changes in methacholine hyper-reactivity, lead to a diagnosis of occupational asthma, or substance specific challenges in an exposure chamber (Jajosky 1999).

Methods Used: UCONN chose to rely on spirometric changes, ie., documenting a decrement in the work place between morning and afternoon, an improvement from Friday afternoon to Monday morning, or a progressive decline across the work week. UCONN did not use peak expiratory flow rate diaries. Some occupational physicians prefer not to use these as they can be more easily manipulated by patients. UCONN also chose not to rely on paired methacholine challenges, possibly because these are quite expensive (usually ~ $1000) and must be separated by four to six weeks of no exposure, i.e., removal from the work place.

UCONN relied on a standard approach. Review of the records suggests careful documentation of symptoms, their onset, duration, and patterns.

Health Condition: Hypersensitivity Pneumonitis

Hypersensitivity pneumonitis represents a granulomatous lung disease based on both type III and type IV immunologic reactions. It is a restrictive disease, i.e., is associated with loss of lung volumes and a block in diffusing capabilities in the lung. It requires the development of a specific immunological reaction, and the hallmark is a granulomatous reaction in the lung. It comes in acute and chronic forms. Symptoms and inflammation may occur within six to eight hours and resolve two to three days after cessation of exposure. They may occur chronically, without a temporal pattern, and require months to resolve. In several series, 60% to 70% of patients with hypersensitivity pneumonitis have also had evidence for airways obstruction. For many years lung biopsy, either transbronchial or open was practiced, although over the last years, many authors have argued that clinical diagnoses based on symptoms, performed through lung function testing and imaging has been adequate. Lung function testing usually includes lung volumes and diffusing capacity; imaging includes chest x-rays and high resolution computed tomographic scanning, and may include gallium scanning. (Zacharisen, Dangman)

Methods Used: UCONN appears to have chosen to rely on clinical, not biopsy-driven, diagnostic strategies. Some authors prefer, even in outbreak settings, to have a few biopsy-documented (tissue diagnosis) cases rather than relying on only clinical evidence. Given the multiple investigations and the overwhelming evidence for restrictive disease with radiologic evidence of abnormalities, it is reasonable to move forward without lung biopsies.

Health Condition: Sarcoidosis

Sarcoidosis is a granulomatous disease of uncertain etiology. For many years authors have discussed the possible overlaps with hypersensitivity pneumonitis, as the disease has substantial overlaps. In addition, sarcoidosis has been seen in many outbreaks of hypersensitivity pneumonitis. Sarcoidosis is a chronic disease, generally without acute, i.e., short-term changes in symptoms. Over the last several years, three separate case-control studies have identified moisture in indoor environments as risk factors for disease, along with silica, solvents, and others (Ortiz 1997, Kucera 2003, Newman 2005). Linkage is possible only through associations documented in the epidemiologic literature based on likely mechanisms and similar exposures.

Methods Used: In this case, UCONN appears to have relied on the moisture incursion of indoor environmental conditions. No actual biological exposures or assessments were undertaken in the case-control studies (Ortiz, Kucera, Newman), so that association there is based on recall and subjective assessment, and not supported by scientific measurements or independent professional assessment.

Health Condition: Rhinitis/Sinusitis

Upper airways symptoms, i.e., runny and stuffy nose, sinus drainage, headaches and ear aches associated with nasal symptoms, often occur on the basis of allergies. The clinical tests that can be used include nasal scrapings for eosinophiles, nasal lavage for immunologic markers, and volumetric (rhinometry) and resistance (rhinomanometry). CT scans of the sinuses are common, to document underlying inflammation. Still, most clinicians simply use symptoms, physical examination markers, and allergy testing as diagnostic approaches.

There is much controversy on the utility of allergy testing in such work-ups. Symptoms based on allergic mechanisms can be distinguished from irritant symptoms only with great difficulty. Some individuals may develop mucosal symptoms on the basis of irritant exposures with underlying sinusitis from either allergic or other causes.

4.14.2 Are the diagnostic methods used in the records you reviewed able to rule out other possible exposures outside of work?

Hypersensitivity pneumonitis: Use of acute/dynamic testing shows work-relatedness in a clear way. Other factors, such as air pollution, are not a confounder. A biopsy would not be able to distinguish work from non-work-related disease. Laboratory challenge tests are far too dangerous to be used, except in strictly controlled settings in research institutions.

Asthma: Use of bracketed spirometry is the standard approach to linkage. It cannot conclusively exclude ambient pollutants as a possible contributor but, in general, indoor environments show substantially lower levels of ambient pollutants than do outdoor levels.

Sarcoidosis: These approaches are unable to rule out competing causes.

Rhinitis/sinusitis: Symptom patterns represent the most common approach to documenting linkage. Reliance on the patient cannot exclude other causes if the patient fails to tell the truth.

4.14.3 In your professional opinion, based upon the records you reviewed and scientific fact, what is the likelihood that there may still be something in this building that may be affecting occupants health?

The documentation of lung function decrements in individuals with long-standing symptoms and disease before January 2004 indicates that something is still going on. Lung function decrements indicate the presence of a problem; the usual pattern of lung function is to increase from the morning to the afternoon by ~3%.

Review of medical records indicates that a substantial portion of individuals with symptoms continue to have decrements in lung function testing. These decrements are described in chart notes letters and documented in the actual lung function tests.

4.14.4 In your professional opinion, based upon the medical records you reviewed, should any occupants be removed from this building based upon medical concerns? If so, what specific medical tests and test results should be used as a basis for removal?

Recommendations:

Individuals with documented building related lung function decrements suggesting asthma or hypersensitivity pneumonitis, as determined by Occupational Health physicians using medically accepted methods/standards, should be moved out of the building as a precaution. The presence of lung function decrements does indicate the presence of a problem. Until that problem is resolved, lung disease is likely to continue. Such progression implies inflammation and lung remodeling.

The scientific literature suggests that individuals with hypersensitivity pneumonitis will experience progression of their underlying disease, with early development of pulmonary pathology and insufficiency, from ongoing exposures even if they are asymptomatic. That is, the presence of exposure to the pertinent cause will lead to progressive disease even in the absence of symptoms. This is not thought to be so for asthma.

Because the presence of lung function decrements indicates the presence of a problem, I recommend that all individuals with restrictive lung function changes, decrements in forced vital capacity, or decreased single breath carbon monoxide diffusing capacity, be removed from the building. The sooner they are removed, the less the likelihood of long-term adverse consequences.

In general, as a class, individuals with upper airways symptoms need not be removed from the building if intervention moves forward.

The State may benefit from developing an on-site spirometry program, to obtain a better handle on examining pre/post shift lung function changes more precisely. Individuals with chest symptoms (cough, wheezing, and chest tightness) should complete those in one of the patterns to document changes at work. Individuals should also undergo single breath carbon monoxide diffusing capacity and lung volumes if they have chest and "systemic" symptoms such as fatigue, muscle aches, or feverishness.

Such tests should be conducted under the supervision of an occupational physician with actual public health experience, i.e., in managing outbreaks. That physician will need some collaboration with a pulmonary specialist.

Once the highest priority findings as described in the TBS portion of this report have been addressed, reintroduction to the building may begin with physician oversight. Such oversight will require close attention to symptoms and lung function decrements. It will require close collaboration between all involved parties.

Medical References:

Dangman KH, Cole SR, Hodgson MJ, Kuhn C, Metersky ML, Schenck P, Storey E. The hypersensitivity pneumonitis diagnostic index: use of non-invasive testing to diagnose hypersensitivity pneumonitis in metalworkers. Am J Ind Med. 2002;42:150-62.

Edmondson DA, Nordness ME, Zacharisen MC, Kurup VP, Fink JN. Allergy and "toxic mold syndrome". Ann Allergy Asthma Immunol. 2005;94:234-9.

Jajosky RA, Harrison R, Reinisch F, Flattery J, Chan J, Tumpowsky C, Davis L, Reilly MJ, Rosenman KD, Kalinowski D, Stanbury M, Schill DP, Wood J . Surveillance of work-related asthma in selected U.S. states using surveillance guidelines for state health departments--California, Massachusetts, Michigan, and New Jersey, 1993-1995. *Mor* Mortal Wkly Rep CDC Surveill Summ 1999;48(3):1-20.

Kucera GP; Rybicki BA; Kirkey KL; Coon SW; Major ML; Maliarik MJ; Iannuzzi MC. Occupational risk factors for sarcoidosis in African-American siblings. Chest 2003; 123: 1527-35.

Newman LS, Rose CS, Bresnitz EA, Rossman MD, Barnard J, Frederick M, Terrin ML, Weinberger SE, Moller DR, McLennan G, Hunninghake G, DePalo L, Baughman RP, Iannuzzi MC, Judson MA, Knatterud GL, Thompson BW, Teirstein AS, Yeager H Jr, Johns CJ, Rabin DL, Rybicki BA, Cherniack R; ACCESS Research Group. A case control etiologic study of sarcoidosis: environmental and occupational risk factors. Am J Respir Crit Care Med. 2004 Dec 15;170 (12):1324-30. Epub 2004 Sep 3.

Ortiz C, Hodgson MJ, McNally D, Storey E. A case-control study. In: Johanning E, editor. Bioaerosols, Fungi, and Mycotoxins: Health Effects, Assessment, Prevention, and Control. Proceedings of the Third International Conference on Bioaerosols. Mount Sinai School of Medicine, Federal Occupational Health, New York, NY, 1999:476-481.

Trout DB, Seltzer JM, Page EH, Biagini RE, Schmechel D, Lewis DM, Boudreau AY. Clinical use of immunoassays in assessing exposure to fungi and potential health effects related to fungal exposure. Ann Allergy Asthma Immunol. 2004;92:483-91.

Zacharisen MC, Kadambi AR, Schlueter DP, Kurup VP, Shack JB, Fox JL, Anderson HA, Fink JN. The spectrum of respiratory disease associated with exposure to metal working fluids. J Occup Environ Med. 1998;40:640-7.

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