June 6, 2016

Clemson University
310 Klugh Avenue
Clemson, South Carolina 29634

Attn: Mr. W. Robert Newberry, IV
E-mail: wnewber@clemson.edu

Re: Limited Mold Investigation
International Center for Automotive Research (ICAR)
Campbell Graduate Engineering Center AT&T Auditorium
Greenville, South Carolina
Terracon Project No. 86127158 – Task 60

Dear Mr. Newberry:

Terracon Consultants, Inc. (Terracon) conducted a limited mold investigation in the AT&T Auditorium at the Campbell Graduate Engineering Center (CGEC) in the ICAR facility located at 5 Research Drive in Greenville, South Carolina. This service was conducted in general accordance with our Master Service Agreement with Clemson University.

PROJECT DESCRIPTION

Scope of Services

At the request of Clemson University, Terracon representative Mr. Benjamin Hestir had discussions with staff members and performed limited indoor air quality (IAQ) testing in the auditorium on May 25, 2016. Specifically, our efforts focused on identifying potential causes of visually observed fungal (mold) growth located around the majority of the heating, ventilation and air conditioning (HVAC) supply registers in the ceiling of the auditorium. Another vendor had previously collected swab samples from one supply and one return register and analytical results from those samples were also reviewed by Terracon.

The Campbell Graduate Engineering Center, which includes the AT&T Auditorium, was originally constructed in 2006 for graduate research, classroom and laboratory activities. The AT&T Auditorium is a multi-tiered amphitheater style space that seats 292 attendees. In addition to discussions with site management and maintenance staff, Terracon conducted airborne mold sampling which consisted of collecting air samples in four locations inside the Center and two additional samples outside for comparison. Temperature and relative humidity measurements were also collected.

Standard of Care

This sampling was conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions in the same locale. Terracon did not attempt to identify every potential exposure or hazard present in the subject building. The results, findings, conclusions, and recommendations expressed in this report are based on conditions observed during our sampling. Many factors, such as weather conditions, building occupancy, ventilation patterns, and seasonal variations in fungal/bacterial concentrations or local sources of volatile chemicals, can affect the conditions observed. The information contained in this report should not be relied upon to represent conditions that existed prior to or after this sampling. Terracon does not warrant the services of regulatory agencies, laboratories, or other third parties supplying information that may have been used in the preparation of this report.

Review of Swab Samples Analytical Data

Analytical data from three swab samples collected by Nano Cleaning Solutions and analyzed by EMSL was reviewed. According to the descriptions on the analytical results, the surface (swab) samples were collected from the surface of one supply register and one return register and apparently from a wall on the auditorium stage, although the precise locations within the auditorium were not specified. The HVAC supply and return locations identified primarily *Cladosporium* and *Aspergillis* at "high" levels while the sample from the stage wall only identified "rare" and "low" amounts of *Ascospores*, *Aspergillis/Penicillium*, *Basidiospores*, *Bipolaris* and *Cladosporium*. As no additional detail was provided, the information is primarily a qualitative addition to our limited investigation.

Discussion with Site Staff

Terracon met on May 25, 2016 with Frank Webb, Mike Lee and Jim Mann of the CGEC to discuss the use of the auditorium and the functioning of the dedicated air handler that services the auditorium. The auditorium encompasses 4,500 square feet and is designed to accommodate 292 audience members. It is an amphitheater-style room and slopes upward from front to back. There is a large stage at the front of the room and an audio-visual control room at the back. The air handler is manufactured by McQuay, model number CAH025GVAC and has a maximum flow rate of 13,628 cubic feet per minute (CFM). According to information received from Mike Lee, unless events schedules dictate otherwise, the system is currently turned completely off on week nights from 11 pm to 5 am. On Saturday morning the system currently comes back on and runs from 8 am until 11 pm and on Sunday morning it comes on and runs from 9 am to 11 pm. During normal business hours, the system is set to run at 50% of maximum capacity when no events are scheduled and the room is expected to be largely empty. Mike also indicated that they have on occasion turned down the fan speed during presentations due to the noise generated by the air handling unit.

Mold Sampling

Total non-viable (non-culturable) fungal spore trap samples were collected using Air-O-Cell™ spore trap cassettes specifically designed for the collection of airborne mold spores. Air samples were collected using a calibrated Zefon Bio-Pump™ at a flow rate of 15 liters per minute (LPM) for 5 minutes at each location.

After air sample collection, the samples were hand delivered to Southeast Environmental Microbiology Laboratories, Inc. (SEEML), accredited by the American Industrial Hygiene Association (AIHA®) Laboratory Accreditation Programs, LLC under the Environmental Microbiology Laboratory Accreditation Program (EMLAP), Accreditation #173667. Air samples were analyzed by direct microscopic examination and are reported in spores per cubic meter of air (spores/m^3).

To help interpret the sampling results, we compared indoor air and outdoor air measurements. High variability in airborne fungal spore concentrations can exist in different geographic locations, during different seasons, and weather patterns, and over the course of a given day. As a general rule, indoor air fungal spore concentrations in an HVAC-supplied building are typically less than, but qualitatively similar to, fungal spore concentrations found in the outside environment.

There are no state or federal exposure limits established for fungal aerosols. There are currently no regulatory standards or medically based threshold limit or dose-response relationships for exposure to airborne or surface concentrations of mold spores. Terracon relies upon experience, professional judgment, current scientific literature, guidelines and recommendations made by professional organizations and experts, and statistical methods in interpreting mold sampling results.

Temperature and Relative Humidity

Indoor air temperature and relative humidity are physical conditions important to the perception of comfort. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommendations regarding thermal comfort. ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy, identifies six primary factors that affect comfort: metabolic rate (affected by the activity being performed); clothing insulation; air temperature; radiant temperature; air speed; and humidity.

Although the relationships are complex, a temperature range between 73 and 79 degrees Fahrenheit (°F) with relative humidity between roughly 20 and 60 percent (%) are recommended for persons in a conditioned setting wearing light summer clothing. Higher temperatures require lower humidity for comfort.

EPA recommends maintaining indoor humidity below 60%, ideally 30-50%, if possible.

Readings of temperature and relative humidity were collected with an Extech Model 445580 IAQ instrument which was calibrated by the manufacturer.

FINDINGS

Mold Air Sampling

On the morning of Wednesday, May 25, 2016, Terracon collected four (4) non-viable mold spore trap samples inside the AT&T Auditorium and adjacent hallway and two (2) outdoor samples for comparison. Evidence of water intrusion was not observed during a cursory visual inspection. Apparent fungal (mold) growth was observed in a radius extending out several feet around all but one of the supply registers located on the ceiling of the auditorium. Sample locations and total spore count samples analyses are summarized in Table 1 below.

Table 1: Summary of Total Spore Count Analyses – May 25, 2016

Sample #	ICAR-1	ICAR-2	ICAR-3	ICAR-4	ICAR-5	ICAR-6
Location Description	**On stage – podium**	**Mid-auditorium**	**Rear of auditorium**	**Hallway to auditorium**	**Outside at Cafe**	**Outside on Millennium Blvd**
Spore Type	**Spores/m³**	**Spores/m³**	**Spores/m³**	**Spores/m³**	**Spores/m³**	**Spores/m³**
Alternaria	---	---	---	---	13	13
Ascospores	---	---	39	---	390	78
Basidiospores	195	156	78	---	2,340	2,500
Bipolaris/Drechslera	---	---	---	---	---	26
Cladosporium	39-	741	117	13	507	1,390
Curvalaria	---	---	---	---	13	13
Epiccocum	---	---	---	---	91	65
Cercospora	---	---	---	---	13	---
Nigrospora	---	---	---	---	13	---
Aspergillis / Penicillium	312	234	117	---	156	312
Polythrincium	---	---	---	---	---	13
Rusts	---	---	13	---	---	39
Total	**546**	**1,130**	**364**	**13**	**3,540**	**4,450**

The highest total spore count inside was approximately one-third of the highest outside total spore count and the dominant indoor genera were *Aspergillus/Penicillium and Cladosporium.* The dominant genera outdoors were *Basidiospores* and *Cladosporium.*

The laboratory analytical report is attached.

Temperature and Relative Humidity

The indoor temperature in the auditorium was 71.4º F and the relative humidity was 52%. The outdoor temperature was 83.8º F and the relative humidity was 38.1% on a sunny, warm day.

Indoor temperatures and humidity levels were within recommended comfort ranges.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are provided based on our assessment:

- Indoor fungal spore counts in the auditorium and adjacent hallway were not elevated as compared to outside air.

- Temperature and relative humidity measurements were within acceptable ranges for indoor workspaces at this time of year; however this is a spot measurement. Terracon recommends to track humidity levels in this space over a period of time and at different heights to verify humidity levels do not increase and possibly cause condensation issues as described below.

- No water intrusion was observed or reported in the AT&T Auditorium.

- Other than the rings of fungal growth surrounding all but one of the HVAC supply registers, no mold growth was observed in the auditorium. Therefore the fungal growth is believed to have been triggered by condensation in the areas adjacent to the HVAC supply registers. Condensation occurs when warm humid air comes into contact with a cooler surface. When the HVAC is not in use in the auditorium, the heat in the room tends to rise and accumulate against the ceiling. Once the HVAC cycles, the surfaces adjacent to the supply registers are quickly cooled and the moisture in the warm air may condense on the cooler surface.

- Terracon recommends that the usage of the HVAC controls be discussed with the contractor that manages the system for the CGEC. Additional air movement could reduce the condensation issue. During warmer, more humid weather, it may be necessary to provide more consistent cooling and or additional air movement to prevent condensation and thus mold growth in these areas. An HVAC Engineer should be consulted to provide corrective action.

- The surfaces with mold growth appear to include both gypsum drywall and a drop in ceiling panel material of unknown composition. The mold growth appears to be surficial and caused by a humidity issue. Terracon recommends cleaning the surfaces and treatment with a fungal growth inhibitor such as Microban^{Ò} or an equivalent material.

- Terracon reviewed analytical data from EMSL based on swab samples collected by Nano Cleaning Solutions. The HVAC supply and return locations identified primarily *Cladosporium* and *Aspergillis* at “high” levels while the sample from the stage wall only identified “rare” and “low” amounts of *Ascospores*, *Aspergillis/Penicillium*, *Basidiospores*, *Bipolaris* and *Cladosporium*. As no additional detail was provided, the information is primarily a qualitative addition to our limited investigation.

Terracon appreciates the opportunity to provide this service to Clemson University. If you have any questions regarding this limited mold investigation report, please contact the undersigned at 864-292-2901.

Sincerely,
Terracon Consultants, Inc.

Benjamin Hestir, P.E.
Project Industrial Hygienist

Jeffrey A. Gurrie
Senior Industrial Hygienist

Attachments: Laboratory Results

Laboratory Results