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March 12, 2002

Mr. Douglas J. Pearson
MADISON METROPOLITAN SCHOOL DISTRICT
Building Services
4711 Pflaum Road
Madison, Wisconsin 53718-6765

REFERENCE: Microbial Proliferation at Chavez Elementary School
Mechanisms of Causation: A Preliminary, Summary Report
Project Architect & Engineer: Potter Lawson, Inc.
Prime Contractor: Westra Construction, Inc.
Michaels Project No.: M0101AAI

Dear Mr. Pearson:

This report is provided per your request, and is in regard to work conducted to date by Michaels Engineering, Inc., relevant to the referenced facility. This remains a preliminary report due to the lack of unrestricted access to information that may be relevant in this effort. Based on the information we have received, this document presents our professional opinion at this time on the likely causes of fungal contamination within the Cesar Chavez Elementary School building.

These opinions were developed by the team of Wane A. Baker, P.E., RPIH, of Michaels Engineering Inc., and John Lampe, P.E. and Registered Architect, of Lampe Consulting. Our opinions are based on the findings of our investigative efforts, as considered in the light of our experience in the professional practice of the arts and sciences of architecture and engineering.

INTRODUCTION

Madison Metropolitan School District (MMSD) asked the Michaels team to evaluate the circumstances surrounding the referenced project, particularly as they relate to the presence and proliferation of unacceptable levels of mold. Accordingly, we examined various construction documents, photographs and videos, and interviewed individuals with specific, first-hand knowledge of conditions at the construction site.

We also contacted a number of sub-contractors to this project in an effort to gather additional eyewitness accounts of conditions during construction. In all cases, those we contacted declined to provide access to personnel who had worked at this site.

As a result of the efforts described above, and recognizing that there may be additional documentation or personal accounts to which we do not currently have access, we have established the following findings, and reached the preliminary conclusions described below.

RELEVANT FINDINGS

Our efforts concentrated on identifying sources of moisture as the critical component that one can and must control to avoid microbial growth. In general, the proliferation of fungi requires the presence of viable spores, a suitable nutrient source, temperatures in the range that human beings find tolerable, and moisture. Moisture sufficient to support fungal growth may be in the form of liquid water or in the form of water vapor. Under certain conditions, the first form of moisture will result from condensation of the second form.

We have received multiple confirming reports that the following events or conditions were specifically noted by MMSD professional, trade, and/or custodial staff as well as by other parties while on site during construction of this facility.

The factors described below, when taken together, significantly increased the likelihood of, and we believe subsequently caused, fungal growth within this facility during the time of construction. The following list is provided in a numbered format strictly for convenience in future reference; we made no attempt to present the list in rank order of importance to causation.

FACTORS IN CAUSATION:

1. It is our understanding that start-up of the chiller occurred on or about June 15, 2001. The discharge temperature of the chilled water that was provided to AHU-1 was reset to 55ºF at the time of, or shortly after, start-up. The scheduled design temperature of the chilled water was 44ºF. As a result, the ability of the chilled water coil to remove moisture (i.e., to dehumidify the airstream) was significantly reduced under all operating conditions.

2. The boiler was not started until after the building was occupied. As a result, the capability for reheat that would normally be provided at the VAV boxes was not available during the hot and humid weather of June, July and August, 2001.

3. The return air damper at AHU-1 was manually closed and the outdoor air damper opened such that the air handler operated with 100% outdoor air.

4. Fenestration openings to the second floor, specifically along the north and east sides of Unit “D”, were used to gain access for purposes of moving supplies and materials into the building.

   The practice of bringing materials into the building in this fashion occurred both before and after the permanent ventilation system (AHU-1) was used in an apparent attempt to dehumidify the building. However, during hot and humid weather, this practice would have led to the incursion of large quantities of moisture-laden air.

5. The zone-level temperature controls were not active until late in the construction process. As a result, it is our understanding that the VAV boxes initially operated without benefit of space temperature controls. It has been reported by numerous individuals that interior spaces served by AHU-1 were “very cold”. In aggregate, we take these comments to strongly suggest that the air temperature within Units “B” and “D” was often below 70ºF, and has been estimated to have been approximately 65ºF.

The combination of these first five factors constitute a scenario under which intermittent condensation on surfaces would very likely occur. The intermittent nature of such events would coincide with changes in outdoor temperature and humidity conditions. The most likely locations for condensation to occur would have been:

a. the concrete floors, due to their large mass
b. areas of the structure and GWB near the roof deck on the second floor, due to the buoyant nature of hot, humid air

6. Consistent with the scenario described immediately above, multiple events of condensation on the unfinished and finished floors of Units "B" and "D" were reported.

   We were informed that the contractor installing the vinyl floor tile was unable to proceed due to the presence of liquid water on the concrete subfloor, and that circulating fans were used by the Prime Contractor to "dry" the subfloor. We also received reports that areas of the finished floors were considered by personnel working on site to be a slip hazard due to the presence of condensation on the surface of the installed floor tile.

7. During pressure testing of a rainwater leader located in the kindergarten wing, a substantial quantity of water was released into the building. This event, which we understand occurred on or about August 7, 2001, led to localized flooding with 1-2 inches of water in the area surrounding Room 125B.

   We have been informed that the subsequent removal of standing water from the affected area, which was not directed nor coordinated by the Owner, proceeded promptly. However, these de-watering efforts were incomplete, as no attempt was undertaken to dry the interior wall cavities that were impacted by this event.

8. Temporary materials used to protect roof openings intermittently failed in serving the intended purpose.

   Consistent with typical construction practices, installation of skylights and exhaust fans did not proceed until the roofing system was complete. However, we received multiple reports that the temporary materials used to cover these openings failed numerous times, permitting precipitation to enter the building. Water incursion via these openings occurred after interior finishes (GWB, floor tile) were in place.

9. Gypsum wallboard was installed in direct contact with the concrete subfloor, in contrast to the details provided in the construction documents.

   The plans called for the GWB to be hung slightly above the concrete subfloor, with a continuous bead of acoustical sealant (sound-proofing caulk) to be provided on each side (see: "Partition Type" details, Sheet A701). We found indications that this was not done in most locations, and that the GWB was instead set directly on the concrete slab.

10. Soils on this site, described in a related geotechnical engineering report as “silty clay”, are highly organic, and the building was not kept clean during construction.

    We received multiple reports that the building was not kept reasonably clean with respect to the accumulation of soil, trash and construction debris. We were also informed that there were few provisions to mitigate the amount of soil brought into the building by foot traffic.

    The organic nature of the soil on this site made the issue of access to the building by foot traffic a more important matter than it would have been for a site with sandy soils. MMSD personnel have indicated that adequate planking or other means for reducing the amount of soil tracked into the building were not provided. As a result, it is likely that the building, its contents and finishes, were inoculated with organic material and atypical levels of fungal spores, which originated from the surrounding soils.

11. Rough carpentry sink bases, which were installed directly on the concrete subfloor, were constructed of untreated wood.

    It appears that most, if not all, wooden casework bases for the sink in each classroom were constructed of untreated “white wood” dimension lumber and untreated plywood. Rough carpentry of this type, when placed directly on the concrete subfloor, was specified to be constructed of pressure-treated lumber and plywood (see: Section 06100 of the Project Specifications).

12. Supply air duct penetrations through interior walls were not continuously insulated.

    In most instances, it is clear that the exterior insulation applied to the supply air ductwork was discontinuous at partition wall penetrations. This was done in contrast to the standard detail for duct and pipe penetrations provided in the construction documents (see: Detail 22, Sheet M701, and Section 15250 of the Project Specifications).

13. Concrete locker bases were poured against installed GWB, rather than keeping the wallboard above the concrete bases as detailed in the construction documents.

    Although it appears that a layer of asphalt-impregnated felt or the equivalent was used in an attempt to protect the GWB, this practice contrasts with the relevant detail provided in the construction documents (see: Detail 7, Sheet A705).

CONCLUSIONS

Again, the conclusions of this report are based on the information made available to us during our fact-finding efforts. These conclusions reflect our professional opinions, and may be subject to revision when additional information becomes available.

In addition to the set of observations described above, we initially considered two other possibilities: (1) that the gypsum wallboard (GWB) was wet or water-damaged at the time it was installed, or (2) that the water damage which led to fungal proliferation was the result of a set of deliberate acts. In the absence of corroborating information along these lines, we have not given further consideration to these possibilities.

In our opinion, non-conformance to the construction documents included the following, in addition to the plan and specification references provided above in the list of *Factors in Causation*:

1. The records do not show that temporary heating, ventilating and cooling were provided to "…control temperature *and humidity* [emphasis added], as necessary to facilitate progress of Work…" and "…to prevent condensation which would have an adverse affect on the products and finishes…" as required under Section 01513 of the Project Specifications.

2. Also in Section 01513, it is made clear that use of the permanent HVAC systems does not absolve the Prime Contractor of their obligation to maintain control of environmental conditions: "…use of the permanent system shall not serve to waive compliance with any requirement of the Contract Documents…"

STANDARD OF CARE

The descriptions and comments contained in this report represent our professional opinions. These opinions were arrived at in accordance with currently accepted architectural and engineering practices at this time and for this location.

Sincerely,

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Michaels Engineering, Inc.

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President
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C: David Waffenschmidt