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16 August 2013

Kevin Krueger, P.E.
Unisys Corporate Environmental Affairs
3199 Pilot Knob Road
MS F1B05
Eagan, MN 55121

Subject: HVAC Evaluation Findings
Southside High School Room 127
Elmira, New York

Dear Kevin:

At Unisys' request, Geosyntec Consultants (Geosyntec) conducted an evaluation of the heating, ventilation and air conditioning (HVAC) system at Southside High School (SSHS) in Elmira, New York in accordance with our 17 July 2013 proposal. The purpose of the evaluation was to assess the ability of the existing HVAC system to achieve positive building pressures in Room 127 in response to New York State Department of Environmental Conservation (NYSDEC) concerns regarding indoor air quality at SSHS. This letter presents the findings of our evaluation.

FINDINGS

On 22 July 2013, Mr. William Wertz, Ph.D. of Geosyntec and Mr. Frederick McKnight, P.E. of Turner Building Science & Design, LLC (TBS) met with representatives of Elmira City School District (ECSD) to review HVAC operations at SSHS and perform an analysis of the pressure differences between the indoor, subslab, and ambient (outdoor) pressures in Room 127 of SSHS. Mr. Anthony Lasorte and Mr. Michael Dunn of ECSD participated.

During the site visit, a blower door was installed temporarily to manipulate the air pressure within the room. Pressure meters were also installed to monitor the differential pressures between Room 127 and the subslab, between Room 127 and the outdoor air, and between Room 127 and the adjoining rooms (Rooms 126 and 128). Differential pressures were monitored during blower door operations and then during operation of the SSHS HVAC system with the blower door fan off. Based on the observed differential pressures, operation of the HVAC system associated with Room 127 results in positive pressurization of the room with respect to both the subslab and the outdoor air. Although subslab to indoor, or outdoor to indoor pressure differences in the adjoining rooms were not measured directly, comparison of the Room 127 pressures to the pressures inside those rooms suggest that they too are positively pressurized when their respective HVAC systems are operating. In contrast to the pressure fields associated with periods of HVAC operation, the pressure differences between Room 127 and the subslab point

were substantially smaller when the HVAC units were shut off. During those times, there appeared to be little difference in pressure between the indoor and the subslab points.

Based on information provided verbally by Mr. Dunn and Mr. Lasorte of ECSD, under normal circumstances the HVAC units in Room 127 are turned off in the afternoon after classes have finished for the day, and are turned on in the morning just before classes start for the day (approximately 3:00 PM and 7:00 AM, respectively). In order to assess whether the pressure-HVAC relationships that were observed on 22 July 2013 were representative of the longer-term relationships, Geosyntec and TBS recommended monitoring the differential pressures in Room 127 for a one week period of HVAC system operation. With Unisys' approval and agreement of ECSD, TBS provided ECSD with a differential pressure meter and logging device that ECSD deployed in Room 127 for a period of a week (29 July to 5 August 2013). During Monday through Wednesday of that period (July 29-31), the Room 127 HVAC system was operated as it normally would be if classes were in session, during Thursday and Friday of that period, the HVAC system was operated to simulate a maximum heating and a maximum cooling condition, respectively. The HVAC system was set to run on a normal summer schedule over the weekend of the deployment period. The results of that week-long monitoring event are consistent with the results observed on 22 July 2013. When the HVAC system is running in Room 127, the room is positively pressurized (by approximately 5 pascals) with respect to the subslab, and is also positively pressurized with respect to the outdoors. During mid-afternoon through early morning periods and on weekends when the HVAC system is not running, the pressure difference between Room 127 and the subslab hovers around neutral (i.e., there is little to no pressure difference), and the room is under-pressurized relative to the outdoors. A copy of a report by TBS which includes additional discussion of the building characteristics and pressure-HVAC relationships, and a plot of the week-long monitoring results is attached.

In conclusion, our findings show that Room 127 is positively pressurized with respect to the subslab and outdoor air during the observed normal HVAC system operations between approximately 7:00 AM and 3:00 PM when students normally occupy the room. Outside of those times, there is little pressure difference between indoor air and the subslab and the room is under-pressurized with respect to outdoor air.

CLOSING

Thank you for the opportunity to assist you with this project. Should you have any questions regarding this letter or have additional questions please contact the undersigned at 518.477.5499 or 410.381.4333.

Sincerely,

William E. Wertz, Ph. D.
Senior Consultant

Aron Krasnopoler, Ph.D., P.E.
Project Manager

Attachments: Interim Report on Building Enclosure Air Pressure Monitoring of Room 127 at the Southside High School in Elmira, NY; TBS Project S1094-01

Copies to: Paul Brookner, MBA, P.G. – Geosyntec

TURNER GROUP

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August 15, 2013

Mr. William Wertz. via Email WWertz@Geosyntec.com
Geosyntec

Dear Mr. Wertz:

Subject: Interim Report on Building Enclosure Air Pressure Monitoring of Room 127 at the Southside High School in Elmira, NY
TBS Project S1094-01

In accordance with our approved scope of services we are pleased to provide the following interim report of our building enclosure monitoring efforts at the Southside High School in Elmira, NY. Our monitoring included recording the pressure difference across the building enclosure at two locations within Room 127 of the Southside High School while operating the HVAC system under a select set of operating conditions.

We are pleased to have served you as professional consultants. If requested, we are available to assist you with additional services. Please do not hesitate to contact our offices if there are any questions or subjects presented that need further clarification. You can reach me at our Vermont office at (802) 626-8233, or (802) 684.2134 cell or alternatively contact, Mr. William Turner at our Harrison, Maine office at (207) 583-4571, ext 311.

Sincerely,
TURNER BUILDING SCIENCE & DESIGN, LLC

Frederick T. McKnight, P.E.
Senior Vice President

William A. Turner, P.E.
President & CEO

FTM/
Enclosures
cc: WAT, file

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Background:

At the request of Mr. William Wertz and Mr. Paul Brookner of Geosyntec, Turner Building Science & Design, LLC (TBS) conducted a long term (1 week) building enclosure pressure monitoring assessment to obtain the a set of enclosure pressure difference measurements. Our site pressure monitoring was conducted the week of July 29, 2013 through August 5, 2013. Monitoring was based on site observations conducted on earlier in July 22, 2013.

Monitoring Site Description:

School was out of session during our monitoring period and during our site observations. Room 127 of the Southside High School is a slab on grade space with an external wall on one side and internal walls on three sides. The finish floor is a tile type, reportedly over a concrete slab. A pressure monitoring port was installed through the floor some 6 feet or more away from the exterior wall. The exterior wall is a brick façade concrete masonry unit CMU wall with two aluminum framed windows as the major wall penetrations. One window frame was fitted with a port to measure the pressure difference across the exterior wall without having to open the window. Depending on function, the interior walls are a combination of gypsum sheathed cavity framed walls and CMU walls. The interior wall separating the classroom from the corridor is assumed to be fairly well sealed due to its fire rating requirements. The two interior walls that separate room 127 from room 128 and 126 are thought to be less tightly sealed.

The finished ceiling is a suspended type with a plenum space above. The top of the plenum is the floor above and is a steel pan with a layer of concrete above it. The supporting structure is steel joists. Utilities such as HVAC distribution ductwork, plumbing piping, and electrical cable etc. run in the plenum space above the dropped ceiling. The penetrations in the wall made for the utilities and the fit of the wall to the steel floor pan are likely the major air leakage points between rooms. Note: These penetrations are sealed with fire rated putty and other material where fire rating is required (between the corridor and the classroom).

The room is served by a ceiling mounted unit ventilator (UV) and an exhaust fan. The UV (UV-4) is dedicated to room 127 and the exhaust fan (EF 112) serves three classrooms (125, 126, 127). The UV supplies a quantity of outdoor air (OA) which will vary from a minimum rate, reportedly 450 CFM, to meet ventilation requirements to 100% of the UV capacity when the HVAC system is in economizer cooling mode. The

exhaust fan reportedly runs only in economizer mode.

Building Air Leakage

Typically, the largest portion of vapor migration from the vadose zone under a building to the air space within a building is associated with advective flow from the vadose zone to the space within the building enclosure. Air pressure differences between the vadose zone and the enclosed space is the driving force behind the flow. The air pressure in the enclosed space must be lower than the pressure of the vadose zone in order for vapor migration from the vadose zone into the enclosed space to occur. Usually buildings run at a lower pressure than the ambient due to the stack effect and the inclination for the HVAC system to exhaust more air than it introduces.

To limit the migration of vapors from the vadose zone, the air pressure of the enclosure must be higher than the air pressure of the vadose zone. A buildings HVAC system normally introduces some quantity of OA for ventilation. If the amount of OA being introduced into the enclosure by the HVAC system is greater than the amount being extracted by the HVAC system and the enclosure walls, roof, and floor are relatively air tight, the enclosure can be driven to an air pressure that is above the air pressure of the vadose zone. When the enclosure air pressure is above the vadose zone air pressure the migration of vapors from the vadose zone into the enclosure is dramatically limited.

Summary Findings:

Observations and Monitoring:

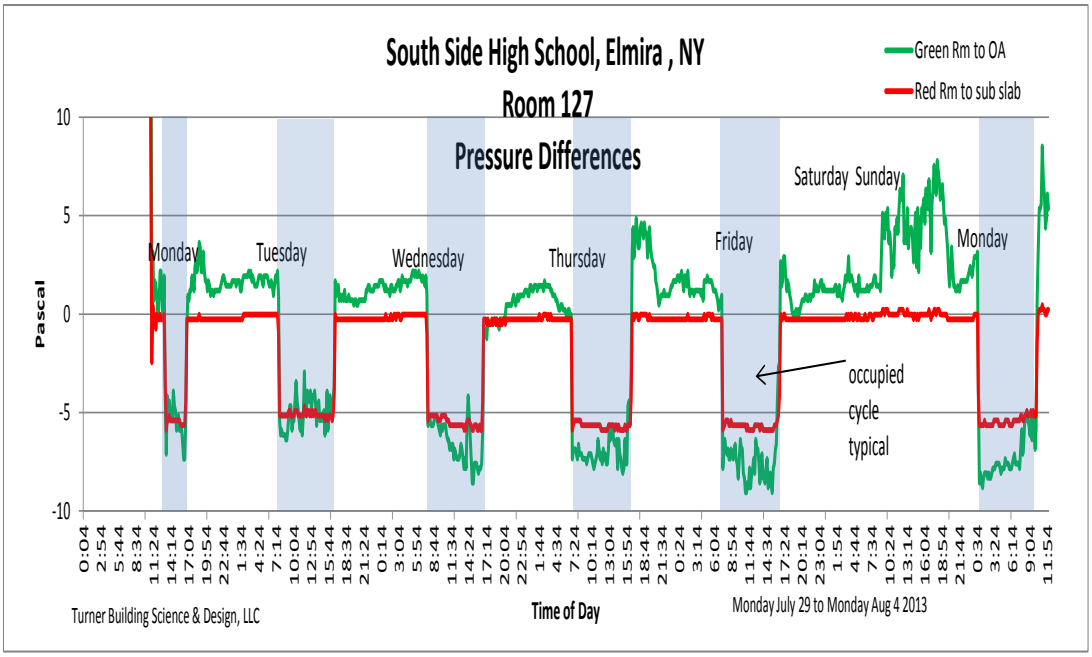
Based on observations made during our July 22 site visit, we determined that, when running, the HVAC system normally provides enough OA to room 127 to place the room at a higher air pressure than the air pressure of the vadose zone and the ambient (i.e. outside) air pressure. Additionally, we observed that when the HVAC system is not operational, such as when it is in unoccupied mode (off), the building enclosure pressure difference with respect to the ambient or the vadose zone is close to zero.

After the site visit of July 22, we set up a system of pressure monitors and data loggers to track the building enclosure operating pressure with respect to the ambient air and the vadose zone for a week. We also arranged, with the assistance of the building operators, to have the building HVAC systems that served room 127 operate under with a normal occupied week control sequence, with respect to HVAC occupied / unoccupied schedules. Additionally, we had the building operators adjust the room thermostat set points to place the HVAC system in heating mode on Thursday, and in the cooling mode on Friday. Heating mode would limit the OA being introduced by the UV to the minimum quantity and the exhaust fan would be off, while cooling mode would reset the OA quantity to approximately 100% and turn on the exhaust fan and

run it at approximately 100%. Either of these conditions would represent the most likely opportunity for the space pressure to fall below the ambient air and vadose zone pressures.

Discussion of Monitoring Results:
The chart below is a record of the building pressure difference between room 127 and the subslab (vadose zone) and room 127 and the outside (ambient). Room 127 is the reference and the pressure difference across the subslab and the wall to the outside are the inputs. When the inputs are at a lower pressure than the reference, the pressure value, in Pascal, is recorded as a negative number. The negative values indicate the inputs are at a lower pressure than the reference (i.e. the room is positively pressurized with respect to those locations). When the inputs are at a higher pressure than the reference, the pressure difference is recorded as a positive number, which indicates the room is at a lower pressure than the ambient air or the vadose zone, (i.e. the room is negatively pressurized with respect to those locations).

Table 1 Pressure Differences at Room 127



The chart indicates that while the HVAC system is running, the enclosure pressure (reference pressure inside room 127) is higher than the subslab or the ambient (input pressures) by approximately 5 pascals. The chart shows that the subslab and the ambient (outside) are lower in pressure than the room by about -5 Pa. On Thursday and Friday the pressure difference is somewhat greater (approximately -6 Pa) due in part to the heating and cooling mode of operation of the HVAC system. During the unoccupied cycle (late afternoon through early morning), the room and the subslab pressure difference approaches zero while the room to ambient pressure difference goes somewhat positive (i.e. the ambient pressure is greater than the room pressure so the room is negative) and therefore air leaks into the room from the ambient (outside) during the time the "Rm to OA" pressure is indicated as a positive value. The positive pressures occur during the time of unoccupied mode of operation of the HVAC system, reportedly, the unoccupied mode of operation extends from about 3:00 pm until about 6:00 am the next day and all of Saturday and Sunday.

The rather small increase in pressure difference between the room and the slab and the room and the ambient on Thursday and Friday during occupied times indicated that the HVAC system serving the room is not the only driver of the recorded pressure differences. Other HVAC systems such as AHU-4 are also driving the room pressure differences as well as the stack effect. Our measurements and interpretation leaves

open the question of what the effect of other fans in the building may have on the pressures differences in room 127. Other fan systems that may affect the pressure differences include the kitchen exhaust hood and any associated make up air system or other large volume exhaust systems or unbalanced exhaust systems. Because the school was not in normal operating conditions during the recent long term monitoring event, the impact of operation of those fans on the room 127 pressure differentials cannot be assessed using the recent long term data set.