

MEMO

Date: September 30, 2013

From: Global Facility Solutions, LLC.

To: Herb Savje
herb_savje@hcpss.org
Howard County Public Schools

Re: Summary of Initial Findings from Site Visit at Glenwood Middle School located in Glenwood, MD

Executive Summary:

The following summary of findings were identified during the walkthrough conducted on September 12, 2013. This list is intended as a brief overview of the findings and issues identified during the site walk-through. Further information related to these issues will be developed over the next two weeks.



Glenwood Middle School – Glenwood, MD

The focus of the walkthrough was the review of the cooling and ventilation systems serving the building in an effort to determine the source and cause of higher than normal humidity within the classroom areas of the school. Several classrooms were specifically identified by the facilities department at HCPSS as having high humidity levels or higher than normal temperatures. During the initial discussion with the schools facility staff, it was determined that the humidity and temperature issues are prevalent throughout the school building within the classrooms with some rooms experiencing more issues than others. The office areas, media center and gymnasium locations are all served by separate rooftop air handlers. However, the classrooms are served by Unit Ventilators with self-contained fans, dual temperature coils, fresh air dampers and integral controls for temperature control and fan speed. The unit ventilators are supplied both chilled water and heating water from a central plant that contains two oil-fired hot water boilers and chilled water from a newer McQuay air-cooled chiller located across the access road from the school. Primary chilled water lines are routed underground from the chiller to the main mechanical room where distribution pumps circulate the water to all unit ventilators and fan-coil units serving the building.

General Overview:

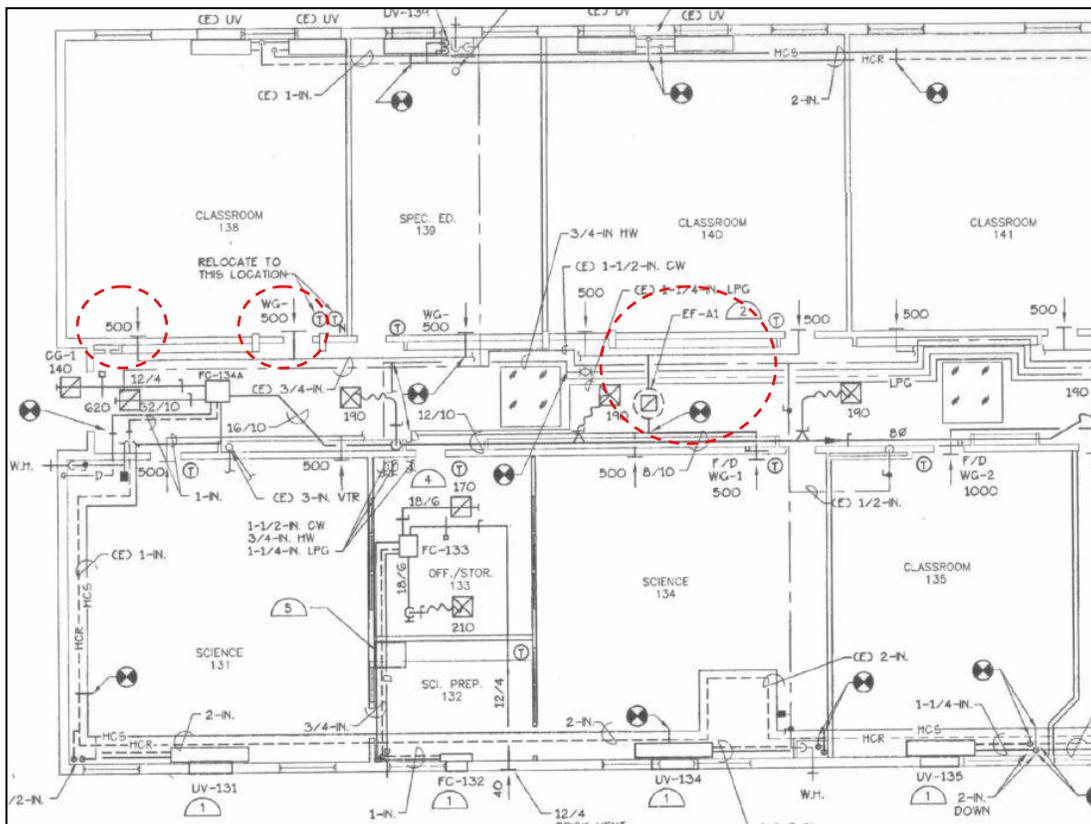
Outside air for ventilation is introduced to the building via fan-coil units located in each common hallway as well as directly through the classroom unit ventilators. Each of the three classroom wings contains two roof mounted exhaust fans that remove air from the individual classrooms to improve air circulation. Rooftop units serving specific areas such as the main administrative office also introduce outside air to these specific locations directly via the rooftop air handler.

Pneumatic controls are located throughout the school to control the temperature within the spaces and overall operation of the HVAC systems serving the building. Each classroom contains a single pneumatic thermostat that controls the dual temperature coil control valve and damper to maintain the temperature within the classroom. Separate thermostats are located in hallways to control the operation of the fan-coil units that introduce outside air and condition the hallways. The school contains a limited Direct Digital Control (DDC) system by Johnson Controls. The DDC control points are limited and are used primarily for occupied/unoccupied scheduling and basic temperature monitoring of zones containing multiple occupied spaces.

Summary of Initial Findings and Potential Issues:

- *Building Under Negative Air Pressure:* Based on observations made during the site visit, the building is under a large negative pressure with respect to the outside. This can be observed at each exterior doorway by opening the door slightly and feeling the in rush of outside air through the door. The amount of negative pressure appears to be high enough that it is drawing air in to the building down through the boiler exhaust flue in the main mechanical room.
- *Outside Air Dampers on Fan-Coil Units Closed:* The fan-coil units located in the hallways are used to introduce outside air to the building and condition the hallways. At some time in the recent past, HCPSS closed the outside air dampers on all fan-coil units in the building. The fan-coil units still continue to condition the hallways, however do not introduce outdoor air in to the building at this time.
- *Controls Sequence of Operations on Unit Ventilators:* The sequence of operations for the Classroom Unit Ventilators does not appear to be functioning properly to effectively manage temperature and humidity within the classrooms. Many of the unit ventilators tested during the site audit do not have properly functioning pneumatic controls. Pneumatic ATC main air pressure at the thermostats varied from 3 psig to 12 psig. Pneumatic controls require a consistent air pressure on the main to properly operate the valves and dampers on the HVAC equipment.
- *Non-Functioning Outside Air Dampers:* The outside air dampers on most unit ventilators inspected during the site visit were found to be non-functioning. The dampers were all closed which provides 100% re-circulated air. The outside air dampers which appeared to function only opened to approximately 5-10% when sequenced to open to a minimum of 20%.

- Exhaust Fans Operating without Make-up Air: The building contains multiple exhaust fans serving the classrooms, restrooms and the school kitchen. Each classroom wing contains two exhaust fans that exhaust air from the classrooms through one or two exhaust grilles located in each room. All exhaust fans are operational during the occupied time period. A lack of make-up air from the HVAC systems is causing the building to operate under a large negative pressure. This permits unconditioned air to infiltrate in to the building through doors, windows, the old steam tunnel (crawl space) and the boiler exhaust flue. Based on a review of the older design drawings for the building and the subsequent renovation drawings, the exhaust fans in the classrooms wings should only operate any time the unit ventilators are in the economizer mode. However, based on a review of the fans at the building, it appears that the fans are operating continuously during the occupied time period, regardless of unit ventilator outside air damper position.



Red circled area shows one of the two exhaust fans serving Classroom Wing A and exhaust from classroom

- Odor from Old Steam Tunnel: Old steam tunnels exist under the classroom wings along the entire perimeter wall of each classroom wing. The tunnels were used to pipe steam directly to the old Classroom Unit Ventilators that once contained steam heating coils. Old pipe penetrations are still visible today within the unit ventilator cabinet. The tunnel has a dirt floor and areas checked appear to be damp with a musty smell from the dirt. Since the building is under negative pressure, air from the tunnels is drawn in to the building through cracks or holes in the floor at the unit ventilators and remaining access hatches located in

the floor. The musty odor from the tunnels is more prevalent in some rooms due to a higher concentration of openings through the floor. Some floor penetrations within the unit ventilator cabinets have been sealed with expanding foam, but a review of several unit ventilators indicates air infiltration from the tunnel remains.



Old Steam Tunnel – Dirt Floor

- *Building envelope lacks sufficient weatherization:* Based on thermal IR photographs around windows, doors and exterior walls, it appears that there is excess air infiltration. There were some exterior doors exposing daylight through there seals as well as “older” style single pane windows radiating heat from the outdoors into the occupied spaces.

Initial Recommendations and Repairs:

Short term corrections:

- *Turn off classroom and hallway exhaust fans:* In order to prevent excessive exhaust air from pulling a negative pressure in the facility, it is recommended that the facility staff cycle off the exhaust fans. The exhaust fans are designed to remove approximately 15,000 CFM when the unit ventilators are in “economizer” mode (OA dampers fully open); however the majority of the unit ventilator OA dampers open to only 5-8% (as currently operating). It is unclear at this time if this is a result of improper set up, faulty equipment, not enough pneumatic pressure or actuators that have failed. However, reducing the exhaust will reduce the unconditioned air infiltration and reduce humidity within the facility.
- *Seal existing steam pipe penetrations in unit ventilators:* It was noticed that there is humid, unconditioned, musty smelling air entering many unit ventilators from the crawl space below. The existing/abandoned steam piping penetrations come through the crawl space floor, and introduce unconditioned, humid air into the unit ventilator cabinet. This air is bypassing the cooling coil and dumping directly into the classrooms. Sealing these floor penetrations with spray foam may help in reducing this infiltration and odors.
- *Weatherization for doors and exterior openings:* Similar to the above mentioned recommendation, it may be necessary to seal major openings for exterior doors and windows. It is critical to get as good as seal as possible when doors and windows are shut to reduce unconditioned air from entering the occupied spaces. Sealing and/or caulking these penetrations may help in reducing this infiltration.

Longer term corrections:

- *Pneumatic control upgrades:* Based on the survey at site it was apparent many pneumatically controlled devices are experiencing issues. Some lack pressure, some appear to have faulty thermostats, some pneumatic lines are disconnected, etc. If the pneumatic controls are “to remain” as an equipment control means – it is critical to have an ATC contractor rehabilitate the pneumatic system to gain proper control of the equipment. This may require a full pneumatic study, thermostat calibrations (possible replacements), air compressor surveys, identifying leaks above the ceiling, etc. Repairing and upgrading existing pneumatics will help in proper control and operation of the existing equipment.
- *Unit ventilator replacement:* As detailed in this report, many older unit ventilators are in need of replacement. Specifically, the outside air dampers that control the make-up air to the occupied spaces are not functioning properly. Many 3-way water valves are stuck open allowing hot or chilled water to flow regardless of the thermostat position. The existing unit ventilators have approached the end of their useful life cycle and need to be replaced (similar to the renovation performed in 1998 under the EAI engineering designs).
- *Unit ventilator OA minimum adjustments:* Once the unit ventilators have working OA dampers, it is recommended that an engineering study be accomplished to re-adjust the OA to be in compliance with current ASHRAE 62.1 guidelines. This will most likely reduce the amount of required outside air to the spaces; hence, reducing the chiller (and boiler) operations and cycling.
- *Operate main exhaust fans on VFD (variable frequency drives):* The exhaust fans are currently drawing more CFM than is re-introduced (properly conditioned) to the building causing a humid and uncomfortable temperature. It may be feasible to operate the exhaust fans on VFD's, managing the amount of air exhausted via static pressure. This type of operation will reduce the negative pressure within the building as well as reduce the speed of the exhaust fan motors, when not required to operate at 100%. New exhaust fan motors and controls/ATC may be required in order to properly operate them on VFD's, however, savings will be found in the way of reduced motor operation.
- *Pneumatic to DDC upgrade:* The most effective and efficient way to control HVAC equipment, temperature and humidity within a building today is with a direct digital controls (DDC) system. Many Howard County Public School buildings are already operating with DDC. These buildings can be managed, operated and controlled remotely by facility engineers working from the main maintenance office in Columbia. Glenwood has some high level DDC controls, however, the extent is only for occupied/unoccupied modes. Installing a complete DDC system is a much more expensive option (that could be coupled with equipment replacements), however, would promote much better system operation. Systems upgraded to DDC would include the chilled and heating water systems, fan coils, pumps, exhaust fans and classroom unit ventilators (with digital thermostats).

Additional Documentation:

Thermal Scanning of Building Envelope – Appendix A:

The building envelope was inspected during the site survey to observe potential outside air infiltration. From the inside of the building, thermal camera pictures were captured in order to identify air infiltration through the walls, ceilings and equipment. GFS uses a FLIR BCAM thermal imaging camera to record digital photos of selected locations.

Specific Equipment Checkouts – Appendix B:

In order to gain an understanding of equipment operation, multiple units were checked including the chiller, unit ventilators and pneumatic thermostats. Appendix B includes the Functional Check Sheets filled out at the time of the survey.

Site Data Logging Graphs – Appendix C:

Once they are retrieved, downloaded and analyzed, Appendix C will contain the data logging results.

Initial Findings Report Conclusion:

Based on the initial site survey, it may be necessary to implement multiple recommendations in order to rectify the temperature and humidity problems being experienced within the school. However, it appears that many of the humidity issues may be directly related to the air infiltration/negative air pressure issues identified by GFS during the site visit. Pneumatic control and equipment deficiencies are also major contributors to the control problems within the facility. We believe working towards correcting the deficiencies listed in this report will help return the HVAC system back to the way it is designed to operate.

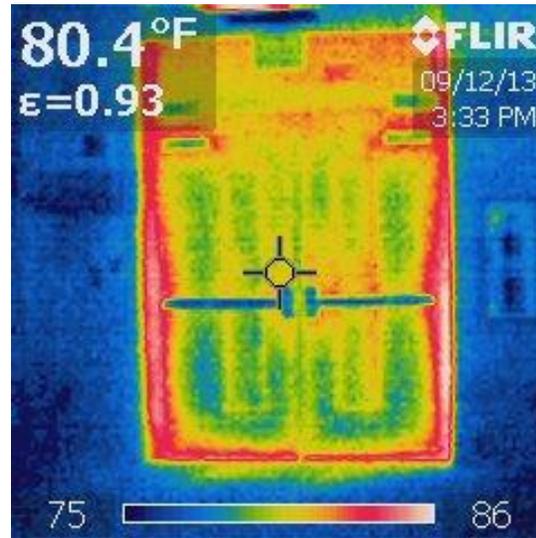
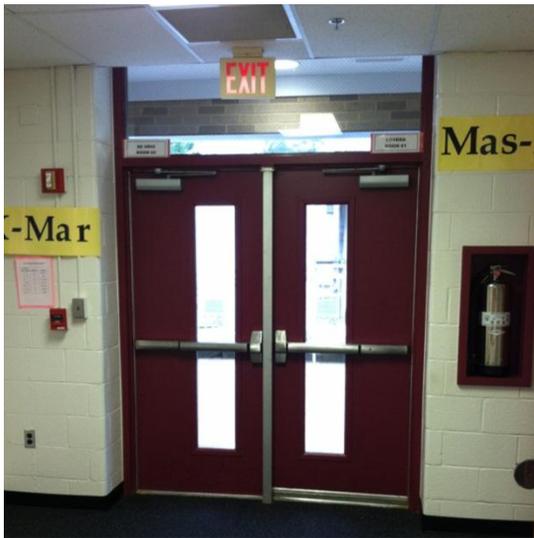
Thank you for the opportunity to help with the issues at this facility. We look forward to reviewing these issues with HCPSS and developing a list of next steps for Glenwood MS.

Robert K. Calloway, P.E.

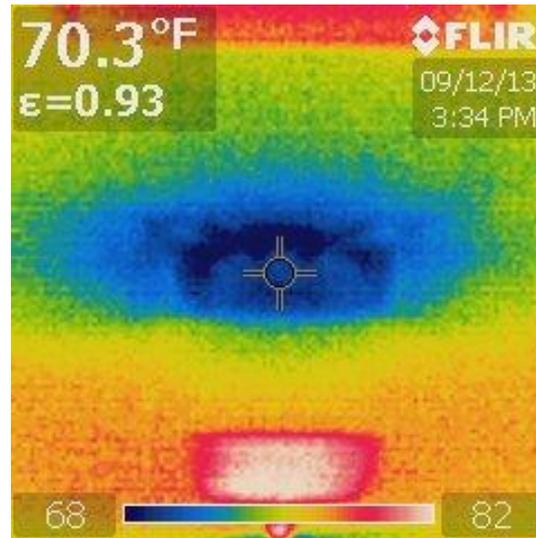
President/CEO

Global Facility Solutions, LLC.

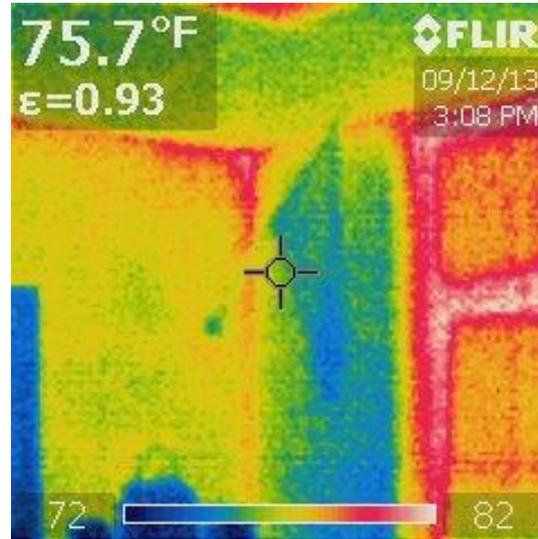
APPENDIX A – Infrared Thermal Images



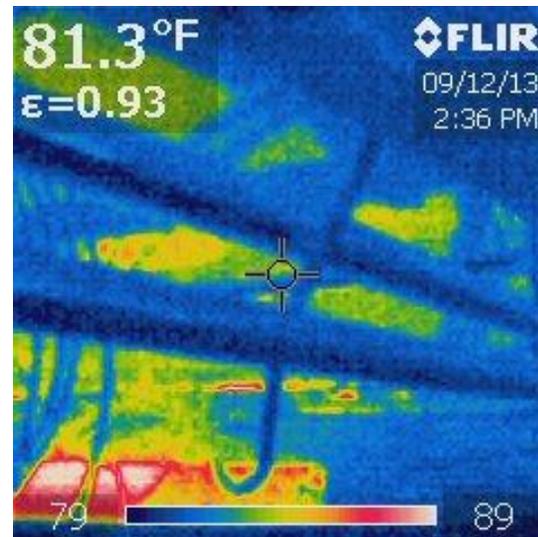
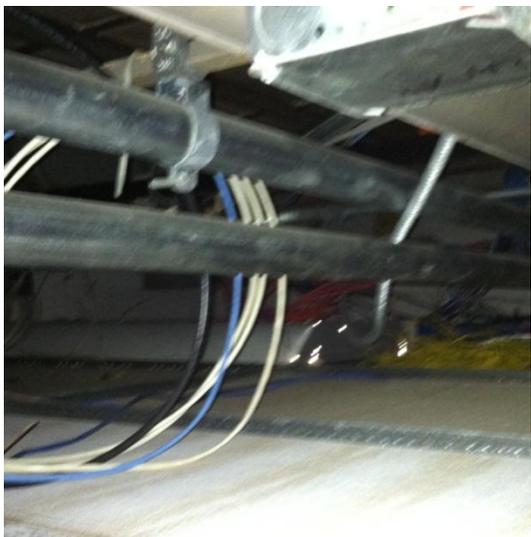
Exterior door in middle classroom wing hallway. IR Photo shows higher temperature around the door edges indicating air infiltration through the door edges.



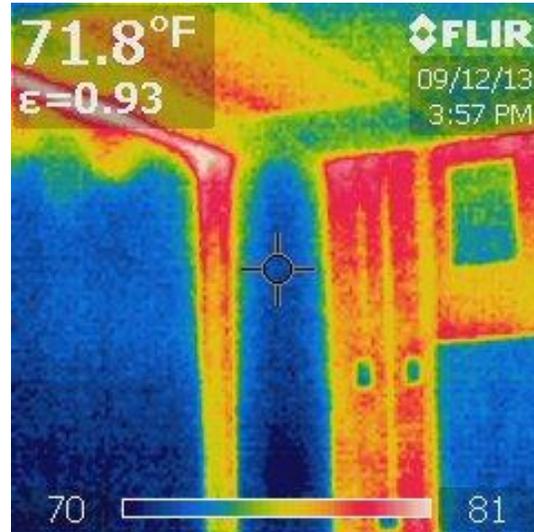
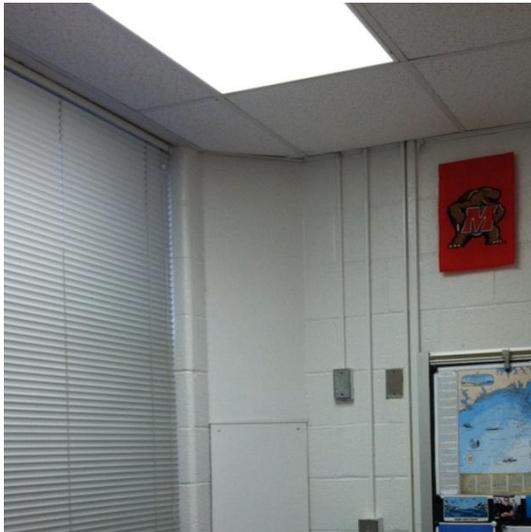
Supply air diffuser from Hallway Fan-Coil unit. IR Photo shows that the hallway unit is currently supplying 68 deg F air. No evidence of condensation at the time of the audit.



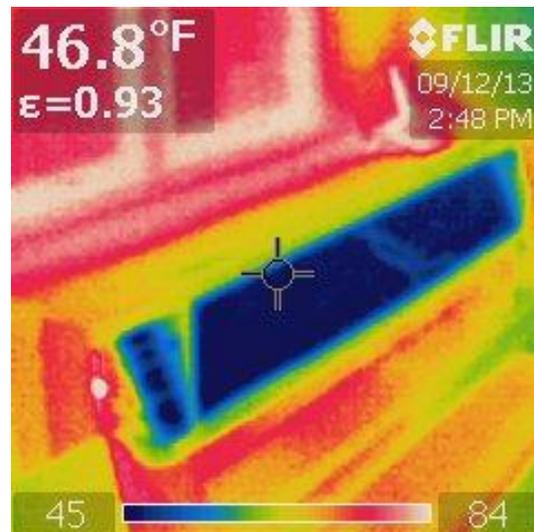
IR Photo of exterior wall and window in Room 31. IR Image indicates heat infiltration at window frame and corner of wall.



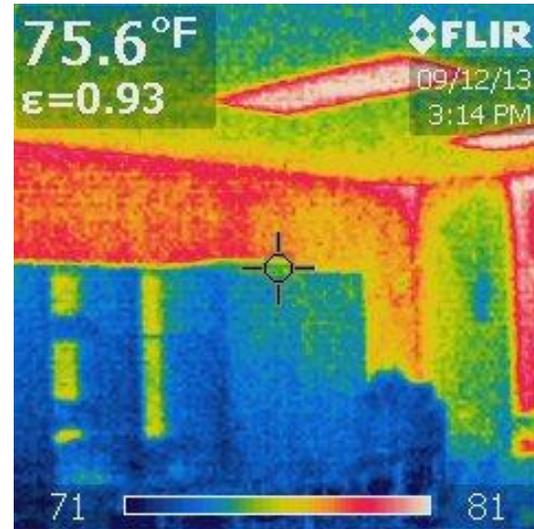
IR Photo above Room 33 ceiling tiles. Minimal heat loss through roof indicated.



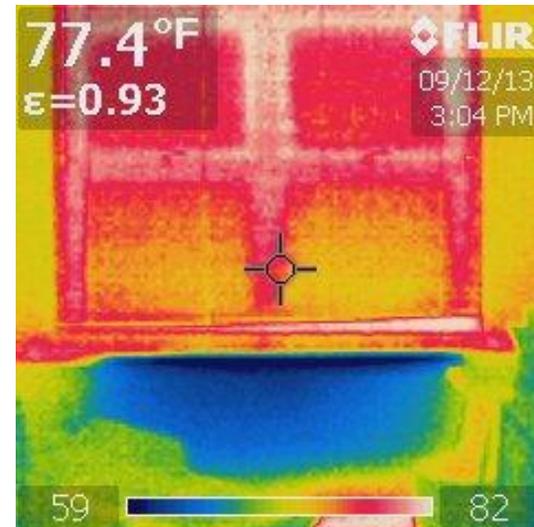
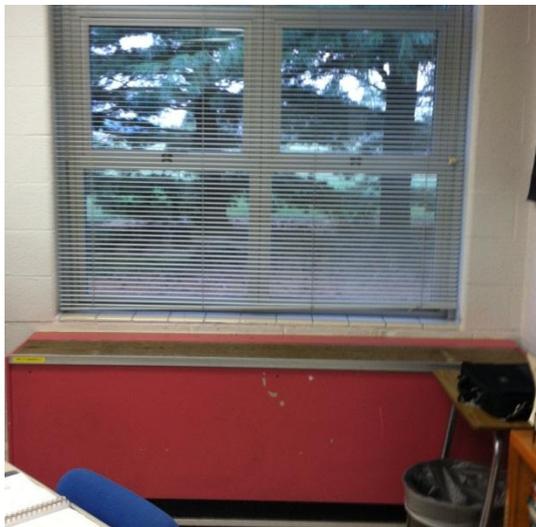
IR Photo of south wall in Room 11. Shows heat infiltration along south wall and around window frame. Negative air pressure within the building appears to be drawing air through cracks in the exterior wall and around the window frames.



IR Photo of Room 33 Unit Ventilator interior showing cooling coil, unit interior and classroom window in background. The IR photo indicates heat infiltration inside the unit ventilator and around the window frame.



IR Photo of Room 31 showing heat infiltration along the back wall behind cabinets and at window near the Unit Ventilator. Wall behind the cabinets is a West facing wall and the IR image was captured at approximately 4:00PM.



IR Photo of Room 31 Unit Ventilator and window. IR Photo shows heat infiltration at the window frame and window sill above the unit ventilator. Condensation was noted on the Unit Ventilator right side outer panel.

APPENDIX B – Equipment Check Sheets

RCx Checklist

Project Title:	<u>Glenwood Middle School</u>	Document Date:	<u>9/12/2013</u>
Owner/Clients Name:	<u>Howard County Public School System</u>	Document Version:	<u>Version 1.0</u>
		GFS Project Number:	<u>13-158</u>
Equipment System / Type:	<u>Unit Ventilator</u>	Equipment Tag(s):	<u></u>
		Location/Room:	<u>Room 11</u>
Name Plate Data			
Manufacturer:	<u>Trane</u>	Type:	<u></u>
Model Number:	<u>TUVA12VA2A</u>	Electrical Data:	<u></u>
Serial Number:	<u></u>	Horsepower/BTU:	<u>1/4 HP</u>
		Fan CFM:	<u></u>

Line Item	Description	Complete (Yes or N/A)	Comments
1	Room Temperature / Relative Humidity	--	73°F
2	Thermostat set point	--	70°F
3	Thermostat calibrated	N	Pneumatic pressure ok
4	Fan Setting - speed switch	--	N/A
5	CHW Coil - no damage (if damaged, record extent)	Y	
6	Heating Coil - no damage (if damaged, record extent)	--	
7	Piping, fittings, and components are free from apparent leaks.	Y	
8	Water piping accessories are insulated	Y	
9	Condensate pan(s) has (have) no debris or clogged drain(s).	Y	
10	Condensate piping is run to the nearest drain, pitched toward the drain, trap installed properly, and is properly supported.	Y	
11	Supply fan - no excessive noise or vibration.	Y	
12	There are no undue vibrations of the unit or piping while the unit is operating.	Y	
13	Fan Works Properly on All Settings	--	N/A
14	Cooling DAT is correct (50-60°F)	Y	52°F
15	Heating DAT is correct (90-120°F)	--	
16	Valve Operation (actuation)	N	Hose on the actuator is cut and disconnected

Additional Comments/Notes:

1 unit in room

3 way valve (others were 2 way)

I hereby certify that the above is accurate and truthful to the best of my knowledge and that the above system(s) are ready for functional testing in accordance with the requirements of the contract documents, please sign below:

<u>Responsible Company</u>	<u>M. Gagnon</u>	<u>Signature</u>
	Print Name	

RCx Checklist

Project Title:	<u>Glenwood Middle School</u>	Document Date:	<u>9/12/2013</u>
Owner/Clients Name:	<u>Howard County Public School System</u>	Document Version:	<u>Version 1.0</u>
		GFS Project Number:	<u>13-158</u>
Equipment System / Type:	<u>Unit Ventilator</u>	Equipment Tag(s):	<u></u>
		Location/Room:	<u>Room 15</u>
Name Plate Data			
Manufacturer:	<u>Trane</u>	Type:	<u></u>
Model Number:	<u>TUVA10VAZAD11SN</u>	Electrical Data:	<u>115 / 1 / 60Hz</u>
Serial Number:	<u>S86-036S1</u>	Horsepower/BTU:	<u>1/6 HP</u>
		Fan CFM:	<u></u>

Line Item	Description	Complete (Yes or N/A)	Comments
1	Room Temperature / Relative Humidity	--	71°F
2	Thermostat set point	--	71°F
3	Thermostat calibrated	Y	
4	Fan Setting - speed switch	--	N/A
5	CHW Coil - no damage (if damaged, record extent)	Y	
6	Heating Coil - no damage (if damaged, record extent)	--	
7	Piping, fittings, and components are free from apparent leaks.	Y	
8	Water piping accessories are insulated	Y	
9	Condensate pan(s) has (have) no debris or clogged drain(s).	Y	
10	Condensate piping is run to the nearest drain, pitched toward the drain, trap installed properly, and is properly supported.	Y	A lot of condensate present
11	Supply fan - no excessive noise or vibration.	Y	
12	There are no undue vibrations of the unit or piping while the unit is operating.	Y	
13	Fan Works Properly on All Settings	--	N/A
14	Cooling DAT is correct (50-60°F)	N	High at 62°F
15	Heating DAT is correct (90-120°F)	--	
16	Valve Operation (actuation)	Y	

Additional Comments/Notes:

Outside air damper is shut

No windows in this room

I hereby certify that the above is accurate and truthful to the best of my knowledge and that the above system(s) are ready for functional testing in accordance with the requirements of the contract documents, please sign below:

<u></u>	<u>M. Gagnon</u>	<u></u>
Responsible Company	Print Name	Signature

RCx Checklist

Project Title:	<u>Glenwood Middle School</u>	Document Date:	<u>9/12/2013</u>
Owner/Clients Name:	<u>Howard County Public School System</u>	Document Version:	<u>Version 1.0</u>
		GFS Project Number:	<u>13-158</u>
Equipment System / Type:	<u>Unit Ventilator</u>	Equipment Tag(s):	<u></u>
		Location/Room:	<u>Room 31</u>
Name Plate Data			
Manufacturer:	<u>Trane</u>	Type:	<u></u>
Model Number:	<u>TUVA10VAZAD11SN1</u>	Electrical Data:	<u>115 V / 10 / 60Hz</u>
Serial Number:	<u></u>	Horsepower/BTU:	<u>1/6 HP blower</u>
		Fan CFM:	<u></u>

Line Item	Description	Complete (Yes or N/A)	Comments
1	Room Temperature / Relative Humidity	--	73°F
2	Thermostat set point	--	75°F
3	Thermostat calibrated	N	2 psi high
4	Fan Setting - speed switch	--	N/A
5	CHW Coil - no damage (if damaged, record extent)	Y	
6	Heating Coil - no damage (if damaged, record extent)	--	
7	Piping, fittings, and components are free from apparent leaks.	Y	
8	Water piping accessories are insulated	Y	
9	Condensate pan(s) has (have) no debris or clogged drain(s).	Y	
10	Condensate piping is run to the nearest drain, pitched toward the drain, trap installed properly, and is properly supported.	Y	
11	Supply fan - no excessive noise or vibration.	Y	
12	There are no undue vibrations of the unit or piping while the unit is operating.	Y	
13	Fan Works Properly on All Settings	--	N/A
14	Cooling DAT is correct (50-60°F)	Y	60°F
15	Heating DAT is correct (90-120°F)	--	
16	Valve Operation (actuation)	N	Damper and valve did not actuate on call from thermostat

Additional Comments/Notes:

Musty damp odor

Chiller water running through idle unit in the room

Only using 1 unit in the room

I hereby certify that the above is accurate and truthful to the best of my knowledge and that the above system(s) are ready for functional testing in accordance with the requirements of the contract documents, please sign below:

<u>Responsible Company</u>	<u>M. Gagnon</u>	<u>Signature</u>
	Print Name	

RCx Checklist

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Owner/Clients Name:	<u>Howard County Public School System</u>	Document Version:	<u>Version 1.0</u>
		GFS Project Number:	<u>13-158</u>
Equipment System / Type:	<u>Unit Ventilator</u>	Equipment Tag(s):	<u></u>
		Location/Room:	<u>Band Room</u>
Name Plate Data			
Manufacturer:	<u>Trane</u>	Type:	<u></u>
Model Number:	<u>VUVE15000HON1EB</u>	Electrical Data:	<u>115 V / 1 / 60</u>
Serial Number:	<u>T12G36704</u>	Horsepower/BTU:	<u>10-Jan</u>
		Fan CFM:	<u></u>

Line Item	Description	Complete (Yes or N/A)	Comments
1	Room Temperature / Relative Humidity	--	72°F
2	Thermostat set point	--	73°F
3	Thermostat calibrated	Y	
4	Fan Setting - speed switch	--	Low
5	CHW Coil - no damage (if damaged, record extent)	Y	
6	Heating Coil - no damage (if damaged, record extent)	--	
7	Piping, fittings, and components are free from apparent leaks.	Y	
8	Water piping accessories are insulated	Y	A lot of condensate present
9	Condensate pan(s) has (have) no debris or clogged drain(s).	Y	
10	Condensate piping is run to the nearest drain, pitched toward the drain, trap installed properly, and is properly supported.	Y	
11	Supply fan - no excessive noise or vibration.	Y	
12	There are no undue vibrations of the unit or piping while the unit is operating.	Y	
13	Fan Works Properly on All Settings	N	Fan speeds appear incorrect, med is high.
14	Cooling DAT is correct (50-60°F)	Y	55°F
15	Heating DAT is correct (90-120°F)	--	
16	Valve Operation (actuation)	N	Valve not operating on demand

Additional Comments/Notes:

New unit

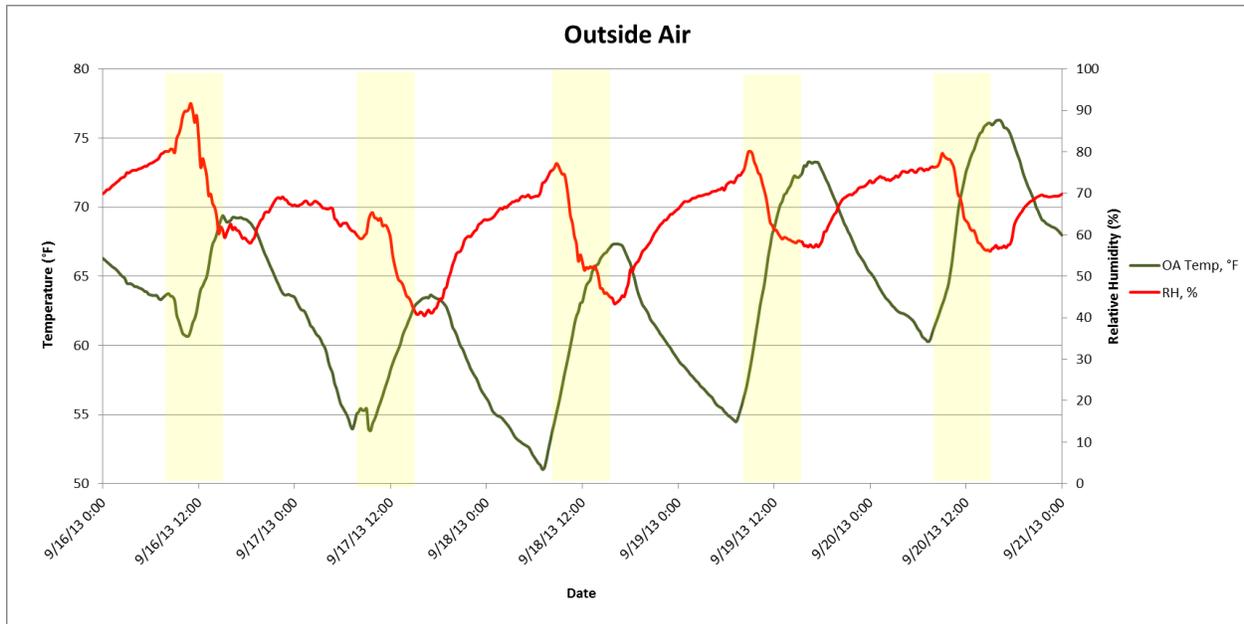
12 psi at thermostat (new thermostat)

3 way valve

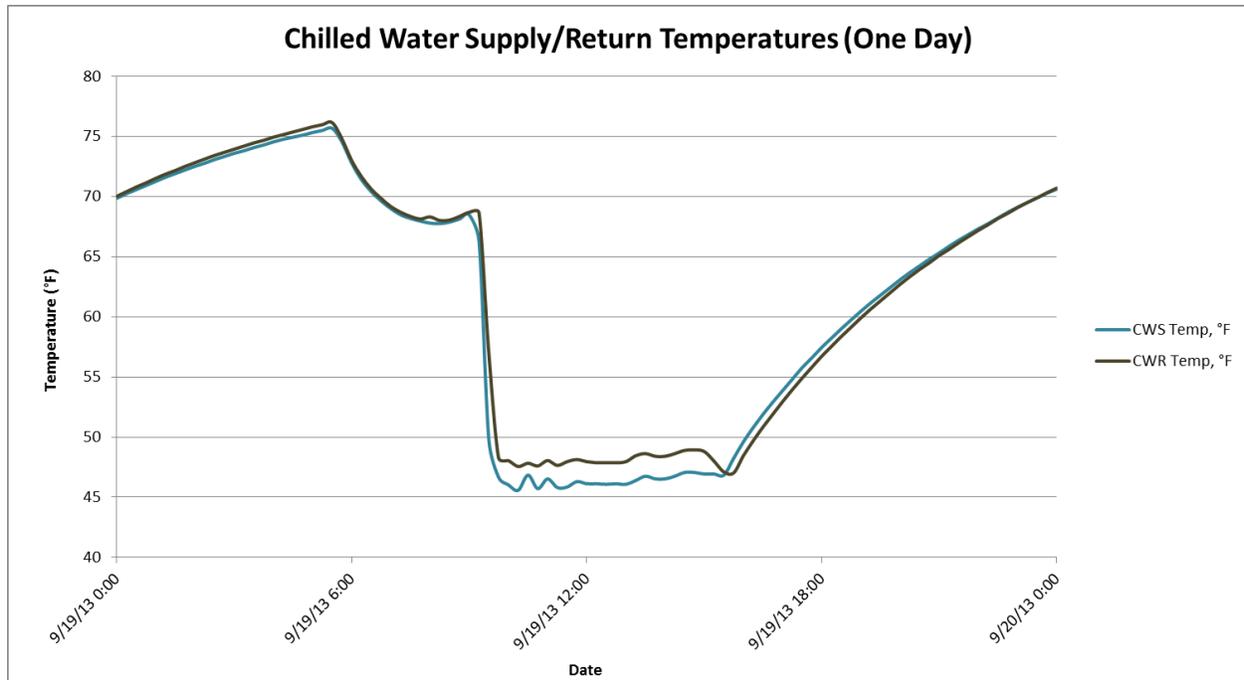
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<u></u>	<u>M. Gagnon</u>	<u></u>
Responsible Company	Print Name	Signature

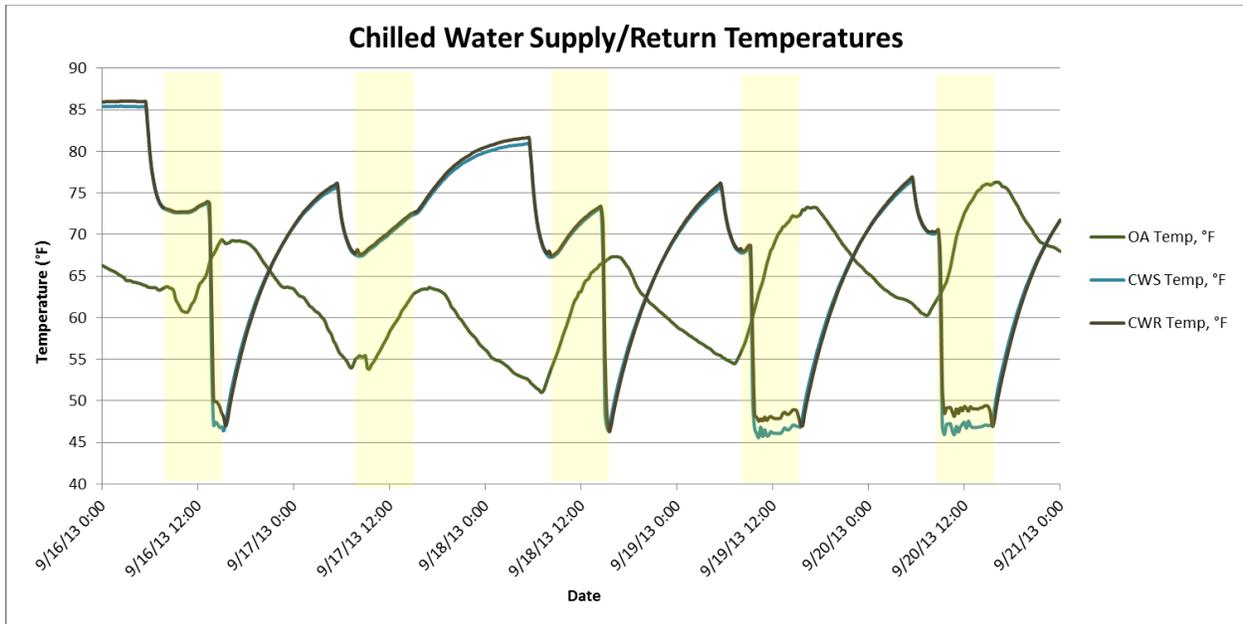
APPENDIX C – Data Trend Graphs



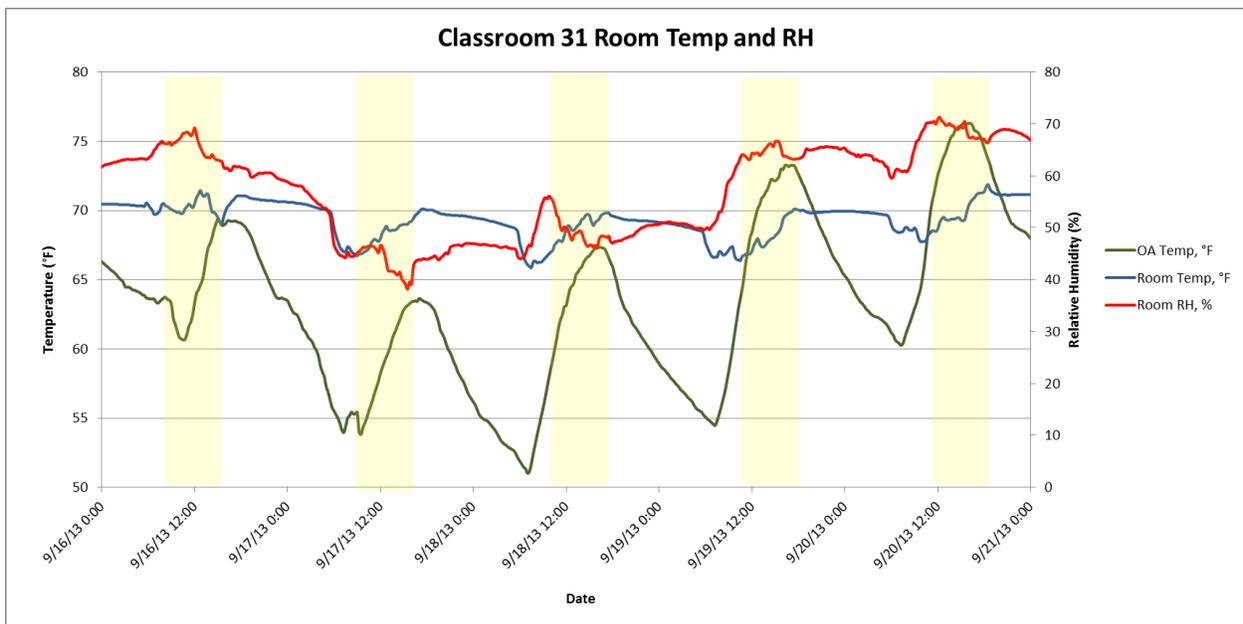
The above graph provides a summary of the outside air temperature and relative humidity as measured by the data logger placed outside near the cafeteria on the north side of the building. The data loggers were installed for over a 7 day period spanning a full week of school days and two weekends. As can be seen in the graph above, the outside air temperature and humidity unfortunately do not represent the peak temperature and humidity that is experienced during the summer months. NOTE: Yellow bars indicate “occupied” hours each day.



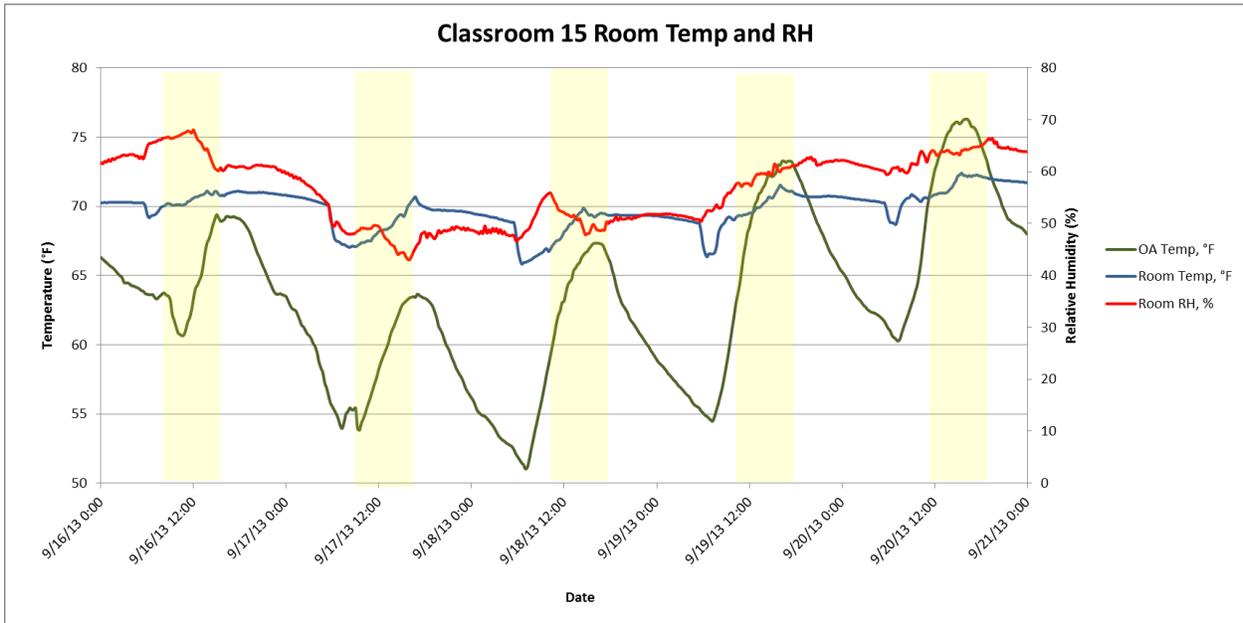
The above graph provides a summary of the chilled water supply & return temperature for a one day period. The chiller operated for only two days during the data logging time period. A 2°F temperature differential indicates only a small cooling load on the chiller.



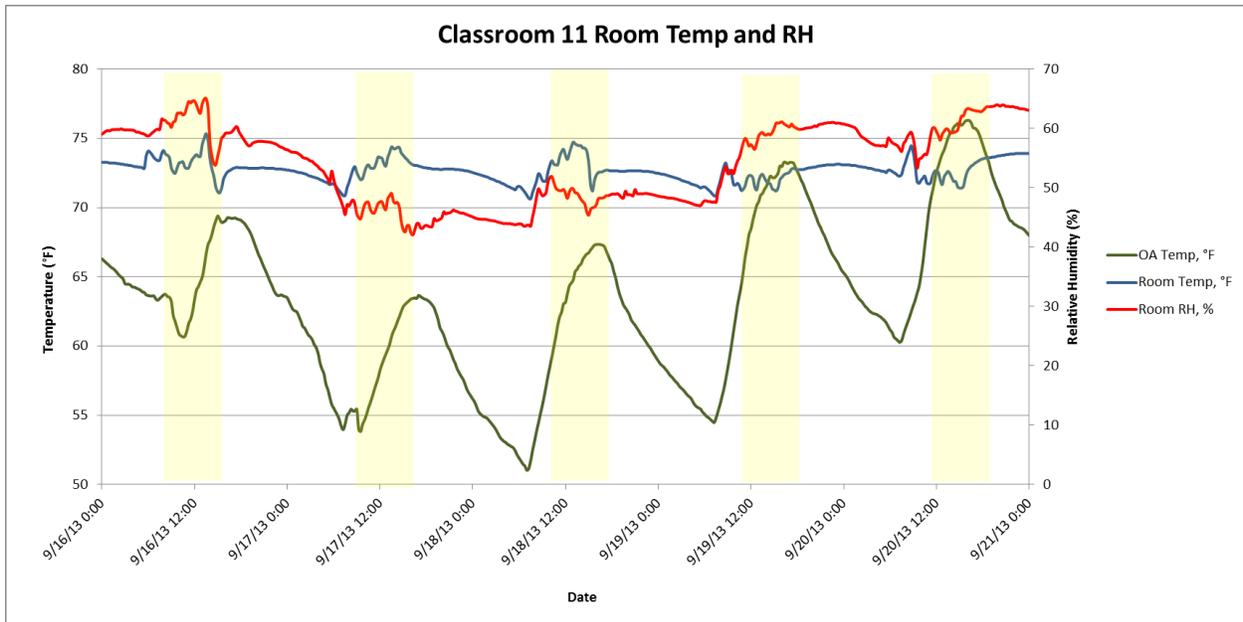
The graph above provides a summary of the chilled water supply and return temperature during the week. Based on the graph, the chiller was operated on Monday for a short time period and all occupied hours on Thursday and Friday. The chilled water supply temperature appears to be maintained at 46 to 47 deg F with little load on the chiller plant on Thursday and Friday.



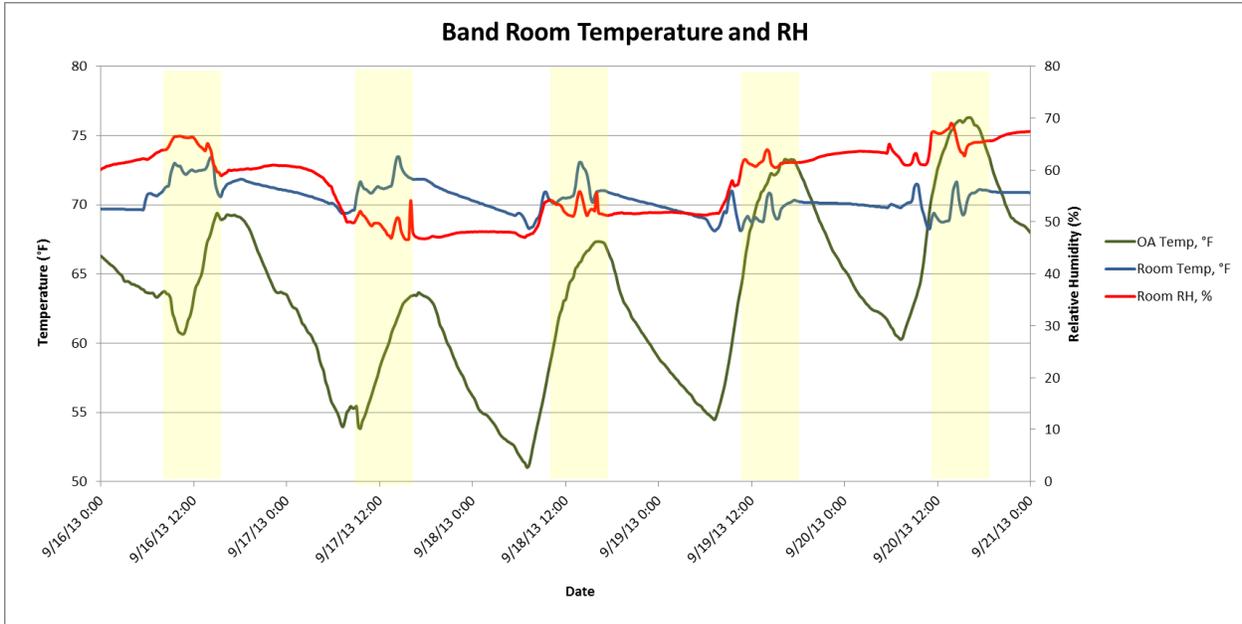
The above graph shows how the room temperature and humidity varies during the day and over the week. The yellow bars indicate the occupied time period for Monday through Friday. While the dry-bulb temperature remains fairly steady throughout the week, the room relative humidity percent increases along with the outside air temperature indicating high infiltration.



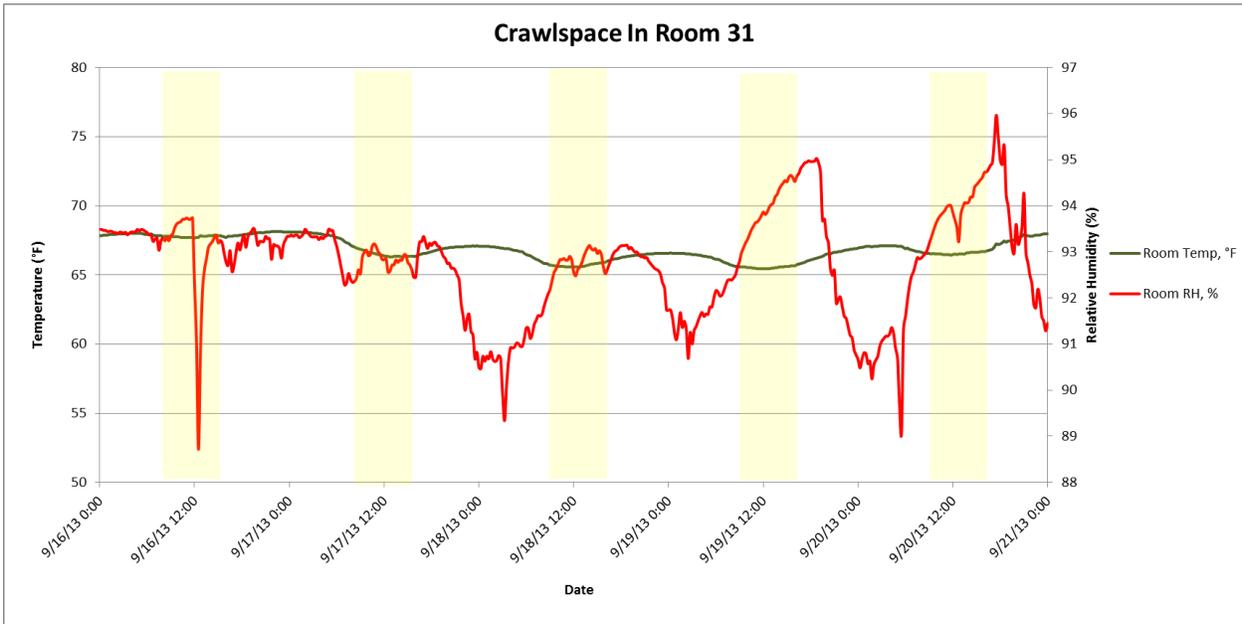
The above graph provides a view of the temperature and humidity within Classroom 15 during the week. Humidity levels were higher than expected on Monday and Thursday/Friday of the week. The dry-bulb temperature remained in the acceptable range throughout the week.



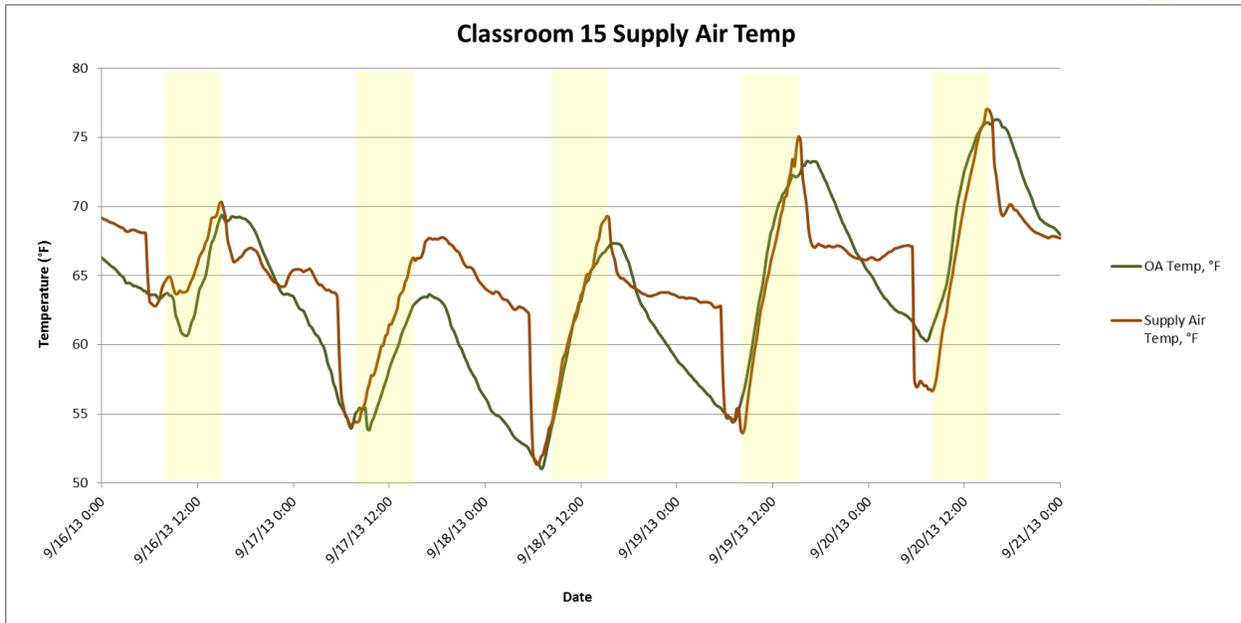
The above graph provides a summary of the temperature and humidity for Classroom 11. The temperature and humidity varies throughout the occupied time period and the dry-bulb temperature and humidity are outside of the normal range during the occupied time period. Peak conditions occurred on Thursday and Friday when the space temperature reached 73 to 75 degs F and the relative humidity peaked at 65%.



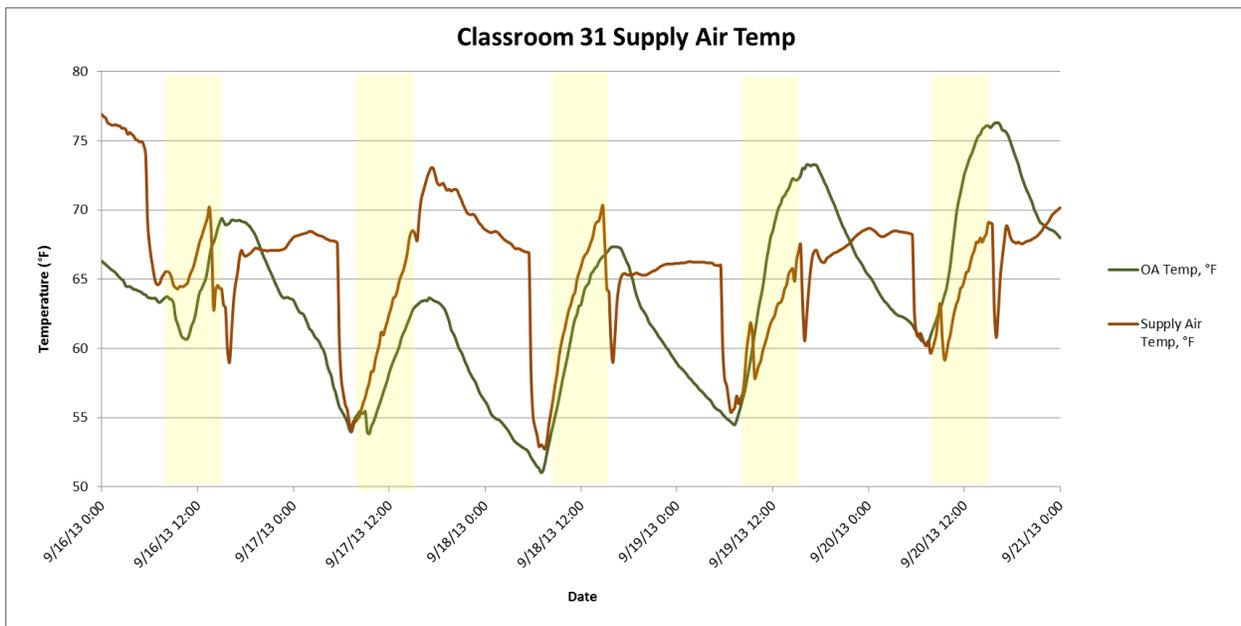
The Band Room contains a newer Trane unit ventilator. The graph above shows how the temperature and the humidity are maintained within acceptable ranges during the week.



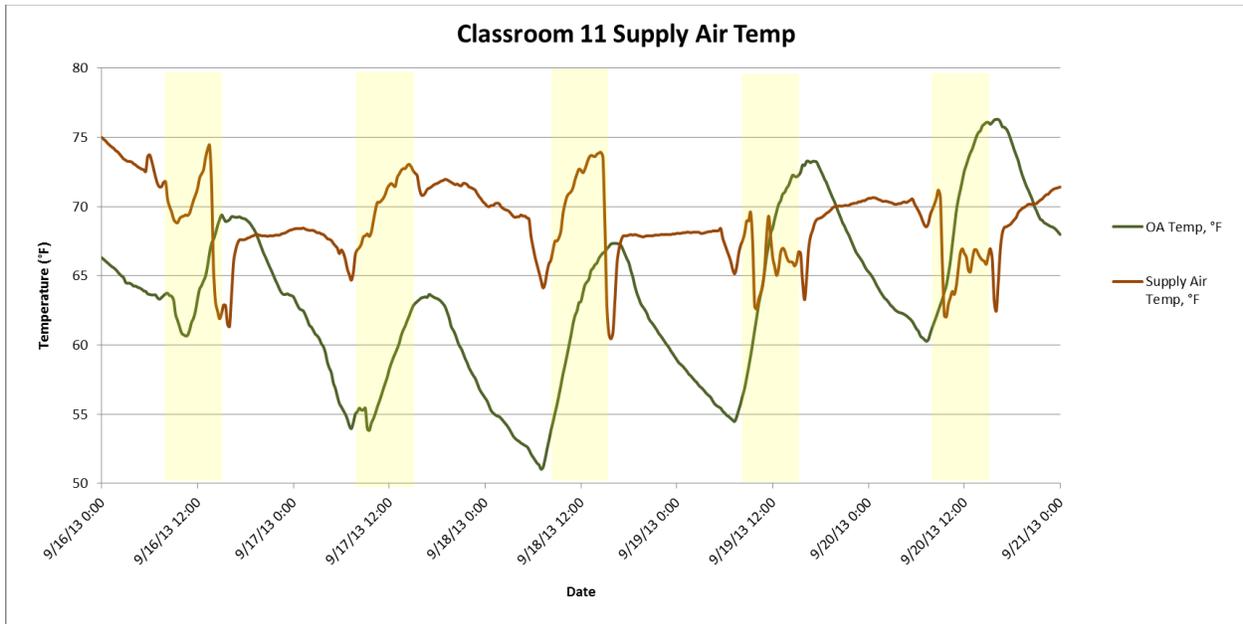
The abandoned steam tunnels are located under most classrooms in each of the classroom wings. The tunnels consist of block walls with dirt floors. One tunnel was checked during the site review and found to be very damp with a musty smell. The above graph provides a summary of the temperature and humidity in the tunnel crawlspace during the week. As can be seen in the graph, there were periods when the relative humidity reached 93 to 96% RH while the temperature maintained a consistent 68 deg F.



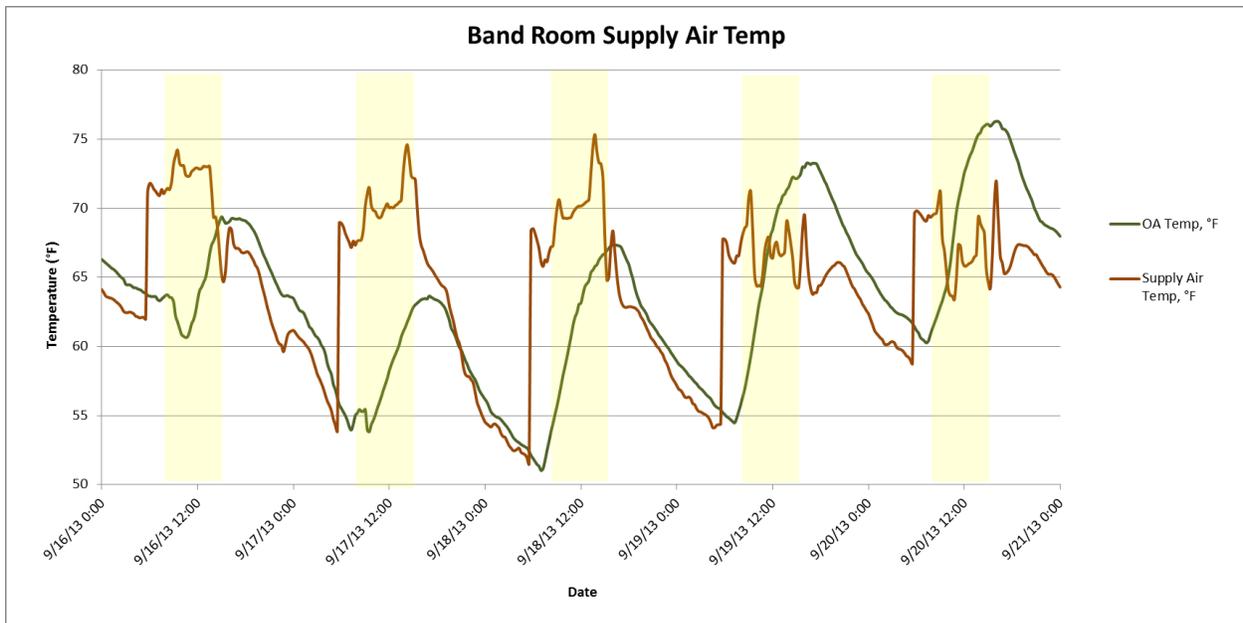
The above graph represents the supply air temperature (red line) discharging from the unit ventilator within Classroom 15. Supply air temperatures were high and out of the range needed to properly condition the space. However, the chiller was only operating on Thursday and Friday of the week. It appears that the chiller operation does not have an impact on the supply air temperature within the room indicating problems with the controls.



The above graph represents the supply air temperature (red line) discharging from the unit ventilator within Classroom 31. Supply air temperatures were within range during portions of the week, but were high on Thursday and Friday.



The above graph represents the supply air temperature (red line) discharging from the unit ventilator within Classroom 11. Supply air temperatures were high during the entire week and remained high even when the chiller plant was operational on Thursday and Friday.



The above graph represents the supply air temperature (red line) discharging from the unit ventilator within the Band Room. The supply air temperature dropped during the night time hours indicating that the Trane unit remained operational throughout the unoccupied time periods or there was a large amount of air leakage through the Trane unit ventilator permitting outside air to cross over the data logger while the unit was off.