ESL-TR-06-06-01

Austin ISD

St. Elmo Elementary School

HVAC Renovations

Commissioning Report

Prepared for

Austin Independent School District (AISD)
Austin, Texas

Under Task Order #16

Submitted by

Marvin Zeig, Jr.
Gary Napper
Guanghua Wei, P.E.
Dan Turner, Ph.D., P.E

Energy Systems Laboratory
Texas Engineering Experiment Station
The Texas A&M University System
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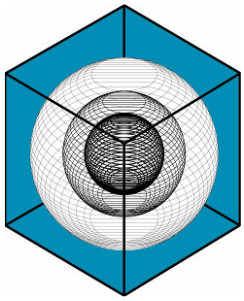

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Executive Summary

The Energy Systems Laboratory (ESL) of Texas A&M University was contracted by AISD to perform commissioning on the HVAC renovations project at St. Elmo Elementary School. ESL engineers visited the school on May 10-12, 2006 to commission the new HVAC equipment. At the time of the visit, the equipment had been operating between 6 and 8 months with satisfactory results. After investigating the facilities, the following observations and recommendations were made.

Field Observations:

- AHUs 1, 2, 3, and 4 and RTUs 1 and 2 operated as specified/designed with correct discharge temperatures and air flows.
- AHU-4 hot gas reheat heats the treated outside air up to 10°F below the outside air temperature. This is not required since the treated outside air is supplied to other AHUs.
- AHU-4 heating setpoint is set at 6F-65°F (when in the heating mode). This setpoint could be decreased to 40-45°F since the outside air is supplied to other AHUs.
- AHUs 1, 2, and 3 did not have filters installed prior to the unit's intake.
- The AHU heat pump/condensing unit area, which has a perimeter fence and gate, does not have a lock and can be accessed by anyone.
- Indoor air quality was within acceptable temperature, CO_2 and relative humidity limits.
- All sensors were verified and were within calibration limits.

Recommendations for Austin ISD:

1) For AHU-4, when in the cooling mode, turn off the hot gas reheat or decrease it to its minimum amount.
2) Decrease the heating setpoint for AHU-4 to 40-45°F. This has been done by ESL.
3) AHUs 1, 2, and 3 need to have filters installed to prevent the evaporator coils from getting dirty. These coils need to be inspected and cleaned since the units have been running for 6-8 months without filters. If filters cannot be installed on these three units due to filter access difficulty, a filter rack needs to be installed in the mixed air plenum.
4) A lock needs to be put on the gate to the heat pump/condensing unit area to prevent unwanted access to the area and equipment.

Project Description

The project for HVAC renovations at St. Elmo Elementary School involved the addition of two packaged rooftop units and four new air handling units, one of which is 100% outside air. All units utilize DX cooling and electric heating. For the air handling units, a concrete slab was poured next to the building in order for their condensing units/heat pumps to sit. The four air handling units are all located in mechanical room 09. The two roof top units were installed on the roof of the building. AHU-4 serves AHUs 1 through 3 with conditioned outside air. With the installation of the new units, new ductwork was installed as well as seven new exhaust fans. AHU-1 serves classroom 05, AHU-2 serves classroom 04 and the corridor, and AHU-3 serves classroom 11. The rooftop units serve the front administrative office area.

Upon installation of the units, monitoring points and start/stop control was to be put on the TAC Vista workstation. The start/stop control is via a time schedule and the monitoring points include return air and supply air temperatures as well as fan status and how many cooling and heating stages are on. This project renovation was substantially completed by October 2005.

Equipment Designed Operation and Controls

Roof Top Units (RTUs)

Located on the roof of the school are two new additional RTUs which were manufactured by Trane. Both RTUs serve the front administration office areas. As designed the RTUs supply a total of 1050 cfm of which outside air comprises 80 cfm, each. The amount of naturally drafted outside air to these units is set by a manual damper. These units utilize one stage of DX cooling and one stage of electric heat which stage in sequence to maintain the zone space temperature setpoint as specified through TAC Vista workstation. The control sequences for the two RTUs are similar to the control sequences for AHUs 1, 2, and 3 and are detailed below. The two RTUs are equipped with monitoring points and tied to the TAC Vista workstation which allows the user to view the operation of the units. Figure 1 shows a schematic of the RTUs.

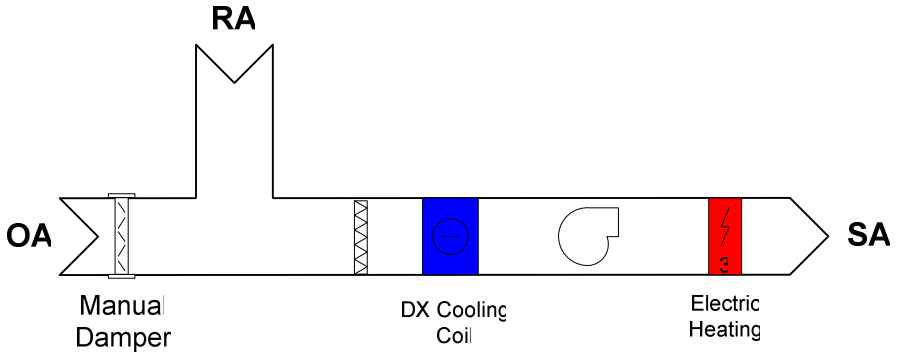

Figure 1: Typical RTU schematic.

Air Handling Units (AHUs)

Located in one mechanical room are 4 new AHUs. AHU-1, AHU-2, and AHU-3 are all manufactured by Trane and are of their TWE, high efficiency model units. These three units are vertical draw through which condition mixed return air and pre-conditioned outside air and supply it to the space. These units have one stage of cooling and one stage of heating. AHU-1 serves classroom 05, AHU-2 serves classroom 04 and the corridor, and AHU-3 serves classroom 11. AHU-4 is manufactured by Addison and is a horizontal draw through type unit. This unit conditions 100% outside air. AHU 4 has one stage of cooling and one stage of heating. The unit is also equipped with a hot gas reheat coil located directly after the cooling coil. Table 1 shows the design airflows for these three units. Figure 2 shows a schematic of AHUs-1, 2, and 3 and Figure 3 shows AHU-4. The condensing units or heat pumps for all 4 AHUs are located on a concrete pad next to the building.

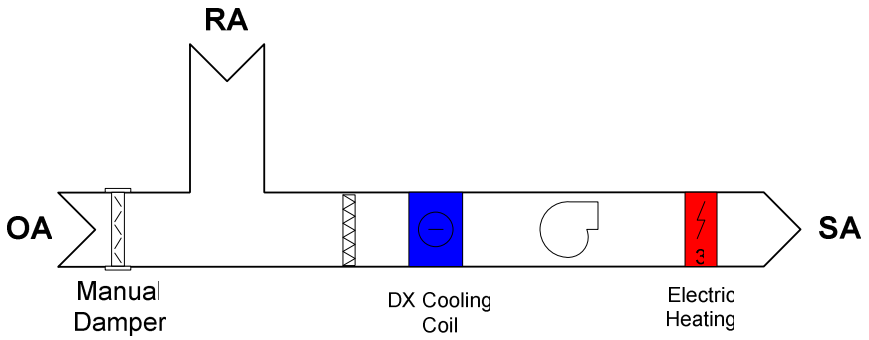

Figure 2: AHUs 1, 2, and 3 Schematic.

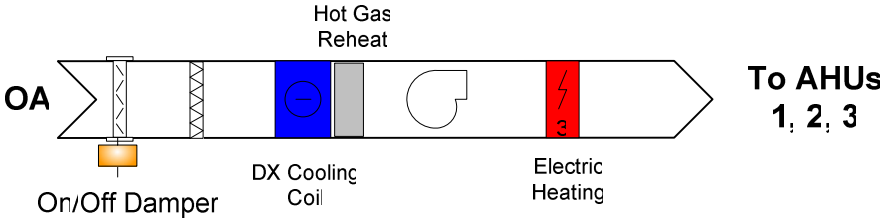

Figure 3: AHU 4 Schematic

Control Sequences

AHUs 1, 2, and 3 and RTU 1 and 2 are started and stopped via an adjustable time schedule through TAC Vista workstation. When the unit is started, the fan runs continuously. A current sensing relay proves the fan status, and if the sensor fails to prove the status, an alarm will be sent to the TAC Vista workstation. A space temperature sensor cycles the compressor in sequence with stages of electric heat to maintain the room temperature setpoints (adjustable). Return and supply air temperature sensors are used to monitor the respective airstreams through

TAC Vista workstation. Unoccupied high and low space temperature limits are implemented and are 85°F and 60°F. If the zone temperature strays beyond these limits while unoccupied, the respective unit will turn on and bring the space temperature back within these limits. The occupied cooling set points for AHUs 1, 2, and 3 and the RTUs is 74°F and the heating setpoint is 69°F. AHU 1, 2, and 3 space temperature sensors have adjustment capabilities and an override button. The override button will turn the respective unit on to maintain the occupied setpoints for 2 hours. The space temperature adjustment capability is ±3°F.

AHU 4 is enabled and disabled by an adjustable time schedule through TAC Vista. The unit has self contained controls which cycle heating and cooling as needed through factory provided thermostats. When the unit is energized, the outside air damper opens and the fan will start after a time delay. The cooling coil and electric heating coil leaving air temperature and fan and compressor status will be monitored through TAC Vista workstation. The on-board factory controls include a remote field installed system switch to start/stop the air handler blower motor. An adjustable compressor ambient lock-out thermostat controls the cooling operation at a nominal setting between 55°F and 70°F (existing setpoint is 55°F). The compressor starts when the outside air temperature is above the adjustable setpoint. In the cooling mode the leaving air temperature will be maintained by hot gas bypass and/or unloading the compressor. This is accomplished through suction pressure sensing and hot gas bypass and/or unloading the compressor, thus tracking the outside air variations. The typical temperature drop across the cooling coil is 30-40°F at high outside air temperatures to maintain a cooling temperature between 55-60°F. The hot gas reheat is always on and is controlled by its own in-line valve to maintain a differential pressure of 8-10 psig. If more or less reheat is desired, this differential pressure can be increased or decreased, respectively. As existing, the leaving air temperature off of the reheat coil was maintained 10°F lower than the outside air temperature or at 60°F, which ever is higher. In the heating mode the heating device will be enabled when the outside air is below the set point of the adjustable ambient thermostat. The heating thermostat is set between 60-65°F.

Issues and Field Observations

1. **AHU 1, 2, 3 and 4 and RTU 1 and 2 measurements and operation**
   Field measurements taken on these units were compared to the units' design schedules. The table below details the measured values versus the design values. These values are within acceptable limits of the design/setpoint values. For AHU-4, when in the cooling mode, the AHU operated as designed and the hot gas reheat provided a supply air temperature of 65°F. The heating control was not tested since heating was locked out or not required with the outside air temperatures was above 90°F.

	DX Cooing (°F)		Heating (°F)		Supply air flow (cfm)		Outside air flow (cfm)	
	Meas.	Design	Meas.	Design	Meas.	Design	Meas.	Design
AHU-1	56.4	55	N/A	85	1270	1400	430	395
AHU-2	56.1	55	N/A	85	760	875	160	110
AHU-3	55.8	55	N/A	83	1420	1600	480	395
AHU-4	N/A	55-60	N/A	85	1060	900	1060	900
RTU-1	50.8	51	N/A	86	1250	1050	75	80
RTU-2	51.1	51	N/A	86	990	1050	95	80

   Note: Design cooling is with an entering air temperature (EAT) of 78°F for AHUs 1, 2, and 3 and RTUs 1 and 2. For AHU-4, the design cooling is with and EAT of 98°F. For heating, the design EAT is 70°F for AHUs 1, 2, and 3 and RTUs 1 and 2 and is 20°F for AHU-4.

2. **AHU-4 hot gas reheat**
   Currently, the hot gas reheat for AHU-4 heats the air off of the cooling coil back up to 60°F or approximately 10°F below the outside air temperature, whichever is higher. This is not required since the treated outside air is supplied directly to another AHU and not to the space. It is recommended to turn off the hot gas reheat or decrease the amount of hot gas reheat to its minimum position. To decrease the amount of reheat, the hot gas reheat valve needs to be adjusted to maintain the lowest differential pressure setting which is acceptable by the manufacturer. To do this, discharge pressure gauges need to be connected to the Schraeder connections upstream and downstream of the valve. The valve cap needs to be removed and turn the stem clockwise to increase the pressure differential and counterclockwise to decrease the differential. Upon doing this, the valve operation needs to be verified.

3. **AHUs 1, 2, and 3 filters**
   AHUs 1, 2, and 3 do not have filters installed in the mixed air stream prior to the AHU and the cooling coil. There is a provision where a filter should be installed as shown in Figure 4. These units need to have filters installed to prevent the cooling coil from getting dirty. It is difficult to install a filter in this access due to the routing of the condensate piping located in front of the filter access. If filters can not be installed at this location, a filter rack should be installed under the unit and in the mixed air plenum. The evaporator coils for these three units need to be inspected and possibly cleaned since they have been running for 6-8 months without filters.

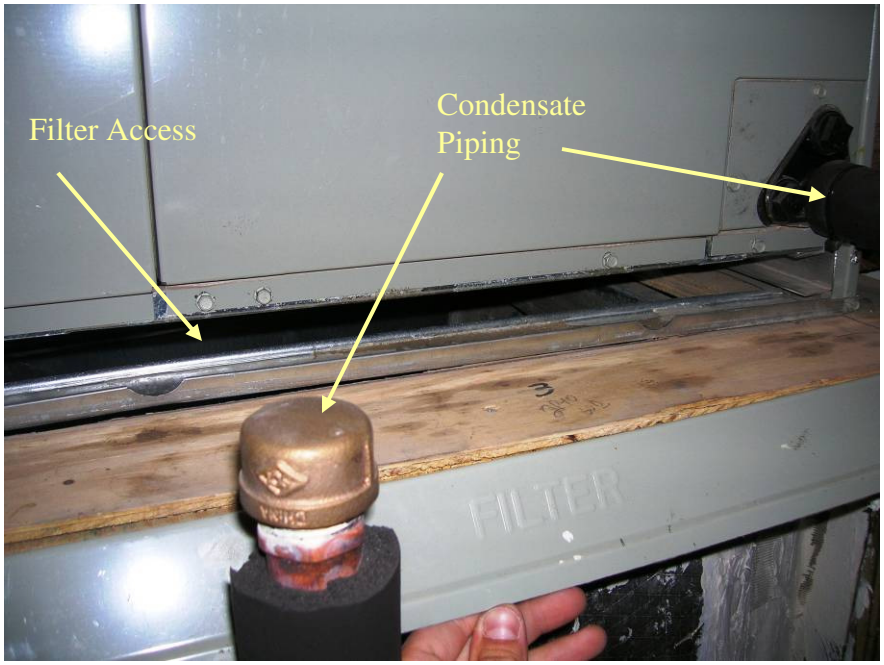

Figure 4: AHU 1, 2, and 3 filter access without filter.

4. **AHU heat pump pad area without lock on gate**
   The fenced and gated, concrete pad in which the heat pumps for the AHUs are mounted does not have a lock on the gate. This area needs to be locked to prevent people and students from entering.

5. **Sensor verification**
   All sensors were verified by taking field measurements and comparing them with the readings provided on the TAC Vista workstation. All sensors readings were within ±1°F of the measured values.

6. **Indoor air quality**
   Indoor air quality measurements were taken in the areas the new HVAC equipment served. These measurements included space temperatures, relative humidity levels, and CO_2 levels. The school had acceptable indoor air quality. Space temperatures for St. Elmo rooms ranged between 71-74°F with humidity levels between 57-64%. CO_2 levels fluctuated between 700-1000ppm.

Summary and Recommendations

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