Middle School

Summary update of diagnostic work performed from 7/5/05 through 7/26/05

The slides that follow are specifically intended to be objective in nature. As such, they describe and illustrate the conditions we found during our inspection of the equipment.

Systems examined

- AHU-7 / CU-7
- RTU-1
- Unit ventilators (not complete).
- Liebert unit for data room #209 (brief check resulting from a service request).

AHU-7 / CU-7

- Area(s) served: Hallways

Reported problems

- Hallways always warm.
- Hallways humid.
- Balance report in question.

Observations as found

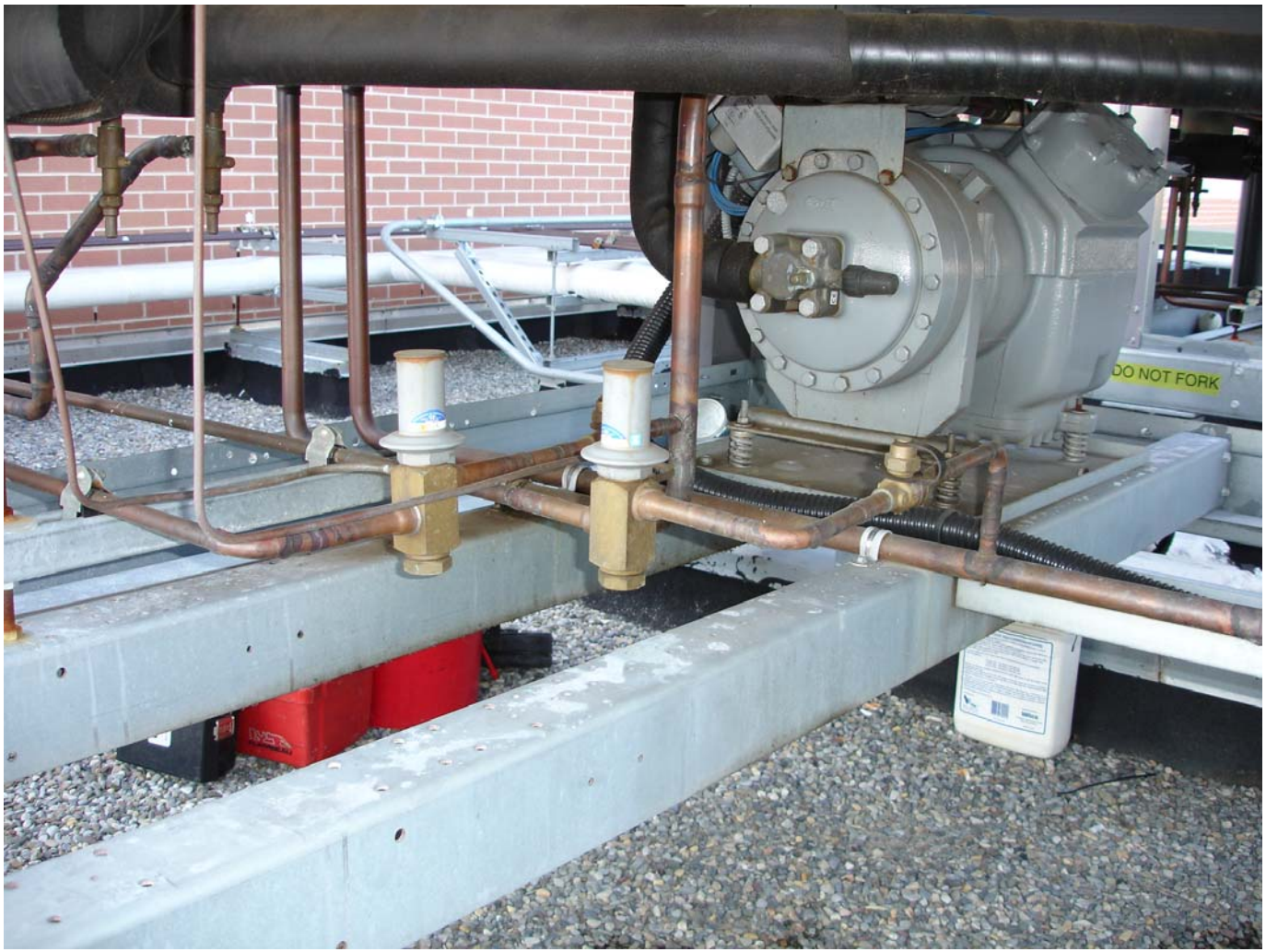
- Hallway hot and humid.
- Compressor #1 running and feeding hot gas via hot gas bypass valve.
- Supply air temperature 80°.
- Liquid line solenoid closed.
- Compressor #2 started and the supply air temperature dropped to 55°.

Items noted during inspection of CU-7

- Circuit #1 and #2 liquid line solenoid valves improperly wired from terminal board to valves (reversed).
- Field DDC wired to correct terminals on unit control board.
- Missing hot gas bypass solenoid valve and wiring upstream of hot gas valve. See photo #1408.
- Compressor #1 unloader incorrectly set causing compressor to operate mostly unloaded.
- Circuit #1 and #2 superheat operating at 4° (too low) and 15° respectively.
- Hot gas bypass regulator set to be fully open at 50 psig suction pressure (approximate 8 psig range (start to open to fully open) on this type of valve).
- Condenser coil is matted. See photos #1405, 1406, 1429.
- Oily matted residue on a few spots on the condenser coil which could indicate a refrigerant leak at these locations. Possible oil stain on roof. See photo's #1402, 1403, 1407.
- Oil level in both compressors is higher than recommended by Carlyle (should be 1/8-3/8 gin the sight glass). See photo #1434.
- Net oil pressure on compressor #1 and #2 was 30 psig and 36 psig respectively (within the normal range).
- No access ports on the discharge pressure side of the compressor to allow testing of the high pressure safety.
- Time did not allow for testing of the oil pressure safety switches, installing a test port on the discharge side of the compressor, etc.
- Both refrigerant sight glasses were clear when both stages were running.
- Low pressure switches on both compressors have insulation stripped to expose a small section of wire. See photo's #1410 and 1411.
- The condenser fan pressure control is connected to the backseat port of the discharge service valve (factory). See photo #1429.

Photo #1408

Hot gas bypass valves. Note missing solenoid valves.



Condenser coil photo #1402

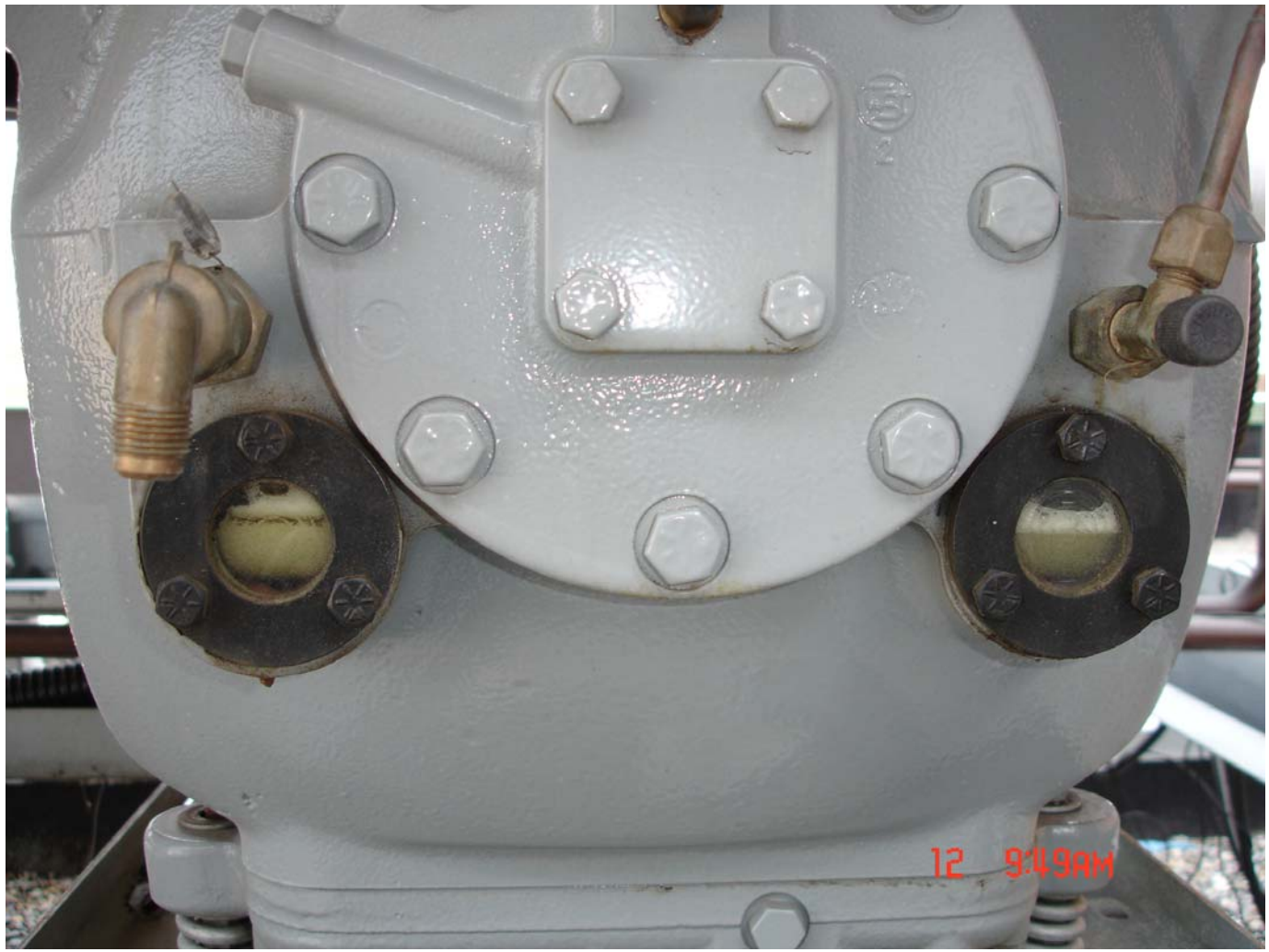
Condenser coil photo #1403

Condenser coil photo #1406

Condenser coil photo #1407.

Condenser coil photo #1429.

Compressor oil level photo #1434.



Compressor low pressure switch photo #1410.

Compressor low pressure switch photo #1411.

Condenser fan cycling pressure switch photo #1429 (factory).

Items noted during inspection of AHU-7 (major and minor issues)

- Air filters plugged, incorrect depth, and dislodged from rack. See photo's #1414-1416.
- Insulation missing on #2 suction line. See photo #1423.
- Penetrations for refrigerant piping not sealed and in some cases the piping is in direct contact with the sheet metal casing which will result in a future leaks. See photo's #1425, 1426, 1483, 1484.
- Refrigerant piping making metal to metal contact at casing penetration in some cases.
- Condensate drain piping drains short of the floor drain. See photo's #1439 and 1440.
- Possible condensate carry-over from the cooling coil into the fan section. See photo's #1484, 1485, 1486.
- Condensate forming on the exterior of the duct work at the air handler and also in the boiler room (high dew point in the spaces). See photo's #1458, 1463, 1464.
- Gas vent penetrations to outdoors are not sealed. See photo #1465.
- Air bypass from fan discharge to fan suction on the supply fan. See photo's #1475, 1476, 1479.
- The sensor numbers in the DDC status display for reheats #14 & 15 are reversed from what is shown on the mechanical drawings. Could be a typo or a wiring error and requires further investigation.
- The balance report shows 11,341 CFM. Our hood readings (back pressure compensated) totaled 12,016 CFM (6% variance).

Air filter photo #1414.

Air filter photo #1415.

Air filter photo #1416.

Insulation photo #1423.

Piping penetration photo #1425.

Piping penetration photo #1426.

Piping penetration photo #1483.

Piping penetration photo #1484.

Condensate drain piping photo #1439.

Condensate drain piping photo #1440.

Possible condensate carry-over photo #1484.

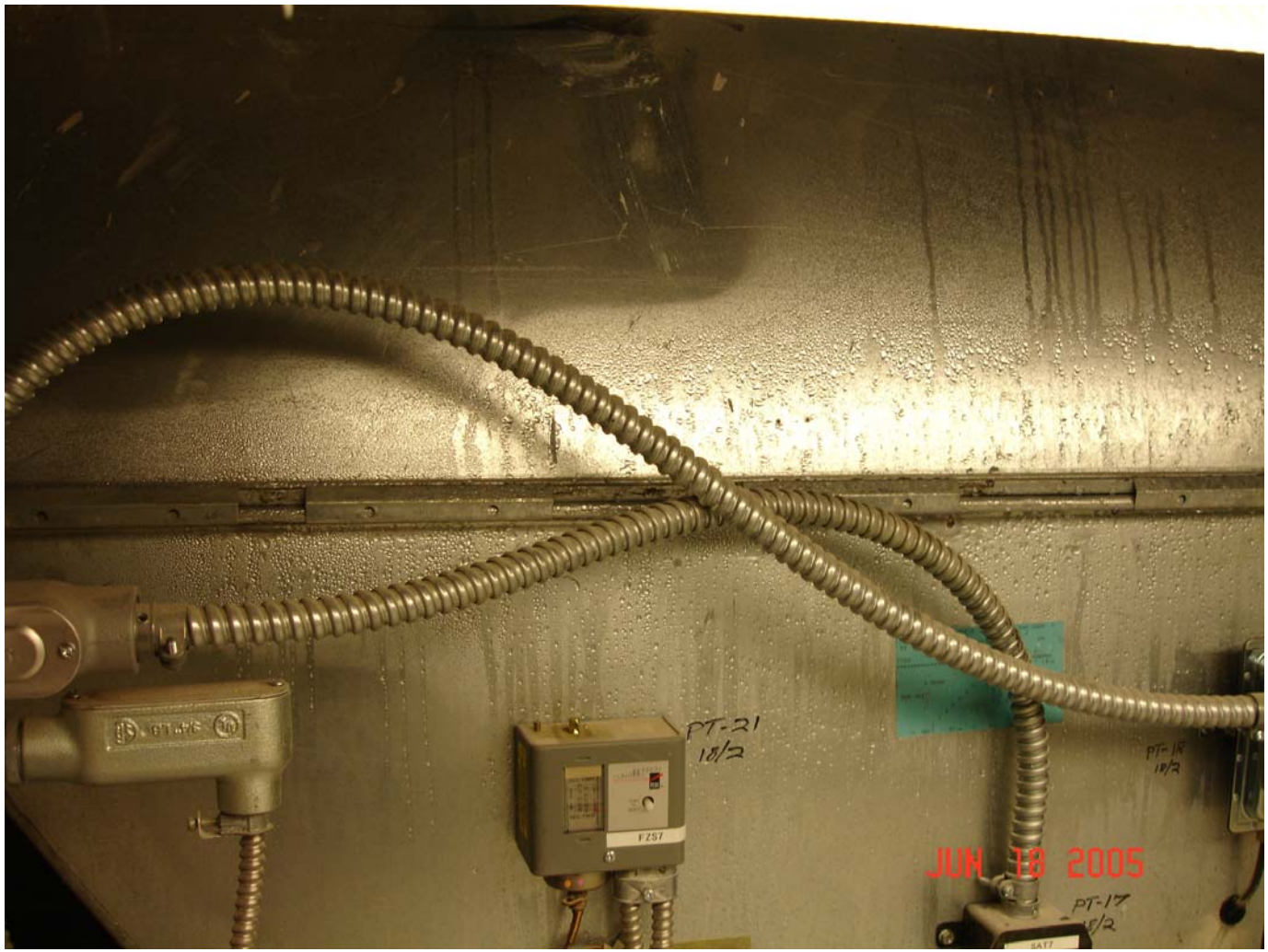
Possible condensate carry-over photo #1485.

Possible condensate carry-over photo #1486.

Condensate on exterior of duct photo #1458.

Condensate on exterior duct photo #1463.

Condensate on exterior duct photo #1464.



Gas vent penetration photo #1465.

Supply fan air bypass photo #1475.

Supply fan air bypass photo #1476.

Supply fan air bypass photo #1479.

Corrective action taken on AHU-7 / CU-7 to date

- Correctly wired the liquid line solenoid valves.
- Adjusted superheat on circuit #1 to 16°.
- Adjusted compressor #1 unloader to unload at 55 psig (30° saturated suction temperature) and to load at 70 psig (41° saturated suction temperature).
- Set hot gas bypass to be fully open at 53 psig (approx 28.5° saturated suction temperature). With an approximate 8 psig range (direct acting valve), hot gas will begin to open at approximately 34.5° saturated suction temperature).
- Acid tested the oil on compressor #1. Test was negative for acid.
- Tested the low pressure cutouts on circuits #1 and #2. cutout pressure was 22 psig and 24 psig respectively.
- Measured supply air volume at diffusers.
- Show balance comparison pdf.

RTU-1

- Area(s) served: Offices

Reported problems

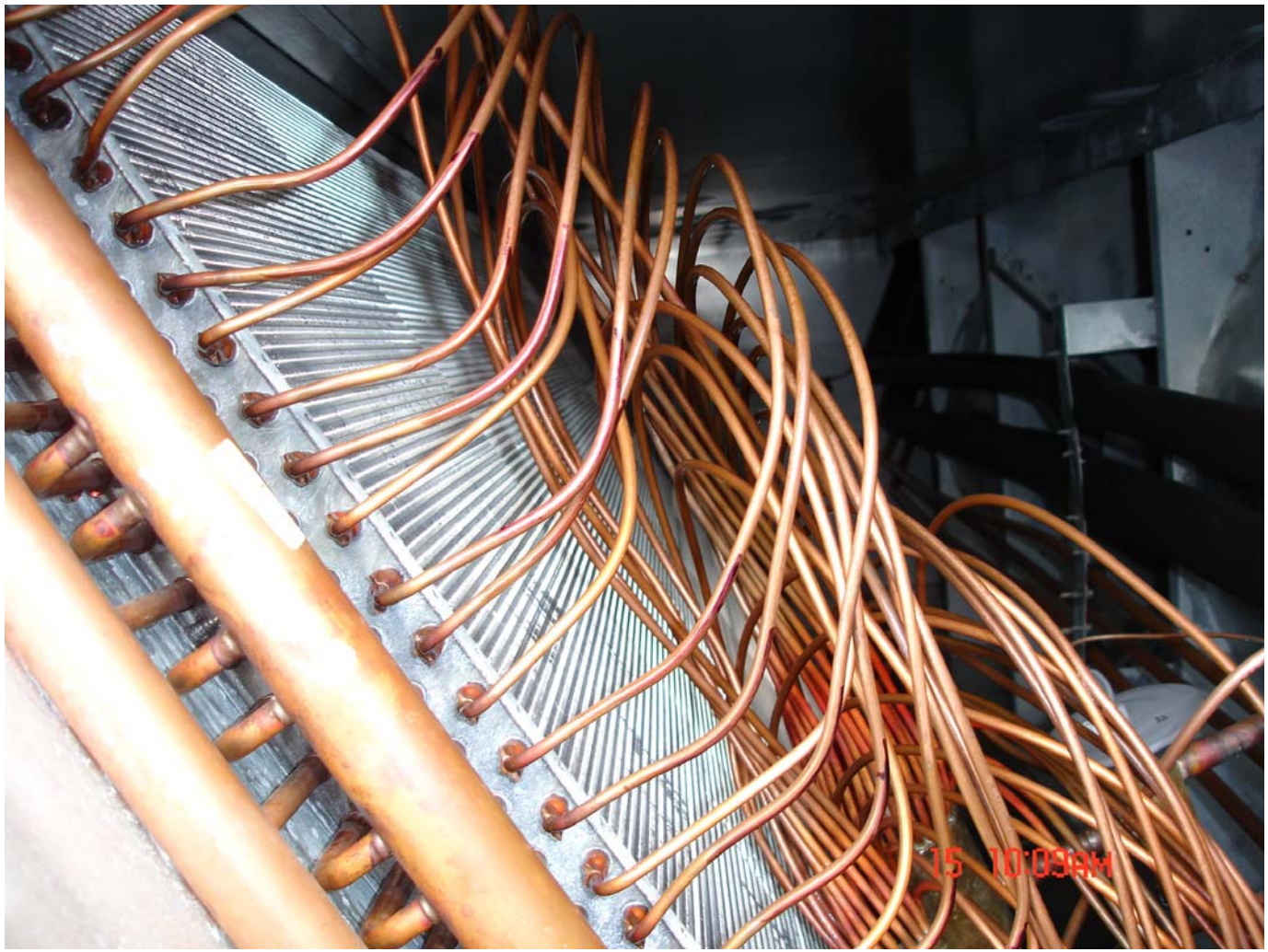
- Warm in summer, cold in winter.
- Baseboard heat on when cooling is required.
- Balance report in question.

Items noted during inspection of RTU-1 (during this visit).

- Superheat on all circuits is a little on the high side (approx 25°). May require adjustment based on compressor discharge temperatures.
- Distributor tubing rubbing on the top of the unit. See photo's #1449 and 1450.
- Air leakage under the unit at supply duct connections.
- Possible uneven coil loading or other problem (requires further investigation). On both circuits the lower suction headers have a surface temperature of 48° while the upper circuit suction headers measured 78°.
- Condensate discharges directly to the roof from a relatively high outlet (possible future roof problem). See photo's #1447, 1448.
- Supply air reset (by CCN controller) requires further investigation. Measurements were taken along with several screen captures but the data has not been processed.
- CAV diffusers with not control supply the first floor electrical closets. Air volume may be higher than design as these run wild and are quite noisy.
- The building is in a negative pressure relative to outdoors.
- Hot water baseboard control valves have not been investigated.
- Reheat is required in certain instances, but the boilers are locked out on outdoor ambient. This type of system will likely require the boilers to operate year round.

Distributor tubing photo #1449.

Distributor tubing photo #1450.



Condensate drain photo #1447.

Condensate drain photo #1448.

Corrective action taken on RTU-1 to date

- Disabled discharge air reset.

Unit ventilators

- Area(s) served: Classrooms

Reported problems

- Rooms warm in summer.
- Rooms humid.
- Rooms cold in winter.
- Balance report in question.
- Noise.

Items noted during inspection of unit ventilators

- Outside air dampers commanded closed but reading approximately 100 CFM of outdoor air.
- Air volume readings not complete but air volume on units measured is slightly higher or slightly lower than manufacturer's date. Paul to explain.
- Some insulation on compressor suction lines missing resulting in condensation.

Corrective action taken on unit ventilators to date

- None, observation and data gathering only.

Liebert unit (service call)

- Area(s) served: Data room #209

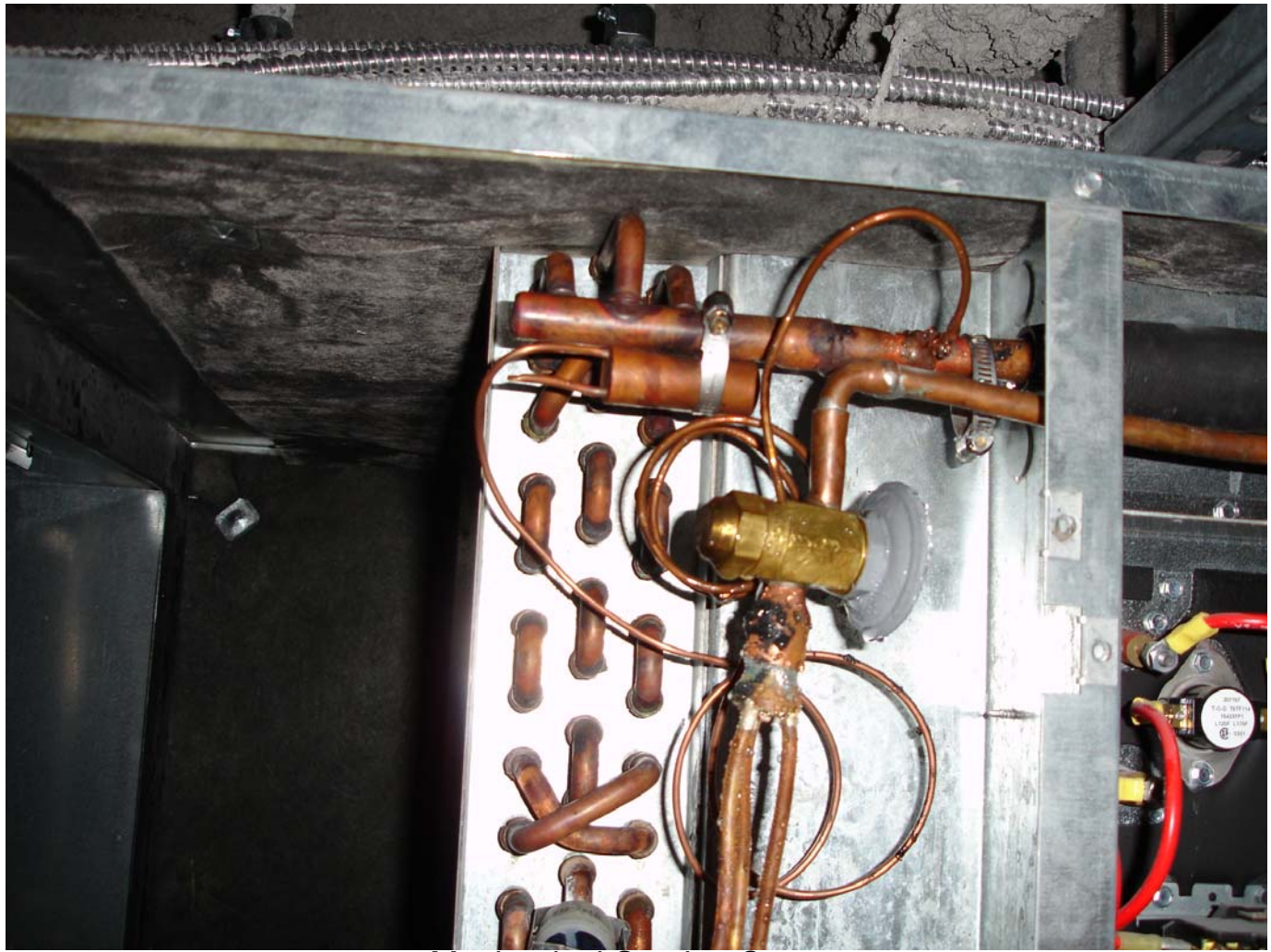
Reported problems

- Room in high temperature alarm.

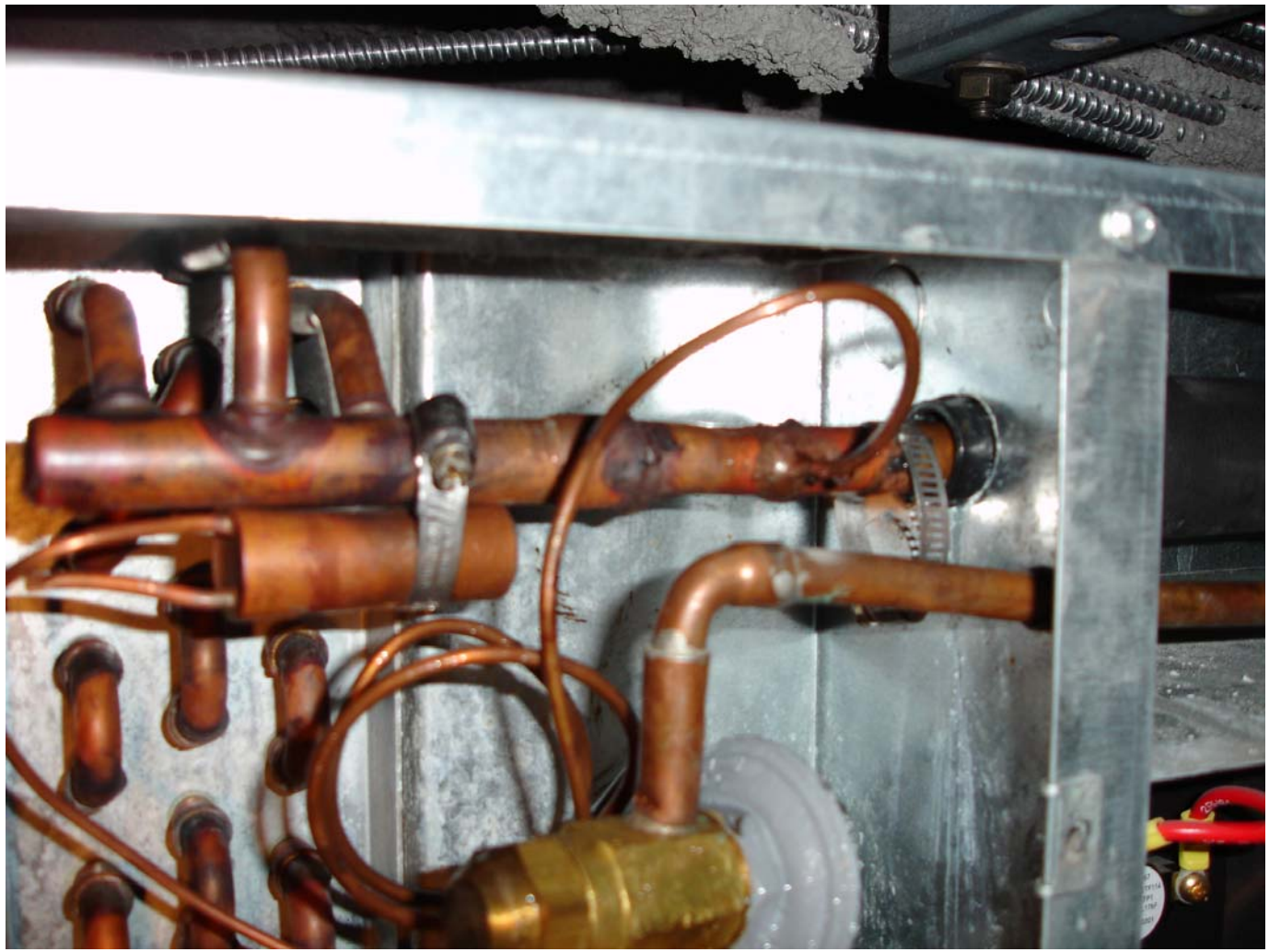
Items noted during inspection of unit ventilators

- Found faulty expansion valve. See photo's #1400, 1401.
- Dirty filter. See photo's #1396, 1397.

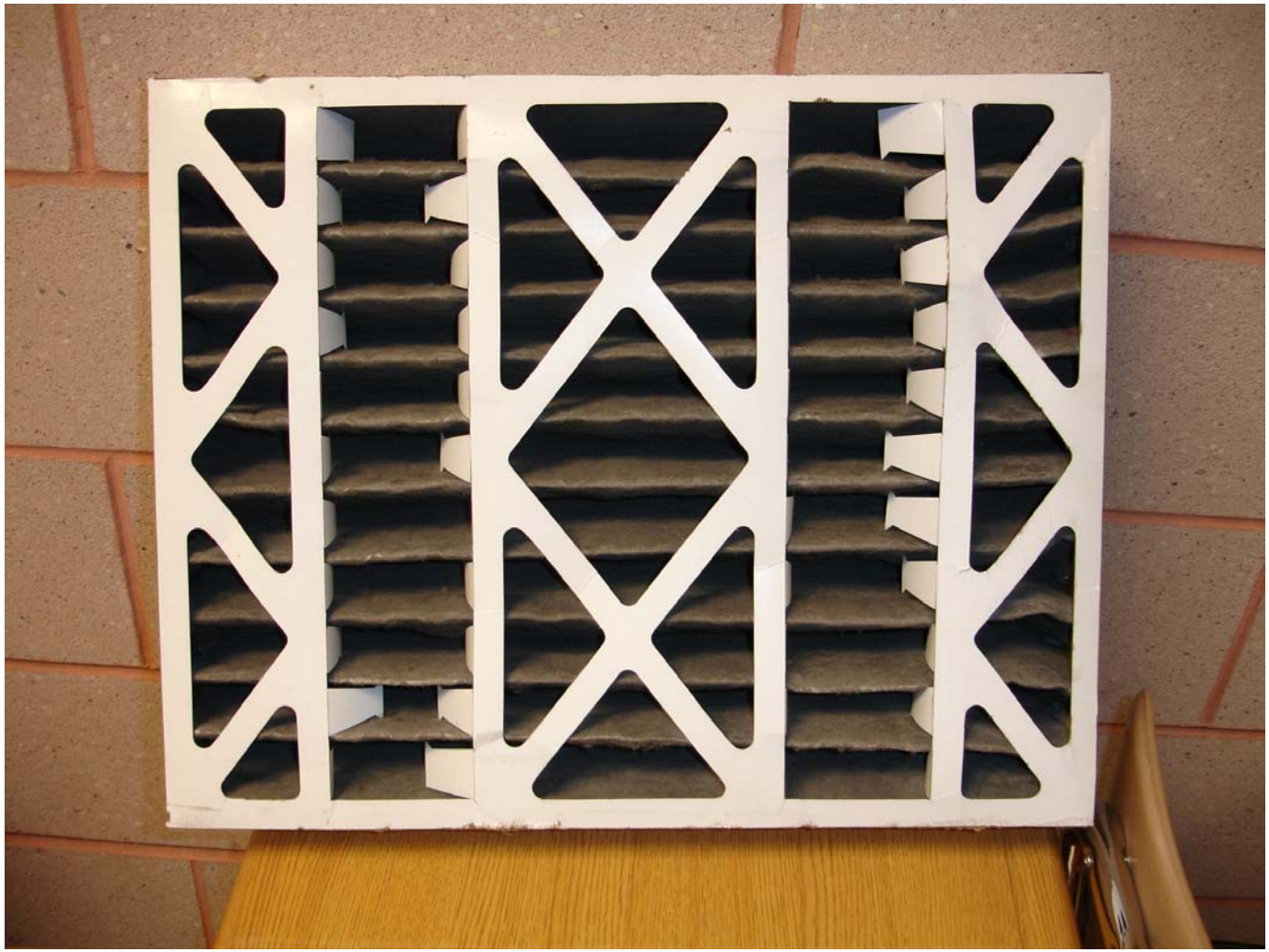
Expansion valve photo #1400 showing liquid entering suction line through external equalizer. Note condensate.



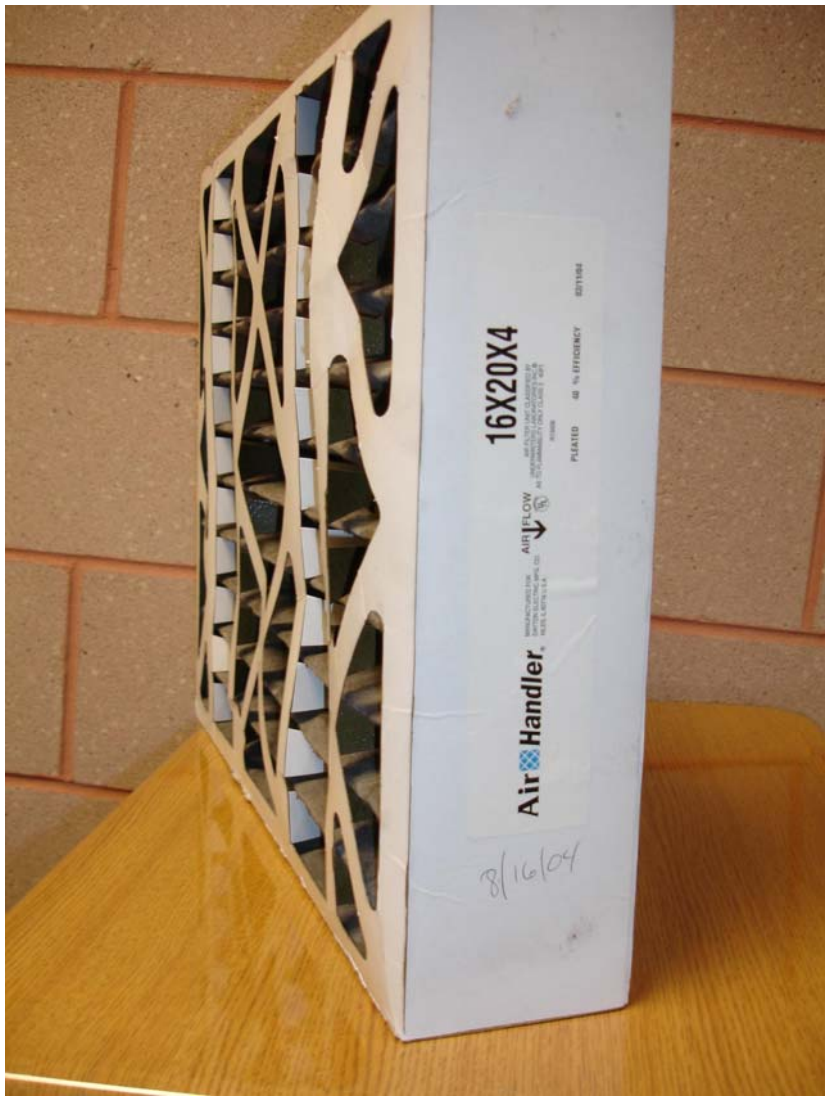
Expansion valve photo #1401 showing liquid entering suction line through external equalizer. Note condensate.



Air filter photo #1396.



Air filter photo #1397.



Other items to consider

- RH in the building runs very high due to infiltration, constant fan and control sequence (typical CAV control sequence).
- Was the control sequence approved by the Engineer?
- Outdoor air dampers on unit ventilators must be opened.
- Space temperatures should be decreased for cooling to a maximum of 72° to allow comfort with the relatively high humidity.
- Heating still to be investigated.

Corrective action taken on Liebert unit

- None. Reported problem to construction manager and correction was assigned to others. Disposition unknown.

Report on work performed from 7/20/05 through 7/26/05.

Systems examined

- AHU6 / CU6
- Attic finned tube
- Unit ventilators
- Radiation loop
- Boilers
- Freeze pump 6
- Principals' loop (flow)
- VAV 104

AHU-6 / CU-6

- Area(s) served: Corridors.

Reported problems AHU-6/CU6

- No cooling.

Observations as found

- Compressors not operating and condenser fans running.
- Faulty transformer for safety lockout circuit.
- Circuit #1 running high discharge pressure and high subcooling.
- Circuit #1 superheat a little low at the compressor.
- Reheat valve for 3rd floor reheat (RHV-9) bleeding by when closed.
- Dirty and matted condenser coil.

Repairs / corrections performed while on site.

- Replaced faulty control transformer.
- Started unit.
- Took a full set of readings.
- Adjusted superheat on circuit #1 to 24 deg.

AHU-6 / CU-6 notes

- Circuit #1 is running high head pressure. Could be overcharged. This should be investigated further addressed.
- Circuit #2 compressor oil level is high (7/8 glass).

Air handler 6, Photo #1409

Poor drain connection.
Condensate draining to floor.

Air handler 6, Photo #1409

- Separated liquid tight flexible conduit.

Air handler 6, Photo #1409

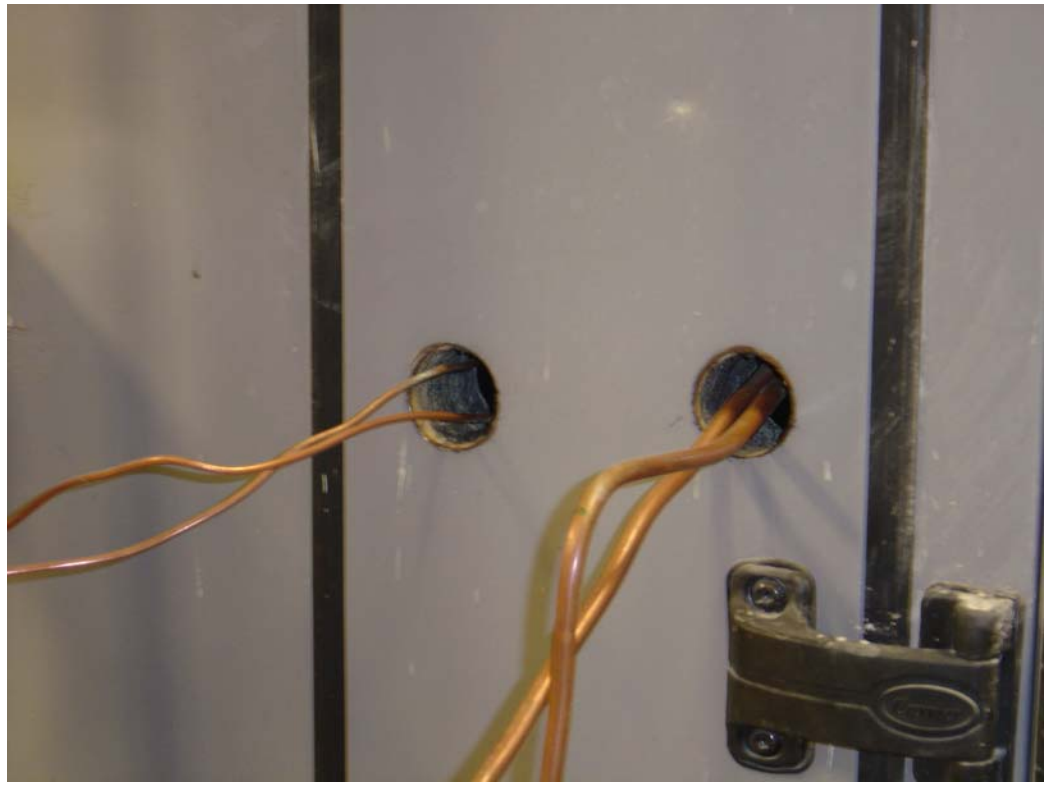
Suction line insulation missing which adds to condensate problem.

Air handler 6, photo #1410

- Penetrations not sealed.
- Metal to metal contact between copper and sheet metal.
- Uninsulated piping.

Air handler 6, photo #1411

- Copper tubing in contact with sheet metal.
- Penetrations not sealed.

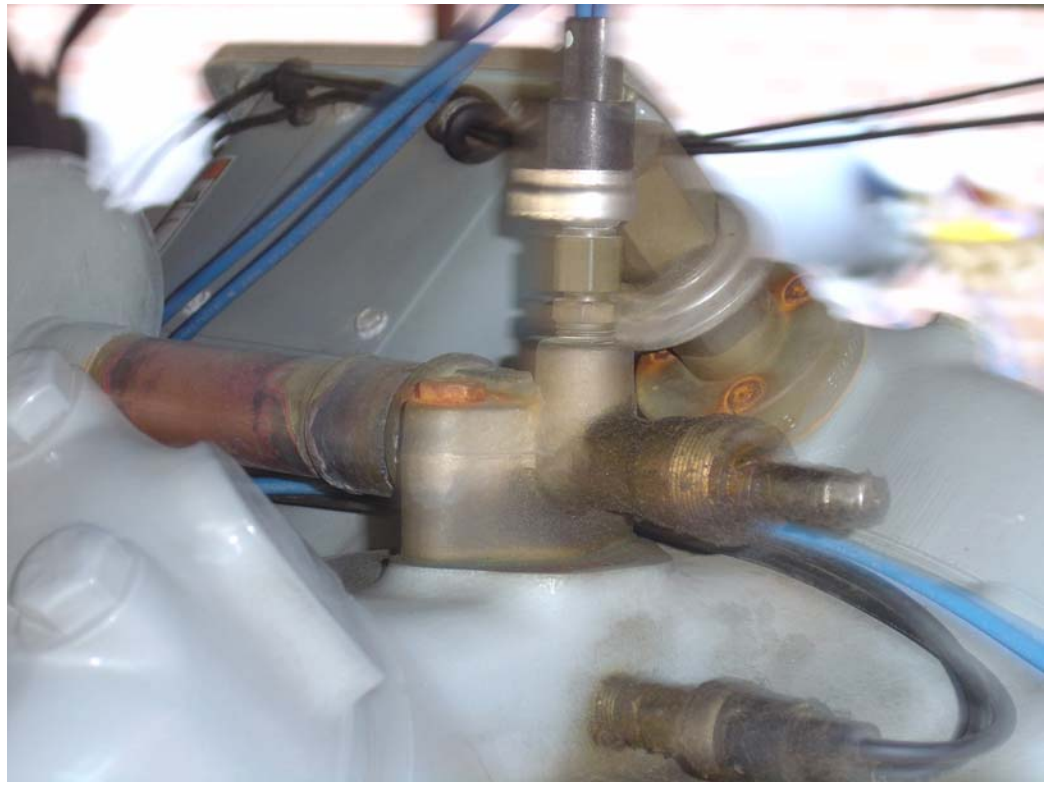


Condensing unit 6, photo #1413

- Dirty condenser coil.
- Service valve missing cap.

Condensing unit 6, photo #1419

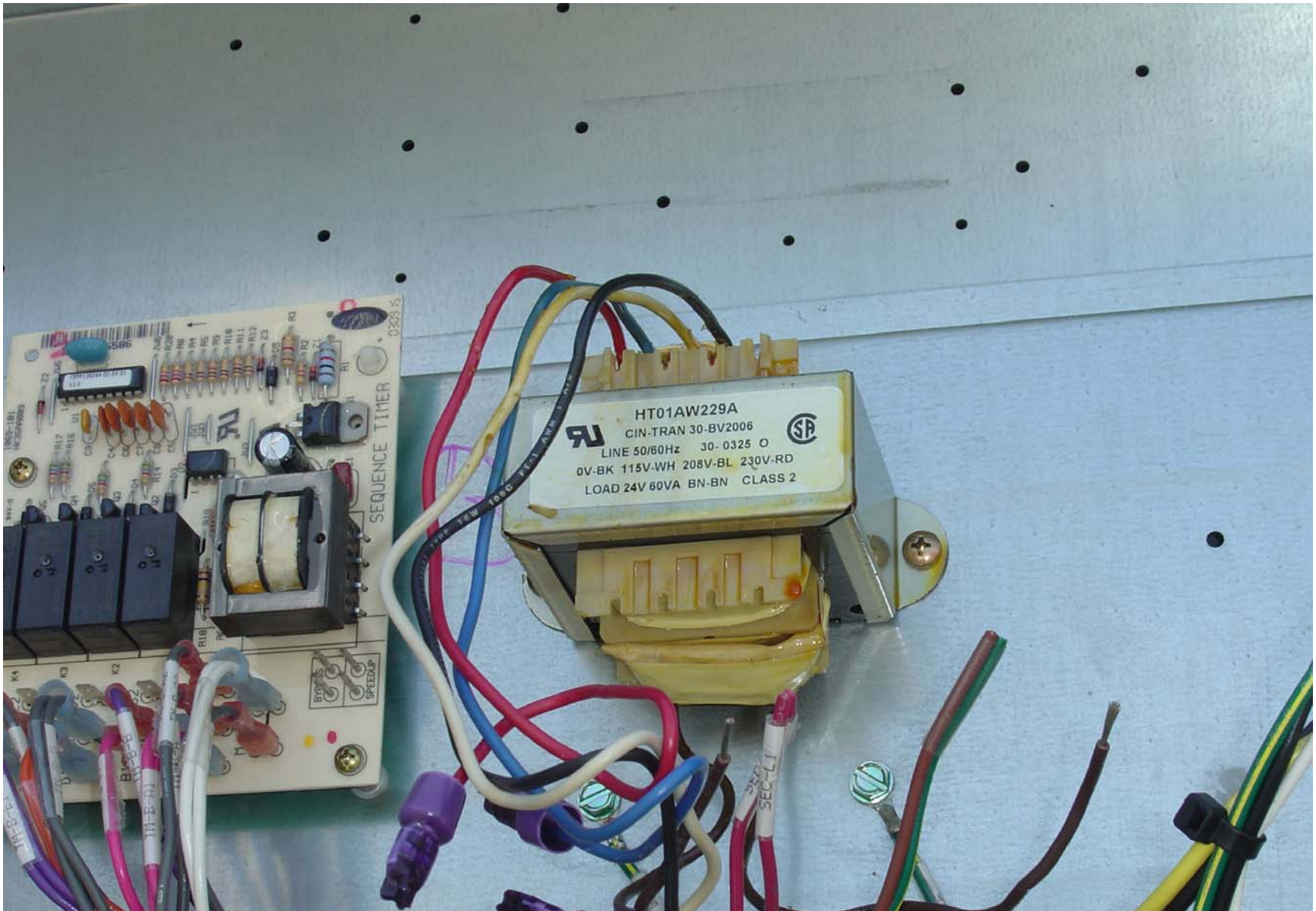
- Missing refrigeration valve caps.
- Evidence of leaking due to missing cap.



Condensing unit 6, photo #1416

- Uninstalled refrigeration valve caps.

Condensing unit 6, photo #1420, faulty transformer



Condensing unit 6, photo #1420, discharge pressure comparison ckt #1 vs. ckt #2

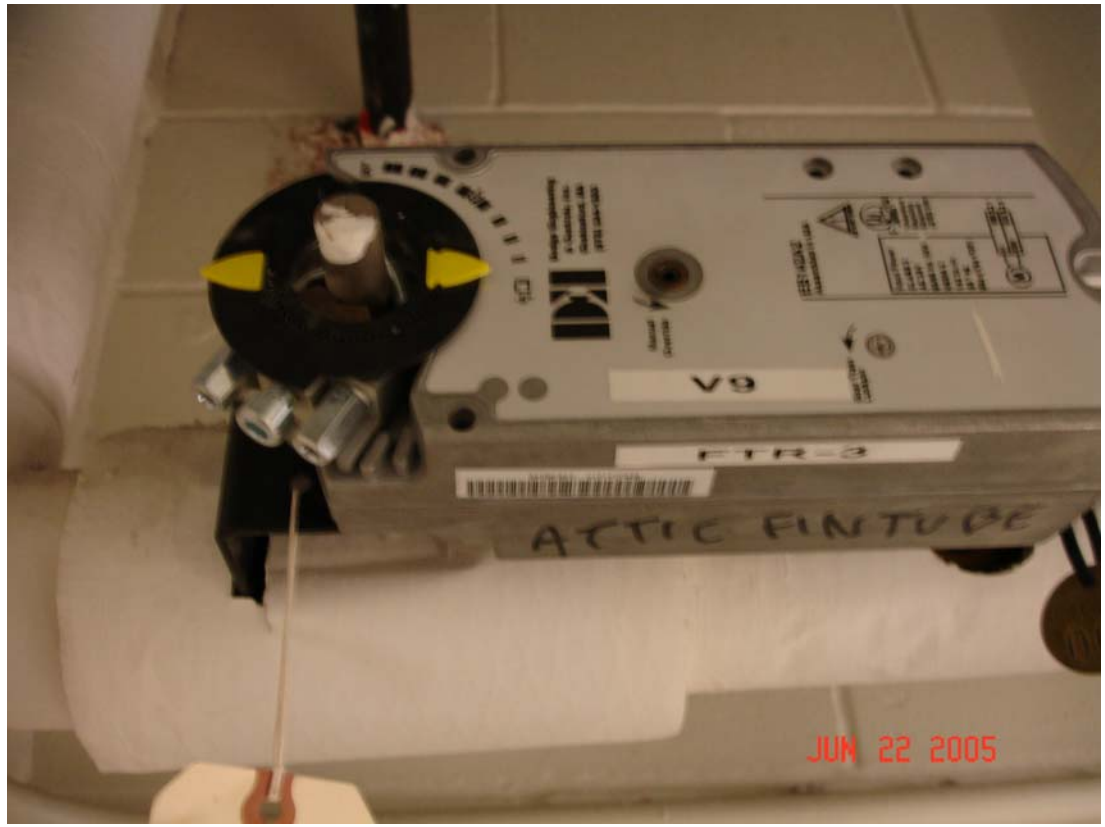
Attic finned tube radiation

Attic finned tube radiation, photo #1576

- Attic loop is piped to the main boiler loop (180 deg). Attic loop water is not reset based on outdoor temperature.

Attic finned tube radiation, photo #1575

- Unable to locate source of control. Valve is in the 100% open position. Anytime the boiler pumps are on this will allow full flow.



Attic finned tube radiation, photo #1576

Finned tube installed above insulation in corridor.
Question for Engineer: Is this correct?

Attic finned tube radiation, photo #1585

Finned tube and piping installed above insulation in uninsulated attic space.

Is this correct?

Attic finned tube radiation, photo #1587

Another photo of the attic radiation in the uninsulated space. This photo is above the corridor on the 3rd floor.

Attic finned tube radiation, photo #1588

- This photo shows attic finned tube radiation. Actual piping is reversed from that shown on drawing. Since flow was also reversed, the only impact is the 16’ sections and the 18’ sections of finned tube are installed on the opposite side of the building from how it is shown on drawing #M7.

Unit Ventilators

- Area(s) served: Classrooms, Teachers lounge.

General notes applicable to all units (7/5 through 7/20)

- Airflow was tested on all units.
- All except one unit are delivering between the manufacturers' advertised high speed design value, and design plus 15% with a dry coil (volume will drop slightly when coil becomes wet). Final values will be calculated for each unit and provided in our separate test report.
- Room occupied setpoints were lowered by XXX to 72° for cooling and 70° for heating.
- The minimum outside air was returned to the design settings (also by XXX).
- With the lower cooling setpoints the rooms are more comfortable however, room relative humidity is still high.
- All filters were changed by XXX following our original single unit inspection in early June.
- Any units that were lifted for leveling after the bases were foam sealed, must be resealed.
- Outdoor air dampers may need to be readjusted and aligned on all units.
- The electrical box insulation has fallen off on all units. We (MSC) re-glued this last winter but the adhesive apparently did not adhere properly since the casing temperature was low. Welded pins should be used.

General notes (continued) applicable to all units (7/5 through 7/20)

- With the boilers and pumps on and operating at 180°, MSC walked through all classrooms on the 2nd and 3rd floors and most classrooms on the 1st floor (not completed due to lack of time). Overheating was noted in the following areas:
  - 3rd floor: Room numbers 310, 320, 308
  - 2nd floor: Room numbers 226, 227, 232, 222, 213, 212, 203, 236, 235, 234.
  - 1st floor: Room numbers (not complete): 128, 132, 130, 138, 129, 127, 143.

- Further notes are available on the specific problems noted in each of these spaces.

Specific unit ventilator notes

- Units missing insulation on refrigerant distributor, suction line or both: 214, 111, 224, 129, 229, 232, 136.
- Room 310: The 3-way heating valve is in the full flow position (open). When boiler and pumps are on, the room receives full heat. Valve would not close via the controller but will close manually using an allen wrench. Actuator may be faulty or signal may be incorrect from controller. Unit also tripping on coil freeze protection (MagicAire device).
- Room 311: Heating valve not automatically driving open or closed. Unit adjusted (by others) for condensate drainage.
- Room 226: Weather stripping for mixed air damper is hanging off and needs to be re-glued.
- Room 227: Unit off due to condensate leak. Unit has been leveled (by others) but the condensate pan is still sloped away from the drain. The heating coil on this unit is slightly buckled indicating damage at some point. See photo #1404.
- Room 224: Heat valve actuator is hanging alongside valve and is not attached. See photo #1425.
- Room 306: Compressor noisy at startup.
- Room 111: Found wiring harness to motor pulled out.
- Room 318: Labeled as room 316 in program.
- Room 235: Labeled as room 255 in program.
- Room 212: Units' air noise is greater than other units of the same size. This is the single unit mentioned earlier that is delivering approximately 18% over design. Compressor is also noisy.

Unit ventilator, Photo #1387

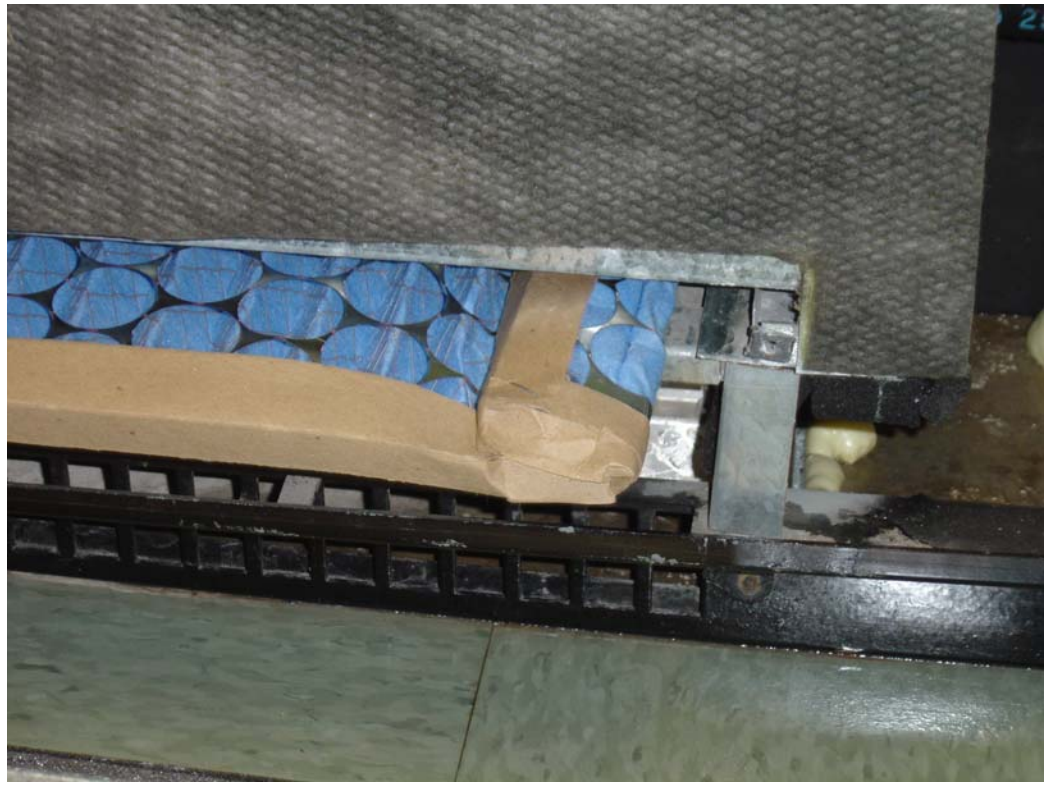
Equipment used for traverse of each size unit to establish the actual flow to establish a correction factor to allow use of the flow hood for other readings.

Unit ventilator, Photo #1389

Electrical panel insulation loose. Insulation glues to the bottom of the electrical panel.

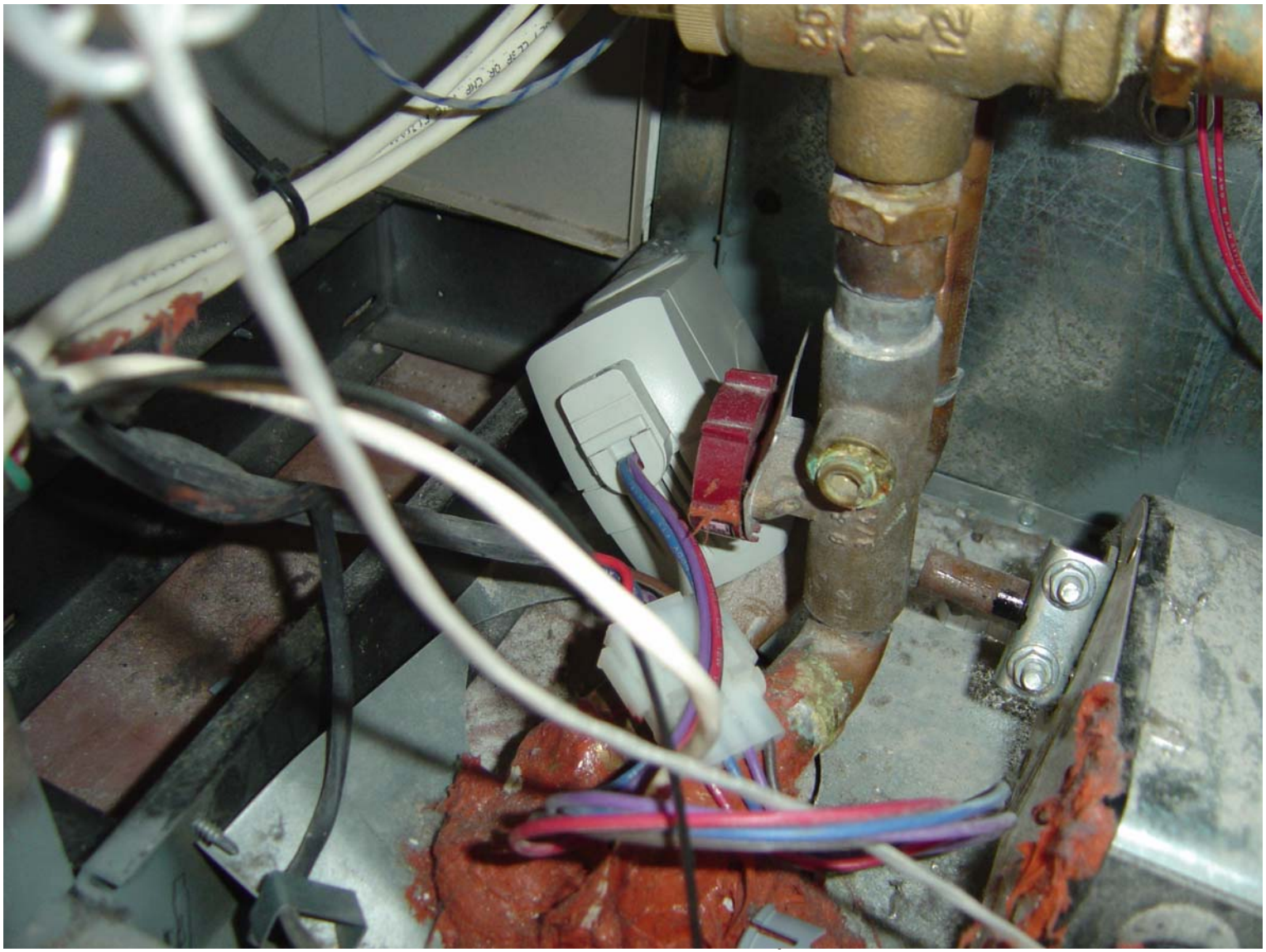
Unit ventilator, Photo #1390

Improper filter installation.

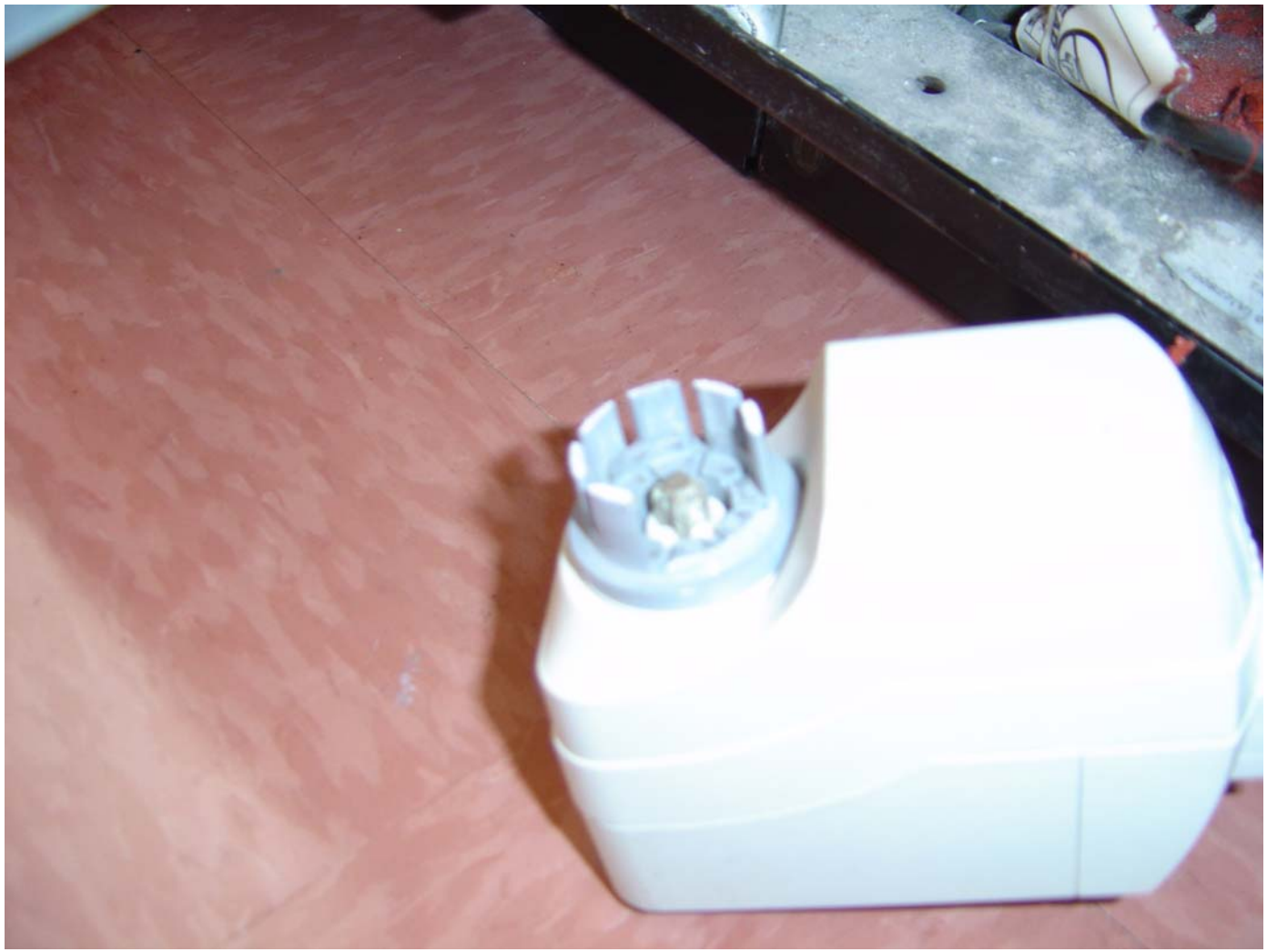


Unit ventilator, Photo #1404
Note bowed coil

Unit ventilator, Photo #1425 Valve actuator not attached to 3-way valve. Attachment device snapped.

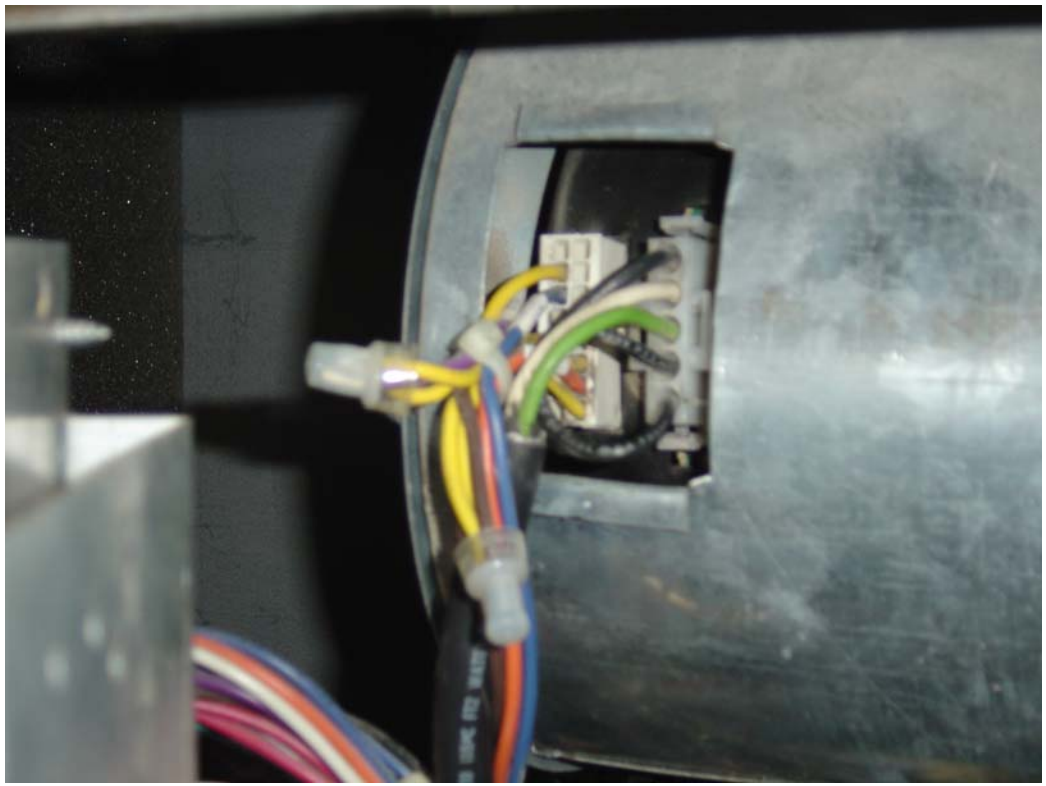


Unit ventilator, Photo #1426. View of broken attachment device for above actuator.



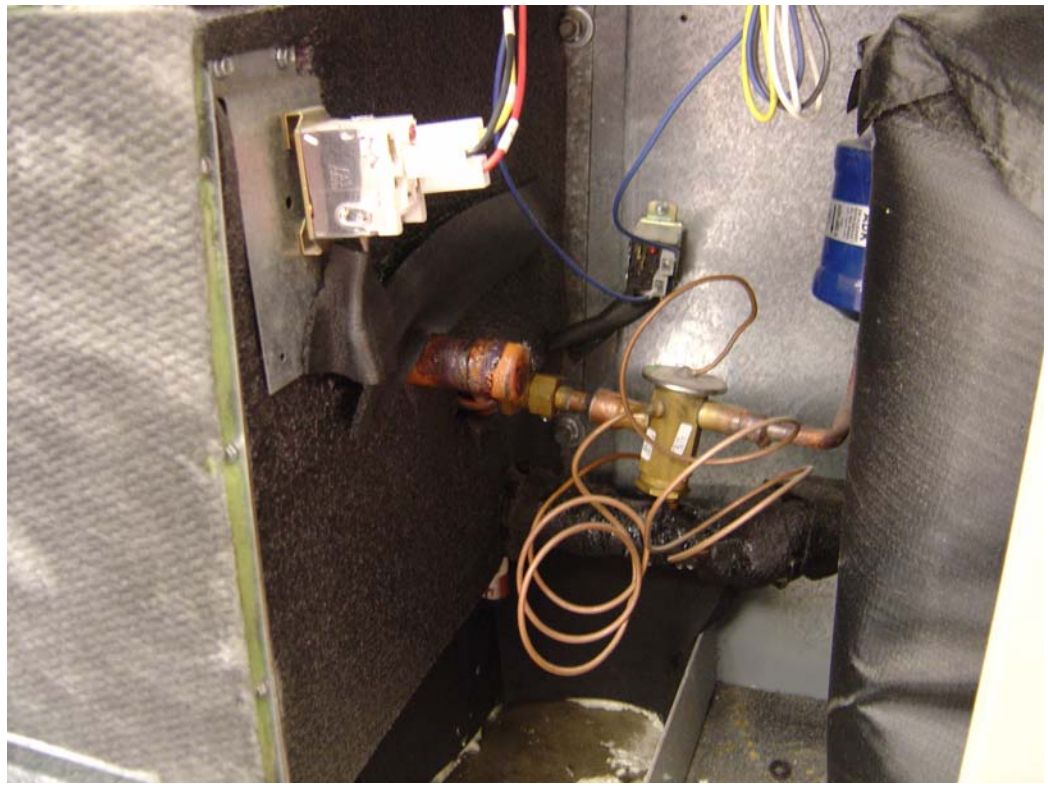
Unit ventilator, Photo #1393

The fan motor power and control connectors were found disconnected on room 111. The fan was not operating but the compressor was still cycling on and off on the mechanical freeze-stat supplied by the manufacturer.



Unit ventilator, Photo #1392

Expansion valve and distributor sweating in compressor compartment. Insulation is missing.



Unit ventilator, Photo #1406
room #227

- Photo shows approximate 5/8” deviation between top of unit and adjacent book shelf after shimming (by others).
- Unit still leaks as condensate pan is distorted.

Unit ventilator, Photo #1422
room #127 ceiling

- Photo shows two hot water baseboard zone valves installed above the ceiling of room #127. These valves control the hot water baseboard behind the book cases in rooms #127 and #222.
- Both valves are not wired and are manually locked in the open position.
- Both rooms have been reported to overheat.
- We only sampled this area. We did not check other units.

Radiation Loop

- Area(s) served: Corridors, office areas.

Reported problems

- Inadequate heat.

Observations as found

- Pump PR1 / PR2 (radiation pumps) flow found at 11.9 GPM at the pump station. (see photo #1559). Design flow is 40 GPM. Balancer's report shows a flow of 12.2 GPM.
- Flow rate at the Principals' office varied from 0.36 to 0.45 GPM (design is 0.98 GPM). Flow dropped to 0.26 GPM when the zone valve in an adjacent room was opened.
- No pressure taps on pumps to allow a cutoff test.
- Strainers clean.
- Found 2" circuit setter closed. The 1" circuit setter was 100% open.

Repairs / corrections performed while on site.

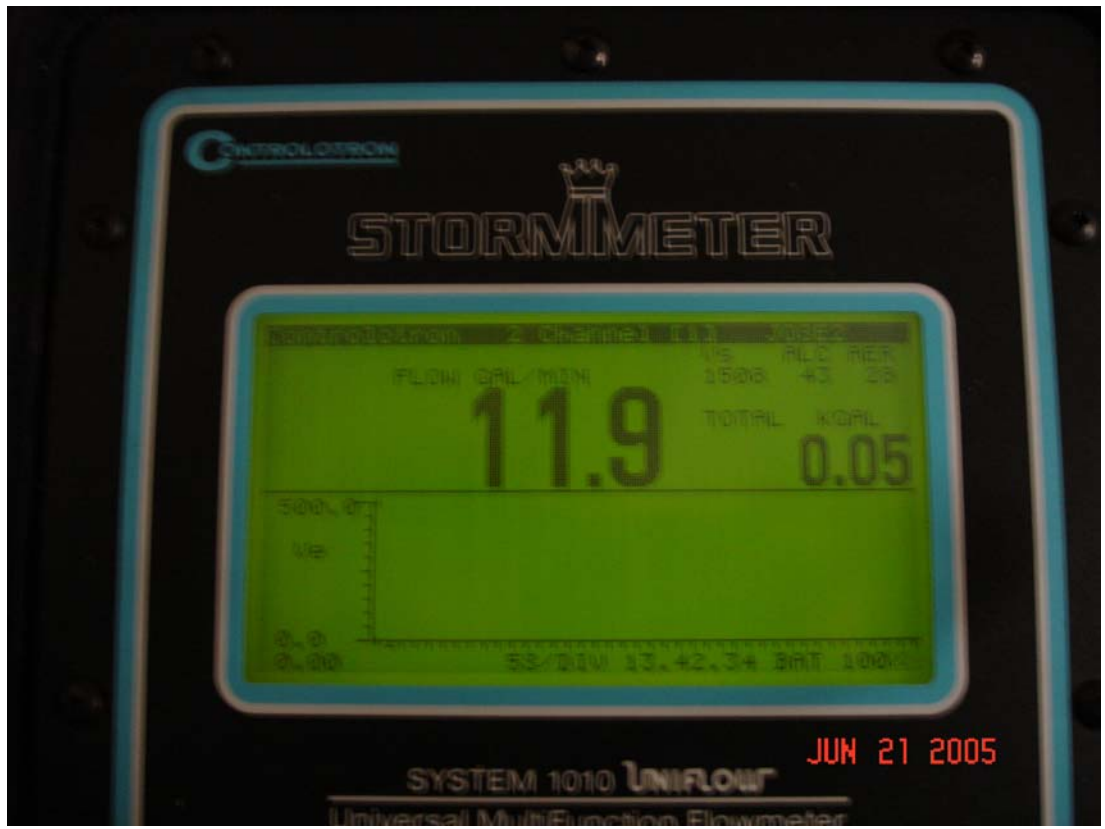
- Set 2” circuit setter to fully open. Pump flow increased to 49.5 GPM.
- Set the circuit setter to approximately 30 GPM to distribute as intended by the Engineer.
- Re-measured flow in Principals’ office at 1.48 GPM. No true balancing valve installed to balance each zone of baseboard.

Radiant loop notes

- In general, the reason for inadequate heat was that the circuit setter was closed serving the 2” branch of the radiant loop.
- With circuit setter closed, slight flow existed in the principal’s office. There may be cross connected piping or the balance valve may not close off 100%. Further investigation required.
- There is one zone of baseboard in a classroom (room without cabinets adjacent to unit vent) that is fed from the high temperature loop. Room number not recorded.
- There does not appear to be any control over the stairwell radiation. This baseboard is supplied by the high temperature loop.

Radiant loop, Photo #1559

Ultrasonic flow meter. Shows GPM flow on radiant loop as found.



Radiant loop, Photo #1574

Ultrasonic flow meter. Shows GPM flow on radiant loop after the 2” circuit setter was opened.

Radiant loop, Photo #1543

Photo shows hand valves possibly adjusted for flow (used as balancing valves).

Radiant loop, Photo #1540

Photo shows uninsulated radiant loop piping above the ceiling near Principal's office.

Radiant loop, Photo #1590

Typical baseboard cover. Thermostatic radiator valve is installed at the location of the flashlight on the floor and is not readily accessible.

VAV-104

- Area(s) served: Principal's office.

Reported problems

Inadequate heat.

Observations as found

- Took a circuit setter reading on VAV reheat coil. Circuit setter was set for 26% with a resulting ΔP was 0.68 ft. (off the readable scale).

Repairs / corrections performed while on site.

- Made final adjustment and was able to achieve 0.85 GPM at 1.02 feet ΔP.
- Design flow is 0.75 GPM.

VAV-104 notes

- VAV reheat actuator on 3 way valve would not move when commanded by controller. Problem must be investigated and corrected.

VAV 104
, Photo #1546

View of piping and circuit setter for reheat coil.

VAV 104
, Photo #1547

View of balancer's flow reading location. Al took flow readings on the other side of the tee and read 0.75 GPM. The balancer reported 0.1 GPM. Flow is available, but the 3-way will not permit it to flow through the coil.

Boilers

Observations as found

- Relief valves on both boilers are lifting each time the boilers fire from a cold start.
- Makeup valve set for 32 psig.
- Induced draft fan belts slapping and very loose.

Repairs / corrections performed while on site.

- None

Boiler notes

- Investigate and determine the cause of the relief valves lifting.
- Install a gauge between the makeup regulator and the ball valve to provide a gauge reading after adjustment.
- Repair belts.
- Boiler control circuit including outside air damper control were not tested.

Boiler photo #1528
Relief valves lift as boiler heats

Boiler photo #1533
System pressure above setting of relief valves

Boiler photo #1527
Expansion tank