**CCP Basics and Troubleshooting Part I: Overview, Priority Shutdown (Changeover Bypass and Delivered VAV)**

Topics: 1) A brief overview of CCP system function. 2) Suggestions for collecting basic information in order to begin troubleshooting problems with CCP systems.

Familiarity with CCP operation at the level of this overview is an absolute minimum requirement for servicing a CCP system. The ability to navigate the system to find answers to questions like those below, and to understand what they mean in terms of CCP operation, is essential to successful troubleshooting. This summary is a good starting point. There are also four separate summaries available for each of four core functions of the system: producing conditioned air, delivering conditioned air to zones, zone controller operations, and system communications. Note that these are summaries. See product documentation for complete information: CCP Operator Guide, VAV-SVU01A-EN available from e-library, or see HVAC Knowledge Center WAVE 1587, and UCM 4.2 Installation and Operations Guide, VAV-SVX01C-EN.

Produce Appropriately Conditioned Air: WAVE xxxxx, CCP Basics and Troubleshooting Part II: Producing Conditioned Air – AHU, Changeover, Supply Air Temperature Control, Outside Air Damper (CB)

Supply Air to Zones: WAVE xxxxx, CCP Basics and Troubleshooting III: Supplying Air to Zones – AHU, Static Pressure Control, Bypass Damper Control (CB)

Zone control: WAVE xxxxx, CCP Basics and Troubleshooting Part IV: Using Conditioned Air - Zone Controller Operations (CB and Del. VAV)

Communications: WAVE xxxxx, CCP Basics and Troubleshooting Part V: Internal Communications (Comm4)

The CCP III runs one of two possible sequences of operation, Change-Over Bypass (CB) or Delivered VAV (Del. VAV). In order to effectively troubleshoot a CCP system it is necessary to understand how the system is designed to work. What follows is a greatly condensed summary of the operation of each CCP configuration. The summary may be of value if it is necessary to service a CCP system, but when no prior information or training has been available. There then is a description of priority shutdown for both CB and Del. VAV. This is included for two reasons. A CCP in priority shutdown is not running at all. This is a specific situation that may be encountered on a service call so it is important to know the causes. In addition, the causes of priority shutdown emphasize some of the most important aspects of the CCP’s control sequence. Finally, there is a list of questions. They are meant to illustrate the type of information that will be helpful in understanding and troubleshooting CCP operation. Answering these questions should provide a good place to start troubleshooting as they are key aspects of CCP operation. The process will also necessitate looking at various parts of the system and this may provide additional information.

Both CB and Del. VAV are zoned systems but they differ in the way static pressure is controlled and in the way heat in the air handler is used. It is possible to view which sequence is active at the operator display under advanced/set-up and status, or on the main status page of the workstation software. The operator can not designate which sequence is used. The CCP determines which sequence to use by polling the air handler to determine its physical configuration.

**A Change-over Bypass System** consists of a CCP (operator display is optional), an air handler, up to 24 individual zone controllers, a communicating bypass controller, and a bypass damper. The communicating bypass controller includes sensors for supply air temperature and duct static pressure. Change-over bypass uses an air handler with a constant volume fan. Duct static pressure is controlled by the communicating bypass controller. Individual zone controllers modulate an air valve and local reheat, if present, to maintain a zone temperature setpoint. The CCP directs the air handler to produce either cold or hot air based on the number of zones that are too hot or too cold. The CCP commands the air handler to stage heating or cooling to achieve a supply air temperature heating or cooling setpoint as measured at the communicating bypass controller. The CCP communicates the supply air temperature to the zone controllers so they can determine whether the available air will heat or cool the spaces. Low capacitance, twisted pair, shielded, is used for communications between controllers. Polarity of the communications wire must be maintained throughout.

**Priority Shutdown in CB:** The CCP can not decide whether to request cold or hot air from the air handler if no zones are communicating or if no zones are voting. The CCP can not control supply air temperature, and the zone controllers can not determine their control action, if the supply air temperature sensor has failed or if the bypass controller is not communicating. Any of these conditions results in a CCP priority shutdown. Priority shutdown can also be initiated by a communicated command from a Tracker, a closure of the Priority Shutdown binary input on the CCP termination board, or by a closure of the Emergency Stop or High Temperature switch on the air handler. Priority shutdown is a catastrophic failure of some essential part of the CCP system. It means that the CCP does not have the minimum equipment and/or information needed to run. Any priority 3 diagnostic results in priority shutdown. See the IOM for a complete list. Priority shutdown can not be overridden or reset. The CCP will not run until the cause of the shutdown has been corrected. However, in many cases if the air handler has a hardwired zone sensor and setpoint, it will run stand-alone when the communications interface is disconnected. It will attempt to control temperature at the zone sensor as if it were a single zone constant volume unit. Duct static pressure will not be controlled. Zone controllers will not be able to determine the correct control action unless they have an auxiliary temperature sensor in the supply air. See HVAC Knowledge Center WAVE 2822.

**A Delivered VAV System** requires a CCP with an operator display, an air handler, and up to 32 zone controllers. Typically the air handler controls duct static pressure with a VFD, to a setpoint supplied by the CCP. The system functions like a typical VAS. When occupied, the air handler supplies cold air and controls duct static pressure. Building load and/or local reheat are the only heat sources. The CCP sends the air handler supply temperature to the zone controllers so they can determine their correct control action (whether the supply air would cool or warm the space). Local zone controllers modulate an air valve and stage local reheat, if present, to maintain local space temperature setpoints. Heat in the air handler is used only in morning warm-up and daytime warm-up. In both of these modes the fan and the heat operate at 100%. All local zone controllers drive their air dampers to the maximum flow position. Electric local zone reheat will usually not be available because the supply air temperature will be above the lockout point. DWU and MWU are intended to warm the building as a whole as quickly as possible. Obviously any zones that are already too warm will get even warmer, so temperature control in some zones may become worse.

**Priority Shutdown in Del. VAV:** The delivered vav sequence requires an operator display on the CCP. Lack of an operator display results in priority shutdown and the CCP will not run. As with the CB sequence, priority shutdown can also be initiated by a communicated command from a Tracker, a closure of the Priority Shutdown binary input on the CCP termination board, or by a closure of the Emergency Stop or High Temperature switch on the air handler. Failure of the supply air temperature sensor on the air handler results in priority shutdown. This information is essential since the air handler can not know if the supply air temperature is above or below setpoint, and it is not possible for zones to determine their control action. Basically none of the controllers can determine whether a particular action will make the situation better or worse, so they do nothing.

**Important information to begin troubleshooting:**

1. Is the system configuration Change-over Bypass or is it Delivered VAV.
2. How does the CCP control the air handler? Is there a TCI communications interface on the air handler, or is there a relay board in the CCP?
3. How many zones are there?
4. Is communications to the air handler (HVAC Comm. Status on System Status of the CCP Editor) up? Is communications to all zones up? Is communications up to the Bypass Assembly?
5. What is the supply air temperature? What is the supply air temperature setpoint?
6. What is the duct static pressure? What is the duct static pressure setpoint?
7. What is the fan status (on, off, % output)? What is the Bypass Damper position?
8. What are the operating mode (Occupied/Unoccupied) and the operating status (Heat/Cool/etc)?
9. How many stages of heating or cooling are operating?
10. How many heat and cool callers (Change-over Bypass only)? Are any zones tagged “No Vote”
11. How long before changeover is allowed (Change-over Bypass only)?
12. Are there diagnostics present?
13. What is the control action of the zones?
14. What are zone air damper positions? What are the zone minimum, and zone maximum air flow setpoints?
15. Are any zones overridden occupied, unoccupied, to max., or to min. airflow?

**Two Possible Short Term Solutions / Shortcuts:**

1) Restore to Factory Defaults. Sometimes the system is not working as desired because some part of the configuration has been changed by an unknown person for an unknown reason, possibly inadvertently or by mistake, possibly by an occupant, or on a previous service visit. This can be confusing for someone who is unfamiliar with the site. In some cases it may be most time efficient to use the restore to factory defaults function (Setup menu/Panel Utilities/Restore to Factory Defaults). This will result in a simple configuration that is known to work. All configuration returns to default values. It is possible to backup the database (with the workstation PC software) prior to restoring to defaults and this is probably a good idea. But, the backed up copy will contain the configuration that has been causing confusion. Zone names will be lost, but zone controller configurations will not. It may be best to prepare by writing down some notes about the system and configuration.

2) It may be possible to provide hot or cold air to the zones in an emergency by disconnecting the communications interface from the AHU. Provide a hardwired zone sensor with setpoint directly to the AHU and it will operate stand-alone. It will attempt to control temperature at the zone sensor (possibly in the return air) as if it were a single zone constant volume unit. Duct static pressure will not be controlled. Zone controllers will not be able to determine the correct control action unless they have an auxiliary temperature sensor in the supply air.

**CCP Basics and Troubleshooting Part II: Producing Conditioned Air – AHU, Changeover, Supply Air Temperature Control, Outside Air Damper**

Topics: 1) A summary of how the CCP decides what kind of air is needed, and how the CCP produces appropriately conditioned air. 2) Some suggestions for troubleshooting heat / cool mode change-over, heat / cool staging, outside air damper and supply air temperature problems.

**Changeover:** When using the Change-over Bypass sequence the CCP III commands the AHU to make either hot or cold air in response to conditions in individual zones. It is a voting system. Voting is somewhat complicated but the basic idea is that when a zone is too hot it requests cool air from the CCP; when a zone is too cold it requests hot air from the CCP. The CCP keeps track of the number of zones requesting hot air and the number requesting cold air and makes a decision to command the AHU appropriately. Zones have two types of votes, opposite callers and opposite strong callers. The number required for changeover is configurable (Setup tab 1 in the CCP workstation software editor, or CCP setup on the operator display). There is also a minimum time to changeover. This is also configurable, the default is 15 min. Be aware that voting can be more complicated than this summary. In particular the rules for voting depend on zone configuration for local heat and priority local heat. In addition zones can be tagged (Setup tab 1) to prevent voting if zone temperature is a long way from setpoint for an extended period, or configured to never vote (individual zone editor). This is good because it can prevent a single problem zone from driving operation of the entire system. However, it also means that a zone that is far from setpoint may be unable to request changeover. Information about zone votes is on the CCP editor Service Summary tab of the CCP workstation software, and below on the Zone List (this does not auto refresh). It is also available on the operator display. See HVAC Knowledge Center WAVE 2589 and the CCP III Operator Guide VAV-SVN03A-EN (available on e-Library) for details. The control mode must be set to Auto for changeover to occur (CCP editor setup tab 1 of the workstation software).

**Staging heat and cooling and supply air temperature control:** The CCP uses the Supply Air Temperature sensor on the Communicating Bypass controller (typically located in the duct between the AHU and the bypass damper) to control supply air temperature. There are configurable supply air temperature setpoints for heating and cooling (found on setup tab1 on the CCP editor of the workstation software, or on the operator display). The CCP will command the AHU to stage heating or cooling on or off to achieve the supply air temperature setpoint. Keep in mind that the primary purpose of controlling supply air temperature is to provide either air that will cool zones or air that will warm zones. Control of supply air temperature per se. is a secondary function and control to within a narrow range is not necessary. Expect a range of about +/- 5-8 °F. The AHU will not heat to maintain a cooling supply air temperature setpoint nor will it cool to maintain a heating supply air temperature setpoint. If all voting zones are satisfied (there are no callers) the CCP will not request heat or cooling. The AHU will supply return air and outside air required for ventilation. If the supply air temperature setpoint is set close to 70° it may cause problems for zone control. This is because it will be hard for the zone controllers to determine whether the supply air will heat or cool the space.

If the AHU has an economizer and the outside air conditions allow economizing, the AHU will use economizer cooling as the first stage of cooling. It will not use any DX cooling until the outside air damper (OAD) is open 100%. The decision to economize can be local (set up using a POT on the economizer module at the AHU), or remote (using dry bulb temperature at the hardwired OAT sensor on a Tracker). Configure the economizer for local or Tracker control and set the minimum position on Setup tab 2 of the CCP editor in the workstation software, or at the operator display. Status tab 2 in the CCP editor shows whether economizing is presently allowed. The CCP is designed to use an AHU with two stages of cooling. If the AHU has an economizer and only a single compressor, the compressor may not run at all when economizing is allowed.

The CCP is capable of demand controlled ventilation. This can result in the outside air damper being open beyond the minimum position when conditions would not allow economizer cooling. On hot days this may allow warm humid air into the AHU for the purpose of ventilation. This increases the demand for cooling and may make it harder (in extreme cases impossible) for the AHU to maintain its supply air temperature setpoint.

Newer versions of the Voyager and Precedent economizer module use a different method to determine the outside air damper minimum position to implement an ASHRAE standard for demand controlled ventilation. This sometimes results in a minimum position that is half the expected value. See Knowledge Center WAVE 36044.

**Troubleshooting Suggestions:**

1. Before troubleshooting make sure the unit is not in Calibration or in Balance Mode. Check for overrides. (Setup Tab 2, Service Summary, After Hours Button). Check Occupancy. Check the Alarm Log.

2. Consider using Restore to Factory Defaults as a troubleshooting tool. Sometimes the system is not working as desired because some part of the configuration has been changed by an unknown person for an unknown reason, possibly inadvertently or by mistake, possibly by an occupant, or on a previous service visit. This can be confusing for someone who is unfamiliar with the site. In some cases it may be most time efficient to use the restore to factory defaults function (Setup menu/Panel Utilities/Restore to Factory Defaults). All configuration returns to default values. This will result in a configuration that we know will work. It is possible to backup the database (with the workstation PC software) prior to restoring to defaults and this is probably a good idea. But, the backed up copy will contain the configuration that has been causing confusion. Zone names will be lost, but zone controller configurations will not. It may be best to prepare by writing down some notes about the system and configuration.

3. If zones are too hot and AHU is heating, or if zones are too cold and the AHU is cooling, check the things that influence changeover.

a) Make sure that the control mode is set to Auto on CCP Editor Setup Tab 1.

b) Check the number of votes required for changeover (Setup Tab 1). Check the number of current votes (CCP Editor Status Tab 1 or CCP Editor Service Summary).

c) Check that zones are not tagged (CCP Editor Service Summary Zone status), or disable Tagging (Setup Tab1). Check that zones are allowed to vote (individual zone editors).

d) Check the time remaining to changeover. If the changeover allowed in time (CCP Editor Service Summary) is 110 the control mode is not set to Auto.

4. If the AHU is in the cooling mode but no DX cooling is on:

a) Check the Heat/Cool mode on the Service Summary.

b) Check for alarms and diagnostics. Check the AHU for error codes. Run the AHU in test mode to be sure DX cooling runs.

c) Check the supply air temperature setpoint and the supply air temperature (CCP Editor Service Summary). The AHU will not run DX cooling if the setpoint is satisfied. Do not expect a deviation from setpoint less than +/- 5-8 degrees.

d) Check for cool callers. The CCP will not request cooling if there are no cool callers.

e) On CCP Editor Status tab 2; check whether the AHU is economizing. Check the OAD position. When economizing, the AHU will not run DX cooling until the OAD is open 100%.

f) Check the number of compressors. Single compressor units will not run the compressor when economizing.

5. If the AHU is in the heating mode but no heat is on:

a) Check the Heat/Cool mode on the Service Summary.

b) Check for alarms and diagnostics. Check the AHU for error codes. Run the AHU in test mode to be sure heating comes on.

c) Check the supply air temperature setpoint and the supply air temperature (CCP Editor Service Summary). The AHU will not run heat if the setpoint is satisfied. Do not expect a deviation from setpoint less than +/- 5-8 degrees.

d) Check for heat callers. The CCP will not request heat if there are no heat callers.

6. If the supply air temperature is far from setpoint:

a) Check for alarms and diagnostics. Check the number of Heat/Cool stages running on the Service Summary.

c) Check whether Supply Air Tempering is enabled (Setup Tab1).

d) A deviation from setpoint as much as +/- 5-8 degrees is probably normal.

e) Check the number of compressors. Single compressor units will not run the compressor when economizing.

7. The supply fan is not running.

a) Check the schedule. Make sure the CCP is occupied. See Knowledge Center WAVE 8834 for schedule priority. Run the unit in test mode.

b) Check the occupied fan mode on Setup Tab 1.

c) Check the Alarm Log. Any priority 3 diagnostics result in priority shutdown and the system will not run.

8. The supply fan is running when the CCP is Unoccupied:

a) Make sure there are no timed override requests (After Hours Button).

b) Make sure all zones and groups are unoccupied. A single occupied zone or group will require the AHU to run.

c) Make sure that no zone temperature is above or below its unoccupied setpoints.

d) In some cases, high CO2 values will cause the AHU to run when it is unoccupied.

9. If status shows the OAD open more than the minimum position and OK to economize is NO (Status Tab 2):

a) Check the OAD actuator. It may be stuck.

b) The demand controlled ventilation (CO2) sequence may be causing the damper to open.

10. If status shows the OAD open less than the configured minimum (i.e. half the configured minimum):

a) This probably due to the new economizer sequence for demand controlled ventilation. See Knowledge Center Wave 36044.

11. It may be possible to provide hot or cold air to the zones in an emergency by disconnecting the communications interface from the AHU. Provide a hardwired zone sensor with setpoint directly to the AHU and it will operate stand-alone. It will attempt to control temperature at the zone sensor (possibly in the return air) as if it were a single zone constant volume unit. Duct static pressure will not be controlled. Zone controllers will not be able to determine the correct control action unless they have an auxiliary temperature sensor in the supply air.

**CCP Basics and Troubleshooting Part III: Supplying Air to Zones – AHU, Static Pressure Control, Bypass Damper Control (CB)**

Topics: 1) A summary of how the CCP makes an appropriate volume of conditioned air available to zones. 2) Some suggestions for troubleshooting problems with static pressure setpoint, static pressure control, bypass damper calibration, and bypass damper control.

In the CCP Changeover Bypass system duct static pressure is controlled with a bypass damper. The Communicating Bypass Assembly contains a controller that is identical to the zone controllers (UCM 4.2). It is on the same Comm4 communications link as the AHU TCI interface and the zone controllers. It must have dip switch address 33. The system will not run if there is no controller at address 33. The system’s supply air temperature sensor and the duct static pressure sensor are terminated on the bypass controller. Values from these sensors are communicated to the CCP and displayed on the CCP Editor Service Summary Tab of the workstation software and at the operator display. The bypass controller modulates the bypass damper, using tri-state modulation, to maintain a static pressure setpoint communicated from the CCP. The configured actuator drive time must be correct for this to work correctly (Setup Tab 1). Ordinarily the CCP runs a calibration sequence once a day on the transition from occupied to unoccupied. It also calibrates on a power cycle, or on a command from the operator display or the workstation software. Calibration takes about fifteen minutes. There is no way to prevent calibration on a power cycle so be aware that normal operation will not resume for at least fifteen minutes after power is turned on.

During calibration a zero flow reading is taken, the bypass is driven closed, zone dampers are driven open, the fan turned on, and a duct static pressure setpoint is established. The static pressure setpoint is not configured directly. Instead, a configurable multiplier (Setup Tab 1) is applied to a reference pressure taken during calibration. The reference pressure is determined with the bypass damper driven closed and zone dampers driven open. See Knowledge Center WAVE 4876. If calibration fails the default setpoint is .5 IWC. If the static pressure sensor fails the default bypass position is 50%. Failure to read a valid zero flow is a common cause of calibration failure.

**Troubleshooting Suggestions:**

1. Before troubleshooting make sure the unit is not in Calibration or in Balance Mode. Check for overrides. (Setup Tab 2, Service Summary, After Hours Button). Check Occupancy. Check the Alarm Log.

2. Poor ductwork design, improper air balance, or incorrectly sized supply fan capacity can make it impossible to control duct static pressure effectively.

3. Bypass Damper / duct static pressure is too high or too low / low air flow / noisy ductwork:

a) If the bypass position is always 50% or the static pressure setpoint is .5 IWC investigate the static pressure sensor and check calibration.

b) Make sure bypass calibration succeeded. When calibration fails the damper will be at a default position of 50% and the default duct static pressure setpoint will be .5 IWC. Look for Bypass Calibration Fail in the Alarm Log. The static pressure sensor needs to see a zero value during calibration. If there is air flow in the duct during calibration it will fail. Some causes of failure are supply fan or exhaust fan running during calibration. Series VAV fans running during calibration. Calibration will also fail if the sensor is faulty.

c) See Knowledge Center WAVE 1084 to troubleshoot the static pressure sensor.

d) The Bypass Damper can be overridden for the purpose of troubleshooting (Panel Setup Field Service Tab of the workstation software). It can also be overridden from the operator display.

e) Override the damper open and closed and observe duct static pressure. Pressure should increase when the damper is closed.

f) Check that the actual position of the bypass damper is the same as reported status. The bypass damper is controlled with a tri-state modulating actuator. If the drive time is configured incorrectly (Setup Tab 1), or if the actuator sticks, the actual position of the damper will not match the reported position. Override the damper and measure the drive time with a stopwatch.

g) Make sure the bypass damper actuator is wired correctly. If wired backwards it will always drive the wrong direction. Override open and closed and check direction.

h) The bypass controller uses triacs to drive the damper either open or closed. The triacs switch to ground. Test the actuator by grounding drive open and drive closed leads.

4. Zone controllers are in pressure dependent mode.

a) See CCP III Zone control Basics.

**CCP Basics and Troubleshooting Part IV: Using Conditioned Air - Zone Controller Operations (CB and Del. VAV)**

Topics: 1) A summary of the basics of CCP zone controller operation. 2) Some troubleshooting suggestions for zone control problems with CCP systems.

**Zone Controllers:** Each zone uses a UCM 4.2 VAV controller. The UCM 4.2 communicates using the Comm 4 protocol on an 18 AWG, low capacitance, twisted pair, shielded communications wire. The UCM 4.2 controls zone temperature by modulating an air damper, operating an optional series or parallel fan, and/or optional local heat. There is a binary input that can be used for an occupancy sensor. There is an analog input that can be used for either space CO2, or an auxiliary temperature. For stand-alone operation aux temp is used for source air temperature. Complete configuration of the zones is done using the CCP workstation software (individual zone editor) or with Rover. Configuration of flow setpoints can be done from the operator display. This is a summary of the main points. All details are not included. See UCM 4.2 Installation and Operations Guide, VAV-SVX01C-EN for more detailed information.

**Air Flow Setpoints:** Flow setpoints are normally determined by design considerations such as heating or cooling load and ventilation requirements. In pressure independent operation the UCM uses one of four air flow setpoints, Max Flow, Min Flow, Min Heating Flow, Min Local Heat Min Flow. Flow below 5% nominal or above 110% nominal place the controller in pressure dependent mode. In pressure dependent mode the equivalent percent position will be used. There is a separate minimum position that is used for pressure dependent mode (default 40%). See HVAC Knowledge Center WAVE 5744 or the UCM 4.2 Installation and Operations Guide, VAV-SVX01C-EN. The CCP communicates a supply air temperature to the zones. If the supply air is hot and the space temperature is warm, or if the supply air is cold and the space temperature is cold, the controller will use a minimum flow setpoint. This allows the controller to provide minimum ventilation requirements but to limit the flow of air that would drive space temperature farther from setpoint. See HVAC Knowledge Center WAVE 4875 for a complete flow setpoint arbitration table.

The controller uses the cross-sectional area of the box to determine nominal flow and to calculate air flow. If the box size is configured incorrectly, the calculation and therefore flow readings will be wrong. Because control becomes pressure dependent at a proportion of nominal flow, incorrect configuration may cause the controller to report pressure dependent operation.

**Control Action and Auto Changeover:** Control action defines whether the supply air can be used to warm or cool the space. The control action of each zone can be viewed in the Group / Zone List of the CCP Editor of the workstation software. This status does not auto-refresh, press refresh frequently. Zone controllers determine control action by comparing supply air temperature and space temperature. Supply air that is at least 10° warmer than the space will result in control action of heat. Supply air that is below space temperature results in control action of cool. So, control action change-over to heat occurs at 10° above zone temperature. Control action changeover to cool occurs below space temperature. Control action does not change over when supply temperature is between zone temperature and zone temperature + 10°. In this region a minimum flow setpoint (may be either cooling or heating) will always be used. Supply air temperature is supplied by the CCP from the supply air temperature sensor at the communicating bypass assembly, or in some rare cases by the supply air temperature sensor of the AHU. This is one reason the system can not run if the supply air temperature sensor fails or if the communication is down to the bypass controller. If they don’t know supply air temperature the zone controllers can not know whether opening the air valve will make the people happier or unhappier, so they do nothing.

**Air Valve Operation:** The air damper is driven open and closed by two triac outputs using tri-state modulation. The drive time must be configured correctly for this to work (Zone Editor Setup Tab 3). The air valve can control air flow using either a flow sensor or by position alone. Actual flow depends on static pressure when control is by position only. This is referred to pressure dependent control. Position control will be used if no flow sensor is present, if the flow sensor has failed, if flow sensor calibration fails, or if flow can not be accurately determined (outside the range 10% nominal < measured flow < 110% nominal).

**Air Balance:** The system can not be expected to work well if it has not been air balanced. Air balancing is done by CCP Group. Balance Mode is initiated from Setup Tab 2 of the CCP Editor or from the operator display. Local zone heat is disabled. AHU heating and cooling are disabled. AHU fan runs at 100%. Outdoor air damper is driven to minimum position. Zone air dampers are overridden to the configured max flow position. Actual flow is measured with a flow hood. The measured flow is entered in the zone editor for individual zones (Zone Editor Setup Tab 1). Flow gain is calculated and written to zone controller memory.

**Series Fan:** A series fan will be on whenever the air valve is open, generally whenever the controller is occupied. A series fan will also be on when unoccupied if the air valve is open or if local reheat is on. (The series fan can be configured to ignore air valve position but this should only be done with caution.) Fan Enable / Disable as a function of CCP Groups. In the CCP workstation software, Setup menu/CCP Group/Setup Tab. Select “More” on the Zone Editor Status Tab to view whether the fan is Enabled / Disabled, and whether it is ON or OFF.

**Parallel Fan:** A parallel fan can be configured for either flow control or temperature control. Temperature control is most common. When configured for temperature control the parallel fan acts as the first stage of local heat. It turns on at a configured offset (Zone Editor Setup Tab 1) above the heating setpoint and draws warm plenum air in to the space. Fan Enable / Disable as a function of CCP Groups. In the CCP workstation software, Setup menu/CCP Group/Setup Tab. Select “More” on the Zone Editor Status Tab to view whether the fan is Enabled / Disabled, or whether it is ON or OFF.

**Local Reheat:** The UCM 4.2 can be configured for staged hot water, modulating hot water, staged electric, or slow pulse width modulating electric reheat. There are a total of three triac binary outputs to control the fan, if present, and any local reheat. If a fan is present this limits the outputs available for reheat.

Local hot water reheat is always available to warm the space. Local electric reheat is only available if the supply air temperature is below 70° F. This means that local electric reheat will usually be locked out when the AHU is in the heating mode, and it also means the local electric reheat may be locked out when the supply air is nearly neutral to space temperature. This is very important to keep in mind.

In general, reheat stages are turned on at the Heating Setpoint, Heating Setpoint - 1°, and Heating Setpoint - 2° respectively. This is for staged reheat. It oversimplifies reheat control but it does give a general idea how quickly reheat capacity is increased.

Electric reheat is turned off if air flow falls to less than the Minimum Heating Flow Setpoint – 3%. This is for safety; it prevents electric reheat from operating when air flow is too low.

Electric reheat is turned off abruptly when the space temperature rises to more than .5° F above the heating setpoint. Hot water reheat also is turned off when space temperature is more than .5° F above the heating setpoint if the supply air is cold (below space temperature). This is done to save energy but in situations where space temperature control relies on reheat alone the space temperature may tend to fluctuate. Hot water reheat does not turn off at a particular point.

Local reheat can be Enabled / Disabled by CCP Group. In the CCP workstation software, Setup menu/CCP Group/Setup Tab. Select “More” on the Zone Editor Status Tab to view whether the reheat is Enabled / Disabled, and whether it is ON or OFF.

**The \* and \*\* Positions** on the zone sensor thumbwheel are overrides. The \* overrides the air damper to its maximum position. The \*\* overrides the zone unoccupied. It is necessary to press the ON (TOV) button for 2 sec. to initiate the overrides. Overrides remain until the thumbwheel is moved away from the \* / \*\* position. Disabling the local setpoint also disables the \* / \*\* functions. These functions are used primarily for air balancing. Occupants may not realize that overrides are generated by moving the setpoint dial to the extreme positions and this can cause issues. Putting the thumbwheel in the \* or \*\* position essentially prevents the zone controller from controlling space temperature, its main job. For example, an occupant who is cold may turn the thumbwheel to the highest value, the \*. If the zone is cold and the supply air also happens to be cold, the UCM 4.2 would ordinarily drive the air valve to a minimum position to prevent over-cooling the space. However when the occupant moves the thumbwheel to the \* position the air valve is driven open. This will make the situation worse, not better.

**Troubleshooting suggestions:**

**Rover:** Rover is a Trane service tool. It can be used to configure the UCM4.2 zone controllers used in the CCP system. It is not necessary; all configuration can be done through the CCP. If it is used, be aware that both the CCP and Rover should not be on the link at the same time. Also, Rover will force the control action to cool. If this is not taken in to account it can make troubleshooting zone controllers confusing.

**Triac Outputs:** Triac outputs are difficult to troubleshoot with a multi-meter. A meter will generally detect 24 VAC at the output even when it is off. A 24 V LED, or a relay, will provide enough load to detect whether the output is on or off. Remove the spade plugs from the outputs and connect the LED or relay between J8 (hot) and J9, J10, or J11 (the fan or reheat outputs) to isolate problems in the board from problems with the contactors or actuators.

1. It is often good to start troubleshooting by reviewing system status. For zones; check active setpoint, zone temperature, damper position, damper min position, damper max position, occupancy, control action, and overrides (Group / Zone List in the CCP Editor, note that this does not auto-refresh).

2. Most occupant complaints relate to temperature control in zones; the space is too hot, too cold, too drafty, etc.

a) If thumbwheel setting is changed frequently, the controller will be confused. Occupants that fight with each other and fight with the controllers practically guaranty that everyone will be less happy.

b) Check flow setpoints, supply air temperature, control action, reheat.

c) Make sure that the AHU is working properly and can make both hot and cold air. Make sure that changeover can occur. Check votes required for changeover and current number of votes. Check for tagged zones. In CCP Editor and Setup Tab 1; check supply air temperature, check time to changeover, make sure control mode is Auto.

3. If space temperature is below setpoint and local reheat is not on.

a) Check the box configuration for reheat.

a) Check supply air temperature. Electric reheat is allowed only if supply air temperature is below 70°.

b) Check for overrides. Flow overrides lock out reheat. If fan is disabled reheat may be locked out.

c) Make sure local reheat is enabled. This is a CCP Group function (Setup Menu/CCP Group/Setup Tab).

4. If fan does not run.

a) Check for overrides. Make sure fan is enabled.

5. If the air valve is always at the same position. Or, if the air valve is always at 40%, or some other constant value. Or, if the pressure dependent minimum position is 40% but the air valve never opens to 40%.

a) 40% is the default pressure dependent minimum. Check for pressure dependent operation.

b) No minimum air flow setpoint or air valve position can be greater than the maximum position so if the pressure dependent minimum is greater than the maximum position the minimum is the same as the maximum. The air valve gets “stuck” at a single position.

c) Check air flow setpoints. See pressure dependent mode below.

6. If the zone controller is in pressure dependent mode.

a) Check configuration. Make sure it is configured as a VariTrane box. Make sure the box size is correct. If the configuration is wrong, flow and pressure dependent operation will not be reported correctly.

b) Check air flow and duct static pressure. If air flow is too low or too high, flow may be outside the range 5% - 110% nominal. This results in pressure dependent operation. Check bypass damper calibration and operation in CB system. Check fan operation in Del VAV and CB system. Poor duct design, incorrect bypass sizing, or over / under size fan influence duct static pressure control.

c) If minimum flow setpoints are small relative to nominal flow any problem with duct static pressure control may result in pressure dependent operation. If the maximum flow setpoint is small relative to nominal flow the controller can only use a small part of its range. If there are problems with duct static pressure control it may not be possible for the controller to recover pressure independent operation because the pressure dependent minimum can not be greater than the maximum position.

d) Check air flow setpoints. Make sure minimum flow is not too small. Make sure maximum flow is not too small. Keep in mind that these values are typically determined by design requirements for ventilation and heating / cooling loads.

e) Increasing the minimum position for pressure dependent operation may help the controller recover to pressure independent operation.

**CCP Basics and Troubleshooting Part V: Internal Communications (Comm4)**

Topics: 1) A summary of Comm4 communications between CCP, its AHU, and its zone controllers. 2) Some suggestions for troubleshooting Comm4 communications problems.

Components of the CCP III system (VAV zone controllers and the AHU) are generally designed to be able to function stand-alone. However, in order to efficiently coordinate operations the CCP must be able to send information to, and receive status from, the different components of the system. The loss of communications to zone controllers, the air-handler, or to the communicating bypass controller results in a Comm. loss diagnostic in the CCP Alarm Log. The CCP will display ??? for status points (either on the operator display or workstation software) when the value is unknown. This of course happens if communications is lost to a controller, but it may also happen simply when a sensor has failed. Loss of communications to the Bypass controller or to all zone controllers results in priority shutdown. The CCP system will not run until the condition has been corrected. However, if the air handler has a hardwired zone sensor and setpoint it will run stand-alone if the communications interface is disconnected. It will attempt to control temperature at the zone sensor as if it were a single zone constant volume unit. In some cases this is a reasonable emergency solution.

The CCP communications link consists of the CCP itself, the zone controllers (UCM 4.2), the communicating Bypass controller (if CB system), and a communications interface card (TCI) in the air handler (will always be present if Del. VAV, will not be present in a CB system if the CCP uses the optional relay board to control the AHU). Communications wire is low capacitance, twisted pair, and must be shielded (18 awg “Trane purple” or equivalent is preferred, although shielded 22AWG Level 4 wire is allowed). The use of any other type of communications wire will likely result in problems. The shield must be grounded in one place only (usually at the CCP). At every node (controller) the shield on the in and out sides must be taped together. At the far end the shield must be taped back. Polarity must be maintained throughout. A straight line daisy chain topology is highly recommended. See HVAC Knowledge Center WAVE 3541.

Dip switches are used to give each controller an address on the communications link. The addresses must be unique and in a specified range. There is only one permissible address for the TCI communications interface on the AHU, all five dip switches must be in the off position. (For older Voyager RTU with UCP controls there are six dip switches. The first switch is not part of the address. For UCP controls ignore the first switch and set the remaining five switches to off.) In addition, the TCI interface has a daughter board that must be positioned with the non-isolated Comm3 Comm4 connections adjacent to the dip switches. See the Installers Guide for the TCI interface ACC SVN18B-EN (available from e-Library), or HVAC Knowledge Center WAVE 833 for more information. Table 2 on page 26 of the CCP Installation Manual gives permissible addresses for zone controllers. This is VAV-SVN03A-EN. It is available on e-library, or see HVAC Knowledge Center WAVE 1587.

**Troubleshooting Suggestions:**

First be aware that while communications failures can be caused by defective controller boards, that this is rare. Failures are much more often caused by problems with wire (shield, crimp connections, polarity), addressing, power supplies or grounding. Also, it is often not possible to determine the physical location of a wiring problem by looking at the link as a whole. Dividing the link to isolate the problem is usually necessary. This can be time consuming. So even though a failed CCP board is unlikely it may be desirable to eliminate the possibility at the outset. This can be done with a spare zone controller board. Disconnect the communications link. Give the spare a valid address and connect it to the CCP with a short piece of communications wire. Make sure everything is powered and grounded correctly.

1. Check Communications wire continuity and shielding:

a) Lift the shield from ground on the CCP. Measure resistance to ground with a multi-meter. This should be completely open (infinite resistance, 0L MΩ). If it is not completely open the shield is grounded, or partly grounded, at some other place. Possible causes may be that the shield is not properly taped together at all controllers, or the wire is damaged at some point. Divide the link and repeat this test on each new segment in order to isolate and correct the problem.

b) Ring out the Comm. wires to check for continuity and shorts. Disconnect the wires from the controller at one end of the comm. link and wire nut the two wires together. At the other end disconnect the wires from the last controller and measure resistance across the two wires. The resistance will be variable depending on the length of wire and whether controllers are powered. Disconnect the comm. wires at the first end. This should now be an open circuit. If it is not open there is a short between the comm. wires. Possible causes are damaged wire or bad crimp connections. Divide the link and repeat this test on each new segment in order to isolate and correct the problem.

c) Lift the shield and comm. wires from the termination board of the CCP. Measure resistance between the shield and each of the comm. wires. This should be open (infinite resistance, 0L MΩ). If it is not, there is a short between the shield and the comm. wires. Similarly there should be no shorts between the two comm. wires. Look for damaged wire or improperly taped shield. Divide the link and repeat this test on each new segment in order to isolate and correct the problem.

2. Improper power supplies or grounding can result in communications failures:

1. Best practice for controller wiring calls for each controller to have a single dedicated 24 VAC Class 2 transformer. In practice this is not always done. If power supplies are shared it is important to maintain polarity. It is particularly important that the CCP have its own power supply. If communications problems occur it may be useful to selectively add dedicated power supplies. Start with the CCP.
2. All controllers must be grounded. UCM 4.2 is grounded through the stand-offs. The CCP has a ground terminal on the termination board. Ordinarily, grounding to sheet metal should be sufficient but if there are building wide electrical grounding issues there may be communications problems.

3. Polarity and zone controller (UCM4.2) LEDs:

1. The LED CR1 (yellow) can be used to diagnose communications problems. On steady indicates incorrect polarity or a short between the wires. Random Flicker indicates communications activity with incorrect polarity. Steady off indicates correct polarity but no communications activity. Blinking on .2 sec, off .2 sec indicates correct polarity, communications activity, and response from controller. Blinking on .6 sec., off 1.5 sec indicates correct polarity, communications activity, but no response from controller. LED CR1 should usually show one of the two distinct blinking patterns or it may be off (no communications activity). It should never be on solid or flickering randomly.
2. The LED CR2 (green) should be on solid when the board is powered. If it is off or flashing replace the board.

4. If communications is down to the air handler (HVAC Comm Status from CCP Status on the operator display or from the workstation software) check the dip switch address (all off) and the position of the daughter board on the TCI communications interface (non isolated Comm3 / Comm4).

5. Communications wire bundled with, or run in conduit with, AC power is susceptible to induced voltage that can cause communications failures.

6. Communications wire run near transformers or florescent ballasts is susceptible to induced voltage that can cause communications failures.

7. DC voltage on the communications link (as measured with a multi-meter) is small. This is not a particularly informative unless it is very high or very low.

8. Signal analysis and the detection of noise on the communications link require an oscilloscope. This usually not necessary.