SEQUENCE OF OPERATION

GENERAL:

1. ALL CONTROLS SYSTEMS SHALL BE COMPLETE AND OPERATIONAL AT THE CONCLUSION OF THE CONSTRUCTION PROJECT.
2. IN A VISIBLE LOCATION ON HVAC EQUIPMENT UNDER DIRECT DIGITAL CONTROLLER (DDC) CONTROL, MOUNT A LAMINATED PLATE INSCRIBED WITH THE FOLLOWING:

   "CAUTION: THIS EQUIPMENT IS UNDER CENTRAL CONTROL AND MAY START OR STOP SUDDENLY. CONTACT PUBLIC WORKS BEFORE PERFORMING ANY MAINTENANCE OR DISCONNECTING ANY COMPONENTS."
3. DDC CONTROLLERS SHALL UTILIZE SHORT CYCLING DELAYS TO PROTECT NONMODULATING TYPE EQUIPMENT SUCH AS FANS, PUMPS, COMPRESSORS, ETC. FROM SHORT CYCLING.
4. TERMINAL CONTROL UNITS (TCUs) SHALL BE STAND-ALONE PROGRAMMABLE AND SHALL BE SELECTED WITH THE APPROPRIATE NUMBER OF INPUTS AND OUTPUTS AS REQUIRED BY THE UNITS SEQUENCE OF OPERATION AND THE I/O SCHEDULE.
5. ALL CONTROL AND INTERLOCK WIRING SHALL BE SUPPLIED AND INSTALLED IN ACCORDANCE WITH THE SUPPLIED UNITS MANUFACTURERS RECOMMENDATIONS.

AIR HANDLER AHU1

GENERAL:

1. THE AHU SHALL BE STARTED AND STOPPED BY ITS DIRECT DIGITAL CONTROLLER (DDC) BASED ON A TIMED OCCUPANCY AS SCHEDULED.
2. A DUCT MOUNTED SMOKE DETECTOR SHALL SHUT DOWN THE AIR HANDLING UNIT, CLOSE THE OUTSIDE AIR DAMPER AND SIGNAL THE BUILDING FIRE ALARM CONTROL PANEL UPON SENSING SMOKE.
3. VARIABLE FREQUENCY DRIVE SHALL CONTROL FAN SPEED IN RESPONSE TO A DUCT STATIC PRESSURE SENSOR (LOCATED APPROXIMATELY 2/3 DOWN STREAM IN AN ACCESSIBLE LOCATION) THROUGH THE DDC TO PROVIDE PROPER PRESSURE.

OCCUPIED MODE:

1. DURING OCCUPIED MODE, THE AHU SHALL RUN CONTINUOUSLY. THE OUTSIDE AIR DAMPER AND RETURN AIR DAMPER (OPPOSED BLADE) SHALL BE MODULATED TO MAINTAIN THE MINIMUM OUTSIDE AIR REQUIRED.
2. IN THE COOLING MODE THE DDC SHALL MODULATE THE CHILLED WATER VALVE TO MAINTAIN THE FAN DISCHARGE AIR TEMPERATURE SETPOINT OF 53°F (ADJUSTABLE).

UNOCCUPIED MODE:

1. DURING THE UNOCCUPIED MODE, THE OUTSIDE AIR DAMPER (OPPOSED BLADE) SHALL REMAIN CLOSED AND THE AHU FAN SHALL BE OFF EXCEPT AS REQUIRED BELOW.
2. IN THE COOLING MODE THE DDC SHALL ENERGIZE THE AHU FAN, START THE CHILLED WATER SYSTEM AND MODULATE THE CHILLED WATER COIL CONTROL VALVE TO MAINTAIN UNOCCUPIED SETPOINT AT THE VAV BOX TERMINAL CONTROL UNIT (TCU).
3. THE AHU SHALL DE-ENERGIZE WHEN SETBACK TEMPERATURES ARE SATISFIED.

SAFETY FEATURE:

1. A FREEZE STAT SHALL SHUT DOWN THE FAN AND CLOSE THE OUTSIDE AIR DAMPER WHEN TEMPERATURE LEAVING THE COOLING COIL DROPS BELOW 37°F (ADJUSTABLE).
2. UPON ACTIVATION OF ANY DUCT SMOKE DETECTOR OR ACTIVATION OF THE BUILDING FIRE ALARM CONTROL PANEL, THE AHU SHALL SHUT DOWN.
3. A DIFFERENTIAL PRESSURE SWITCH ACROSS THE UNIT FILTERS SHALL ALARM THE DDC FOR FILTER MAINTENANCE.

VAV BOXES

GENERAL:

1. THE VAV BOX DAMPER SHALL BE CONTROLLED BY ITS TERMINAL CONTROL UNIT (TCU) BASED ON A TIMED OCCUPANCY AS SCHEDULED FOR THE AIR HANDLING UNIT WHICH IT SERVES.
2. A WALL MOUNTED SPACE SENSOR SHALL CONTROL ROOM CONDITIONS THROUGH THE TCU AND ENABLE THE ROOM OCCUPANTS TO VARY THE SPACE SETPOINT OVER A LIMITED RANGE AS DETERMINED BY THE DDC.
3. THE SPACE SENSOR SHALL DISPLAY TEMPERATURE SETPOINT AND SPACE TEMPERATURE.
4. THE SPACE SENSOR SHALL PROVIDE A TIMED OVERRIDE SCHEDULE THROUGH AN ON/OFF BUTTON.

OCCUPIED MODE:

1. IN THE COOLING MODE THE TCU SHALL MODULATE THE VAV BOX SUPPLY AIR DAMPER TO MAINTAIN THE SPACE SETPOINT OF 75°F (ADJUSTABLE). ON A DROP IN SPACE TEMPERATURE, THE TCU SALL MODULATE THE VAV BOX DAMPER TO ITS MINIMUM POSITION.
2. IN THE HEATING MODE THE TCU SHALL SHALL ACTIVATE THE HOT WATER SYSTEM THROUGH THE DDC TO MAINTAIN THE SPACE SETPOINT OF 70°F (ADJUSTABLE). ON A DROP IN SPACE TEMPERATURE,

ERV

OCCUPIED MODE:

1. OPERATION OF THE ERV SHALL BE CONTROLLED BY THE DDC SYSTEM. THE UNIT SHALL RUN WHENEVER THE AHU IS ON.

UNOCCUPIED MODE:

2. OPERATION SHALL BE CONTROLLED BY THE DDC SYSTEM. DURING THE UNOCCUPIED MODE THE UNIT SHALL BE OFF AND THE OUTSIDE AIR DAMPER SHALL BE CLOSED.

MORNING WARM-UP/COOL DOWN:

3. OPERATION SHALL BE CONTROLLED BY THE DDC SYSTEM. DURING THE WARM-UP/COOL DOWN PERIOD THE UNIT SHALL BE OFF AND OA DAMPER SHALL BE CLOSED.

OVERRIDE MODE:

4. OPERATION SHALL BE CONTROLLED BY THE DDC SYSTEM WHEN ANY AHU IS ENERGIZED DURING OVERRIDE PERIOD THE UNIT SHALL RUN AND SHALL BE DE-ENERGIZED WHEN OVERRIDE PERIOD IS CONCLUDED.

COOLING TOWER (CT1)

GENERAL:

1. A COOLING TOWER STAND ALONE CONTROLLER (SAC) SHALL CONTROL THE COOLING TOWER AS INDEXED BY THE DDC. THE CHILLER SAC SHALL BE PROVIDED BY THE COOLING TOWER MANUFACTURER WITH SOFTWARE FEATURES AND STRATEGIES AS DESCRIBED BELOW.
2. THE COOLING TOWER SAC SHALL PROVIDE ITS OWN INTERNALLY GENERATED STAGING COMMANDS.
3. THE COOLING TOWER SAC SHALL INTERFACE WITH THE DDC FOR MONITORING INPUTS AS LISTED IN THE I/O SUMMARY AND FOR REMOTE SETPOINT ADJUSTMENTS.

COOLING TOWER STAGING:

1. THE COOLING TOWER SAC SHALL PROVIDE INTERNALLY GENERATED STAGING COMMANDS TO MAINTAIN THE WATER SUPPLY TEMPERATURE SETPOINT AS DIRECTED BY THE DDC. THE COOLING TOWER SHALL NOT OPERATE UNTIL SYSTEM FLOW IS PROVEN.

HOT WATER SYSTEM

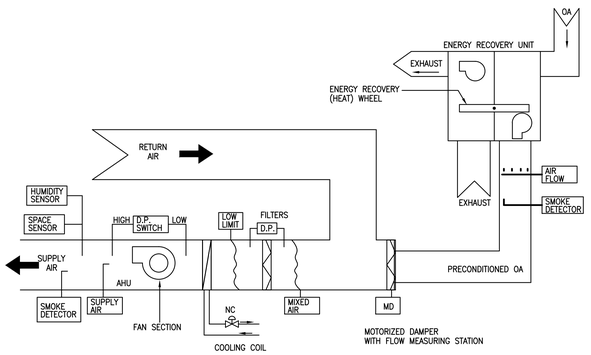
1. THE DDC SHALL CONTROL THE HEATING WSHP'S, HOT WATER TEMPERATURE AND THE HEATING SYSTEM PUMP.
2. PROVIDE HEATING SYSTEM PUMP WITH A HAND-OFF-AUTO SWITCH. IN THE "HAND" POSITION, THE PUMP SHALL BE CONTROLLED MANUALLY. IN THE "AUTO" POSITION, THE PUMP SHALL BE CONTROLLED BY THE DDC.
3. THE CONDENSER WATER BOILER SHALL BE STARTED AND STOPPED BY THE DDC WHEN CONDENSER WATER TEMPERATURE DROPS BELOW 40°F (ADJUSTABLE)
4. THE CONDENSER WATER BOILER SHALL RESET BASED ON OUTDOOR AIR TEMPERATURE.

AIR HANDLER (AHU2/HP6)

1. AHU SHALL BE ENABLED/DISABLED BY THE DDC SYSTEM. ZONE THERMOSTAT SHALL CONTROL AHU.
2. IN THE COOLING MODE THE AIR HANDLER SHALL MAINTAIN THE SPACE SETPOINT OF 75°F (ADJUSTABLE). ON A DROP IN SPACE TEMPERATURE, THE AHU SHALL TURN OFF.
3. IN THE HEATING MODE THE AIR HANDLER SHALL MAINTAIN THE SPACE SETPOINT OF 70°F (ADJUSTABLE). ON A RISE IN SPACE TEMPERATURE, THE AHU SHALL TURN OFF.
4. A TEMPERATURE RISE ABOVE 85° SHALL ALARM THE DDC FOR UNIT MAINTENANCE.

DDC INPUT/OUTPUT (I/O) SUMMARY

UNIT	GEN.	HARDWARE																																SOFTWARE																			
		OUTPUT																				INPUT												ALARMS												CONTROL PROGRAM FUNCTION							
		DIGITAL								ANALOG												DIGITAL				ANALOG								DIGITAL							ANALOG													
		VARIABLE SPEED FAN DRIVE (START/STOP)	VARIABLE SPEED PUMP DRIVE (START/STOP)	SINGLE SPEED PUMP (START/STOP)	BOILER (ENABLE/DISABLE)	COOLING TOWER (ENABLE/DISABLE)	AIR HANDLER (ENABLE/DISABLE)	VARIABLE SPEED FAN DRIVE (SPEED)	VARIABLE SPEED PUMP DRIVE (SPEED)	COOLING COIL 2-WAY VALVE POSITION	BOILER WATER TEMPERATURE	HEAT COIL 3-WAY VALVE POSITION	CHILLED WATER MIXING VALVE POSITION	RETURN AIR DAMPER POSITION	OUTSIDE AIR DAMPER POSITION	VAV BOX DAMPER POSITION	ALARM FAULT	FREEZE STAT SWITCH STATUS	SMOKE DETECTOR STATUS	WATER FLOW DIFF. PRESSURE SWITCH	AIR FLOW DIFF. PRESSURE SWITCH-FAN	RETURN AIR TEMPERATURE SENSOR	OUTSIDE AIR RELATIVE HUMIDITY	ROOM HUMIDITY	ROOM TEMPERATURE	HEAT COIL DISCHARGE AIR TEMPERATURE	DUCT STATIC PRESSURE SENSOR	PIPE PRESSURE SENSOR	SUPPLY FAN DISCHARGE AIR TEMPERATURE	CHILLED WATER FLOW METER	CHILLED WATER ENTER T.	WATER TEMPERATURE	ICE LEVEL INDICATOR	VAV BOX AIR FLOW SENSOR	VAV BOX HEATING COIL DISCHARGE TEMPERATURE	COMMUNICATION FAILURE	FREEZE STAT SWITCH	MOTOR DRIVE FAILURE	FILTER PRESSURE DROP	HIGH TEMPERATURE	LOW TEMPERATURE	GRAPHIC DISPLAY	GRAPHIC PROGRAMMING	TIME SCHEDULING	OPTIMUM START	DEMAND CONTROL	RUNTIME LOGGING							
AIR HANDLER (AHU1)	*		■					■		■		■		■	■		■			■		■		■	■			■						■	■	■			■			■	■		■	■		■					
ENERGY RECOVERY UNIT (ERU1)																																																						
VAV (TYP. OF 20)																■		■							■							■	■																					
COOLING TOWER (CT1)						■													■											■				■	■																				
PUMP (P1)				■					■								■										■							■																				
PUMP (P2)				■					■								■										■							■																				
PUMP (P3)				■					■								■										■							■																				
PUMP (P4)					■												■										■							■																				
AIR HANDLER (AHU2)							■										■			■														■																				
BOILER (B1)						■											■																	■							■													



TYPICAL AHU WITH ENERGY RECOVERY (ERU1)

FINAL SUBMISSION
APRIL 18, 2012

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