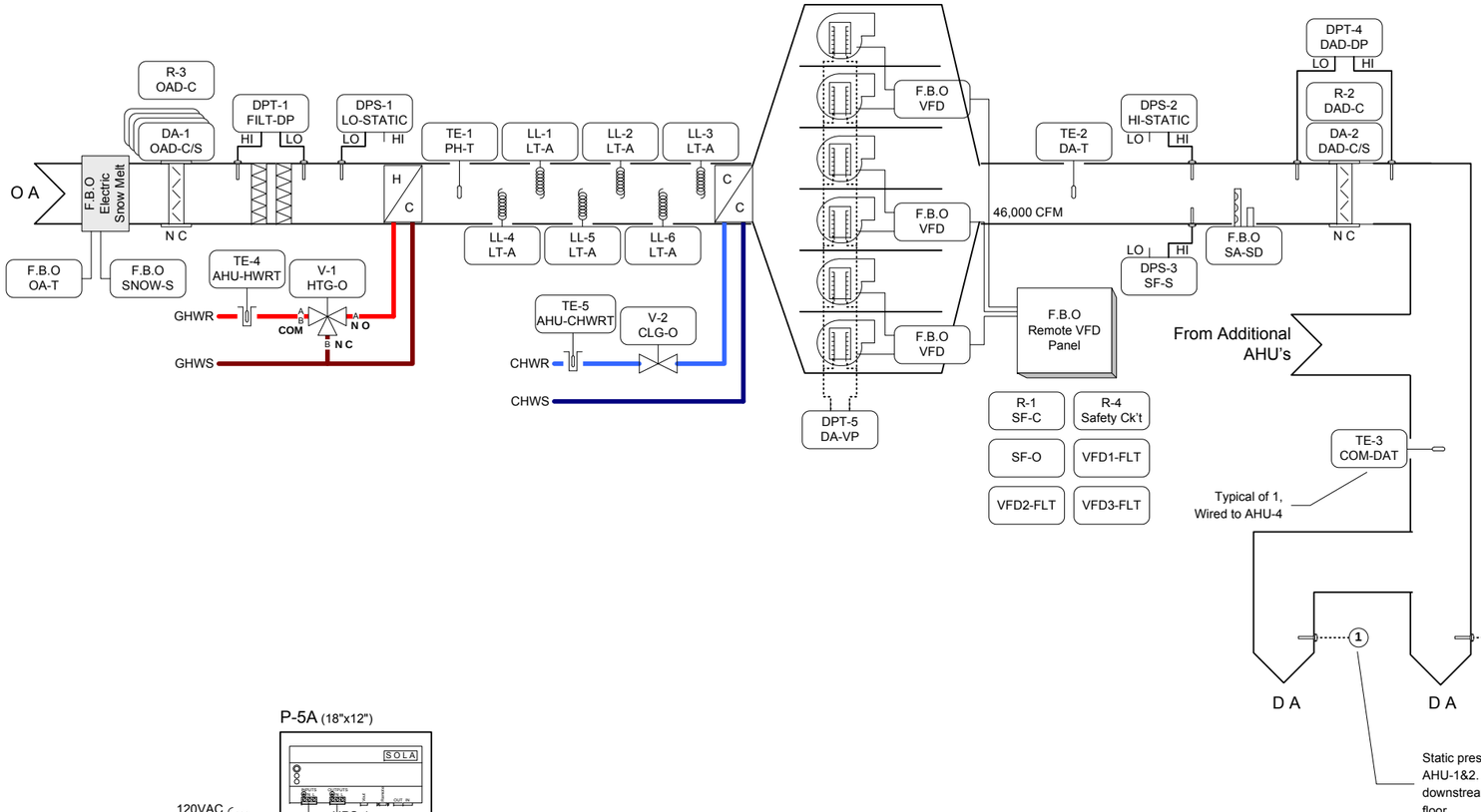

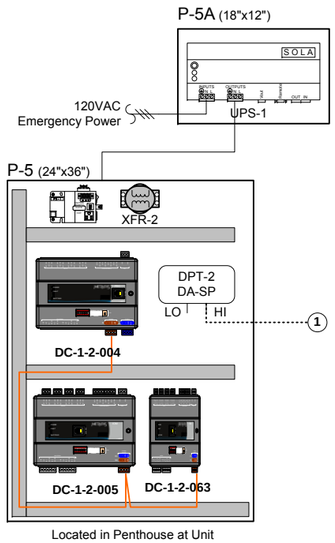

BILL OF MATERIALS

TAG	QTY	MFG/VNDR	PART #	DESCRIPTION
PANEL DEVICES:				
DPT-2~3	2	JCI	2671-MR3-W-D-2E-AK	DIFF PRESS XMTR, 0-1.25"WC, LCD, 0-10VDC
	2	JCI	FTG18A-600R	SENSING TUBE KIT
P-5	4	JCI	PAKGJJ002BH0	24"X36" PNL, FEC2611, IOM4711, 2 96VA XFR
P-5A	4	KELE	SC18126	18"X12"X6" ENCL. W/ PREFORATED BACK PNL
UPS-1	4	SOLA	SDU850	UPS, DIN, 850VA/510W, 120VACIN/OUT, 2 MIN
XFR-2	4	JCI	Y64T15-0	XFMR, 120VAC PRI, 24VAC SEC, 92VA
FIELD DEVICES:				
DA-1	16	JCI	M9220-BGC-3	ACTUATOR, 70 LB-IN, 24VAC, 2 AUX
DPS-1,2	8	JCI	AFS-460-DSS	AIR FLOW SW, 2 SPST, 1.25-12"WC, ADJ
	8	JCI	FTG18A-600R	SENSING TUBE KIT
DPS-3	4	JCI	AFS-262	AIR FLOW SWITCH, SPDT, .05" – 2.0"WC
DPT-1,2,4,5	16	JCI	2671-MR3-W-D-2E-AK	DIFF PRESS XMTR, 0-1.25"WC, LCD, 0-10VDC
	16	JCI	FTG18A-600R	SENSING TUBE KIT
LL-1~6	24	JCI	A70GA-1C	LO LIMIT STAT, DPST, AUTO RESET
R-1~4	16	VERIS	V100	10AMP, SPDT, 10-30VAC/DC/120VAC
TE-1~3	9	JCI	TE-6311P-1	TEMP SENSOR, 1KΩ NI, 0.1%, 8" DUCT
TE-4,5	8	JCI	TE-631AP-1	TEMP SENSOR, 1KΩ NI, 0.1%, 6" DUCT
	8	JCI	TE-6300W-101	6" BRASS WELL W/ THERMAL GREASE

AHU-1 Detail

(Typical for AHU-2 thru AHU-4)

NO.	Date	Revision Record

EMC SERVICES
116 Budlong Road
Cranston, Rhode Island 02920

Mechanical Contractor
Address
City, State

Customer
Address
City, State

JOB NUMBER: 10-370	SCALE: NTS	DRAWN BY:	P. Braga
		APPROVED BY:	W. Roskowski
FILE: **AHU-1~4.vsd**			
DATE: 04/13/12	DRAWING NUMBER:	**ATC-5**	

All AHU's will operate continuously 24/7. The AHU's normally operate in parallel at reduced speed. Upon failure of any unit, the remaining units will increase speed to compensate.

Start/Stop:
AHU's will be started and stopped from the BAS. AHU startup will not occur until flow in the laboratory exhaust system is proven. Once exhaust flow status is proven, AHU startup will be initiated.

Upon a signal to start, the outside air damper and smoke isolation damper will open fully. Once proven open by damper end-switches the VFD will be enabled and run on its minimum speed. After a 60 second delay, the fan speed will be increased, as needed to achieve the duct system static pressure setpoint. If failure of an air handler occurs during an automatic start, two additional attempts will be made. Each subsequent attempt at restart will not begin until all dampers are in their fail-safe position. After the final attempt at restart, the AHU will be locked out and an alarm will be initiated at the BAS.

Start-up of an offline AHU after shutdown will be initiated manually through the BAS. When an AHU is commanded to start while the other units connected to the same system remain in service the following will occur: The outside air damper will fully open and be proven by end switch, the fan VFD will be enabled at low speed. The fan speed will then increase until the pressure differential across the smoke isolation damper is 0.1"(adj.). After a 30 second delay, the smoke isolation damper will be commanded to open. While the smoke isolation damper is opening, the temperature control sequence will be released and the starting fan VFD speed will be modulated in response to static pressure deviations from setpoint as according to the volume control sequence below. The other units will be held at constant speed during start-up of the additional AHU. When smoke isolation damper is fully open, as proven by end switch, the BAS will compare the VFD speed of the AHU's operating in parallel. The fan speed of all AHU's will be adjusted until they are operating at the same nominal percentage of full motor speed without sacrificing control of the duct static pressure setpoint. The fans will then be modulated (all AHU's in unison) in accordance with the volume control sequence below.

When an AHU is commanded to stop, the following will occur: Associated smoke isolation damper will start to slowly close. AHU fan speed will then be modulated by the BAS to obtain a differential pressure across the smoke damper of 0.1" (adj.). When the smoke damper is fully closed, the VFD will be de-energized and the outdoor air damper will be closed. The operating AHU's (not the AHU shutting down) will modulate to maintain static pressure setpoint in accordance with the volume control sequence below.

Volume Control:
The AHU supply air fan speed will modulate as needed to maintain supply duct system static pressure setpoint using a low select strategy. After initial AHU startup, the BAS will adjust the speed of the AHU's until they are all operating at the same percentage of full motor speed. Once the AHU's are running at the same speed, the BAS will modulated the fans in parallel to maintain system static pressure setpoint. As the system static pressure decreases, the VFD's will increase their output (in unison). As the system static pressure increases, the VFD's will reduce in speed (in unison). A differential of 0.5" (adj.) of setpoint will prevent excessively rapid changes in VFD speed. The static pressure setpoint to control the active supply air fans will be initially set at 1.2"wc (adj) and will be optimized during air balancing. Airflow will be monitored via the supply airflow station (F.B.O).

The BAS will employ a static pressure setpoint reset strategy through monitoring all of the VAV and CAV supply boxes served by the air system and reset the static pressure setpoint downward until no box dampers are greater than 90% open.

Supply Air Temperature Control:
Discharge air temperature setpoint of 55°F will be maintain whenever the AHU is operating. When CHW is available (chillers operational), on a rise in discharge air temperature above cooling setpoint, the cooling valve will modulate open to maintain the discharge air temperature setpoint. On a drop in discharge air temperature below its heating setpoint the glycol heat recovery coil valve will modulate to maintain the discharge air temperature setpoint.

Common temperature sensor will be used by the BAS to monitor the operation of the parallel AHU's. If the common temperature is more than 4°F above or below the temperature setpoint of the individual AHU's, an alarm will be issued at the BAS.

AHU Staging:
Units will be staged based on supply airflow measured at flow measuring stations at each AHU. The BAS will monitor the flow rate of each operating AHU. When any operating AHU's flow drops below 20,000 CFM the next operating AHU in sequence will be commanded to shut down as described above. When any of the operating AHU supply airflows reaches its normal design flow rate of 46,000 CFM, the next available fan in sequence will be commanded to start as described above.

Operation on Standby (Generator) Power:
Upon a loss of normal power, all AHU's will de-energize. Once emergency power has been established, in accordance with the priority scheme for stating HVAC equipment on emergency power, one AHU and its associated exhaust fans will be started per sequence. Upon restoration of normal power, the remaining AHU's will be brought online, one at a time per the sequences.

Safeties:
The following safeties, each with manual resets, will shut down the AHU supply fans, thru hard-wired interlocks, and initiate an alarm at the BAS.:
1. High static pressure above 6" at DPS-2
2. Low static pressure below 4" at DPS-1
3. Freezestat senses a temperature below 36°F.
4. Upon smoke detection from smoke detector (F.B.O).

The preheat coil discharge air temperature sensor (TE-1) will limit the cooling coil entering air temperature to a minimum of 40°F.

Alarms:
Upon any of the following conditions an alarm will be sent to the BAS:
1. Fan is commanded on and status is not indicated within 15 seconds.
2. Auxiliary alarm contacts in the AHU VFD indicates a failure of the VFD.
3. AHU VFD is not in the "auto" position (fan status is proven but the command is off)
4. Discharge air temperature rises above 70° or falls below 45°F for 10 minutes when AHU is on
5. Discharge static pressure goes below 1.25" for 10 minutes when AHU is on.
6. Filter differential pressure rises above 1.5" for 10 minutes
7. End switches do no indicate appropriate damper position for 5 minutes.
8. Temperature sensors after heating coil and downstream of cooling coil indicate that the unit is simultaneously heating and cooling.

AHU-1 Sequence of Operations

(Typical for AHU-2 thru AHU-4)

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EMC | SERVICES
116 Budlong Road
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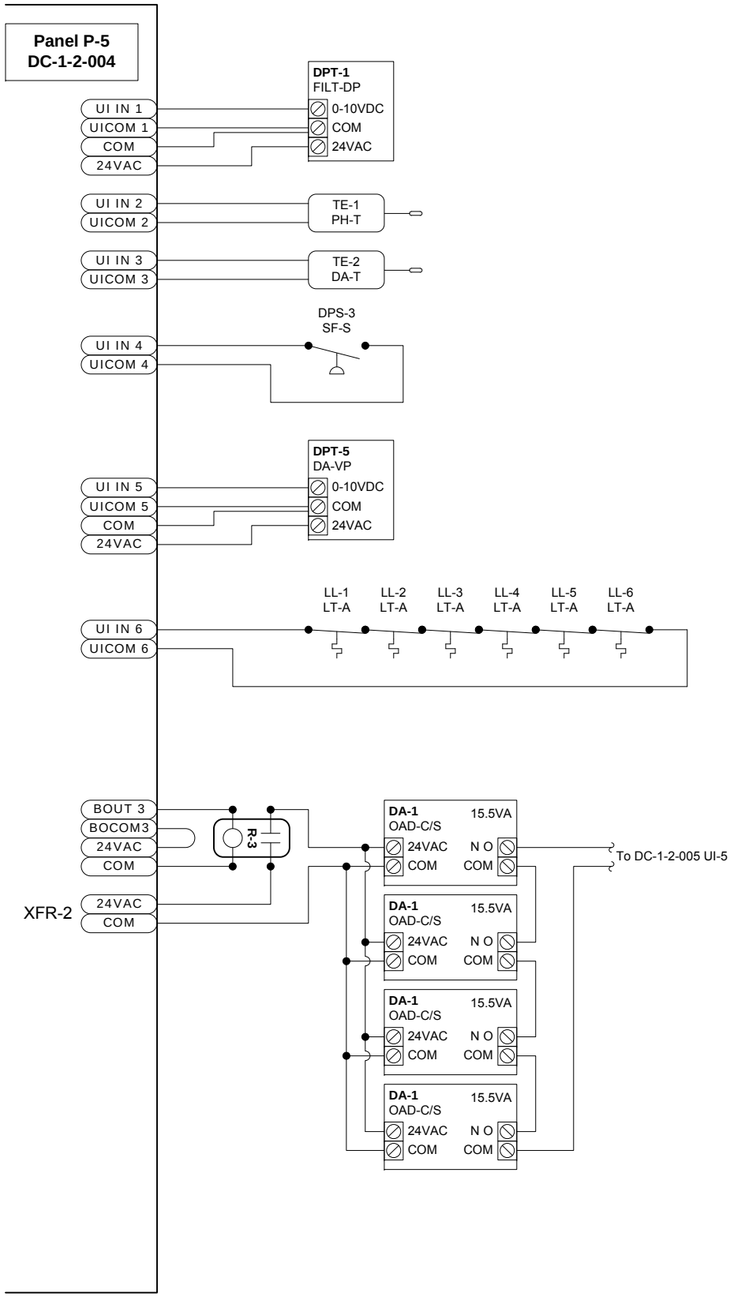
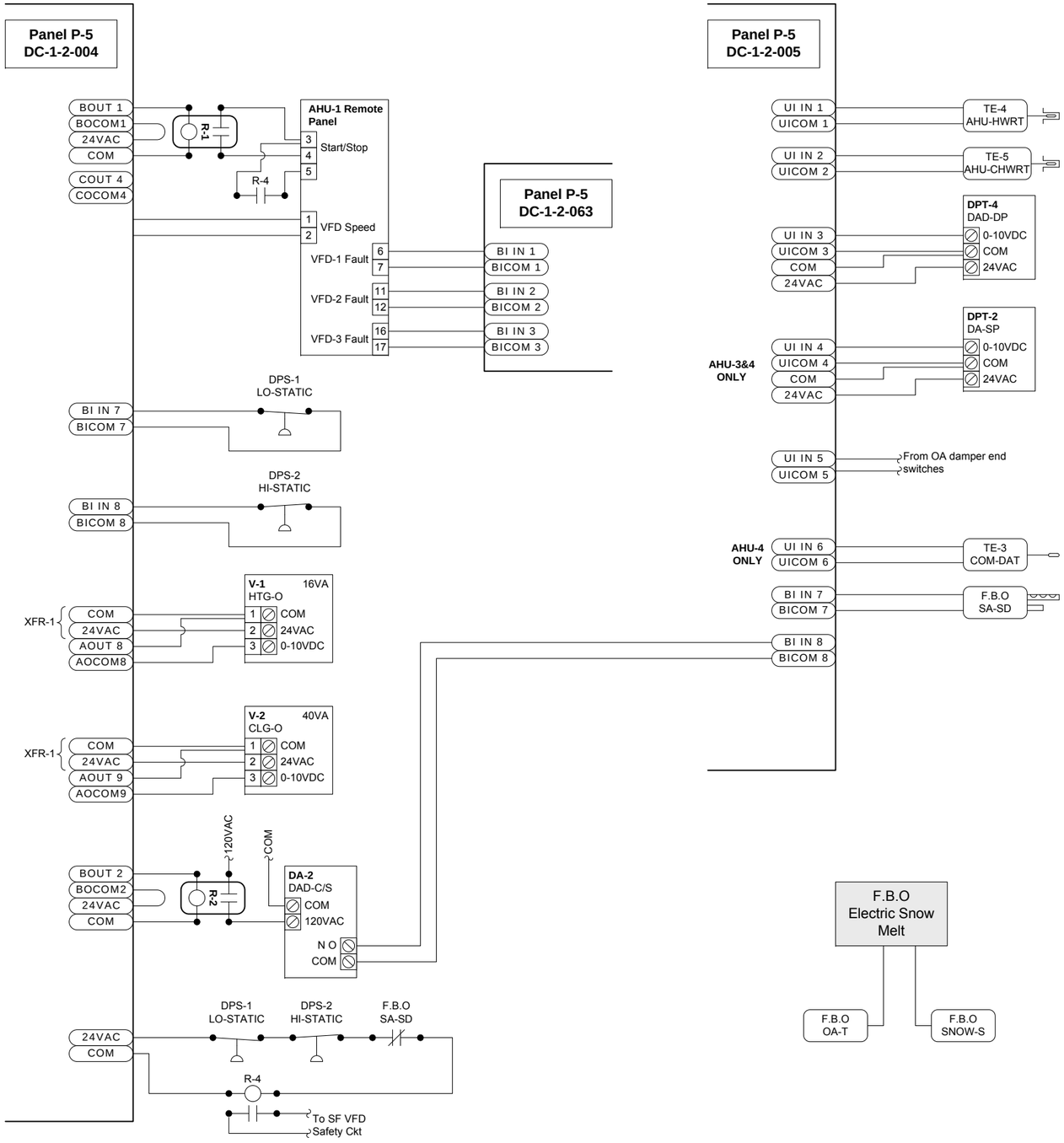
JOB NUMBER: 10-370	SCALE: NTS	DRAWN BY:	P. Braga
		APPROVED BY:	W. Roskowski
FILE: **AHU-1~4.vsd**			
DATE: 04/13/12	DRAWING NUMBER: **ATC-5A**		

Submittal		Point Information			Controller Information								Intermediate Device		Field Device			
Tag	Point Type	System Name	Object Name	Expanded ID	Controller Type	Trunk Type	Trunk Nbr	Trunk Addr.	Cable Destination Bay/Terminal	DO Type	Module Type	Panel	Device	Location	Wiring /Tubing	Device	Location	Comment
		AHU-1			FEC/IOM							P-5						Power to Controller
		AHU-1			FEC/IOM	MS/TP	2	4				P-5						BacNet FC Bus
	UI IN-1	AHU-1	FILT-DP	Filter Diff Pressure	FEC/IOM	MS/TP	2	4	UI IN-1			P-5			4/18	0-10VDC		
	UI IN-2	AHU-1	PH-T	Heating Coil Temp	FEC/IOM	MS/TP	2	4	UI IN-2			P-5			2/18	TE-6300 (1kΩ Ni)		
	UI IN-3	AHU-1	DA-T	Discharge Air Temperature	FEC/IOM	MS/TP	2	4	UI IN-3			P-5			2/18	TE-6300 (1kΩ Ni)		
	UI IN-4	AHU-1	SF-S	Supply Fan Status	FEC/IOM	MS/TP	2	4	UI IN-4			P-5			2/18	Contact (NO)		
	UI IN-5	AHU-1	DA-VP	Discharge Air Velocity Pressur	FEC/IOM	MS/TP	2	4	UI IN-5			P-5			4/18	0-10VDC		
	UI IN-6	AHU-1	LT-A	Low Temperature Alarm	FEC/IOM	MS/TP	2	4	UI IN-6			P-5			2/18	Contact (NO)		
	BI IN-7	AHU-1	LO-STATIC	Low Static Press Alarm	FEC/IOM	MS/TP	2	4	BI IN-7			P-5			2/18	Contact (NO)		
	BI IN-8	AHU-1	HI-STATIC	High Static Press Alarm	FEC/IOM	MS/TP	2	4	BI IN-8			P-5			2/18	Contact (NO)		
	BO OUT-1	AHU-1	SF-C	Supply Fan Command	FEC/IOM	MS/TP	2	4	BO OUT-1			P-5	Relay		2/18	24VAC Out		
	BO OUT-2	AHU-1	DAD-C	Diuscharge Air Damper Comm	FEC/IOM	MS/TP	2	4	BO OUT-2			P-5	Relay		2/18	24VAC Out		
	BO OUT-3	AHU-1	OAD-C	Outdoor Air Damper Comman	FEC/IOM	MS/TP	2	4	BO OUT-3			P-5	Relay		2/18	24VAC Out		
	CO OUT-4	AHU-1	SF-O	Supply Fan Output	FEC/IOM	MS/TP	2	4	CO OUT-4			P-5	Relay		2/18	2-10VDC		
	CO OUT-5	AHU-1			FEC/IOM	MS/TP	2	4	CO OUT-5			P-5						
	CO OUT-6	AHU-1			FEC/IOM	MS/TP	2	4	CO OUT-6			P-5						
	CO OUT-7	AHU-1			FEC/IOM	MS/TP	2	4	CO OUT-7			P-5						
	AO OUT-8	AHU-1	HTG-O	Heating Valve Output	FEC/IOM	MS/TP	2	4	AO OUT-8			P-5			4/18	0-10VDC		
	AO OUT-9	AHU-1	CLG-O	Cooling Valve Output	FEC/IOM	MS/TP	2	4	AO OUT-9			P-5			4/18	2-10VDC		
		AHU-1			FEC/IOM							P-5						Power to Controller
		AHU-1			FEC/IOM	SA Bus	2	5				P-5						BacNet SA Bus
	UI IN-1	AHU-1	AHU-HWRT	AHU HW Return Temp	FEC/IOM	SA Bus	2	5	UI IN-1			P-5			2/18	TE-6300 (1kΩ Ni)		
	UI IN-2	AHU-1	AHU-CHWRT	AHU CHW Return Temp	FEC/IOM	SA Bus	2	5	UI IN-2			P-5			2/18	TE-6300 (1kΩ Ni)		
	UI IN-3	AHU-1	DAD-DP	Disch Air Dpr Diff Press	FEC/IOM	SA Bus	2	5	UI IN-3			P-5			4/18	0-10VDC		
	UI IN-4	AHU-1	DA-SP	Discharge Air Static Pressure	FEC/IOM	SA Bus	2	5	UI IN-4			P-5			4/18	0-10VDC		
	UI IN-5	AHU-1	OAD-S	Outdoor Air Dpr Status	FEC/IOM	SA Bus	2	5	UI IN-5			P-5			2/18	Contact (NO)		
	UI IN-6	AHU-1	COM-DAT	Common Discharge Air Temp	FEC/IOM	SA Bus	2	5	UI IN-6			P-5			2/18	TE-6300 (1kΩ Ni)		**Typical for AHU-4 Only**
	BI IN-7	AHU-1	DA-SD	Discharge Air Smoke Alarm	FEC/IOM	SA Bus	2	5	BI IN-7			P-5			2/18	Contact (NO)		
	BI IN-8	AHU-1	DA-DS	Discharge Air Dpr Status	FEC/IOM	SA Bus	2	5	BI IN-8			P-5			2/18	Contact (NO)		
	BO OUT-1	AHU-1			FEC/IOM	SA Bus	2	5	BO OUT-1			P-5						
	BO OUT-2	AHU-1			FEC/IOM	SA Bus	2	5	BO OUT-2			P-5						
	BO OUT-3	AHU-1			FEC/IOM	SA Bus	2	5	BO OUT-3			P-5						
	CO OUT-4	AHU-1			FEC/IOM	SA Bus	2	5	CO OUT-4			P-5						
	CO OUT-5	AHU-1			FEC/IOM	SA Bus	2	5	CO OUT-5			P-5						
	CO OUT-6	AHU-1			FEC/IOM	SA Bus	2	5	CO OUT-6			P-5						
	CO OUT-7	AHU-1			FEC/IOM	SA Bus	2	5	CO OUT-7			P-5						
	AO OUT-8	AHU-1			FEC/IOM	SA Bus	2	5	AO OUT-8			P-5						
	AO OUT-9	AHU-1			FEC/IOM	SA Bus	2	5	AO OUT-9			P-5						
		AHU-1			FEC/IOM							P-5						Power to Controller
		AHU-1			FEC/IOM	SA Bus	2	63				P-5						BacNet SA Bus
	BI IN-1	AHU-1	VFD1-FLT	VFD-1 Fault	FEC/IOM	SA Bus	2	63	BI IN-1			P-5			2/18	Contact (NO)		
	BI IN-2	AHU-1	VFD2-FLT	VFD-2 Fault	FEC/IOM	SA Bus	2	63	BI IN-2			P-5			2/18	Contact (NO)		
	BI IN-3	AHU-1	VFD3-FLT	VFD-3 Fault	FEC/IOM	SA Bus	2	63	BI IN-3			P-5			2/18	Contact (NO)		
	BI IN-4	AHU-1			FEC/IOM	SA Bus	2	63	BI IN-4			P-5						



AHU-1 Wiring Detail

(Typical for AHU-2 thru AHU-4)



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JOB NUMBER: 10-370	SCALE: NTS	DRAWN BY: P. Braga	
		APPROVED BY: W. Roskowski	
FILE: **AHU-1~4.vsd**			
DATE: 04/13/12	DRAWING NUMBER: **ATC-5C**		