

COIL DATA (cont)

39M UNIT SIZE	30W	30T	35T	36W	37T	40W	50W	61W	72W	85W	96W	110W
5/8-in. CHILLED WATER												
Large Face Area												
Nominal Capacity (cfm) at 500 fpm	14,375	14,705	17,448	18,000	18,438	20,000	24,917	30,333	35,667	42,000	47,250	54,000
Lower Coil Height (in.)	45	36	39	54	45	30	36	42	48	48	54	54
Upper Coil Height (in.)	N/A	36	36	N/A	45	30	33	42	48	48	54	54
Length (in.)	92	59	67	96	59	96	104	104	107	126	126	144
Total Face Area (sq ft)	28.8	29.5	34.9	36.0	36.9	40.0	49.8	60.7	71.3	84.0	94.5	108.0
Medium Face Area												
Nominal Capacity (cfm) at 500 fpm	12,458	12,906	15,354	15,000	15,979	18,000	19,500	24,917	28,979	34,125	38,063	43,500
Lower Coil Height (in.)	39	33	33	45	39	54	54	36	39	39	45	45
Upper Coil Height (in.)	N/A	30	33	N/A	39	N/A	N/A	33	39	39	42	42
Length (in.)	92	59	67	96	59	96	104	104	107	126	126	144
Total Face Area (sq ft)	24.9	25.8	30.7	30.0	32.0	36.0	39.0	49.8	58.0	68.3	76.1	87.0
Bypass Face Area (Internal Chilled Water Only)												
Nominal Capacity (cfm) at 500 fpm	10,542	9,833	11,865	12,000	12,292	15,000	16,250	19,500	23,406	27,563	31,500	36,000
Lower Coil Height (in.)	33	48	51	36	30	45	45	54	33	33	36	36
Upper Coil Height (in.)	N/A	N/A	N/A	N/A	30	N/A	N/A	N/A	30	30	36	36
Length (in.)	92	59	67	96	59	96	104	104	107	126	126	144
Total Face Area (sq ft)	21.1	19.7	23.7	24.0	24.6	30.0	32.5	39.0	46.8	55.1	63.0	72.0
5/8-in. HOT WATER HEATING												
Large Face Area												
Nominal Capacity (cfm) at 700 fpm	20,125	20,650	24,427	25,200	25,813	28,000	34,883	42,467	49,933	58,800	66,150	75,600
Lower Coil Height (in.)	45	36	39	54	45	30	36	42	48	48	54	54
Upper Coil Height (in.)	N/A	36	36	N/A	45	30	33	42	48	48	54	54
Length (in.)	92	59	59	96	67	96	104	104	107	126	126	144
Total Face Area (sq ft)	28.8	29.5	29.5	36.0	34.9	40.0	49.8	60.7	71.3	84.0	94.5	108.0
Medium Face Area												
Nominal Capacity (cfm) at 700 fpm	17,442	18,069	21,496	21,000	22,371	25,200	27,300	34,883	40,571	47,775	53,288	60,900
Lower Coil Height (in.)	39	33	33	45	39	54	54	36	39	39	45	45
Upper Coil Height (in.)	N/A	30	33	N/A	38	N/A	N/A	33	39	39	42	42
Length (in.)	92	59	67	96	59	96	104	104	107	126	126	144
Total Face Area (sq ft)	24.9	25.8	30.7	30.0	32	36.0	39.0	49.8	58.0	68.3	76.1	87.0
Small Face Area												
Nominal Capacity (cfm) at 700 fpm	9,392	11,185	12,702	14,000	14,627	14,000	16,683	21,233	—	—	—	—
Height (in.)	21	39	39	30	51	30	33	42	—	—	—	—
Length (in.)	92	59	67	96	59	96	104	104	—	—	—	—
Total Face Area (sq ft)	13.4	19.7	18.1	20.0	20.9	20.0	23.8	30.3	—	—	—	—
Bypass Face Area (Internal)												
Nominal Capacity (cfm) at 700 fpm	14,758	13,767	16,610	16,800	17,208	21,000	22,750	27,300	32,769	38,588	44,100	50,400
Lower Coil Height (in.)	33	48	51	36	30	45	45	54	33	33	36	36
Upper Coil Height (in.)	N/A	N/A	N/A	N/A	30	N/A	N/A	N/A	30	30	36	36
Length (in.)	92	59	67	96	59	96	104	104	107	126	126	144
Total Face Area (sq ft)	21.1	16.0	23.7	24.0	24.6	30.0	32.5	39.0	46.8	55.1	63.0	72.0
1-in. STEAM HEATING												
Large Face Area												
Nominal Capacity (cfm) at 700 fpm	20,125	12,906	17,588	25,200	15,488	28,000	34,883	42,467	49,933	58,800	66,150	75,600
Lower Coil Height (in.)	45	45	54	54	54	30	36	42	48	48	54	54
Upper Coil Height (in.)	N/A	N/A	N/A	N/A	N/A	30	33	42	48	48	54	54
Length (in.)	92	59	67	96	59	96	104	104	107	126	126	144
Total Face Area (sq ft)	28.8	18.4	25.1	36.0	22.1	40.0	49.8	60.7	71.3	84.0	94.5	108.0
Medium Face Area												
Nominal Capacity (cfm) at 700 fpm	17,442	11,185	14,656	21,000	12,906	25,200	27,300	34,883	40,571	47,775	53,288	60,900
Lower Coil Height (in.)	39	39	45	45	45	54	54	36	39	39	45	45
Upper Coil Height (in.)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	33	39	39	42	42
Length (in.)	92	59	67	96	59	96	104	104	107	126	126	144
Total Face Area (sq ft)	24.9	19.7	20.9	30.0	18.4	36.0	39.0	49.8	58.0	68.3	76.1	87.0
Small Face Area												
Nominal Capacity (cfm) at 700 fpm	9,392	6,023	9771	14,000	8,604	14,000	16,683	21,233	—	—	—	—
Height (in.)	21	21	30	30	30	30	33	42	—	—	—	—
Length (in.)	92	59	67	96	59	96	104	104	—	—	—	—
Total Face Area (sq ft)	13.4	8.6	14.0	20.0	12.3	20.0	23.8	30.3	—	—	—	—
Bypass Face Area (Internal)												
Nominal Capacity (cfm) at 700 fpm	14,758	9,465	11,725	16,800	10,325	21,000	22,750	27,300	32,769	38,588	44,100	50,400
Lower Coil Height (in.)	33	33	36	36	36	45	45	54	33	33	36	36
Upper Coil Height (in.)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30	30	36	36
Length (in.)	92	59	67	96	59	96	104	104	107	126	126	144
Total Face Area (sq ft)	21.1	13.5	16.8	24.0	14.8	30.0	32.5	39.0	46.8	55.1	63.0	72.0
5/8-in. HOT WATER INTEGRAL FACE AND BYPASS												
Nominal Capacity (cfm)	15,000	15,000	17,500	18,000	18,500	20,000	25,000	30,500	36,000	42,500	48,000	55,000
Coil Height (in.)	33	33	45	45	45	51	60	75	87	87	96	96
Length (in.)	81.4	81.4	81.4	81.4	81.4	81.4	92.4	92.4	92.4	114.4	114.4	136.4
Total Face Area (sq ft)	17.6	19.6	25.6	24.1	25.4	27.3	36.7	45.8	53.2	66.5	73.3	88.0
5/8-in. STEAM INTEGRAL FACE AND BYPASS												
Nominal Capacity (cfm)	15,000	15,000	17,500	18,000	18,500	20,000	25,000	30,500	36,000	42,500	48,000	55,000
Coil Height (in.)	33	33	45	45	45	51	60	75	87	87	96	96
Length (in.)	81.4	81.4	81.4	81.4	81.4	81.4	92.4	92.4	92.4	114.4	114.4	136.4
Total Face Area (sq ft)	17.6	19.6	25.6	25.6	25.4	27.3	36.7	45.8	53.2	66.5	73.3	88.0

Physical data (cont)



1/2-in. WATER COIL CONNECTION SIZES

FACE AREA	ROWS	CIRCUIT TYPE	39M UNIT SIZE																									
			03W	06W	08W	10W	12W	14W	16T	17W	18T	21W	22T	25W	25T	30W	30T	35T	36W	37T	40W	50W	61W	72W	85W	96W	110W	
			Nozzle Size (in. MPT)																									
LARGE	1, 2	HALF/FULL	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)1.5	(2)1.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5
	4	HALF/FULL	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)1.5	(2)1.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5
		DOUBLE	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5
		HALF	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)1.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5
	6, 8, 10	FULL	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	(2)1.5	(2)2.5	(2)2.5	(2)3	(2)3	(2)3	(2)3	
		DOUBLE	2.5	2.5	2.5	2.5	2.5	2.5	(2)2.5	3	(2)2.5	3	(2)3	3	(2)3	3	(2)3	(2)3	3	3	(2)3	(2)2.5	(2)2.5	(2)3	(2)3	(2)3	(2)3	
MEDIUM	1, 2	HALF/FULL	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)1.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5
	4	HALF/FULL	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)1.5	(2)2.5	(2)2.5	
		DOUBLE	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)2.5	(2)2.5	(2)2.5	
		HALF	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)2.5	(2)2.5	(2)2.5	
	6, 8, 10	FULL	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)2.5	(2)2.5	(2)2.5	
		DOUBLE	2.5	2.5	2.5	2.5	2.5	2.5	3.0	2.5	3	3	1.5	3	3.5	1.5	3	(2)2.5	3	(2)3	3	3	(2)2.5	(2)3	(2)3	(2)3	(2)3	
BYPASS	1, 2	HALF/FULL	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	3	1.5	3	1.5	3	1.5	2.5	2.5	2.5	2.5	2.5	(2)1.5	(2)1.5	(2)1.5	(2)1.5	
	4	HALF/FULL	1.5	1.5	1.5	1.5	1.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)1.5	(2)1.5	(2)1.5	
		DOUBLE	2.5	2.5	2.5	2.5	2.5	2.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)2.5	(2)2.5	(2)2.5	
		HALF/FULL	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)2.5	(2)2.5	(2)2.5	
	6, 8, 10	DOUBLE	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	3	2.5	3	2.5	3	2.5	3	3	3	2.5	3	3	3	(2)2.5	(2)2.5	(2)2.5	(2)2.5	
		DOUBLE	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	3	2.5	3	2.5	3	2.5	3	3	3	2.5	3	3	3	(2)2.5	(2)2.5	(2)2.5	(2)2.5	
SMALL	1, 2	HALF/FULL	—	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	—	—	—	
	4	HALF/FULL	—	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	—	—	—	
		DOUBLE	—	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	—	—	—	

NOTES:

1. Large face area sizes 40, 50 and 61 and medium face area size 61 units have 2 sets of water coil connections.
2. All 72-110 size units have 2 sets of water coil connections.

5/8-in. WATER COIL CONNECTION SIZES

FACE AREA	ROWS	CIRCUIT TYPE	39M UNIT SIZE																									
			03W	06W	08W	10W	12W	14W	16T	17W	18T	21W	22T	25W	25T	30W	30T	35T	36W	37T	40W	50W	61W	72W	85W	96W	110W	
			Nozzle Size (in. MPT)																									
LARGE	1	HALF	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2	(2)1.5	(2)1.5	(2)2	(2)2	(2)2	(2)2	(2)2	(2)2
	2,4	HALF	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2	2	(2)1.5	(2)1.5	(2)2	(2)2	(2)2	(2)2	(2)2
		FULL	2	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)2	(2)2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5
	6,8	FULL	2	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	3	3	3	3	3	(2)2	(2)2.5	(2)2.5	(2)3	(2)3	(2)3	(2)3
		DOUBLE	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	3	3	3	3	3	(2)2.5	(2)2.5	(2)2.5	(2)4	(2)4	(2)4	(2)4
MEDIUM	1	HALF	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2	2	2	(2)1.5	(2)2	(2)2	(2)2	(2)2	(2)2
	2,4	HALF	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2	2	2	(2)1.5	(2)2	(2)2	(2)2	(2)2	(2)2
		FULL	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)2	(2)2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5
	6,8	FULL	1.5	1.5	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	(2)2.5	(2)3	(2)3	(2)3	(2)3	(2)3
		DOUBLE	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	(2)2.5	(2)3	(2)3	(2)3	(2)3	(2)3
BYPASS	1	HALF	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	(2)1.5	(2)1.5	(2)1.5	(2)1.5	(2)1.5
	2,4	HALF	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	(2)1.5	(2)1.5	(2)1.5	(2)1.5
		FULL	1.5	1.5	1.5	1.5	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	6,8	FULL	1.5	1.5	1.5	1.5	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
		DOUBLE	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	(2)3	(2)3	(2)3	(2)3
SMALL	1	HALF	—	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	—	—	—	—	
	2	HALF	—	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	—	—	—	—	
		FULL	—	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2	2	2	2	2	—	—	—	—

NOTES:

1. Large face area sizes 40, 50 and 61 and medium face area size 61 units have 2 sets of water coil connections.
2. All 72-110 size units have 2 sets of water coil connections.

1-in. STEAM COIL CONNECTION SIZES

FACE AREA	ROWS	CONNECTION	39M UNIT SIZE																									
			03W	06W	08W	10W	12W	14W	16T	17W	18T	21W	22T	25W	25T	30W	30T	35T	36W	37T	40W	50W	61W	72W	85W	96W	110W	
			Nozzle Size (in. MPT)																									
ALL*	ALL	INLET	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5	
		OUTLET	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	(2)2.5	(2)2.5	(2)2.5	(2)2.5

*Large face area sizes 40, 50 and 61 and medium face area size 61 units have 2 sets of steam coil connections.

5/8-in. STEAM COIL CONNECTION SIZES

FACE AREA	ROWS	CONNECTION	39M UNIT SIZE																								
			03W	06W	08W	10W	12W	14W	16T	17W	18T	21W	22T	25W	25T	30W	30T	35T	36W	37W	40W	50W	61W	72W	85W	96W	110W
			Nozzle Size (in. MPT)																								
LARGE	1	INLET	2	2	2	2	2	2	(2)2	2	(2)2	2.5	(2)2	2.5	(2)2	—	—	—	—	—	—	—	—	—	—	—	—
		OUTLET	2	2	2	2	2	2	2	2	2	2	2	2	2	—	—	—	—	—	—	—	—	—	—	—	
MEDIUM		INLET	2	2	2	2	2	2	2.5	2	2.5	2	2.5	2	(2)2	—	—	—	—	—	—	—	—	—	—	—	—
		OUTLET	2	2	2	2	2	2	2	2	2	2	2	2	2	—	—	—	—	—	—	—	—	—	—	—	
BYPASS		INLET	2	2	2	2	2	2	2	2	2	2	2	2	2	—	—	—	—	—	—	—	—	—	—	—	—
		OUTLET	2	2	2	2	2	2	2	2	2	2	2	2	2	—	—	—	—	—	—	—	—	—	—	—	—
SMALL		INLET	2	2	2	2	2	2	2	2	2	2	2	2	2	—	—	—	—	—	—	—	—	—	—	—	—
		OUTLET	2	2	2	2	2	2	2	2	2	2	2	2	2	—	—	—	—	—	—	—	—	—	—	—	—
LARGE	2	INLET	2.5	2.5	2.5	2.5	2.5	2.5	(2)2.5	2.5	(2)2.5	3	(2)2.5	3	(2)2.5	—	—	—	—	—	—	—	—	—	—	—	—
		OUTLET	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	—	—	—	—	—	—	—	—	—	—	—	
MEDIUM		INLET	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	3	2.5	3	2.5	(2)2.5	—	—	—	—	—	—	—	—	—	—	—	—
		OUTLET	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	—	—	—	—	—	—	—	—	—	—	—	
BYPASS		INLET	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	—	—	—	—	—	—	—	—	—	—	—	—
		OUTLET	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	—	—	—	—	—	—	—	—	—	—	—	—
SMALL		INLET	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	—	—	—	—	—	—	—	—	—	—	—	—
		OUTLET	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	—	—	—	—	—	—	—	—	—	—	—	—

HOT WATER — INTEGRAL FACE AND BYPASS COIL CONNECTION SIZES

ROWS	CONNECTION	39M UNIT SIZE																									
		03W	06W	08W	10W	12W	14W	16T	17W	18T	21W	22T	25W	25T	30W	30T	35T	36W	37T	40W	50W	61W	72W	85W	96W	110W	
		Nozzle Size (in. MPT)																									
1	INLET	—	2.5	2.5	2.5	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
	OUTLET	—	2.5	2.5	2.5	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
2	INLET	—	2.5	2.5	2.5	2.5	2.5	2	2	2	2	2	2	2	2.5	2	2	2.5	2	2.5	2.5	2.5	2.5	3	3	3	
	OUTLET	—	2.5	2.5	2.5	2.5	2.5	2	2	2	2	2	2	2	2.5	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	
3	INLET	—	2.5	2.5	2.5	2.5	2.5	2	2	2	2	2	2	2	2.5	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	
	OUTLET	—	2.5	2.5	2.5	2.5	2.5	2	2	2	2	2	2	2	2.5	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	

STEAM — INTEGRAL FACE AND BYPASS COIL CONNECTION SIZES

ROWS	CONNECTION	39M UNIT SIZE																									
		03W	06W	08W	10W	12W	14W	16T	17W	18T	21W	22T	25W	25T	30W	30T	35T	36W	37T	40W	50W	61W	72W	85W	96W	110W	
		Nozzle Size (in. MPT)																									
1	INLET	—	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	3	3	
	OUTLET	—	2.5	2.5	2.5	2.5	2.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	
2	INLET	—	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	3	2.5	3	2.5	3	2.5	3	3	2.5	3	3	3	3	4	4	4	
	OUTLET	—	2.5	2.5	2.5	2.5	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	
3	INLET	—	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	3	2.5	3	2.5	3	2.5	3	3	2.5	3	3	3	3	4	4	4	
	OUTLET	—	2.5	2.5	2.5	2.5	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	

Physical data (cont)



OPERATING CHARGE (Approximate) — DIRECT-EXPANSION COIL

ROWS	CONNECTION	39M UNIT SIZE																									
		03W	06W	08W	10W	12W	14W	16T	17W	18T	21W	22T	25W	25T	30W	30T	35T	36W	37T	40W	50W	61W	72W	85W	96W	110W	
		Refrigerant R-410A (lb)																									
4	Large	1	3	4	4	5	6	7	7	8	9	10	11	11	13	13	15	16	16	18	22	27	32	37	42	48	
	Medium	1	2	3	3	4	5	5	6	6	7	7	8	8	10	10	12	12	12	13	17	20	24	28	32	36	
6	Large	2	4	6	7	9	10	12	12	13	15	16	18	18	22	22	26	26	27	29	37	45	53	62	70	80	
	Medium	2	3	4	5	7	8	9	9	10	11	12	14	14	16	16	19	20	20	22	27	33	39	47	53	60	
8	Large	3	6	8	10	12	15	17	18	19	22	23	26	26	31	31	36	37	38	42	52	63	75	88	100	114	
	Medium	2	5	6	8	9	11	12	13	14	16	17	20	20	23	23	27	28	29	31	39	48	56	66	75	86	

COIL VOLUME (Gal. Water)

39M UNIT SIZE	03W	06W	08W	10W	12W	14W	16T	17W	18T	21W	22T	25W	25T	30W	30T	35T	36W	37T	40W	50W	61W	72W	85W	96W	110W	
CHILLED WATER																										
Large Face Area																										
4-Row	1.4	2.2	2.8	3.7	4.7	5.3	5.7	6.2	6.6	7.8	8.1	8.9	9.1	11.0	10.9	12.7	13.3	13.9	14.5	18.3	22.2	26.2	30.7	34.7	39.6	
6-Row	2.0	3.3	4.3	5.5	7.0	7.9	8.5	9.3	9.9	11.8	12.2	13.3	13.6	16.5	16.3	19.1	19.9	20.8	21.7	27.4	33.3	39.3	46.1	52.0	59.3	
8-Row	2.7	4.4	5.7	7.3	9.3	10.5	11.3	12.4	13.2	15.7	16.3	17.8	18.2	22.0	21.8	25.5	26.5	27.8	29.0	36.5	44.4	52.3	61.5	69.3	79.1	
10-Row	3.4	5.5	7.1	9.1	11.6	13.1	14.1	15.5	16.5	19.6	20.3	22.2	22.7	27.5	27.2	31.8	33.2	34.7	36.2	45.7	55.5	65.4	76.8	86.7	98.9	
Medium Face Area																										
4-Row	0.9	1.5	2.1	2.7	3.7	4.5	4.4	4.9	5.6	6.6	6.6	7.5	6.9	9.3	8.3	10.2	10.9	11.3	13.3	14.4	18.3	21.5	25.2	28.4	32.4	
6-Row	1.4	2.3	3.1	4.0	5.5	6.8	6.6	7.4	8.3	9.9	9.9	11.2	10.4	13.9	12.4	15.3	16.3	16.9	19.9	21.5	27.4	32.2	37.8	42.6	48.5	
8-Row	1.9	3.1	4.1	5.3	7.3	9.0	8.9	9.9	11.1	13.2	13.3	15.0	13.8	18.5	16.5	20.4	21.7	22.5	26.5	28.7	36.5	42.9	50.4	56.7	64.7	
10-Row	2.4	3.9	5.2	6.6	9.1	11.3	11.1	12.4	13.9	16.5	16.6	18.7	17.7	23.1	20.6	25.5	27.1	28.1	33.2	35.9	45.7	53.7	63.0	70.9	80.9	
Small Face Area																										
4-Row	—	1.3	1.5	2.0	2.3	2.6	3.0	3.3	3.4	3.7	3.9	4.2	4.1	5.2	4.9	7.2	7.2	7.1	7.2	9.1	11.1	—	—	—	—	
Bypass Face Area																										
4-Row	0.8	1.3	1.8	2.3	3.3	3.8	3.7	4.5	4.2	5.8	5.1	6.5	6.0	8.1	7.1	8.5	9.0	9.0	10.9	11.7	14.4	16.8	19.7	22.1	25.2	
6-Row	1.2	2.0	2.7	3.5	5.0	5.6	5.5	6.8	6.3	8.7	7.7	9.8	8.9	12.2	10.7	12.7	13.6	13.5	16.3	17.6	21.5	25.2	29.6	33.1	37.8	
8-Row	1.6	2.7	3.6	4.7	6.6	7.5	7.4	9.1	8.5	11.5	10.2	13.1	11.9	16.2	14.3	17.0	18.1	18.0	21.7	23.5	28.7	33.6	39.4	44.1	50.3	
10-Row	2.0	3.3	4.5	5.8	8.3	9.4	9.2	11.3	10.6	14.4	12.8	16.4	14.9	20.3	17.8	21.2	22.6	22.5	27.1	29.4	35.9	41.9	49.3	55.2	62.9	
HOT WATER																										
Large Face Area																										
1-Row	0.3	0.6	0.7	0.9	1.2	1.3	1.4	1.5	1.7	2.0	2.0	2.2	2.3	2.7	2.7	3.2	3.3	3.5	3.6	4.6	5.5	6.5	7.7	8.7	9.9	
2-Row	0.7	1.1	1.4	1.8	2.3	2.6	2.8	3.1	3.3	3.9	4.1	4.4	4.5	5.5	5.4	6.4	6.6	6.9	7.2	9.1	11.1	13.1	15.4	17.3	19.8	
Medium Face Area																										
1-Row	0.2	0.4	0.5	0.7	0.9	1.1	1.1	1.2	1.4	1.6	1.7	1.9	1.7	2.3	2.1	2.5	2.7	2.8	3.3	3.6	4.6	5.4	6.3	7.1	8.1	
2-Row	0.5	0.8	1.0	1.3	1.8	2.3	2.2	2.5	2.8	3.3	3.3	3.7	3.5	4.6	4.1	5.1	5.4	5.6	6.6	7.2	9.1	10.7	12.6	14.2	16.2	
Small Face Area																										
1-Row	—	0.3	0.4	0.5	0.6	0.7	.07	0.8	0.9	0.9	1.0	1.1	1.0	1.3	1.2	1.8	1.8	1.8	1.8	2.3	2.8	—	—	—	—	
2-Row	—	0.7	0.8	1.0	1.2	1.3	1.5	1.6	1.7	1.9	2.0	2.1	2.0	2.6	2.4	3.6	3.6	3.6	3.6	4.6	5.5	—	—	—	—	
Bypass Face Area																										
1-Row	0.2	0.3	0.5	0.6	0.8	0.9	0.9	1.1	1.1	1.4	1.0	1.6	1.5	2.0	1.8	2.1	2.3	2.3	2.7	2.9	3.6	4.2	4.9	5.5	6.3	
2-Row	0.4	0.7	0.9	1.2	1.7	1.9	1.8	2.3	2.1	2.9	2.0	3.3	3.0	4.1	3.6	4.2	4.5	4.5	5.4	5.9	7.2	8.4	9.9	11.0	12.6	
Integral Bypass Face Area																										
1-Row	—	0.3	0.5	0.6	0.6	0.7	0.5	0.6	0.5	0.8	0.9	0.8	1.0	1.2	1.3	1.7	1.6	1.6	1.8	2.4	3.0	3.4	4.3	4.7	5.6	
2-Row	—	0.6	0.9	1.2	1.2	1.4	1.0	1.2	1.1	1.7	1.8	1.7	1.9	2.3	2.5	3.3	3.2	3.3	3.6	4.8	5.9	6.8	8.5	9.4	11.3	
3-Row	—	0.8	1.4	1.8	1.8	2.0	1.5	1.9	1.6	2.5	2.6	2.5	2.9	3.5	3.8	5.0	4.7	4.9	5.3	7.1	8.9	10.3	12.8	14.1	16.9	

NOTE: One gallon of water weighs 8.33 lb.

DRY COIL WEIGHTS (lb)

COIL TYPE	FACE AREA	ROWS	FPI	39M UNIT SIZE																								
				03W	06W	08W	10W	12W	14W	16T	17W	18T	21W	22T	25W	25T	30W	30T	35T	36W	37T	40W	50W	61W	72W	85W	96W	110W
CHILLED WATER OR DIRECT EXPANSION	LARGE	4	8	50	85	110	143	182	207	219	244	256	309	317	353	355	437	428	503	528	546	576	728	884	1043	1229	1386	1584
			11	52	89	115	149	190	215	228	254	267	322	330	367	370	455	446	523	550	568	600	758	921	1087	1280	1444	1650
			14	54	92	119	155	197	224	237	264	278	335	344	382	385	473	463	544	572	591	624	789	958	1130	1331	1502	1716
		6	8	70	120	154	200	255	289	306	341	359	432	444	494	497	612	599	704	739	764	806	1019	1238	1461	1720	1940	2218
			11	73	124	160	209	265	301	319	355	374	450	463	514	518	637	624	733	770	796	840	1062	1289	1521	1792	2021	2310
			14	76	129	167	217	276	313	331	370	389	468	481	535	539	663	649	762	801	828	874	1104	1341	1582	1863	2102	2402
		8	8	90	154	198	258	328	372	393	439	461	556	571	635	639	787	770	905	950	982	1037	1310	1591	1878	2211	2495	2851
			11	94	160	206	268	341	387	410	457	480	579	595	661	666	819	802	942	990	1023	1080	1365	1658	1956	2303	2599	2970
			14	98	166	215	279	355	403	426	475	500	602	619	688	693	852	834	980	1030	1064	1123	1420	1724	2034	2396	2703	3089
		10	8	107	182	235	305	388	441	466	520	547	659	677	753	758	932	913	1072	1126	1164	1229	1553	1886	2226	2621	2957	3379
			11	111	190	244	318	404	459	486	542	569	686	705	784	789	971	951	1117	1173	1213	1280	1618	1964	2318	2730	3080	3520
			14	116	197	254	331	421	477	505	563	592	714	733	815	821	1010	989	1161	1220	1261	1331	1682	2043	2411	2839	3203	3661
	MEDIUM	4	8	35	60	80	104	143	177	171	195	215	260	259	296	270	368	325	402	432	443	528	572	728	856	1008	1134	1296
			11	36	62	83	108	149	184	178	203	224	271	269	308	281	383	338	419	450	461	550	596	758	892	1050	1181	1350
			14	38	64	87	113	155	192	185	211	233	282	280	321	292	399	352	436	468	479	572	620	789	927	1092	1229	1404
		6	8	49	83	112	146	200	248	239	273	301	364	362	414	377	515	454	563	605	620	739	801	1019	1198	1411	1588	1814
			11	51	87	117	152	209	258	249	284	314	379	377	432	393	537	473	586	630	645	770	834	1062	1248	1470	1654	1890
			14	53	90	121	158	217	268	259	296	326	394	392	449	409	558	492	786	836	851	1001	1104	1298	1529	1720	1966	
		8	8	63	107	144	187	257	319	308	351	387	468	465	533	485	662	584	724	778	797	950	1030	1310	1541	1814	2041	2333
			11	66	112	150	195	268	332	321	366	404	488	485	555	505	690	608	758	810	830	990	1073	1365	1605	1890	2126	2430
			14	68	116	156	203	279	345	333	380	420	507	504	577	526	718	633	810	842	863	1030	1115	1420	1669	1966	2211	2527
		10	8	75	127	171	222	305	378	365	416	459	555	551	631	575	785	692	858	922	944	1126	1220	1553	1826	2150	2419	2765
			11	78	132	178	231	318	393	380	433	478	578	574	658	599	818	721	893	960	983	1173	1271	1618	1902	2240	2520	2880
			14	81	138	185	240	330	409	395	451	497	601	597	684	623	850	750	929	998	1023	1220	1322	1682	1978	2300	2621	2995
	SMALL	4	8	—	51	60	78	91	103	114	130	133	146	153	167	159	207	192	285	288	280	288	364	442	—	—	—	—
			11	—	53	63	81	95	108	119	135	139	152	159	173	166	216	200	297	300	292	300	379	460	—	—	—	—
			14	—	55	65	85	99	112	124	141	144	158	165	180	173	224	208	308	312	304	312	394	479	—	—	—	—
		6	8	30	51	70	91	130	148	143	179	164	228	200	259	233	322	280	335	360	354	432	468	572	669	788	882	1008
			11	31	53	73	95	135	154	148	186	171	237	208	270	242	335	292	349	375	369	450	488	596	697	820	919	1050
			14	33	55	76	99	141	160	154	194	178	246	216	281	252	349	304	363	390	384	468	507	620	724	853	956	1092
		8	8	42	71	98	127	182	207	200	250	230	319	280	363	326	451	392	469	504	496	605	655	801	936	1103	1235	1411
			11	44	74	102	133	190	215	208	261	239	332	291	378	339	470	409	489	525	516	630	683	834	975	1148	1286	1470
			14	46	77	106	138	197	224	216	271	249	345	303	393	353	488	425	508	546	537	655	710	868	1014	1194	1338	1529
		10	8	54	92	126	164	234	266	257	322	295	410	360	466	419	580	504	603	648	637	778	842	1030	1204	1418	1588	1814
			11	56	96	131	171	244	277	267	335	308	427	375	486	436	604	525	628	675	664	810	878	1073	1254	1477	1654	1890
			14	59	99	137	177	254	288	278	349	320	444	390	505	454	628	546	653	702	690	842	913	1115	1304	1536	1720	1966
BYPASS	4	8	64	109	149	194	277	315	304	381	350	485	426	553	497	687	598	715	768	755	922	998	1220	1427	1680	1882	2150	
		11	67	113	156	202	289	328	317	397	364	506	444	576	517	716	623	744	800	787	960	1040	1271	1486	1750	1960	2240	
		14	69	118	162	210	300	341	329	413	379	526	462	599	538	744	648	774	832	818	998	1082	1322	1546	1820	2038	2330	
	6	8	30	51	70	91	130	148	143	179	164	228	200	259	233	322	280	335	360	354	432	468	572	669	788	882	1008	
		11	31	53	73	95	135	154	148	186	171	237	208	270	242	335	292	349	375	369	450	488	596	697	820	919	1050	
		14	33	55	76	99	141	160	154	194	178	246	216	281	252	349	304	363	390	384	468	507	620	724	853	956	1092	
	8	8	42	71	98	127	182	207	200	250	230	319	280	363	326	451	392	469	504	496	605	655	801	936	1103	1235	1411	
		11	44	74	102	133	190	215	208	261	239	332	291	378	339	470	409	489	525	516	630	683	834	975	1148	1286	1470	
		14	46	77	106	138	197	224	216	271	249	345	303	393	353	488	425	508	546	537	655	710	868	1014	1194	1338	1529	
	10	8	54	92	126	164	234	266	257	322	295	410	360	466	419	580	504	603	648	637	778	842	1030	1204	1418	1588	1814	
		11	56	96	131	171	244	277	267	335	308	427	375	486	436	604	525	628	675	664	810	878	1073	1254	1477	1654	1890	
		14	59	99	137	177	254	288	278	349	320	444	390	505	454	628	546	653	702	690	842	913	1115	1304	1536	1720	1966	
HOT WATER	LARGE	1	8	17	28	37	48	61	69	73	81	85	103	106	118	118	146	143	178	176	182	192	243	295	348	410	462	528
			11	17	30	38	50	63	72	76	85	89	107	110	122	123	152	149	174	183	189	200	253	307	362	427	481	550
			14	18	31	40	52	66	75	79	88	93	112	115	127	128	158	154	181	191	197	208	263	317	372	444	501	572
		2	8	23	40	51	67	85	96	102	114	120	144	148	165	166	204	200	235	246	255	269	340	413	487	573	647	739
			11	24	41	53	70	88	100	106	118	125	150	154	171	173	212	208	244	257	265	280	354	430	507	597	674	770
			14	25	43	56	72	92	104	110	123	130	156	160	178	180	221	216	254	267	276	291	368	447	527	621	701	801
		4	8	50	85	110	143	182	207	—	244	—	309	—	353	—	437	—	—	528	—	576	728	884	1043	1229	1386	1584
			11	52	89	115	149	190	215	—	254	—	322	—	367	—	455	—	—	550	—	600	758	921	1087	1280	1444	1650
			14	54	92	119	155	1																				

LEGEND

FPI — Fins Per Inch
IDT — Inner Distributing Tube

NOTES:

- Weights shown include headers and are the sum of two coils where applicable.
- Coils are full length.
- Weights shown are for aluminum fin coils; for copper fin coils, multiply by 1.20.
- Weights shown are for 1/2-in., .016 in. wall tubes; for 1/2-in., .025-in. wall tubes, multiply by 1.15.
- Weights shown are for 1/2-in., .016-in. wall tubes; for 5/8-in., .020-in. wall tubes, multiply by 1.15.

6. Weights shown are for 1/2-in., .016-in. wall tubes; for 5/8-in., .035-in. wall tubes, multiply by 1.50.

Physical data (cont)



DRY COIL WEIGHTS (lb) (cont)

COIL TYPE	FACE AREA	ROWS	FPI	39M UNIT SIZE																								
				03W	06W	08W	10W	12W	14W	16T	17W	18T	21W	22T	25W	25T	30W	30T	35T	36W	37T	40W	50W	61W	72W	85W	96W	110W
5/8-IN. IDT STEAM	LARGE	1	6	19	32	41	53	68	77	82	91	96	115	118	132	133	—	—	—	—	—	—	—	—	—	—	—	—
			9	19	33	43	56	71	80	85	95	100	120	123	137	138	—	—	—	—	—	—	—	—	—	—	—	—
			12	20	35	44	58	74	84	88	99	104	125	128	143	144	—	—	—	—	—	—	—	—	—	—	—	—
		2	6	23	40	51	67	85	96	102	114	120	144	148	165	166	—	—	—	—	—	—	—	—	—	—	—	—
			9	24	41	53	70	88	100	106	118	125	150	154	171	173	—	—	—	—	—	—	—	—	—	—	—	—
			12	25	43	56	72	92	104	110	123	130	156	160	178	180	—	—	—	—	—	—	—	—	—	—	—	—
	MEDIUM	1	6	13	22	30	39	53	66	64	73	80	97	97	111	101	—	—	—	—	—	—	—	—	—	—	—	—
			9	14	23	31	40	56	69	67	76	84	101	101	115	105	—	—	—	—	—	—	—	—	—	—	—	
			12	14	24	32	42	58	72	69	79	87	105	105	120	109	—	—	—	—	—	—	—	—	—	—	—	
		2	6	16	28	37	49	67	83	80	91	100	121	121	138	126	—	—	—	—	—	—	—	—	—	—	—	
			9	17	29	39	51	70	86	83	95	105	126	126	144	131	—	—	—	—	—	—	—	—	—	—	—	
			12	18	30	40	53	72	89	86	99	109	131	131	150	136	—	—	—	—	—	—	—	—	—	—	—	
SMALL	1	6	—	19	22	29	34	39	43	49	50	55	57	62	59	—	—	—	—	—	—	—	—	—	—	—	—	
		9	—	20	23	30	35	40	44	51	52	57	59	65	63	—	—	—	—	—	—	—	—	—	—	—		
		12	—	21	24	32	37	42	46	53	54	59	62	67	64	—	—	—	—	—	—	—	—	—	—	—		
	2	6	—	24	28	36	42	48	53	61	62	68	71	78	74	—	—	—	—	—	—	—	—	—	—	—		
		9	—	25	29	38	44	50	55	63	65	71	74	81	77	—	—	—	—	—	—	—	—	—	—	—		
		12	—	26	30	39	46	52	58	66	67	74	77	84	81	—	—	—	—	—	—	—	—	—	—	—		
BYPASS	1	6	11	19	26	34	49	55	53	67	61	85	75	97	87	—	—	—	—	—	—	—	—	—	—	—		
		9	12	20	27	35	51	57	55	70	64	88	78	101	91	—	—	—	—	—	—	—	—	—	—	—		
		12	12	21	28	37	53	60	58	72	66	92	81	105	94	—	—	—	—	—	—	—	—	—	—	—		
	2	6	14	24	33	42	61	69	67	83	78	106	93	121	109	—	—	—	—	—	—	—	—	—	—	—		
		9	15	25	34	44	63	72	69	87	80	111	97	126	113	—	—	—	—	—	—	—	—	—	—	—		
		12	15	26	35	46	66	75	72	90	83	115	101	131	118	—	—	—	—	—	—	—	—	—	—	—		
HOT WATER OR STEAM	INTEGRAL FACE AND BYPASS	1	6	—	146	192	224	224	239	400	507	411	587	541	587	565	749	677	811	853	788	906	1064	1181	1356	1628	1699	1983
			9	—	152	200	233	233	249	417	528	428	612	564	612	588	780	706	845	889	821	944	1108	1230	1412	1695	1769	2066
			12	—	158	208	242	242	259	434	550	446	637	587	637	613	813	735	880	926	855	983	1154	1281	1471	1766	1843	2152
		2	6	—	152	202	237	237	254	429	536	442	630	598	630	621	810	752	909	935	885	997	1180	1320	1530	1846	1931	2262
			9	—	158	210	247	247	265	447	559	461	657	623	657	647	844	783	947	974	922	1039	1229	1375	1594	1923	2011	2356
			12	—	164	218	257	257	276	466	582	480	684	649	684	674	879	816	986	1015	960	1082	1280	1432	1660	2003	2095	2454
		3	6	—	158	212	251	251	269	469	585	483	695	658	695	690	899	844	1028	1044	999	1117	1327	1675	1736	2102	2202	2586
			9	—	165	221	261	261	280	489	610	503	724	685	724	719	936	879	1070	1088	1041	1164	1382	1745	1809	2190	2293	2694
			12	—	172	230	271	271	291	509	635	524	754	714	754	749	975	916	1115	1133	1084	1212	1440	1818	1884	2281	2389	2806

LEGEND

FPI — Fins Per Inch
IDT — Inner Distributing Tube

NOTES:

- Weights shown include headers and are the sum of two coils where applicable.
- Coils are full length.

- Weights shown are for aluminum fin coils; for copper fin coils, multiply by 1.20.
- Weights shown are for 1/2-in., .016 in. wall tubes; for 1/2-in., .025-in. wall tubes, multiply by 1.15.
- Weights shown are for 1/2-in., .016-in. wall tubes; for 5/8-in., .020-in. wall tubes, multiply by 1.15.
- Weights shown are for 1/2-in., .016-in. wall tubes; for 5/8-in., .035-in. wall tubes, multiply by 1.50.

MOTOR WEIGHTS (lb)

HP	230/460-3-60		200/400-3-50*		575-3-60	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
1	40	68	29	34	37	60/68
1 1/2	46	66	36	41	48	60/66
2	54	66	41	47	50	65/66
3	87	92	73	62	70	87
5	94	99	102	72	88	89/99
7 1/2	130	158	121	105	89	142/158
10	126	200	139	128	119	154/200
15	217	259	170	210	170	250/259
20	250	290	205	254	212	287/290
25	309	358	273	363	240	394/368
30	300	436	283	414	284	436/436
40	415	661	416†	470†	370	661/661
50	414	686	403†	527†	440	686/686
60	652**	799	545	790†	591	799
75	706**	850**	651†	884†	670	850
100	782**	1475**	1133†	1450†	750	1008†
125	1000**	1600**	1210†	1625†	950	1714†
150	1318**	1773**	—	—	—	—

LEGEND

ODP — Open Drip Proof
TEFC — Totally Enclosed Fan Cooled

*Both ODP and TEFC 50 Hz motors available in standard models only.

†Availability unconfirmed.

**460 volt only.

NOTE: Multiply motor weight by 0.10 to estimate drive weight.

ELECTRICAL DATA - PREMIUM EFFICIENCY EISA COMPLIANT MOTORS

ODP T-FRAME MOTORS - 1800 RPM

MOTOR HP	FLA FOR 3-PHASE, 60 Hz VOLTAGES				EFF. (%)	NEMA FRAME
	208	230	460	575		
1	3.1	2.8	1.4	1.1	85.5	143T
1.5	4.6	4.2	2.1	1.7	86.5	145T
2	6.1	5.6	2.8	2.2	86.5	145T
3	8.6	7.8	3.9	3.1	89.5	182T
5	14.3	13.0	6.5	5.2	89.5	184T
7.5	20.8	18.8	9.4	7.5	91.0	213T
10	27.3	24.7	12.4	9.9	91.7	215T
15	39.8	36.0	18.0	14.4	93.0	254T
20	53.1	48.0	24.0	19.2	93.0	256T
25	65.5	59.3	29.6	23.7	93.6	284T
30	77.8	70.4	35.2	28.2	94.1	286T
40	103.8	93.8	46.9	37.5	94.1	324T
50	128.6	116.3	58.2	46.5	94.5	326T
60	152.7	138.1	69.1	55.2	95.0	364T
75	190.9	172.6	86.3	69.1	95.0	365T
100	252.4	228.3	114.1	91.3	95.4	404T
125	—	—	142.7	114.1	95.4	405T
150	—	—	169.8	135.8	95.8	444T

ODP T-FRAME MOTORS - 3600 RPM

MOTOR HP	FLA FOR 3-PHASE, 60 Hz VOLTAGES				EFF. (%)	NEMA FRAME
	208	230	460	575		
1	3.9	3.5	1.8	1.4	77.0	143T
1.5	4.9	4.4	2.2	1.8	84.0	143T
2	6.3	5.7	2.8	2.3	85.5	145T
3	9.4	8.5	4.3	3.4	85.5	145T
5	15.4	13.9	6.9	5.6	86.5	182T
7.5	22.0	19.9	9.9	8.0	88.5	184T
10	28.7	25.9	13.0	10.4	89.5	213T
15	42.4	38.3	19.1	15.3	90.2	215T
20	55.5	50.2	25.1	20.1	91.0	254T
25	68.3	61.8	30.9	24.7	91.7	256T
30	82.0	74.1	37.1	29.6	91.7	284T
40	107.6	97.3	48.7	38.9	92.4	286T
50	132.8	120.1	60.0	48.0	93.0	324T
60	157.3	142.3	71.1	56.9	93.6	326T
75	196.6	177.8	88.9	71.1	93.6	364T
100	262.2	237.1	118.6	94.8	93.6	365T
125	—	—	146.6	117.3	94.1	404T
150	—	—	176.0	140.8	94.1	405T

TEFC T-FRAME MOTORS - 1800 RPM

MOTOR HP	FLA FOR 3-PHASE, 60 HZ VOLTAGES				EFF. (%)	NEMA FRAME
	208	230	460	575		
1	3.1	2.8	1.4	1.1	85.5	143T
1.5	4.6	4.2	2.1	1.7	86.5	145T
2	6.1	5.6	2.8	2.2	86.5	145T
3	8.6	7.8	3.9	3.1	89.5	182T
5	14.3	13.0	6.5	5.2	89.5	184T
7.5	20.5	18.5	9.3	7.4	91.7	213T
10	27.3	24.7	12.4	9.9	91.7	215T
15	40.4	36.5	18.2	14.6	92.4	254T
20	53.1	48.0	24.0	19.2	93.0	256T
25	65.5	59.3	29.6	23.7	93.6	284T
30	78.7	71.1	35.6	28.5	93.6	286T
40	103.8	93.8	46.9	37.5	94.1	324T
50	128.6	116.3	58.2	46.5	94.5	326T
60	152.7	138.1	69.1	55.2	95.0	364T
75	189.3	171.2	85.6	68.5	95.4	365T
100	252.4	228.3	114.1	91.3	95.4	405T
125	—	—	142.7	114.1	95.4	444T
150	—	—	169.8	135.8	95.8	445T

TEFC T-FRAME MOTORS - 3600 RPM

MOTOR HP	FLA FOR 3-PHASE, 60 HZ VOLTAGES				EFF. (%)	NEMA FRAME
	208	230	460	575		
1	3.9	3.5	1.8	1.4	77.0	143T
1.5	4.9	4.4	2.2	1.8	84.0	143T
2	6.3	5.7	2.8	2.3	85.5	145T
3	9.2	8.3	4.2	3.3	86.5	182T
5	14.7	13.3	6.6	5.3	88.5	184T
7.5	21.5	19.5	9.7	7.8	89.5	213T
10	28.2	25.5	12.8	10.2	90.2	215T
15	41.6	37.6	18.8	15.1	91.0	254T
20	55.5	50.2	25.1	20.1	91.0	256T
25	68.3	61.8	30.9	24.7	91.7	284T
30	82.0	74.1	37.1	29.6	91.7	286T
40	107.6	97.3	48.7	38.9	92.4	324T
50	132.8	120.1	60.0	48.0	93.0	326T
60	157.3	142.3	71.1	56.9	93.6	364T
75	196.6	177.8	88.9	71.1	93.6	365T
100	259.4	234.6	117.3	93.8	94.1	405T
125	—	—	143.9	115.1	95.0	444T
150	—	—	172.6	138.1	95.0	445T

LEGEND

EFF. — Efficiency
EISA — Energy Independence and Security Act of 2007
FLA — Full Load Amps
NEMA — National Electrical Manufacturers Association
ODP — Open Drip Proof
TEFC — Totally Enclosed Fan Cooled

NOTES:

1. Approximate motor full load amps listed. Actual motor full load amps can be found on the motor nameplate.
2. Motor voltage and availability is controlled by **AHUBuilder** software.

39M Indoor Air Handler Units

HVAC Guide Specifications

Size Range: **1,500 to 60,500 Nominal Cfm**

Carrier Model Number: **39MN — Indoor Unit**

Part 1 — General

1.01 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
Company specializing in manufacturing the products specified in this section with minimum of five years documented experience.
- B. The management system governing the manufacturing of this product is ISO (International Organization for Standardization) 9001:2008 certified.
- C. Air-handling unit assembly shall have UL (Underwriters Laboratories) 1995 certification for safety, including use with electric heat.
- D. Products requiring electric connection shall be listed and classified by ETL and CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.
- E. Coil performance shall be certified in accordance with AHRI (Air-Conditioning, Heating, and Refrigerating Institute) Standard 410, latest edition.
- F. Unit performance shall be rated in accordance with AHRI Standard 430 for Central Air Handling Units and subject to verification of rating accuracy by AHRI-sponsored, third party testing. Units shall meet NFPA (National Fire Protection Association) 90A requirements.

1.02 DELIVERY, STORAGE AND PROTECTION

- A. All indoor units, painted or unpainted, shall be completely shrink-wrapped from the factory for protection during shipment. Tarping of bare units is unacceptable.
- B. Inspect for transportation damage and store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.03 START-UP REQUIREMENTS

Do not operate units until ductwork is clean, filters are in place, bearings lubricated, condensate properly trapped, piping connections verified and leak tested, belts aligned and tensioned, all shipping braces have been removed, and fan has been test run under observation.

Part 2 — Products

2.01 GENERAL DESCRIPTION

- A. Units shall ship in the number of sections necessary to meet project requirements and shall ship in as many splits as specified in selection software. Split options as follows:
 - 1. Shipped in sections — shipping split.
 - 2. Shipped assembled — base rail break (ship attached).
 - 3. Shipped assembled — solid base rail.

- B. Unit shall be factory-supplied, central station air handler. The air-handling unit may consist of a fan with the following factory-installed components as indicated on the equipment schedule.

1. Mixing Box Section:
 - a. No filter tracks.
 - b. With flat filter tracks.
 - c. With angle filter tracks.
 - d. With bag cartridge filter tracks.
 - e. With exhaust air dampers.
2. Air Mixer Section.
3. Exhaust Box Section.
4. Integral Face and Bypass Section:
 - a. With hot water coil.
 - b. With steam coil.
5. Internal Face and Bypass Damper Section.
6. External Face and Bypass Damper Section.
7. Plenum Section:
 - a. With drain pan.
 - b. No drain pan.
8. Humidifier Section.
9. Blow-Thru Discharge Plenum.
10. Filter Section:
 - a. 2-in. flat filters.
 - b. 4-in. flat filters.
 - c. 4-in. flat filters with 2-in. pre-filters.
 - d. 2-in. angle filters.
 - e. 4-in. angle filters.
 - f. Side loading 12-in. bag/cartridge filters with 2-in. pre-filters.
 - g. Side loading 30-in. bag/cartridge filters with 2-in. pre-filters.
 - h. Face loading bag/cartridge filters without pre-filters. Maximum bag/cartridge filter length is limited to access/plenum sections placed after this section.
 - i. Face loading HEPA (high-efficiency particulate air) bag/cartridge filters without pre-filters.
11. Gas Heating Section.
12. Coil Section:
 - a. Chilled water coil.
 - b. Direct expansion coil.
 - c. Hot water coil.
 - d. Steam coil.
 - e. Electric coil.
13. Multi-Zone Cooling/Heating Coil Section:
 - a. With dampers.
 - b. No dampers (for dual duct).
14. Energy Recovery Wheel Section.

15. Fan Section:

- a. Horizontal draw-thru (supply, return, and exhaust).
- b. Horizontal blow-thru (with integral diffuser on supply fan only).
- c. Plenum fan (with optional exhaust air damper on return fan only).
- d. Vertical draw-thru.

2.02 CASING

A. Construction:

1. Unit shall be constructed of a complete frame with easily removable panels. Removal of any panel shall not affect the structural integrity of the unit.
2. All units shall be supplied with 14-gage or heavier, G-90 galvanized steel base rails. Bolt-on legs are NOT acceptable. Perimeter lifting lugs for overhead lifting shall be provided on each shipping section. Slings in place of lifting lugs shall not be acceptable.
3. Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside.
4. Casing panels (top, sides, and bottom) shall be constructed of galvanized steel, and shall have one of the following exterior finishes as specified:
 - a. Pre-painted with a baked enamel finish passing 500-hour salt spray test (ASTM [American Society of Mechanical Engineers] B-117) for pre-painted steel and 125-hour marine level 1 adhesion test (ASTM G-85.A5) for pre-painted steel.
 - b. Unpainted G-90 galvanized steel.
5. Casing panels (top, sides, and bottom) shall be constructed of galvanized steel or stainless steel, and shall have one of the following interior finishes as specified:
 - a. G-90 pre-coated galvanized steel with a silver zeolite antimicrobial material registered by the US EPA (Environmental Protection Agency) for use in HVAC applications.
 - b. Unpainted G-90 galvanized steel.
 - c. Unpainted 304 stainless steel.
6. Casing panels (top, sides, and bottom) shall be one piece, double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.
7. Casing deflection shall not exceed a L/240 ratio when subject to an internal pressure of ± 8 -in. wg and shall exhibit no permanent deformation at ± 9 -in. wg. L is defined as the longest linear panel or cabinet length (measured to AHRI 1350 Cd level 2).
8. Casing leakage rate shall be less than 1% at 8 in. wg of nominal unit airflow or 50 cfm, whichever is greater. Leakage rate shall be tested and documented on a routine basis on random production units. Optionally, factory witness leak testing and/or test reports shall be available.
9. Side panels shall be easily removable for access to unit and shall seal against a full perimeter automotive style gasket to ensure a tight seal.
10. The panel retention system shall comply with UL 1995 which states all moving parts (for example, fan blades, blower wheels, pulleys, and belts) that, if accidentally contacted, could cause bodily injury, shall be guarded against accidental contact by an enclosure requiring tools for removal.
11. Accessibility options shall be as follows:
 - a. Hinged double-wall access door on either side with removable access panel(s) on the other side.
 - b. Hinged double-wall access doors on both sides.
 - c. Removable double-wall access panels on both sides.
12. Depending on the options selected and the remaining available space inside each section, the following options may be available:
 - a. Thermal pane reinforced glass viewports shall be factory-installed on the access panel(s) or door(s) of the section.
 - b. Marine lights shall be factory installed with or without GFCI (ground fault circuit interrupter) convenience outlets.
13. Fan supports, structural members, panels, or flooring shall not be welded, unless aluminum, stainless steel, or other corrosion-resistant material is used. Painted welds on unit exterior steel or galvanized steel are not acceptable.
14. All coil sections shall be doublewall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13. Single height coil sections shall have removable frame sections to facilitate vertical coil extraction.
15. Blow-thru sections shall have a diffuser plate as an integral part of the fan section.

B. Access Doors:

Access doors shall be one piece, double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.

C. Drain Pans:

Drain pans shall be insulated double-wall galvanized or stainless steel construction. The pan shall be sloped toward the drain connection. Drain pan shall have 1½-in. MPT connection exiting through the hand side or opposite side of the casing as specified. One drain outlet shall be supplied for each cooling

coil section. Drain pan shall allow no standing water and comply with ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers. Standard 62.1-2010. Where 2 or more coils are stacked in a coil bank, intermediate drain pans shall be provided and the condensate shall be piped to the bottom drain pan. The bottom coil shall not serve as a drain path for the upper coil.

2.03 FANS

A. General:

1. Forward-curved fan sections shall have one double-width double-inlet (DWDI) fan wheel and scroll. They shall be constructed of galvanized steel with baked enamel. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have an AMCA class rating corresponding to the static pressure at which the fan is designed to operate (Class I or II). Completed fan assembly shall be dynamically balanced in accordance with AHRI Guideline G and ANSI S2.19 at design operating speed using contract drive and motor if ordered.
2. Airfoil fan sections shall have one DWDI airfoil fan wheel and scroll. Airfoil blades shall be double thickness design constructed of heavy gage, high strength steel or aluminum continuously welded to the backplate and the spun inlet flange. Entire fan assembly shall be cleaned, primed and painted with alkyd enamel, except for an aluminum fan wheel when supplied. Fans shall have an AMCA class rating corresponding to the static pressure at which the fan is designed to operate (Class I or II). Completed fan assembly shall be dynamically balanced to minimum grade of G 6.3 per ANSI/AMCA 204 at design operating speed using contract drive and motor if ordered.
3. Belt drive plenum fan sections shall have one single-width single-inlet (SWSI) airfoil fan wheel. Airfoil blades shall be double thickness design constructed of heavy gage, high strength steel or aluminum continuously welded to the backplate and the spun inlet flange. Entire fan assembly shall be cleaned, primed and painted with alkyd enamel, except for an aluminum fan wheel when supplied. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have an AMCA class rating corresponding to the static pressure at which the fan is designed to operate (Class I or II). Completed fan assembly shall be dynamically balanced to minimum grade of G 6.3 per ANSI/AMCA 204 at design operating speed using contract drive and motor if ordered.
4. Direct drive plenum fan sections shall have the option of one, two, four, or six single width single inlet (SWSI) airfoil fan wheel(s). Airfoil blades shall be double thickness design

continuously welded to the back plate and the front plate. Fan wheel shall be constructed of aluminum. Airfoil blades shall be aluminum extrusions and shall be top welded to the back plate and front plate of the wheel. Fan wheel shall be dynamically balanced per ISO standard 1940 quality grade G6.3.

5. Fan assembly vibration shall not exceed 0.248 in. per second when mounted on active isolators. Vibration shall be measured in both vertical and horizontal directions at the specified fan operating speed using specified motor. For testing purposes, accelerometers shall be mounted on the motor near the bearing locations and removed before shipment.
6. All fan sled components shall provide corrosion protection to pass 100-hour salt spray test per ASTM B-117.
7. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with a maximum operating speed 25% below the first critical.
8. Belt drive fan motor shall be mounted within the fan section casing on slide rails equipped with adjusting screws. Motor shall be premium efficiency, open drip-proof or totally enclosed fan cooled NEMA (National Electrical Manufacturers Association) Design A or B with size and electrical characteristics as shown on the equipment schedule. Motor shall be mounted on a horizontal flat surface and shall not be supported by the fan or its structural members. All three-phase motors shall have a $\pm 10\%$ voltage utilization range and a 1.15 minimum service factor. Motor shall be compliant with the Energy Independence and Security Act (EISA) of 2007 where applicable. Single-phase motors shall be available up to and including 5 hp.

B. Performance Ratings:

Fan performance shall be rated and certified in accordance with AHRI Standard 430, latest edition.

C. Sound Ratings:

Manufacturer shall submit first through eighth octave sound power for fan discharge and casing radiated sound. Sound ratings shall be tested in accordance with AHRI 260.

D. Mounting:

Fan scroll, wheel, shaft, bearings, drives, and motor shall be mounted on a common base assembly. The base assembly is isolated from the outer casing with factory-installed isolators and rubber vibration absorbent fan discharge seal. A canvas style duct connection between fan discharge and cabinet is not acceptable. Units shall use 2-in. deflection spring isolators.

E. Fan Accessories:

1. Forward-curved fans:
 - a. Variable frequency drives with or without bypass.
 - b. Magnetic motor starters.
 - c. Motor disconnects.
 - d. Airflow measuring piezo ring.
 - e. Piezo ring transducer.
 - f. Motor shaft grounding ring.
 - g. Belt guards.
 - h. Inlet screen.
2. Airfoil Fans:
 - a. Variable frequency drives with or without bypass.
 - b. Magnetic motor starters.
 - c. Motor disconnects.
 - d. Airflow measuring piezo ring.
 - e. Piezo ring transducer.
 - f. Motor shaft grounding ring.
 - g. Belt guards.
 - h. Inlet screen.
3. Belt Drive Plenum Fans:
 - a. Variable frequency drives with or without bypass.
 - b. Magnetic motor starters.
 - c. Motor disconnects.
 - d. Airflow measuring piezo ring.
 - e. Piezo ring transducer.
 - f. Motor shaft grounding ring.
 - g. Inlet screen and wheel cage.
4. Direct Drive Plenum Fans:
 - a. Variable frequency drives.
 - b. Motor protection box for motor current protection with a single VFD driving multiple motors.
 - c. Airflow measuring piezo ring.
 - d. Piezo ring transducer.
 - e. Motor shaft grounding ring.
 - f. Inlet guard.
 - g. Blank off plate.
 - h. Backdraft dampers.

Optional backdraft damper blades shall be 6063-T5 extruded aluminum channel with galvanized steel braces and extruded vinyl blade seals. Blades shall be mechanically fastened to axle rod rods rotating in corrosion-resistant, synthetic bearings. Blades open at 0.12 in. wg and are fully open at 0.2 in. wg.

F. Flexible Connection:

The base assembly is isolated from the outer casing with factory-installed isolators and rubber vibration absorbent fan discharge seal. A canvas style duct connection between fan discharge and cabinet is not acceptable.

2.04 BEARINGS AND DRIVES

A. Bearings:

Self-aligning, grease lubricated, anti-friction with lubrication fittings extended to drive side of fan section. Optional grease fittings extended to the exterior of the casing are available. All bearing life calculations shall be done in accordance with ABMA 9 for ball bearings and ABMA 11 for roller bearings.

1. Size 03 to 110 forward-curved fans: Cartridge type bearings for Class I fans. Heavy-duty pillow block type, self-aligning, regreasable ball or roller type bearings selected for a minimum average life (L_{50}) of 200,000 hours or optionally for an (L_{50}) of 500,000 hours.
2. Size 03 to 110 airfoil fans: Heavy-duty pillow block type, self-aligning, regreasable ball or roller type bearings selected for a minimum average life (L_{50}) of 200,000 hours or optionally for an (L_{50}) of 500,000 hours.
3. Size 06 to 110 belt-drive plenum fans: Heavy-duty pillow block type, self-aligning, regreasable roller type bearings selected for a minimum average life (L_{50}) of 200,000 hours or optionally for an (L_{50}) of 500,000 hours.

B. Shafts:

Fan shafts shall be solid steel, turned, ground, polished and coated with a rust inhibitor.

C. V-Belt Drive:

Drive shall be designed for a minimum 1.2 service factor as standard with a 1.5 service factor option and/or a factory-supplied extra set of belts. Drives shall be fixed pitch with optional variable pitch for motors 15 hp and less. All drives shall be factory mounted, with sheaves aligned and belts properly tensioned.

2.05 COILS

- A. All water, steam and direct expansion (DX) refrigerant coils shall be provided to meet the scheduled performance. All coil performance shall be certified in accordance with AHRI Standard 410. All water and direct expansion coils shall be tested at 450 psig air pressure. Direct expansion coils shall be designed and tested in accordance with ANSI/ASHRAE 15 Safety Code for Mechanical Refrigeration (latest edition). Factory-supplied $1\frac{1}{2}$ -in. OD coils shall be covered under the standard product one-year limited warranty. All steam coils, integral face and bypass coils and $\frac{5}{8}$ -in. OD coils shall be warranted for a period not in excess of 12 months from their shipment from the manufacturer. Coil epoxy coating shall be covered under a 5-year limited warranty from the date of shipment from the manufacturer.

B. General Fabrication:

1. All water and refrigerant coils shall have minimum $\frac{1}{2}$ -in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.016 inches. Optional tube wall thickness of 0.025 in. shall be supplied, if specified.
2. Optionally, water coils shall have minimum $\frac{5}{8}$ -in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.020 inches. Optional tube wall thickness of 0.035 in. shall be supplied, if specified.
3. Aluminum plate fin type with belled collars. Optional copper plate fins shall be supplied, if specified. Fin type shall be sine wave construction.
4. Aluminum-finned coils shall be supplied with die-formed casing and tube sheets of mill galvanized steel or stainless steel as specified. Copper-finned coils shall be supplied with stainless steel casing and tube sheets.

C. Hydronic Heating and Cooling Coils:

1. Headers shall be constructed of steel with steel MPT connections. Headers shall have drain and vent connections accessible from the exterior of the unit. Optional non-ferrous headers and red brass MPT connections shall be supplied if specified.
2. Configuration: Coils shall be drainable, with non-trapping circuits. Coils will be suitable for a design working pressure of 300 psig at 200 F.

D. Steam Distribution (Non-Freeze Type) Heating Coils:

1. Headers shall be steel with MPT connections.
2. Inner steam distributing tubes shall be $\frac{5}{8}$ -in. OD, 0.020 in. wall thickness, located within 1 in. OD, 0.030 in. wall outer condensing tubes. Working pressure shall be 175 psig at 400 F.
3. Inner steam distributing tubes shall be $\frac{3}{8}$ -in. OD, 0.020 in. wall thickness, located within $\frac{5}{8}$ -in. OD, 0.035 in. wall outer condensing tubes. Working pressure shall be 175 psig at 400 F.

E. Integral Face and Bypass Coils:

1. Sizes 03-14 shall have horizontal steam or hot water coils with a tubewall thickness of not less than 0.020 inches. Tubes shall be mechanically expanded into die formed collars formed in aluminum plate type fins.
2. Sizes 17-110 shall have vertical steam or hot water coils with a tubewall thickness of not less than 0.035 inches. Fins shall be spiral edge-wound copper. Tubes shall be free-floating for

thermal expansion and contraction without the use of offset bends or floating headers.

F. Refrigerant Coils:

1. Headers shall be constructed of copper with brazed joints.
2. Standard circuiting selections include:
 - a. Single distributor arrangement for sizes 03-17.
 - b. Row split intertwined, multiple distributor arrangement for sizes 03-110.
 - c. Face split, multiple distributor arrangement for sizes 03-110.
3. Thermal expansion valves, replaceable nozzle, brass refrigerant distributors and seamless copper distribution tubes are factory supplied to ensure uniform flow.
4. Submittals must include a DX coil and condensing unit cross plot to show that the coil and condensing unit capacity match at the rated design conditions.

G. Electric Heating Section:

1. The electric heater casing is constructed of galvanized steel. Heater control box access door shall be mounted on the designated hand side of the unit. Element construction as follows:
 - a. Open-wire type, 80% nickel, 20% chromium resistance coils, insulated by Steatite bushings and supported in a galvanized steel frame. Bushings shall be recessed into embossed openings and stacked into supporting brackets, spaced no more than 4-in. centers. Thermal cutouts for overtemperature protection shall be provided to meet UL and NEC requirements. Maximum element heating density shall be 55 watts/sq inch.
 - 1) Contactor control - electric heaters up through 60 kW shall have 3 stages of control, beyond 60 kW shall have 6 stages of control.
 - 2) SCR control - electric heaters up through a maximum of 90 amps are available with full SCR control. The entire heater is modulated to achieve the proportional control based on a 0 to 10 volt DC or 4 to 20 mA control signal.
 - 3) Vernier control - the heater has full modulating control of the first circuit of heat, all of which is rated at equal kW increments. There is a minimum of 3 circuits for this type of control. These stage increments are turned on and off by a step controller. As each stage fulfills the demand for heat, the SCR increment is used as a fully modulating filler between stages. This end output is a fully proportional control of the electric heater based on a 0 to 10 volt DC or 4 to 20 mA control signal.

- b. Sheathed type, 80% nickel, 20% chromium resistance coils, suspended in a magnesium oxide insulator fill within a tubular steel sheath/brazed fin assembly. Silicone rubber end seals shall prevent contamination of the interior, and the exterior shall be protected from corrosion by a high temperature aluminum coating. Thermal cutouts for overtemperature protection shall be provided to meet UL and NEC requirements. Maximum element heating density shall be 55 watts/sq inch.

- 1) Contactor control - electric heaters up through 60 kW shall have 3 stages of control, beyond 60 kW shall have 6 stages of control.
2. The manufacturer shall furnish an integral control box containing thermal cutouts, primary control, subcircuit fusing, airflow switch, and fused control transformer.
3. Electric heaters shall be UL listed for zero clearance and shall meet all applicable National Electric Code requirements.
4. Units with electric heat sections shall be listed under UL 1995 Standard for Safety.

2.06 GAS HEATING SECTION

- A. Indirect fired gas furnace section(s) shall have a minimum thermal efficiency of 80% and incorporate agency listed gas-fired duct furnace(s) per UL, CSA, or ETL for operation on natural or propane gas to the current edition of ANSI Z83.8 or Canadian CSA 2.6 Standard for Gas-Fired Duct Furnaces. Duct furnaces shall be installed on the positive pressure side of the supply fan only.

- B. The duct furnace module(s) shall have:

1. 20 gage galvanized steel heat exchanger cabinet.
2. 1 in. thick, minimum 1 $\frac{1}{2}$ lb per cu ft density thermal insulation for the heat exchanger cabinet.
3. Each furnace shall have an induced-draft fan for the removal of flue gases and to keep the heat exchanger at a negative pressure.
4. Air pressure switches to prove air supply for combustion before operation of gas valve.
5. Patented inshot gas burners with integral carryovers.
6. Direct-spark ignition of the gas burners with remote flame sensor to prove carryover across all burners.
7. A listed 24-vac redundant combination gas valve including two electric shutoff valves, gas pressure regulator, and a manual shutoff valve per furnace.
8. An automatic reset type high limit switch to limit maximum outlet air temperature to less than 250 F.

9. Manual reset flame rollout switches.

10. Minimum of one 40 va, 24 vac control transformer.
11. $\frac{1}{8}$ in. NPT tapped test gage connection in the gas manifold for measuring gas pressure.
12. Union fitting downstream of gas control to facilitate installation and service.
13. Provision for attachment of a vent system to exhaust flue gases to the outdoors.

- C. Gas-fired duct furnace(s) provided shall have an 18 gage tubular heat exchanger assembly suitable to withstand 3.0 in. wg total external static pressure without burner flame disturbance and constructed of either:

1. Type 409 stainless steel (0.044 minimum wall thickness) produced to ASTM A268.
2. Type 304L stainless tubes (0.047 minimum wall thickness) produced to ASTM A249.

- D. Gas heating section modules shall be listed for application downstream of refrigeration and cooling systems and shall provide means for removal of condensate that occurs in the tubes during cooling operation. Heat exchanger tubes shall have (integral formed dimpled restrictors; formed tubulators) to provide for an unobstructed drainage path and tubes shall be formed to provide a positive pitch to promote condensate drainage. Drainage shall be configured so that burners and burner surfaces are not exposed to condensate.

- E. Gas heating section shall incorporate a direct spark ignition control module listed by one of the following: US, CSA, or ETL.

- F. Controls shall provide:

1. 100% safety shutoff.
2. A 15-second minimum pre-purge period prior to trial for ignition.
3. High-energy direct spark ignition of main burners.
4. Electronic flame supervision incorporating a 0.8-second flame failure response time.
5. Up to 2 additional ignition retries preceded by an inter-purge period.
6. A minimum 30-second post-purge.
7. Automatic reset after one hour to initiate additional ignition trials if lockout occurs during heat call.
8. An LED indicator light to provide a flash code to identify the operating condition of the control.

- G. Gas heating section shall be equipped for operation with 115 vac, single-phase, 60 Hz power supply.

- H. All electrical components shall be listed or recognized by UL, CSA, or ETL.

I. Gas Furnace Control:

1. Single furnace — Operates from 10 to 100% of input from a single analog input of 0 to 10 vdc.
2. Two furnaces in series — Lead unit operates from 20 to 100% of input and secondary unit operates in two-stage operation to achieve overall system input of 10 to 100% from a single analog input of 0 to 10 vdc.
3. Furnace rack systems — Multiple furnaces operate from a single analog input of 0 to 10 vdc with a lead modulating furnace and multiple secondary two-stage furnaces to achieve overall system input of 10 to 100%. (10:1 turndown minimum; most rack systems provide greater than 10:1 turndown.)

J. Electronic modulation — Operates from 10 to 100% of input from a single analog input of 0 to 10 vdc. Heat enable contact (supplied by others) initiates and ends heating cycles. Heating unit incorporates two-speed operation of combustion air blower and two-stage gas valve, signal amplifier and timer relay control.

K. Gas supply pressure to the gas valve inlet shall be 5.0 to 13.5 in. wg for natural gas or 11.0 to 13.5 in. wg for propane gas.

L. Units are orificed for operation up to 2000 ft above sea level unless specified for high altitude operation.

M. Duct furnaces shall be test-fired prior to shipment to verify proper ignition, operation and shutdown and satisfactory operation of all components.

N. Furnaces shall be provided with printed installation and maintenance instructions, burner operating and maintenance instructions, piping and wiring diagrams and installation start-up data sheet.

2.07 ENERGY RECOVERY WHEEL

A. Construction:

1. Wheel sections shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
2. The wheel shall be coated with silica gel desiccant, permanently bonded without the use of binders or adhesives.
3. The substrate shall be made of a light weight polymer and shall not degrade nor require additional coatings for application in coastal environments.
4. Coated wheel segments shall be washable with detergent or alkaline coil cleaner and water.
5. The silica gel desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
6. The wheel polymer layers shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop.

7. The wheel shall incorporate the channel matrix design and an optional adjustable mechanical purge.
8. The polymer layers shall be captured in a stainless steel wheel frame or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
9. Energy recovery wheels greater than 25 inches in diameter shall be provided with removable wheel segments.
10. Wheel frame shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without the wheel segments in place.
11. Wheel segments shall be removable without the use of tools to facilitate maintenance and cleaning.
12. Wheel bearings shall provide an L-10 life in excess of 400,000 hours.
13. Wheel rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
14. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set.
15. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
16. The energy recovery section shall be a UL recognized component for electrical and fire safety. The wheel drive motor shall be UL recognized and mounted in the cassette frame and supplied with a service connector or junction box.
17. Thermal performance shall be AHRI Standard 1060 certified and bear the AHRI Certified Product Seal. Cassettes shall be listed in the AHRI Certified Products Directory and bear the AHRI Certified Product Seal.
18. Wheel shall carry a 5-year parts warranty. This warranty is for all wheel cassette components except the drive motor, which carries the motor manufacturer's warranty.

2.08 HUMIDIFIERS

- A. The humidifiers shall be of the direct discharge type, using steam from existing steam lines or boilers to be injected into the air plenums for humidification.
- B. Each humidifier shall consist of multiple, vertical steam discharge pipes, supported on horizontal header manifolds, spaced to provide the optimum of steam to air contact while minimizing pressure drop. Each humidifier shall be sized to nominally match the air plenum width and height for maximum contact of the discharging steam to the air passing around the vertical steam discharge pipes.
- C. The vertical steam discharge pipes shall be constructed of 316 stainless steel. Each pipe shall have

a full-length, inverted slot on each side for steam discharge at 100% air to steam contact. Nozzles and holes have less than 15% air to steam contact and are, therefore, unacceptable.

- D. A full-length stainless steel fishbone shaped baffle shall be used inside the vertical discharge pipe to wick condensate away from the discharge slots and back to the center of the pipe for re-evaporation.
- E. The feeder manifolds shall be constructed of 316 stainless steel, sized to move the steam in a specific mass-flow speed range, for maximum condensate separation. Final condensate separation shall occur inside the feeder manifolds, after the control valve, with the dried steam then injected directly into the vertical discharge pipes.
- F. Insulated uprights provide a cushion of air that reduces both heat gain and condensate formation. Insulated models have nozzles inserted in the uprights to ensure that only dry steam is delivered into the air.
- G. The steam humidifier shall be designed with slip fittings for easy assembly. The steam humidifier shall be designed without plastic nozzles, collars, o-rings or gaskets for zero maintenance.

2.09 FILTER SECTIONS

- A. Flat filter sections shall accept either 2-in. or 4-in. filters. Sections shall include side access slide rails. Optional 6-in. filter racks shall be capable of accepting 4-in. final filters. Optional 2 in. pre-filter shall be available.
- B. Angle filter sections shall accept either 2-in. or 4-in. filters of standard sizes, arranged in a horizontal V formation.
- C. Draw-thru bag/cartridge filter sections shall be capable of accepting headered standard size 6-in. to 12-in. deep rigid media or bag filters and a 2-in. pre-filter.
- D. Draw-thru bag/cartridge filter sections shall be capable of accepting headered standard size 12-in. to 30-in. deep rigid media or bag filters and a 2-in. pre-filter.
- E. Blow-thru bag/cartridge filter sections shall contain a face loading filter frame and be capable of accepting standard size 12-in. deep rigid media (headered or box) or bag filters.
- F. Blow-thru HEPA filter sections shall contain a face loading filter frame and be capable of accepting standard size 12-in. deep HEPA box filters.
- G. Differential Pressure Gages:
 - 1. Housing shall be constructed of a glass filled nylon case and acrylic lens. Exterior finish shall be coated black.
 - 2. Accuracy shall be $\pm 5\%$ of full scale throughout range at 70 F.
 - 3. Pressure limits shall be 30 psig continuous to either pressure connection.
 - 4. Temperature limits shall be 20 to 120 F.

- 5. Diameter of dial face shall be 2.33 in.
- 6. Process connections shall be barbed, $\frac{3}{16}$ -in. for ID tubing

2.10 DAMPERS

- A. Factory-supplied dampers shall be warranted to be free from defects in material and workmanship for a period of 12 months after being installed or placed in service, but in no instance shall the period of warranty be longer than 18 months from the date of the original shipment by the manufacturer.
- B. Mixing boxes, filter-mixing boxes, and exhaust boxes shall have parallel or opposed blades and interconnecting outside-air and return-air dampers.
 - 1. Standard Dampers:

Damper blades shall be constructed of galvanized steel, with blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. Maximum leakage rate shall be 4 cfm/ft² at 1 in. wg differential pressure.
 - 2. Premium Dampers:

Damper blades shall be constructed of galvanized steel with a double-skin airfoil design, with blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. Maximum leakage rate shall be 2 cfm/ft² at 1 in. wg differential pressure.
 - 3. Outside Air Measurement Dampers:
 - a. Damper frame shall be nominal 4 in. x 1 in. x minimum 0.081 in. and constructed of 6063-T5 extruded aluminum.
 - b. Airflow measuring blades shall be airfoil-shaped, heavy gage anodized 6063-T5 extruded aluminum and fixed in 10 in. x minimum 16 gage galvanized steel frame.
 - c. Jamb seals shall be flexible metal compression type along control damper sides.
 - d. Blade seals shall be neoprene along control damper blade edges.
 - e. Bearings shall be molded synthetic.
 - f. Linkage shall be galvanized steel, concealed in frame.
 - g. Axles shall be minimum $\frac{1}{2}$ -in. diameter plated steel, hex-shaped, mechanically attached to blade.
 - h. Operating temperature shall be -22 to 140 F.
 - i. Air straightener section shall be aluminum alloy honeycomb contained in 5 in. long, 16 gage galvanized steel sleeve attached to monitoring blade frame.
 - j. Airflow range shall be 400 to 5,000 ft per minute face velocity.
 - k. Maximum leakage rate shall be 2 cfm/ft² at 1 in. wg differential pressure.

C. Integral Face and Bypass Dampers:

1. Integral face and bypass (IFB) coils shall be capable of maintaining a constant air volume, within 5%, shall be capable of maintaining a constant leaving air temperature as entering air conditions vary, and shall be capable of producing mixed leaving air temperatures within 3 ft downstream with a maximum variance in air temperature of 5° F, regardless of damper position.
2. When no heating is required, dampers shall divert air to bypass around heating surface with minimal temperature override.
3. Coil casing, dampers and baffles shall be fabricated from galvanized steel with an option for stainless steel. Coils shall be tested at 300 psig.
4. Integral face and bypass coils shall be provided with a connection point for field-mounted actuator(s), electrical or pneumatic, or can be provided from the factory at an additional cost.
5. Actuator connection point shall be mechanically attached to dampers via linkage mechanisms. Dampers shall be interconnected for operation simultaneously across each face of coil.

D. Face and Bypass Dampers:

1. Internal Face and Bypass Dampers:

Internal face and bypass dampers shall be factory mounted in galvanized steel frame. Damper blades shall be constructed of galvanized steel, with high temperature blade and edge seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. To eliminate blade warping, face dampers shall be sectionalized to limit blade length to 60 in. maximum. Face damper blades shall be opposed and arranged to match coil face with top bypass, and internal linkage.

2. External Face and Bypass Dampers:

Face damper shall be factory mounted in galvanized steel frame. Damper blades shall be constructed of galvanized steel, with high temperature blade and edge seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. Bypass damper shall be constructed of galvanized steel, with blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to axle rod rotating in self-lubricating synthetic bearings. Face damper blades shall be opposed with top bypass, and internally mounted linkage.

E. Multi-Zone Dampers:

Multi-zone dampers shall be factory mounted in galvanized steel frame. Damper blades shall be constructed of galvanized steel with a double-skin airfoil design, with blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. Maximum leakage rate shall be 11 cfm/ft² at

1 in. wg differential pressure. Maximum pressure drop due to dampers shall be no more than 0.40 in. wg. Number of zones shall vary by size of section.

2.11 AIR MIXER

Air mixer of 0.081-in. aluminum construction of size, performance and maximum pressure drop indicated. The air mixer shall mix two or more airstreams of differing temperature to within $\pm 6^{\circ}$ F of theoretical mixed-air temperature and provide a more uniform air velocity contour entering a downstream filter or coil bank.

2.12 UV-C GERMICIDAL LAMPS

- A. Emitters and fixtures for UV-C lamps shall be designed for use inside an HVAC system and shall be covered by a 1 year warranty. Individual lamp output shall be measured in an ASME nozzled test apparatus using a 45 F airstream moving at not less than 400 fpm. Lamp output at 253.7 nm shall not be less than 10 μ W/cm² per inch of arc length measured at a distance of one meter.
- B. Power supplies for UV-C lamps shall be a high-efficiency electronic type which are matched to the emitters and are capable of producing the specified output intensity with an input power no more than 80 watts.
- C. Fixtures for UV-C lamps shall be factory installed and wired to a SPDT disconnect switch and door interlock switches in each door. Fixtures are wired for 120 v/single ph requiring a minimum circuit ampacity of 15 amps. Lamps shall ship separately for field installation to minimize the chance for bulb damage.
- D. Emitters and fixtures shall be installed in sufficient quantity and arranged so as to provide an equal distribution of UV-C energy on the coil and drain pan.
- E. The minimum UV-C energy striking the leading edge of the coil pan shall be not less than 820 μ W/cm² at the closest point and through placement, not less than 60% of that value at the farthest point. Equal amounts are to strike the drain pan, either directly or indirectly through reflection.
- F. Emitters and fixtures shall be installed such that UV-C energy strikes all surfaces of the coil, drain pan, and the available line of sight airstream.

2.13 ELECTRICAL ACCESSORIES:

A. Marine Lights and Convenience Outlets:

1. Cast, non-ferrous metal, weatherproof, fixture.
2. Cast, non-ferrous metal, weatherproof, electrical junction box.
3. Gasketed, heat and shock resistant glass globe protects against moisture and debris.
4. Cast, non-ferrous metal lamp guard to protect glass globe.
5. UL and CSA listed.
6. 100 watt type 'A' lamp maximum capacity.

7. Each fixture is equipped with a 9.5 watt, 120 volt 800 lumen LED lamp with an average rated life of 25,000 hours, factory installed.
8. Metallic, single gang, electrical junction box, UL listed.
9. With convenience outlet: Factory supplied and wired, SPST, toggle switch and 15 amp, 120 vac/60 Hz, NEMA 5-15 type, ground fault circuit interrupt (GFCI) receptacle, UL listed.
10. Without convenience outlet: Factory supplied and wired, SPST, UL listed toggle switch.
11. Each fixture is factory wired to an externally mounted switch box. (Field power connections are made to the switch box mounted externally on the unit.)
12. All factory wiring penetrating through the panel is protected in 'RIGID' type metal conduit.

B. Disconnects:

Factory-supplied disconnects shall be covered under a 1 year limited warranty from the manufacturer from the date of shipment.

1. 115-230 volt/single-phase non-fused disconnects shall have the following characteristics:
 - a. Plated current carrying components for superior corrosion protection.
 - b. Factory-installed equipment grounding terminals with slot/square drive screws.
 - c. Rated for motor disconnect applications (10 Hp maximum).
 - d. NEMA type 3R non-metallic enclosure.
 - e. Up to 10,000 rms symmetrical amperes SCCR, when protected by a fuse or circuit breaker rated 60 amperes or less.
 - f. Cover padlock hasp.
 - g. Pull-out cartridge type.
 - h. UL listed.
2. 115-230 volt/single-phase fused disconnects shall have the following characteristics:
 - a. Visible blades.
 - b. Quick-make, quick-break operating mechanism.
 - c. Cover padlock hasp and handle lock "OFF."
 - d. 240 vac maximum.
 - e. Factory supplied and installed class 'T Series' fuses (fused disconnects only).
 - f. Up to 10,000 rms symmetrical amperes SCCR, utilizing appropriately rated factory-supplied fuses.
 - g. Horsepower rated for motor applications.
 - h. Tangential combination knockouts for field wiring.
 - i. Spring reinforced plated copper fuse clips.
 - j. NEMA type 1 enclosures.
 - k. Insulated, bondable solid neutral assemblies.
 - l. UL listed, File E2875.

- m. Meet or exceed NEMA KS1-1990.
3. 200-230 volt/3-phase fused and non-fused disconnects shall have the following characteristics:
 - a. Visible blades.
 - b. Quick-make, quick-break operating mechanism.
 - c. Cover padlock hasp and handle lock "OFF."
 - d. 240 vac maximum.
 - e. Factory supplied and installed class RK5 fuses (fused disconnects only).
 - f. Up to 100,000 rms symmetrical amperes SCCR, utilizing appropriately rated, factory-supplied Class R fuses.
 - g. Horsepower rated for motor applications.
 - h. Tangential combination knockouts for field wiring.
 - i. Spring reinforced plated copper fuse clips.
 - j. NEMA type 1 enclosures.
 - k. Insulated, bondable solid neutral assemblies.
 - l. UL listed, File E2875.
 - m. Meet or exceed NEMA KS1-1990.
4. 380-575 volt/3-phase fused and non-fused disconnects shall have the following characteristics:
 - a. Visible switch blades with for positive "OFF" indication.
 - b. Quick-make, quick-break operating mechanism.
 - c. Dual cover interlock.
 - d. Color coded "ON" — "OFF" indicator handle.
 - e. Cover padlock hasp and handle lock "OFF" provision for multiple padlocks.
 - f. 600 vac maximum.
 - g. Factory supplied and installed class RK5 fuses (fused disconnects only).
 - h. Up to 200,000 rms symmetrical amperes SCCR, utilizing appropriately rated, factory-supplied Class R fuses.
 - i. Horsepower rated for motor applications.
 - j. Spring reinforced plated copper fuse clips.
 - k. Tangential combination knockouts.
 - l. NEMA type 1 enclosures.
 - m. Insulated, bondable solid neutral assemblies.
 - n. Wire terminations suitable for aluminum or copper conductors.
 - o. UL listed.
 - p. Meet or exceed NEMA KS1-1999.

C. Starters:

Factory-supplied disconnects shall be covered under a 1 year limited warranty from the manufacturer from the date of shipment.

1. Starter without disconnect:
 - a. Adjustable motor overload with trip indication.
 - b. Manual overload reset button (accessible without opening enclosure).

- c. 115-v fused secondary control transformer (fuse included — fused primary and secondary over 50 amps).
 - d. Hand/Off/Auto selector switch (accessible without opening enclosure).
 - e. Separate 4-position terminal strip for remote H-O-A wiring.
 - f. C series contactors.
 - g. Horsepower rated for motor applications.
 - h. NEMA 4X type non-metallic enclosures.
 - i. Lug connections for field wiring.
 - j. Factory mounted, wired, and run tested with factory-supplied motor.
 - k. UL listed.
2. Combination Starter/Disconnect:
- a. Non-fused UL 508 disconnect switch with lockable handle (locks not provided).
 - b. Cover interlock.
 - c. Adjustable motor overload with trip indication.
 - d. Manual overload reset button (accessible without opening enclosure).
 - e. 115-v fused secondary control transformer (fuse included — fused primary and secondary over 50 amps).
 - f. Hand/Off/Auto selector switch (accessible without opening enclosure).
 - g. Separate 4-position terminal strip for remote H-O-A wiring.
 - h. C series contactors.
 - i. Horsepower rated for motor applications.
 - j. NEMA 4X type non-metallic enclosures.
 - k. Lug connections for field power wiring.
 - l. Factory mounted, wired, and run tested with factory-supplied motor.
 - m. UL listed.

D. Bypass for Variable Frequency Drives:

Factory-supplied bypasses shall be covered under a 1 year limited warranty from the manufacturer from the date of shipment.

- 1. 200-230 v/3 Ph/60 Hz (1 to 7.5 Hp), 460-575 v/3 Ph/60 Hz (1 to 20 Hp), 380 v/3 Ph/50 Hz (1 to 15 Hp):
 - a. 4-position panel-mounted disconnect style switch with lockable handle (locks not provided), meets OSHA 1910.
 - b. Switch position indication (LINE/OFF/DRIVE/TEST).
 - c. Adjustable motor overload with trip indication (LINE position).
 - d. Manual overload reset button.
 - e. Horsepower rated for motor applications.
 - f. Direct control (no contactors, relays, or holding coils).

- g. Complete isolation of inverter in LINE position.
 - h. NEMA 12 type metal enclosures.
 - i. Terminal strip provided for field power supply wiring.
 - j. Lug connection for field ground wire.
 - k. Gold flashed, auxiliary switch contact set (for switch position monitoring).
 - l. Factory mounted, wired to VFD and motor, and run tested (motor and VFD must be factory supplied and installed).
 - m. UL; UL, Canada; CE listed.
2. 200-230 v/3 Ph/60 Hz (10 to 75 Hp), 460-575 v/3 Ph/60 Hz (25 to 150 Hp), 380 v/3 Ph/50 Hz (20 to 75 Hp):
- a. 4-position panel-mounted disconnect style switch with lockable handle (locks not provided), meets OSHA 1910.
 - b. Switch position indication (LINE/OFF/DRIVE/TEST).
 - c. Adjustable motor overload with trip indication (in LINE position).
 - d. Manual overload reset button.
 - e. Horsepower rated for motor applications.
 - f. 115-v control transformer with fused secondary (fused primary on units over 50 amps).
 - g. Contactor for Line Start/Stop.
 - h. Door-mounted Line Start and Line Stop pushbuttons.
 - i. Complete isolation of inverter in LINE position.
 - j. NEMA 12 type metal enclosures.
 - k. Terminal strip provided for field power supply wiring.
 - l. Lug connection for field ground wire.
 - m. Gold flashed, auxiliary switch contact set (for switch position monitoring).
 - n. Factory mounted, wired to VFD and motor, and run tested (motor and VFD must be factory supplied and installed).
 - o. UL; UL, Canada; CE listed.

E. Variable Frequency Drives:

- 1. Factory-mounted variable frequency drives (VFDs) shall be wired to factory-supplied motors.
- 2. Factory-supplied VFDs are programmed and started up from the factory and qualify the VFD, through ABB, for a 24-month warranty from date of commissioning or 30 months from date of sale, whichever occurs first.
- 3. The VFD parameters are programmed into the controller and removable keypad. In the event that the VFD fails and needs replacement, the

- program can then be uploaded to the replacement VFD via the original keypad.
4. The VFD package as specified herein shall be enclosed in a UL Listed type enclosure, exceeding NEMA enclosure design criteria (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in an ISO 9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.
 - a. Environmental operating conditions: VFDs shall be capable of continuous operation at -15 to 40 C (5 to 104 F) ambient temperature with no frost allowed as per VFD manufacturers documented/submittal data or VFD must be oversized to meet these temperature requirements. Not acceptable are VFDs that can only operate at 40 C intermittently (average during a 24-hour period) and therefore, must be oversized. VFDs shall be capable of operating at altitude 0 to 3300 ft above sea level and less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.
 - b. Enclosure shall be rated UL Type 1 and shall be UL listed as a plenum rated VFD. VFDs without these ratings are not acceptable. Type 1 enclosures with only NEMA ratings are not acceptable (must be UL Type 1).
 5. All VFDs shall have the following standard features:
 - a. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
 - b. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
 - c. There shall be a built-in timeclock in the VFD keypad. The clock shall have a battery back-up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays. The VFD shall have a digital input that allows an override to the timeclock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
 - d. The VFDs shall utilize pre-programmed application macros specifically designed to facilitate start-up. The application macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
 - e. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, the VFD shall cycle the cooling fans on and off as required.
 - f. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).
 - g. The VFD shall have the ability to automatically restart after an overcurrent, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
 - h. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
 - i. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFDs with only one DC reactor shall add an AC line reactor.
 - j. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFDs with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120. Input and output current ratings must be shown on the VFD nameplate.
 - k. The VFD shall include a coordinated AC transient surge protection system consisting

of 4 to 120 joule rated MOVs (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

- l. The VFD shall provide a programmable loss-of-load (broken belt/broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and/or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.
 - m. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure/jam condition causing motor overload
 - n. The VFD shall include multiple “two zone” PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4 to 20mA, 0 to 10V, and/or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for “two zone” control.
 - o. If the input reference (4 to 20mA or 2 to 10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and/or over the serial communication bus.
 - p. The VFD shall have programmable “Sleep” and “Wake up” functions to allow the drive to be started and stopped from the level of a process feedback signal.
6. All VFDs to have the following adjustments:
- a. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.
 - b. Two (2) PID set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are typically used for night setback, switching between summer and winter set points, etc.
 - c. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (i.e. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
 - d. Two (2) programmable analog inputs shall accept current or voltage signals.
 - e. Two (2) programmable analog outputs (0 to 20 mA or 4 to 20 mA). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.
 - f. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24 VDC or 24 VAC.
 - g. Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.
 - h. Run permissive circuit: There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display “start enable 1 (or 2) missing”. The safety input status shall also be transmitted over the serial communications bus.

- i. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 to 120 seconds. Start delay shall be active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications).
 - j. Seven (7) programmable preset speeds.
 - k. Two independently adjustable accelerate and decelerate ramps with 1 to 1800 seconds adjustable time ramps.
 - l. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
 - m. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
 - n. The VFD shall include password protection against parameter changes.
7. The keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:
 - a. Start-up assistant
 - b. Parameter assistants
 - c. PID assistant
 - d. Reference assistant
 - e. I/O assistant
 - f. Serial communications assistant
 - g. Option module assistant
 - h. Panel display assistant
 - i. Low noise set-up assistant
 - j. Maintenance assistant
 - k. Troubleshooting assistant
 - l. Drive optimizer assistants
 8. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
 - a. Output Frequency
 - b. Motor Speed (RPM, %, or Engineering units)
 - c. Motor Current
 - d. Motor Torque
 - e. Motor Power (kW)
 - f. DC Bus Voltage
 - g. Output Voltage
 9. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -500 Hz (reverse) to 500 Hz (forward). 2) Operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command.
 10. Serial Communications:
 - a. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet*. [Optional protocols for LonWorks†, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.] Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e., BTL Listing for BACnet). Use of non-certified protocols is not allowed.
 - b. The BACnet connection shall be an EIA-485, RS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
 - 1) Data Sharing – Read Property – B.
 - 2) Data Sharing – Write Property – B.
 - 3) Device Management – Dynamic Device Binding (Who-Is; I-Am).

- 4) Device Management – Dynamic Object Binding (Who-Has; I-Have).
 - 5) Device Management – Communication Control – B.
 - c. If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.
 - d. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.
 - e. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass valve control, chilled water valve / hot water valve control, etc. Both the VFD PID control loop and the independent PID control loop shall continue functioning even if the serial communications connection is lost. As default, the VFD shall keep the last good set point command and last good DO and AO commands in memory in the event the serial communications connection is lost and continue controlling the process.
11. EMI/RFI filters: All VFDs shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.
 12. All VFDs through 75 hp at 480 V shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not sustain damage from this power mis-wiring condition.
 13. Operational Functions:
 - a. The drive shall contain two separate acceleration/deceleration times with auto tuning for optimum setting (0.1 to 6000 seconds) with choice of linear, S, or C curves that shall be factory programmed to match the fan load and prevent nuisance overcurrent fault trips.
 - b. The drive shall be equipped with both local/remote and manual/auto keys on touchpad.
 - c. The drive shall be equipped with a quick setup key.
 - d. The drive shall contain 15 preset speeds, which can be activated from the keypad, terminal inputs, and host computer.
 - e. The drive shall have the capability of storable special custom user setting.
 - f. The drive shall restart into a rotating motor operating in either the forward or reverse direction and match that frequency.
 - g. The drive shall have adjustable soft stall (10% to 150%) which reduces frequency and voltage of the inverter to sustain a run in an overload situation factory programmed for each motor's characteristics.
 - h. The drive shall be capable of performing a time base pattern run using 4 groups of 8 patterns each using the 15 preset speed values for a maximum of 32 different patterns.
 - i. The drive shall have adjustable UL listed electronic overload protection (10% to 100%) factory programmed to match each motor's FLA/RLA (full load amp/rated load amp) ratings.
 - j. The drive shall have a custom programmable volt/hertz pattern.
 14. Protective Features:
 - a. The drive shall be rated for 200,000 AIC (ampere interrupting capacity). The use of input fuses to achieve this rating shall not be acceptable.
 - b. The drive shall have external fault input.
 - c. The drive shall be capable of resetting faults remotely and locally.
 - d. The drive shall be programmable to alert the following alarms:
 - 1) Over torque alarm.
 - 2) Inverter overload pre-alarm.
 - 3) Motor overload pre-alarm.
 - 4) Braking resistor overload pre-alarm.
 - 5) Inverter overheat pre-alarm.
 - 6) Undercurrent alarm.
 - 7) Overcurrent pre-alarm.
 - 8) Communication error alarm.
 - 9) Cumulative timer alarm.
 - 10) Executing retry.
 - e. The drive shall identify and display the following faults:
 - 1) Overcurrent during acceleration trip.

- 2) Overcurrent during deceleration trip.
 - 3) Overcurrent during normal run trip.
 - 4) Overcurrent on the DC Bus during acceleration trip.
 - 5) Overcurrent on the DC Bus during deceleration trip.
 - 6) Overcurrent on the DC Bus during normal run trip.
 - 7) Load end overcurrent trip detected at start-up (output terminals, motor wiring, etc.).
 - 8) U-phase short circuit trip detected at start-up.
 - 9) V-phase short circuit trip detected at start-up.
 - 10) W-phase short circuit trip detected at start-up.
 - 11) Overvoltage during acceleration trip.
 - 12) Overvoltage during deceleration trip.
 - 13) Overvoltage during normal (constant speed) run trip.
 - 14) Inverter overloaded trip.
 - 15) Motor overloaded trip.
 - 16) Inverter overheat trip.
 - 17) Emergency off trip message.
 - 18) EEPROM failure during write cycle.
 - 19) EEPROM abnormality during initial reading.
 - 20) RAM error.
 - 21) ROM error.
 - 22) CPU error.
 - 23) Communication interruption error.
 - 24) Gate array error.
 - 25) Output current detection circuit error.
 - 26) Option PCB error trip.
 - 27) Low operating current trip.
 - 28) Main circuit under voltage trip.
 - 29) Over torque trip.
 - 30) Software detected earth fault trip.
 - 31) Hardware detected earth fault trip.
 - 32) Inverter type form mismatch error.
 - 33) EEPROM type form mismatch error.
15. Monitor Functions:
- a. The drive digital display shall be capable of displaying the following: Frequency, percent current, current amps, percent voltage I/O, voltage in volts I/O, RPM, GPM, I/O watts, torque, and input reference signal, kWh.
 - b. The drive shall have 320 programmable parameters which can be changed while the drive is operating.
 - c. The drive's 353 parameters shall be adjustable from the 8-key touchpad or computer link.
 - d. The drive's 8-key touchpad shall be NEMA 12 rated.
 - e. The drive's keypad shall be capable of being extended 15 ft from the drive.
 - f. The drive shall contain a reset of all parameters to factory default settings or user defaults (whichever one is chosen).
 - g. The drive shall have 2 programmable analog outputs programmable to 17 choices.
 - h. The drive shall have one programmable relay output programmable to 67 choices.
 - i. The drive shall have 8 programmable digital inputs programmable to 54 choices.
 - j. The drive shall have a pulse train out-put proportional to frequency (48, 96, 360 times frequency).
 - k. The drive shall have an elapsed time meter.
16. Options:
- a. VFD with Integral Disconnect:
 - 1) UL listed by the drive manufacturer as a complete assembly.
 - 2) UL 508 labeled .
 - 3) Capable of being locked by three padlocks.

39MW Weathertight Outdoor Air Handlers

HVAC Guide Specifications

Size Range: **1,500 to 60,500 Nominal Cfm**

Carrier Model Number: **39MW — Outdoor Unit**

Part 1 — General

1.01 QUALITY ASSURANCE

A. Manufacturer Qualifications:

Company specializing in manufacturing the products specified in this section with minimum of 5 years documented experience.

B. Units shall be manufactured in a facility registered to ISO (International Organization for Standardization) 9001 manufacturing quality standard.

C. Air-handling unit assembly shall have UL (Underwriters Laboratories) 1995 certification for safety, including use with electric heat.

D. Products requiring electric connection shall be listed and classified by ETL and CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

E. Coil performance shall be certified in accordance with AHRI (Air-Conditioning, Heating, and Refrigerating Institute) Standard 410, latest edition.

F. Unit performance shall be rated in accordance with AHRI Standard 430 for Central Air-Handling Units and subject to verification of rating accuracy by AHRI-sponsored, third party testing. Units shall meet NFPA (National Fire Protection Association) 90A requirements.

1.02 DELIVERY, STORAGE AND PROTECTION

A. All outdoor units shall be completely shrink-wrapped from the factory for protection during shipment. Tarping of bare units is unacceptable.

B. Inspect for transportation damage and store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.03 START-UP REQUIREMENTS

Do not operate units until ductwork is clean, filters are in place, bearings lubricated, condensate properly trapped, piping connections verified and leak tested, belts aligned and tensioned, all shipping braces have been removed, and fan has been test run under observation.

Part 2 — Products

2.01 GENERAL DESCRIPTION

A. Units shall ship in the number of sections necessary to meet project requirements and shall ship in as many splits as specified in selection software. Split options as follows:

1. Shipped in sections — shipping split.
2. Shipped assembled — base rail break (shipped attached).
3. Shipped assembled — solid base rail.

B. Unit shall be factory-supplied, factory-assembled, outdoor, curb-mounted central station air handler. The air-handling unit may consist of a fan with the following factory-installed components as indicated on the equipment schedule.

1. Mixing Box Section:

- a. No filter tracks.
- b. With filter tracks.
- c. With angle filter tracks
- d. With bag cartridge filter tracks.
- e. With exhaust air dampers.

2. Air Mixer Section.

3. Exhaust Box Section.

4. Integral Face and Bypass Section:

- a. With hot water coil.
- b. With steam coil.

5. Internal Face and Bypass Damper Section.

6. Plenum Section:

- a. With drain pan.
- b. No drain pan.

7. Humidifier Section.

8. Blow-Thru Discharge Plenum.

9. Filter Section:

- a. 2-in. flat filters.
- b. 4-in. flat filters.
- c. 4-in. flat filters with 2-in. pre-filters.
- d. 2-in. angle filters.
- e. 4-in. angle filters.
- f. Side loading 12-in. bag/cartridge filters with 2-in. pre-filters.
- g. Side loading 30-in. bag/cartridge filters with 2-in. pre-filters.
- h. Face loading bag/cartridge filters without pre-filters. Maximum bag/cartridge filter length is limited to access/plenum sections placed after this section.
- i. Face loading HEPA (high-efficiency particulate air) bag/cartridge filters without pre-filters.

10. Coil Section:

- a. Chilled water coil.
- b. Direct expansion coil.
- c. Hot water coil.
- d. Steam coil.
- e. Electric coil

11. Gas Heating Section.

12. Fan Section:

- a. Horizontal draw-thru.
- b. Horizontal blow-thru (with integral diffuser).
- c. Plenum fan (with optional exhaust air damper on return fan only).

2.02 CASING

A. Construction:

1. Unit shall be constructed of a complete frame with easily removable panels. Removal of any panel shall not affect the structural integrity of the unit.
2. All units shall be supplied with a perimeter, 14-gage or heavier, G-90 galvanized, high tensile steel base rail with a pocket to accommodate roof curb. Perimeter lifting lugs for overhead lifting shall be provided on each shipping section. Sliding units in place of lifting lugs shall not be acceptable.
3. Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside.
4. Casing panels (top, sides, and bottom) shall be constructed of galvanized steel, and shall have one of the following exterior finishes as specified:
 - a. Pre-painted with a baked enamel finish passing 500-hour salt spray test (ASTM [American Society of Mechanical Engineers] B-117) for pre-painted steel and 125-hour marine level 1 cohesion test (ASTM G-85.A5) for pre-painted steel.
 - b. Unpainted G-90 galvanized steel.
5. Casing panels (top, sides, and bottom) shall be constructed of galvanized or stainless steel, and shall have one of the following interior finishes as specified:
 - a. Pre-coated galvanized steel with a silver zeolite antimicrobial material registered by the US EPA (Environmental Protection Agency) for use in HVAC applications.
 - b. Unpainted G-90 galvanized steel.
 - c. Unpainted 304 stainless steel.
6. Roof shall be double-wall, pitched in four directions at a minimum roof slope of $\frac{1}{4}$ -in. per foot across the width of the unit. No penetrations shall be made in pressure sensitive panels. Roof shall incorporate a standing top seam. All seams in the roof shall be gasketed and capped to prevent water infiltration into the unit.
7. Casing panels (top, sides, and bottom) shall be one piece double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.
8. Casing deflection shall not exceed an L/240 ratio when subject to an internal pressure of ± 8 -in. wg and shall exhibit no permanent deformation at ± 9 in. wg L is defined as the longest linear panel or cabinet length (measured at AHRI 1350 Cd level 2).
9. Casing leakage rate shall be less than 1% at ± 8 in. wg of nominal unit airflow or 50 cfm, which-

ever is greater. Leakage rate shall be tested and documented on a routine basis on random production units. Optionally, factory witness leak testing and/or test reports shall be available.

10. Side panels shall be easily removable for access to unit and shall seal against a full perimeter automotive style gasket to ensure a tight seal.
 11. The panel retention system shall comply with UL 1995 which states all moving parts (for example, fan blades, blower wheels, pulleys, and belts) that, if accidentally contacted, could cause bodily injury, shall be guarded against accidental contact by an enclosure requiring tools for removal.
 12. Base rail shall overhang the curb to facilitate water run-off and protection of the curb to base connection from water intrusion.
 13. Accessibility options shall be as follows:
 - a. Hinged double-wall access door on either side with removable access panel(s) on the other side.
 - b. Hinged double-wall access doors on both sides.
 - c. Removable double-wall access panels on both sides.
 14. Depending on the options selected and the remaining available space inside each section, the following options may be available:
 - a. Thermal pane reinforced glass viewports shall be factory-installed on the access panel(s) or door(s) of this section.
 - b. Marine lights shall be factory-installed with or without GCFI (ground fault circuit interrupter) convenience outlets.
 15. Fan supports, structural members, panels, or flooring shall not be welded, unless aluminum, stainless steel, or other corrosion-resistant material is used. Painted welds on unit exterior steel or galvanized steel are not acceptable.
 16. All coil sections shall be solid double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.
 17. Blow-thru fan sections shall have a diffuser plate as an integral part of the fan section.
- B. Access Doors:
- Access doors shall be one piece double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.
- C. Drain Pans:
- Drain pans shall be insulated double-wall galvanized or stainless steel construction. The pan shall be sloped toward the drain connection. Drain pan shall have $1\frac{1}{2}$ -in. MPT connection exiting through the hand side or opposite side of the casing as specified. Drain connection shall be insulated from the drain

pan to the point at which it exits the casing. One drain outlet shall be supplied for each cooling coil section. Drain pan shall allow no standing water and comply with ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) Standard 62.1-2010. Where 2 or more coils are stacked in a coil bank, intermediate drain pans shall be provided and the condensate shall be piped to the bottom drain pan. The bottom coil shall not serve as a drain path for the upper coil.

D. Roof Curbs:

1. Roof curb shall be delivered to jobsite in an unassembled, knockdown state.
2. Curb shall be constructed of 14-gage G-90 galvanized steel, 14 in. or 24 inches in height.
3. Full perimeter wood nailers shall be securely mounted to curb sheet metal.
4. Curb channel supports will be supplied on all curbs exceeding 10 ft in total unit airway length.
5. Gasketing between curb and unit shall be shipped for field installation with the unit curb.
6. Coil connection housing curb will be offered optionally to enclose coil piping. Multiple coil connection housings may be specified (up to two per side).

E. Hoods and Louvers:

1. Outside Air Hoods:
 - a. Outside air hoods shall be constructed of 20-gage galvanized G-90 steel and sized for 100% of unit nominal cfm.
 - b. Hoods shall include easily accessible 1-in. moisture eliminators with a maximum velocity of no more than 500 fpm.
2. Exhaust Air Hoods:
 - a. Exhaust air hoods shall be constructed of 16-gage galvanized G-90 steel and shipped collapsed in place.
 - b. Expanded metal bird screen shall be provided to prevent entry of unwanted materials into air handler.
3. Power Exhaust Air Hood:
 - a. Power exhaust air hoods shall be constructed of 18-gage galvanized G-90 pre-painted steel.
 - b. Expanded metal bird screen shall be provided to prevent entry of unwanted materials into air handler.
 - c. Optional backdraft damper blades shall be 6063-T5 extruded aluminum channel with galvanized steel braces and extruded vinyl blade seals. Blades shall be mechanically fastened to axle rods rotating in corrosion-resistant, synthetic bearings. Blades begin to open at 0.12 in. wg and are fully open at 0.2 in. wg.

4. Side Intake Louvers:

- a. Frames and blades shall be 6063 alloy, 0.081 in. thick, mechanically fastened with stainless steel fasteners. Frame depth shall be 6 inches.
- b. Vertical blades shall be designed to collect and drain water to exterior at sill by means of a center rain hook and channels in jambs and mullions.
- c. Louvers shall have 1/2-in. mesh removable aluminum bird screen.
- d. Visible mullions required for louver widths greater than 96 inches.
- e. Provide sill-flashing pans 4 in. high by full depth formed from minimum 0.060 in. thick aluminum.
- f. Louvers shall be designed to withstand a wind load of 25 lb per sq ft.
- g. Water penetration shall be no more than 0.01 oz per sq ft of free area at 1250 fpm per AMCA publication 511. The AMCA test was unable to determine the beginning water penetration for this louver due to the fact that it lies above 1250 fpm through free area.
- h. Louver shall have a mill finish.

2.03 FANS

A. General:

1. Forward-curved fan sections shall have one double-width double-inlet (DWDI) fan wheel and scroll. They shall be constructed of galvanized steel with baked enamel. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have an AMCA class rating corresponding to the static pressure at which the fan is designed to operate (Class I or II). Completed fan assembly shall be dynamically balanced in accordance with AHRI Guideline G and ANSI S2.19 at design operating speed using contract drive and motor if ordered.
2. Airfoil fan sections shall have one DWDI airfoil fan wheel and scroll. Airfoil blades shall be double thickness design constructed of heavy gage, high strength steel or aluminum continuously welded to the backplate and the spun inlet flange. Entire fan assembly shall be cleaned, primed and painted with alkyd enamel, except for an aluminum fan wheel when supplied. Fans shall have an AMCA class rating corresponding to the static pressure at which the fan is designed to operate (Class I or II). Completed fan assembly shall be dynamically balanced to minimum grade of G 6.3 per ANSI/AMCA 204 at design operating speed using contract drive and motor if ordered.
3. Belt drive plenum fan sections shall have one single-width single-inlet (SWSI) airfoil fan wheel.

- Airfoil blades shall be double thickness design constructed of heavy gage, high strength steel or aluminum continuously welded to the backplate and the spun inlet flange. Entire fan assembly shall be cleaned, primed and painted with alkylid enamel, except for an aluminum fan wheel when supplied. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have an AMCA class rating corresponding to the static pressure at which the fan is designed to operate (Class I or II). Completed fan assembly shall be dynamically balanced to minimum grade of G 6.3 per ANSI/AMCA 204 at design operating speed using contract drive and motor if ordered.
4. Direct drive plenum fan sections shall have the option of one, two, four, or six single width single inlet (SWSI) airfoil fan wheel(s). Airfoil blades shall be double thickness design continuously welded to the back plate and the front plate. Fan wheel shall be constructed of aluminum. Airfoil blades shall be aluminum extrusions and shall be top welded to the back plate and front plate of the wheel. Fan wheel shall be dynamically balanced per ISO standard 1940 quality grade G6.3.
 5. Fan assembly vibration shall not exceed 0.248 in. per second when mounted on active isolators. Vibration shall be measured in both vertical and horizontal directions at the specified fan operating speed using specified motor. For testing purposes, accelerometers shall be mounted on the motor near the bearing locations and removed before shipment.
 6. All fan sled components shall provide corrosion protection to pass 100-hour salt spray test per ASTM B-117.
 7. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with a maximum operating speed 25% below the first critical.
 8. Belt drive fan motor shall be mounted within the fan section casing on slide rails equipped with adjusting screws. Motor shall be premium efficiency, open drip-proof or totally enclosed fan cooled NEMA (National Electrical Manufacturers Association) Design A or B with size and electrical characteristics as shown on the equipment schedule. Motor shall be mounted on a horizontal flat surface and shall not be supported by the fan or its structural members. All three-phase motors shall have a $\pm 10\%$ voltage utilization range and a 1.15 minimum service factor. Motor shall be compliant with the Energy Independence and Security Act (EISA) of 2007 where applicable. Single-phase motors shall be available up to and including 5 hp.
- B. Performance Ratings:
Fan performance shall be rated and certified in accordance with AHRI Standard 430.
 - C. Sound Ratings:
Manufacturer shall submit first through eighth octave sound power for fan discharge and casing radiated sound. Sound ratings shall be tested in accordance with AHRI 260.
 - D. Mounting:
Fan scroll, wheel, shaft, bearings, drives, and motor shall be mounted on a common base assembly. The base assembly is isolated from the outer casing with factory-installed isolators and vibration absorbent an discharge seal. A canvas style duct connection between fan discharge and cabinet is not acceptable. Units shall use 2-in. deflection spring isolators.
 - E. Fan Accessories:
 1. Forward curved fans:
 - a. Variable frequency drives with or without bypass.
 - b. Magnetic motor starters.
 - c. Motor disconnects.
 - d. Airflow measuring piezo ring.
 - e. Piezo ring transducer.
 - f. Motor shaft grounding ring.
 - g. Belt guards.
 - h. Inlet screen.
 2. Airfoil fans:
 - a. Variable frequency drives with or without bypass.
 - b. Magnetic motor starters.
 - c. Motor disconnects.
 - d. Airflow measuring piezo ring.
 - e. Piezo ring transducer.
 - f. Motor shaft grounding ring.
 - g. Belt guards.
 - h. Inlet screen.
 3. Belt drive plenum fans:
 - a. Variable frequency drives with or without bypass.
 - b. Magnetic motor starters.
 - c. Motor disconnects.
 - d. Airflow measuring piezo ring.
 - e. Piezo ring transducer.
 - f. Motor shaft grounding ring.
 - g. Inlet screen and wheel cage.
 4. Direct Drive Plenum Fans:
 - a. Variable frequency drives.
 - b. Motor protection box for motor current protection with a single VFD driving multiple motors.
 - c. Airflow measuring piezo ring.

- d. Piezo ring transducer.
- e. Motor shaft grounding ring.
- f. Inlet guard.
- g. Blank off plate.
- h. Backdraft Dampers

Optional backdraft damper blades shall be 6063-T5 extruded aluminum channel with galvanized steel braces and extruded vinyl blade seals. Blades shall be mechanically fastened to axle rods rotating in corrosion-resistant synthetic bearings. Blades begin to open at 0.12 in. wg and are fully open at 0.2 in. wg.

F. Flexible Connection:

The base assembly is isolated from the outer casing with factory-installed isolators and vibration absorbent fan discharge seal. A canvas style duct connection between fan discharge and cabinet is not acceptable.

2.04 BEARINGS AND DRIVES

A. Bearings:

Self-aligning, grease lubricated, anti-friction with lubrication fittings extended to drive side of fan section. Optional grease fittings extended to the exterior of the casing are available. All bearing life calculations shall be done in accordance with ABMA 9 for ball bearings and ABMA 11 for roller bearings.

1. Size 03 to 110 forward-curved fans: Cartridge type bearings for Class I fans. Heavy-duty pillow block type, self-aligning, regreasable ball or roller type bearings selected for a minimum average life (L_{50}) of 200,000 hours or optionally for an (L_{50}) of 500,000 hours.
2. Size 03 to 110 airfoil fans: Heavy-duty pillow block type, self-aligning, regreasable ball or roller type bearings selected for a minimum average life (L_{50}) of 200,000 hours or optionally for an (L_{50}) of 500,000 hours.
3. Size 06 to 110 belt-drive plenum fans: Heavy-duty pillow block type, self-aligning, regreasable roller type bearings selected for a minimum average life (L_{50}) of 200,000 hours or optionally for an (L_{50}) of 500,000 hours.

B. Shafts:

Fan shafts shall be solid steel, turned, ground, polished and coated with a rust inhibitor.

C. V-Belt Drive:

Drive shall be designed for a minimum 1.2 service factor as standard with a 1.5 service factor option and/or a factory-supplied extra set of belts. Drives shall be fixed pitch with optional variable pitch for motors 15 hp and less. All drives shall be factory mounted, with sheaves aligned and belts properly tensioned.

2.05 COILS

- #### A. All water, steam and direct expansion (DX) refrigerant coils shall be provided to meet the scheduled

performance. All coil performance shall be certified in accordance with AHRI Standard 410. All water and direct expansion coils shall be tested at 450 psig air pressure. Direct expansion coils shall be designed and tested in accordance with ANSI/ASHRAE 15 Safety Code for Mechanical Refrigeration (latest edition). Factory-supplied $1\frac{1}{2}$ -in. OD coils shall be covered under the standard product one-year limited warranty. All steam coils, integral face and bypass coils and $\frac{5}{8}$ -in. OD coils shall be warranted for a period not in excess of 12 months from their shipment from the manufacturer. Coil epoxy coating shall be covered under a 5-year limited warranty from the date of shipment from the manufacturer.

B. General Fabrication:

1. All water and refrigerant coils shall have minimum $1\frac{1}{2}$ -in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.016 inches. Optional tube wall thickness of 0.025 in. shall be supplied, if specified.
2. Optionally, water coils shall have minimum $\frac{5}{8}$ -in. OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.020 inches. Optional tube wall thickness of 0.035 in. shall be supplied, if specified.
3. Aluminum plate fin type with belled collars. Optional copper plate fins shall be supplied, if specified. Fin type shall be sine wave construction.
4. Aluminum-finned coils shall be supplied with die-formed casing and tube sheets of mill galvanized steel or stainless steel as specified. Copper-finned coils shall be supplied with stainless steel casing and tube sheets.

C. Hydronic Heating and Cooling Coils:

1. Headers shall be constructed of steel with steel MPT connections. Headers shall have drain and vent connections accessible from the exterior of the unit. Optional non-ferrous headers and red brass MPT connections shall be supplied if specified.
2. Configuration: Coils shall be drainable, with non-trapping circuits. Coils will be suitable for a design working pressure of 300 psig at 200 F.

D. Steam Distribution (Non-Freeze Type) Heating Coils:

1. Headers shall be steel with MPT connections.
2. Inner steam distributing tubes shall be $\frac{5}{8}$ -in. OD, 0.020 in. wall thickness, located within 1 in. OD, 0.030 in. wall outer condensing tubes. Working pressure shall be 175 psig at 400 F.
3. Inner steam distributing tubes shall be $\frac{3}{8}$ -in. OD, 0.020 in. wall thickness, located within $\frac{5}{8}$ -in. OD, 0.035 in. wall outer condensing

tubes. Working pressure shall be 175 psig at 400 F.

E. Integral Face and Bypass Coils:

1. Sizes 03-14 shall have horizontal steam or hot water coils with a tubewall thickness of not less than 0.020 inches. Tubes shall be mechanically expanded into die formed collars formed in aluminum plate type fins.
2. Sizes 17-110 shall have vertical steam or hot water coils with a tubewall thickness of not less than 0.035 inches. Fins shall be spiral edge-wound copper. Tubes shall be free-floating for thermal expansion and contraction without the use of offset bends or floating headers.

F. Refrigerant Coils:

1. Headers shall be constructed of copper with brazed joints.
2. Standard circuiting selections include:
 - a. Single distributor arrangement for sizes 03-17.
 - b. Row split intertwined, multiple distributor arrangement for sizes 03-110.
 - c. Face split, multiple distributor arrangement for sizes 03-110.
3. Thermal expansion valve, replaceable nozzle, brass refrigerant distributors and seamless copper distribution tubes are factory supplied to ensure uniform flow.
4. Submittals must include a DX coil and condensing unit cross plot to show that the coil and condensing unit capacity match at the rated design conditions.

G. Electric Heating Section:

1. The electric heater casing is constructed of galvanized steel. Heater control box access door shall be mounted on the designated hand side of the unit. Element construction as follows:
 - a. Open-wire type, 80% nickel, 20% chromium resistance coils, insulated by Steatite bushings and supported in a galvanized steel frame. Bushings shall be recessed into embossed openings and stacked into supporting brackets, spaced no more than 4-in. centers. Thermal cutouts for overtemperature protection shall be provided to meet UL and NEC requirements. Maximum element heating density shall be 55 watts/sq inch.
 - 1) Contactor control - electric heaters up through 60 kW shall have 3 stages of control, beyond 60 kW shall have 6 stages of control.
 - 2) SCR control - electric heaters up through a maximum of 90 amps are available with full SCR control. The entire heater is modulated to achieve the proportional control based on a 0 to 10 volt DC or 4 to 20 mA control signal.

- 3) Vernier control - the heater has full modulating control of the first circuit of heat, all of which is rated at equal kW increments. There is a minimum of 3 circuits for this type of control. These stage increments are turned on and off by a step controller. As each stage fulfills the demand for heat, the SCR increment is used as a fully modulating filler between stages. This end output is a fully proportional control of the electric heater based on a 0 to 10 volt DC or 4 to 20 mA control signal.

- b. Sheathed type, 80% nickel, 20% chromium resistance coils, suspended in a magnesium oxide insulator fill within a tubular steel sheath/brazed fin assembly. Silicone rubber end seals shall prevent contamination of the interior, and the exterior shall be protected from corrosion by a high temperature aluminum coating. Thermal cutouts for overtemperature protection shall be provided to meet UL and NEC requirements. Maximum element heating density shall be 55 watts/sq inch.

- 1) Contactor control - electric heaters up through 60 kW shall have 3 stages of control, beyond 60 kW shall have 6 stages of control.

2. The manufacturer shall furnish an integral control box containing thermal cutouts, primary control, subcircuit fusing, airflow switch, and fused control transformer.

3. Electric heaters shall be UL listed for zero clearance and shall meet all applicable National Electric Code requirements.

4. Units with electric heat sections shall be listed under UL 1995 Standard for Safety.

2.06 GAS HEATING SECTION

- A. Indirect fired gas furnace section(s) shall have a minimum thermal efficiency of 80% and incorporate agency listed gas-fired duct furnace(s) per UL, CSA, or ETL for operation on natural or propane gas to the current edition of ANSI Z83.8 or Canadian CSA 2.6 Standard for Gas-Fired Duct Furnaces. Duct furnaces shall be installed on the positive pressure side of the supply fan only.

- B. The duct furnace modules shall have:

1. 20 gage galvanized steel heat exchanger cabinet.
2. 1 in. thick, minimum 1 1/2 lb per cu ft density thermal insulation for the heat exchanger cabinet.
3. Each furnace shall have an induced-draft fan for the removal of flue gases and to keep the heat exchanger at a negative pressure.
4. Air pressure switches to prove air supply for combustion before operation of gas valve.

5. Patented inshot gas burners with integral carry-overs.
 6. Direct-spark ignition of the gas burners with remote flame sensor to prove carryover across all burners.
 7. A listed 24-vac redundant combination gas valve including two electric shutoff valves, gas pressure regulator, and a manual shutoff valve per furnace.
 8. An automatic reset type high limit switch to limit maximum outlet air temperature to less than 250 F.
 9. Manual reset flame rollout switches.
 10. Minimum of one 40 va, 24 vac control transformer.
 11. $\frac{1}{8}$ in. NPT tapped test gage connection in the gas manifold for measuring gas pressure.
 12. Union fitting downstream of gas control to facilitate installation and service
 13. Provision for attachment of a vent system to exhaust flue gases to the outdoors.
- C. Gas-fired duct furnace(s) provided shall have an 18 gage tubular heat exchanger assembly suitable to withstand 3.0 in. wg total external static pressure without burner flame disturbance and constructed of either:
1. Type 409 stainless steel (0.044 minimum wall thickness) produced to ASTM A268.
 2. Type 304L stainless tubes (0.047 minimum wall thickness) produced to ASTM A249.
- D. Gas heating section modules shall be listed for application downstream of refrigeration and cooling systems and shall provide means for removal of condensate that occurs in the tubes during cooling operation. Heat exchanger tubes shall have (integral formed dimpled restrictors; formed tubulators) to provide for an unobstructed drainage path and tubes shall be formed to provide a positive pitch to promote condensate drainage. Drainage shall be configured so that burners and burner surfaces are not exposed to condensate.
- E. Gas heating section shall incorporate a direct-spark ignition control module listed by one of the following: US, CSA, or ETL.
- F. Controls shall provide:
1. 100% safety shutoff.
 2. A 15-second minimum pre-purge period prior to trial for ignition.
 3. High-energy direct-spark ignition of main burners.
 4. Electronic flame supervision incorporating a 0.8-second flame failure response time.
 5. Up to 2 additional ignition retries preceded by an inter-purge period.
 6. A minimum 30-second post-purge.
 7. Automatic reset after one hour to initiate additional ignition trials if lockout occurs during heat call.
 8. An LED indicator light to provide a flash code to identify the operating condition of the control.
- G. Gas heating section shall be equipped for operation with 115 vac, single-phase, 60 Hz power supply.
- H. All electrical components shall be listed or recognized by UL, CSA, or ETL.
- I. Gas Furnace Control:
1. Single furnace — Operates from 10 to 100% of input from a single analog input of 0 to 10 vdc.
 2. Two furnaces in series — Lead unit operates from 20 to 100% of input and secondary unit operates in two-stage operation to achieve overall system input of 10 to 100% from a single analog input of 0 to 10 vdc.
 3. Furnace rack systems — Multiple furnaces operate from a single analog input of 0 to 10 vdc with a lead modulating furnace and multiple secondary two-stage furnaces to achieve overall system input of 10 to 100%. (10:1 turndown minimum; most rack systems provide greater than 10:1 turndown.)
- J. Electronic modulation — Operates from 10 to 100% of input from a single analog input of 0 to 10 vdc. Heat enable contact (supplied by others) initiates and ends heating cycles. Heating unit incorporates two-speed operation of combustion air blower and two-stage gas valve, signal amplifier and timer relay control.
- K. Gas supply pressure to the gas valve inlet shall be 5.0 to 13.5 in. wg for natural gas or 11.0 to 13.5 in. wg for propane gas.
- L. Units are orificed for operation up to 2000 ft above sea level unless specified for high altitude operation.
- M. Duct furnaces shall be test-fired prior to shipment to verify proper ignition, operation and shutdown and satisfactory operation of all components.
- N. Furnaces shall be provided with printed installation and maintenance instructions, burner operating and maintenance instructions, piping and wiring diagrams and installation start-up data sheet.
- ## 2.07 HUMIDIFIERS
- A. The humidifiers shall be of the direct discharge type, using steam from existing steam lines or boilers to be injected into the air plenums for humidification.
- B. Each humidifier shall consist of multiple, vertical steam discharge pipes, supported on horizontal header manifolds, spaced to provide the optimum of steam to air contact while minimizing pressure drop. Each humidifier shall be sized to nominally match the air plenum width and height for maximum contact of the discharging steam to the air passing around the vertical steam discharge pipes.

- C. The vertical steam discharge pipes shall be constructed of 316 stainless steel. Each pipe shall have a full-length, inverted slot on each side for steam discharge at 100% air to steam contact. Nozzles and holes have less than 15% air to steam contact and are, therefore, unacceptable.
- D. A full-length stainless steel fishbone shaped baffle shall be used inside the vertical discharge pipe to wick condensate away from the discharge slots and back to the center of the pipe for re-evaporation.
- E. The feeder manifolds shall be constructed of 316 stainless steel, sized to move the steam in a specific mass-flow speed range, for maximum condensate separation. Final condensate separation shall occur inside the feeder manifolds, after the control valve, with the dried steam then injected directly into the vertical discharge pipes.
- F. Insulated uprights provide a cushion of air that reduces both heat gain and condensate formation. Insulated models have nozzles inserted in the uprights to ensure that only dry steam is delivered into the air.
- G. The steam humidifier shall be designed with slip fittings for easy assembly. The steam humidifier shall be designed without plastic nozzles, collars, o-rings or gaskets for zero maintenance.

2.08 FILTER SECTIONS

- A. Flat filter sections shall accept either 2-in. or 4-in. filters. Sections shall include side access slide rails. Optional 2 in. pre-filter shall be available.
- B. Angle filter sections shall accept either 2-in. or 4-in. filters of standard sizes, arranged in a horizontal V formation.
- C. Draw-thru bag/cartridge filter sections shall be capable of accepting headered standard size 6-in. to 12-in. deep rigid media or bag filters and a 2-in. pre-filter.
- D. Draw-thru bag/cartridge filter sections shall be capable of accepting headered standard size 12-in. to 30-in. deep rigid media or bag filters and a 2-in. pre-filter.
- E. Blow-thru bag/cartridge filter sections shall contain a face loading filter frame and be capable of accepting standard size 12-in. deep rigid media (headered or box) or bag filters.
- F. Blow-thru HEPA filter sections shall contain a face loading filter frame and be capable of accepting standard size 12-in. deep HEPA box filters.
- G. Differential Pressure Gages:
 - 1. Housing shall be constructed of a glass filled nylon case and acrylic lens. Exterior finish shall be coated black.
 - 2. Accuracy shall be $\pm 5\%$ of full scale throughout range at 70 F.
 - 3. Pressure limits shall be 30 psig continuous to either pressure connection.
 - 4. Temperature limits shall be 20 to 120 F.

- 5. Diameter of dial face shall be 2.33 in.
- 6. Process connections shall be barbed, $\frac{3}{16}$ -in. for ID tubing.

2.09 DAMPERS

- A. Factory-supplied dampers shall be warranted to be free from defects in material and workmanship for a period of 12 months after being installed or placed in service, but in no instance shall the period of warranty be longer than 18 months from the date of the original shipment by the manufacturer.
- B. Mixing boxes, filter-mixing boxes, and exhaust boxes shall have parallel or opposed blades and interconnecting outside-air and return-air dampers.
 - 1. Standard Dampers:

Damper blades shall be constructed of galvanized steel, with blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. Maximum leakage rate shall be 4 cfm/ft² at 1 in. wg differential pressure.
 - 2. Premium Dampers:

Damper blades shall be constructed of galvanized steel with a double-skin airfoil design, with blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. Maximum leakage rate shall be 2 cfm/ft² at 1 in. wg differential pressure.
 - 3. Outside Air Measurement Dampers:
 - a. Damper frame shall be nominal 4 in. x 1 in. x minimum 0.081 in. and constructed of 6063-T5 extruded aluminum.
 - b. Airflow measuring blades shall be airfoil-shaped, heavy gage anodized 6063-T5 extruded aluminum and fixed in 10 in. x minimum 16 gage galvanized steel frame.
 - c. Jamb seals shall be flexible metal compression type along control damper sides.
 - d. Blade seals shall be neoprene along control damper blade edges.
 - e. Bearings shall be molded synthetic.
 - f. Linkage shall be galvanized steel, concealed in frame.
 - g. Axles shall be minimum $\frac{1}{2}$ -in. diameter plated steel, hex-shaped, mechanically attached to blade.
 - h. Operating temperature shall be -22 to 140 F.
 - i. Air straightener section shall be aluminum alloy honeycomb contained in 5 in. long, 16 gage galvanized steel sleeve attached to monitoring blade frame.
 - j. Airflow range shall be 400 to 5,000 ft per minute face velocity.
 - k. Maximum leakage rate shall be 2 cfm/ft² at 1 in. wg differential pressure.

C. Integral Face and Bypass Dampers:

1. Integral face and bypass (IFB) coils shall be capable of maintaining a constant air volume, within 5%, shall be capable of maintaining a constant leaving air temperature as entering air conditions vary, and shall be capable of producing mixed leaving air temperatures within 3 ft downstream with a maximum variance in air temperature of 5° F, regardless of damper position.
2. When no heating is required, dampers shall divert air to bypass around heating surface with minimal temperature override.
3. Coil casing, dampers and baffles shall be fabricated from galvanized steel with an option for stainless steel. Coils shall be tested at 300 psig.
4. Integral face and bypass coils shall be provided with a connection point for field-mounted actuator(s), electrical or pneumatic, or can be provided from the factory at an additional cost.
5. Actuator connection point shall be mechanically attached to dampers via linkage mechanisms. Dampers shall be interconnected for operation simultaneously across each face of coil.

D. Internal Face and Bypass Dampers:

Internal face and bypass dampers shall be factory mounted in galvanized steel frame. Damper blades shall be constructed of galvanized steel, with high temperature blade and edge seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. To eliminate blade warping, face dampers shall be sectionalized to limit blade length to 60 in. maximum. Face damper blades shall be opposed and arranged to match coil face with top bypass, and internal linkage.

E. Power Exhaust Hood Dampers:

Backdraft damper blades shall be 6063-T5 extruded aluminum channel with galvanized steel braces and extruded vinyl blade seals. Blades shall be mechanically fastened to axle rods rotating in corrosion-resistant, synthetic bearings. Blades begin to open at 0.12 in. wg and are fully open at 0.2 in. wg.

2.10 AIR MIXER

Air mixer of 0.081-in. aluminum construction of size, performance and maximum pressure drop indicated. The air mixer shall mix two or more airstreams of differing temperature to within $\pm 6^\circ$ F of theoretical mixed-air temperature and provide a more uniform air velocity contour entering a downstream filter or coil bank.

2.11 UV-C GERMICIDAL LAMPS

- A. Emitters and fixtures for UV-C lamps shall be designed for use inside an HVAC system and shall be covered by a 1 year warranty. Individual lamp output shall be measured in an ASME nozzled test apparatus using a 45 F airstream moving at not less than 400 fpm. Lamp output at 253.7 nm shall not

be less than 10 $\mu\text{W}/\text{cm}^2$ per inch of arc length measured at a distance of one meter.

- B. Power supplies for UV-C lamps shall be a high-efficiency electronic type which are matched to the emitters and are capable of producing the specified output intensity with an input power no more than 80 watts.
- C. Fixtures for UV-C lamps shall be factory installed and wired to a SPDT disconnect switch and door interlock switches in each door. Fixtures are wired for 120 v/single ph requiring a minimum circuit ampacity of 15 amps. Lamps shall ship separately for field installation to minimize the chance for bulb damage.
- D. Emitters and fixtures shall be installed in sufficient quantity and arranged so as to provide an equal distribution of UV-C energy on the coil and drain pan.
- E. The minimum UV-C energy striking the leading edge of the coil pan shall be not less than 820 $\mu\text{W}/\text{cm}^2$ at the closest point and through placement, not less than 60% of that value at the farthest point. Equal amounts are to strike the drain pan, either directly or indirectly through reflection.
- F. Emitters and fixtures shall be installed such that UV-C energy strikes all surfaces of the coil, drain pan, and the available line of sight airstream.

2.12 ELECTRICAL ACCESSORIES

A. Marine Lights and Convenience Outlets:

1. Cast, non-ferrous metal, weatherproof, fixture.
2. Cast, non-ferrous metal, weatherproof, electrical junction box.
3. Gasketed, heat and shock resistant glass globe protects against moisture and debris.
4. Cast, non-ferrous metal lamp guard to protect glass globe.
5. UL and CSA listed.
6. 100 watt type 'A' lamp maximum capacity.
7. Each fixture is equipped with a 9.5 watt, 120 volt, 800 lumen LED lamp with an average rated life of 25,000 hours, factory installed.
8. Cast, non-ferrous metal, single gang, weatherproof, switch enclosure.
9. With convenience outlet: Factory supplied and wired, SPST, toggle switch and 15 amp, 120 vac/60 Hz, NEMA 5-15 type, ground fault circuit interrupt (GFCI) receptacle, weatherproof, 'In-Use' type, lockable cover, UL listed.
10. Without convenience outlet: Factory supplied and wired, SPST switch with non-ferrous metal, weatherproof cover plate, UL listed.
11. Each fixture is factory wired to an externally mounted switch box. (Field power connections are made to the switch box mounted externally on the unit.)
12. All factory wiring penetrating through the panel is protected in 'RIGID' type metal conduit.

B. Disconnects:

Factory-supplied disconnects shall be covered under a 1 year limited warranty from the manufacturer from the date of shipment.

1. 115-230 volt/single-phase non-fused disconnects shall have the following characteristics:
 - a. Plated current carrying components for superior corrosion protection.
 - b. Factory-installed equipment grounding terminals with slot/square drive screws.
 - c. Rated for motor disconnect applications (10 hp maximum).
 - d. NEMA type 3R non-metallic enclosure.
 - e. Up to 10,000 rms symmetrical amperes SCCR, when protected by a fuse or circuit breaker rated 60 amperes or less.
 - f. Cover padlock hasp.
 - g. Pull-out cartridge type.
 - h. UL listed.
2. 115-230 volt/single-phase fused disconnects shall have the following characteristics:
 - a. Visible blades.
 - b. Quick-make, quick-break operating mechanism.
 - c. Cover padlock hasp and handle lock "OFF."
 - d. 240 vac maximum.
 - e. Factory supplied and installed class RK5 fuses.
 - f. Up to 100,000 rms symmetrical amperes SCCR, utilizing appropriately rated, factory supplied, Class R fuses.
 - g. Horsepower rated for motor applications.
 - h. Tangential combination knockouts for field wiring.
 - i. Spring reinforced plated copper fuse clips.
 - j. NEMA type 3R enclosures.
 - k. Insulated, bondable solid neutral assemblies.
 - l. UL listed, File E2875.
 - m. Meet or exceed NEMA KS1-1990.
3. 200-230 volt/3-phase fused and non-fused disconnects shall have the following characteristics:
 - a. Visible blades.
 - b. Quick-make, quick-break operating mechanism.
 - c. Cover padlock hasp and handle lock "OFF."
 - d. 240 vac maximum.
 - e. Factory supplied and installed class RK5 fuses (fused disconnects only).
 - f. Up to 100,000 rms symmetrical amperes SCCR, utilizing appropriately rated Class R fuses.
 - g. Horsepower rated for motor applications.
 - h. Tangential combination knockouts for field wiring.

- i. Spring reinforced plated copper fuse clips.
- j. NEMA type 3R enclosures.
- k. Insulated, bondable solid neutral assemblies.
- l. UL listed, File E2875.
- m. Meet or exceed NEMA KS1-1990.
4. 380-575 volt/3-phase fused and non-fused disconnects shall have the following characteristics:
 - a. Visible switch blades with for positive "OFF" indication.
 - b. Quick-make, quick-break operating mechanism.
 - c. Dual cover interlock.
 - d. Color coded "ON" — "OFF" indicator handle.
 - e. Cover padlock hasp and handle lock "OFF" provision for multiple padlocks.
 - f. 600 vac maximum.
 - g. Factory supplied and installed class RK5 fuses (fused disconnects only).
 - h. Up to 200,000 rms symmetrical amperes SCCR, utilizing appropriately rated Class R fuses.
 - i. Horsepower rated for motor applications.
 - j. Spring reinforced plated copper fuse clips.
 - k. Tangential combination knockouts.
 - l. NEMA type 3R enclosures.
 - m. Insulated, bondable solid neutral assemblies.
 - n. Wire terminations suitable for aluminum or copper conductors.
 - o. UL listed.
 - p. Meet or exceed NEMA KS1-1999.

C. Starters:

Factory-supplied disconnects shall be covered under a 1 year limited warranty from the manufacturer from the date of shipment.

1. Starter without disconnect:
 - a. Adjustable motor overload with trip indication.
 - b. Manual overload reset button (accessible without opening enclosure).
 - c. 115-v fused secondary control transformer (fuse included — fused primary and secondary over 50 amps).
 - d. Hand/Off/Auto selector switch (accessible without opening enclosure).
 - e. Separate 4-position terminal strip for remote H-O-A wiring.
 - f. C series contactors.
 - g. Horsepower rated for motor applications.
 - h. NEMA 4X type non-metallic enclosures.
 - i. Lug connections for field wiring.
 - j. Factory mounted, wired, and run tested with factory-supplied motor.

- k. UL listed.
- 2. Combination Starter/Disconnect:
 - a. Non-fused UL 508 disconnect switch with lockable handle (locks not provided).
 - b. Cover interlock.
 - c. Adjustable motor overload with trip indication.
 - d. Manual overload reset button (accessible without opening enclosure).
 - e. 115-v fused secondary control transformer (fuse included — fused primary and secondary over 50 amps).
 - f. Hand/Off/Auto selector switch (accessible without opening enclosure).
 - g. Separate 4-position terminal strip for remote H-O-A wiring.
 - h. C series contactors.
 - i. Horsepower rated for motor applications.
 - j. NEMA 4X type non-metallic enclosures.
 - k. Lug connections for field power wiring.
 - l. Factory mounted, wired, and run tested with factory-supplied motor.

D. Bypass for Variable Frequency Drives:

Factory-supplied bypasses shall be covered under a 1 year limited warranty from the manufacturer from the date of shipment.

- 1. 200-230 v/3 Ph/60 Hz (1 to 7.5 Hp), 460-575 v/3 Ph/60 Hz (1 to 20 Hp), 380 v/3 Ph/50 Hz (1 to 15 Hp):
 - a. 4-position panel-mounted disconnect style switch with lockable handle (locks not provided), meets OSHA 1910.
 - b. Switch position indication (LINE/OFF/DRIVE/TEST).
 - c. Adjustable motor overload with trip indication (LINE position).
 - d. Manual overload reset button.
 - e. Horsepower rated for motor applications.
 - f. Direct control (no contactors, relays, or holding coils).
 - g. Complete isolation of inverter in LINE position.
 - h. NEMA 4 type metal enclosures.
 - i. Terminal strip provided for field power supply wiring.
 - j. Lug connection for field ground wire.
 - k. Gold flashed, auxiliary switch contact set (for switch position monitoring).
 - l. Factory mounted, wired to VFD and motor, and run tested (motor and VFD must be factory supplied and installed).
 - m. UL; UL, Canada; CE listed.

- 2. 200-230 v/3 Ph/60 Hz (10 to 75 Hp), 460-575 v/3 Ph/60 Hz (25 to 150 Hp), 380 v/3 Ph/50 Hz (20 to 75 Hp):
 - a. 4-position panel-mounted disconnect style switch with lockable handle (locks not provided), meets OSHA 1910.
 - b. Switch position indication (LINE/OFF/DRIVE/TEST).
 - c. Adjustable motor overload with trip indication (in LINE position).
 - d. Manual overload reset button.
 - e. Horsepower rated for motor applications.
 - f. 115-v control transformer with fused secondary (fused primary on units over 50 amps).
 - g. Contactor for Line Start/Stop.
 - h. Door-mounted Line Start and Line Stop pushbuttons.
 - i. Complete isolation of inverter in LINE position.
 - j. NEMA 12 type metal enclosures.
 - k. Terminal strip provided for field power supply wiring.
 - l. Lug connection for field ground wire.
 - m. Gold flashed, auxiliary switch contact set (for switch position monitoring).
 - n. Factory mounted, wired to VFD and motor, and run tested (motor and VFD must be factory supplied and installed).
 - o. UL; UL, Canada; CE listed.

E. Variable Frequency Drives:

- 1. Factory-mounted variable frequency drives (VFDs) shall be wired to factory-supplied motors.
- 2. Factory-supplied VFDs are programmed and started up from the factory and qualify the VFD, through ABB, for a 24-month warranty from date of commissioning or 30 months from date of sale, whichever occurs first.
- 3. The VFD parameters are programmed into the controller and removable keypad. In the event that the VFD fails and needs replacement, the program can then be uploaded to the replacement VFD via the original keypad.
- 4. The VFD shall be mounted inside the unit cabinet shielded from upstream components and within the unit's ambient conditions. Access to the VFD shall be through the unit's hinged access door.
- 5. The VFD package as specified herein shall be enclosed in a UL Listed type enclosure, exceeding NEMA enclosure design criteria (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in an ISO 9001 facility. The VFD tolerated voltage window shall allow the VFD to

operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

- a. Environmental operating conditions: VFDs shall be capable of continuous operation at -15 to 40 C (5 to 104 F) ambient temperature with no frost allowed as per VFD manufacturers documented/submittal data or VFD must be oversized to meet these temperature requirements. Not acceptable are VFDs that can only operate at 40 C intermittently (average during a 24-hour period) and therefore must be oversized. VFDs shall be capable of operating at altitude 0 to 3300 ft above sea level and less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.
 - b. Enclosure shall be rated UL Type 1 and shall be UL listed as a plenum rated VFD. VFDs without these ratings are not acceptable. Type 1 enclosures with only NEMA ratings are not acceptable (must be UL Type 1).
6. All VFDs shall have the following standard features:
- a. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
 - b. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
 - c. There shall be a built-in timeclock in the VFD keypad. The clock shall have a battery back-up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays. The VFD shall have a digital input that allows an override to the timeclock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
 - d. The VFDs shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
 - e. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, the VFD shall cycle the cooling fans on and off as required.
 - f. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).
 - g. The VFD shall have the ability to automatically restart after an overcurrent, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
 - h. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
 - i. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFDs with only one DC reactor shall add an AC line reactor.
 - j. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFDs with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120. Input and output current ratings must be shown on the VFD nameplate.
 - k. The VFD shall include a coordinated AC transient surge protection system consisting of 4 to 120 joule rated MOVs (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
 - l. The VFD shall provide a programmable loss-of-load (broken belt/broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and/or over the serial communications bus.

The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.

- m. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure/jam condition causing motor overload
 - n. The VFD shall include multiple “two zone” PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4 to 20 mA, 0 to 10V, and/or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for “two zone” control.
 - o. If the input reference (4 to 20 mA or 2 to 10 V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and / or over the serial communication bus.
 - p. The VFD shall have programmable “Sleep” and “Wake up” functions to allow the drive to be started and stopped from the level of a process feedback signal.
7. All VFDs to have the following adjustments:
- a. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.
 - b. Two (2) PID set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are typically used for night setback, switching between summer and winter set points, etc.
 - c. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (ie. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
 - d. Two (2) programmable analog inputs shall accept current or voltage signals.
 - e. Two (2) programmable analog outputs (0 to 20 mA or 4 to 20 mA). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.
 - f. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24 VDC or 24 VAC.
 - g. Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.
 - h. Run permissive circuit: There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display “start enable 1 (or 2) missing.” The safety input status shall also be transmitted over the serial communications bus.
 - i. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 to 120 seconds. Start delay shall be active regardless

- of the start command source (keypad command, input contact closure, time-clock control, or serial communications).
- j. Seven (7) programmable preset speeds.
 - k. Two independently adjustable accelerate and decelerate ramps with 1 to 1800 seconds adjustable time ramps.
 - l. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
 - m. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
 - n. The VFD shall include password protection against parameter changes.
8. The keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:
 - a. Start-up assistant
 - b. Parameter assistants
 - c. PID assistant
 - d. Reference assistant
 - e. I/O assistant
 - f. Serial communications assistant
 - g. Option module assistant
 - h. Panel display assistant
 - i. Low noise set-up assistant
 - j. Maintenance assistant
 - k. Troubleshooting assistant
 - l. Drive optimizer assistants
 9. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
 - a. Output Frequency
 - b. Motor Speed (RPM, %, or Engineering units)
 - c. Motor Current
 - d. Motor Torque
 - e. Motor Power (kW)
 - f. DC Bus Voltage
 - g. Output Voltage
 10. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -500 Hz (reverse) to 500 Hz (forward). 2) Operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command.
 11. Serial Communications:
 - a. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. [Optional protocols for LonWorks, Profibus, EtherNet, BACnet IP, and DeviceNet shall be available.] Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e., BTL Listing for BACnet). Use of non-certified protocols is not allowed.
 - b. The BACnet connection shall be an EIA-485, RS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
 - 1) Data Sharing – Read Property – B.
 - 2) Data Sharing – Write Property – B.
 - 3) Device Management – Dynamic Device Binding (Who-Is; I-Am).
 - 4) Device Management – Dynamic Object Binding (Who-Has; I-Have).
 - 5) Device Management – Communication Control – B.
 - c. If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.
 - d. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/

integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

- e. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass valve control, chilled water valve / hot water valve control, etc. Both the VFD PID control loop and the independent PID control loop shall continue functioning even if the serial communications connection is lost. As default, the VFD shall keep the last good set point command and last good DO and AO commands in memory in the event the serial communications connection is lost and continue controlling the process.
- 12. EMI/RFI filters. All VFDs shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.
- 13. All VFDs through 75 hp at 480 V shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not sustain damage from this power mis-wiring condition.
- 14. Operational Functions:
 - a. The drive shall contain two separate acceleration/deceleration times with auto tuning for optimum setting (0.1 to 6000 seconds) with choice of linear, S, or C curves that shall be factory programmed to match the fan load and prevent nuisance overcurrent fault trips.
 - b. The drive shall be equipped with both local/remote and manual/auto keys on touchpad.
 - c. The drive shall be equipped with a quick setup key.
 - d. The drive shall contain 15 preset speeds, which can be activated from the keypad, terminal inputs, and host computer.
 - e. The drive shall have the capability of storable special custom user setting.
 - f. The drive shall restart into a rotating motor operating in either the forward or reverse direction and match that frequency.
 - g. The drive shall have adjustable soft stall (10% to 150%) which reduces frequency and voltage of the inverter to sustain a run in an overload situation factory programmed for each motor's characteristics.
 - h. The drive shall be capable of performing a time base pattern run using 4 groups of 8 patterns each using the 15 preset speed values for a maximum of 32 different patterns.
 - i. The drive shall have adjustable UL listed electronic overload protection (10% to 100%) factory programmed to match each motor's FLA/RLA (full load amps/rated load amps) ratings.
 - j. The drive shall have a custom programmable volt/hertz pattern.
- 15. Protective Features:
 - a. The drive shall be rated for 200,000 AIC (ampere interrupting capacity). The use of input fuses to achieve this rating shall not be acceptable.
 - b. The drive shall have external fault input.
 - c. The drive shall be capable of resetting faults remotely and locally.
 - d. The drive shall be programmable to alert the following alarms:
 - 1) Over torque alarm.
 - 2) Inverter overload pre-alarm.
 - 3) Motor overload pre-alarm.
 - 4) Braking resistor overload pre-alarm.
 - 5) Inverter overheat pre-alarm.
 - 6) Undercurrent alarm.
 - 7) Overcurrent pre-alarm.
 - 8) Communication error alarm.
 - 9) Cumulative timer alarm.
 - 10) Executing retry.
 - e. The drive shall identify and display the following faults:
 - 1) Overcurrent during acceleration trip.
 - 2) Overcurrent during deceleration trip.
 - 3) Overcurrent during normal run trip.
 - 4) Overcurrent on the DC Bus during acceleration trip.
 - 5) Overcurrent on the DC Bus during deceleration trip.
 - 6) Overcurrent on the DC Bus during normal run trip.

- 7) Load end overcurrent trip detected at start-up (output terminals, motor wiring, etc.).
- 8) U-phase short circuit trip detected at start-up.
- 9) V-phase short circuit trip detected at start-up.
- 10) W-phase short circuit trip detected at start-up.
- 11) Overvoltage during acceleration trip.
- 12) Overvoltage during deceleration trip.
- 13) Overvoltage during normal (constant speed) run trip.
- 14) Inverter overloaded trip.
- 15) Motor overloaded trip.
- 16) Inverter overheat trip.
- 17) Emergency off trip message.
- 18) EEPROM failure during write cycle.
- 19) EEPROM abnormality during initial reading.
- 20) RAM error.
- 21) ROM error.
- 22) CPU error.
- 23) Communication interruption error.
- 24) Gate array error.
- 25) Output current detection circuit error.
- 26) Option PCB error trip.
- 27) Low operating current trip.
- 28) Main circuit under voltage trip.
- 29) Over torque trip.
- 30) Software detected earth fault trip.
- 31) Hardware detected earth fault trip.
- 32) Inverter type form mismatch error.
- 33) EEPROM type form mismatch error.

16. Monitor Functions:

- a. The drive digital display shall be capable of displaying the following: Frequency, percent current, current amps, percent voltage I/O, voltage in volts I/O, RPM, GPM, I/O watts, torque, and input reference signal, kWh.
- b. The drive shall have 320 programmable parameters which can be changed while the drive is operating.
- c. The drive's 353 parameters shall be adjustable from the 8-key touchpad or computer link.
- d. The drive's 8-key touchpad shall be NEMA 12 rated.
- e. The drive's keypad shall be capable of being extended 15 ft from the drive.
- f. The drive shall contain a reset of all parameters to factory default settings or user defaults (whichever one is chosen).
- g. The drive shall have 2 programmable analog outputs programmable to 17 choices.
- h. The drive shall have one programmable relay output programmable to 67 choices.
- i. The drive shall have 8 programmable digital inputs programmable to 54 choices.
- j. The drive shall have a pulse train output proportional to frequency (48, 96, 360 times frequency).
- k. The drive shall have an elapsed time meter.

17. Options:

- a. VFD with Integral Disconnect:
 - 1) UL Listed by the drive manufacturer as a complete assembly
 - 2) UL 508 labeled
 - 3) Capable of being locked by three padlocks



Table Of Contents

Project: DC Station 2
Prepared By:

03/16/2018
02:38PM

ACCH-1	2
Unit Report	3
Certified Drawing	4
Field Wiring Diagram	5
Detailed Performance Report	6

ACCH-1

**Tag Cover Sheet
Unit Report
Certified Drawing
Wiring Diagram
Detailed Performance Report**

Unit Report For ACCH-1

Project: DC Station 2
Prepared By:

03/16/2018
02:38PM

Unit Information

Tag Name:..... **ACCH-1**
Model Number:..... **30RAP035**
Condenser Type:..... **Air Cooled**
Compressor Type:..... **Scroll**
Nameplate Voltage:..... **208/230-3-60** V-Ph-Hz
Quantity:..... **1**
Manufacturing Source:..... **Charlotte, NC USA**
Refrigerant:..... **R410A**
Independent Refrigerant Circuits:..... **2**
Capacity Control Steps:..... **5**
Minimum Capacity:..... **8.6** %
Shipping Weight:..... **3055** lb
Operating Weight:..... **2850** lb
Unit Length:..... **89** in
Unit Width:..... **93** in
Unit Height:..... **67** in

Accessories and Installed Options

Evaporator Heater
Micro Channel
Low Sound
Dual Pump, 5 HP High Head
Hot Gas Bypass
Single Point
Fixed Speed Condenser Fan
Vibration Isolation Package

Chiller Warranty Information (Note: for US & Canada only)

First Year - Parts Only (Standard)
Start-Up with 1st Year Carrier CCS Labor - 1st Unit
Compressor Years 2-5 Parts Only

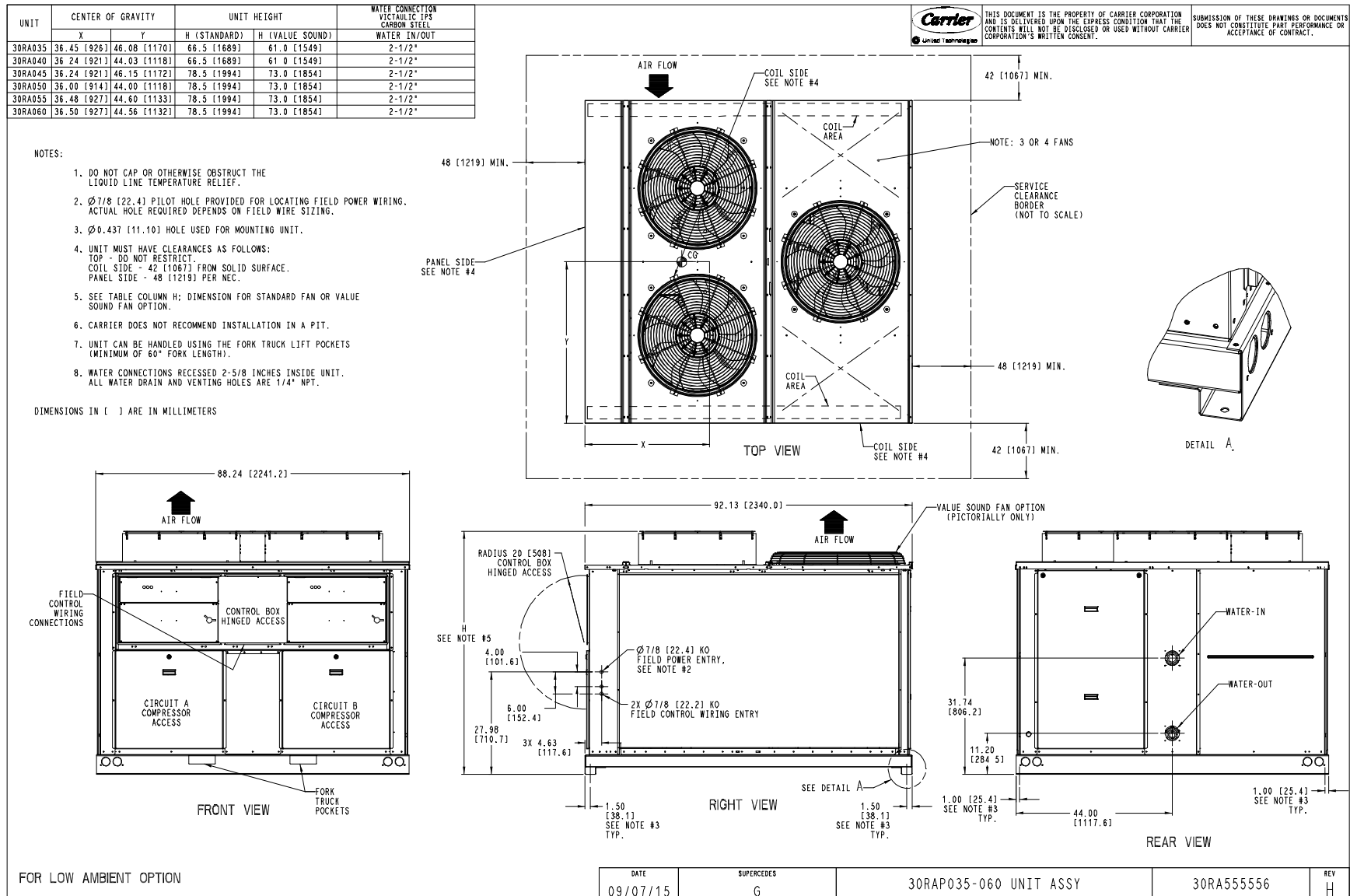
Ordering Information

Part Number	Description	Quantity
30RAP0355D-F1100	Packaged Chiller	1
	Base Unit	
	Evaporator Heater	
	Micro Channel	
	Low Sound	
	Dual Pump, 5 HP High Head	
	Hot Gas Bypass	
	Single Point	
	Fixed Speed Condenser Fan	
30RA-900---005	Vibration Isolation Package	1

Certified Drawing for ACCH-1

Project: DC Station 2
Prepared By:

03/16/2018
02:38PM



Field Wiring Diagram for ACCH-1

Project: DC Station 2
Prepared By:

03/16/2018
02:38PM

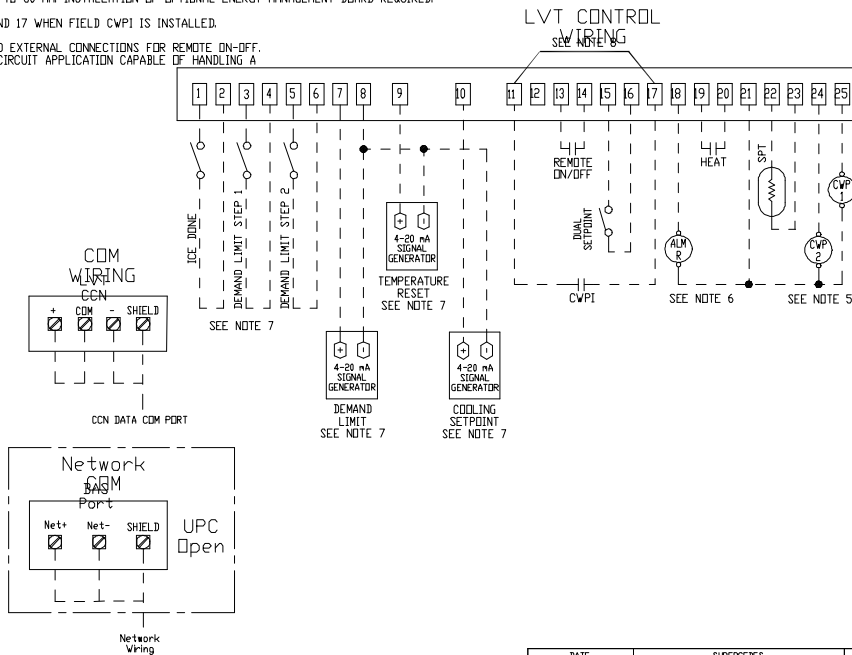
NOTES:

- FACTORY WIRING IS IN ACCORDANCE WITH UL 1995 STANDARDS. FIELD MODIFICATIONS OR ADDITIONS MUST BE IN COMPLIANCE WITH ALL APPLICABLE CODES.
- ALL UNITS OR MODULES HAVE SINGLE POINT PRIMARY POWER CONNECTION. MAIN POWER MUST BE SUPPLIED FROM A FIELD OR FACTORY SUPPLIED DISCONNECT.
- WIRING FOR MAIN FIELD SUPPLY MUST BE RATED 75C. USE COPPER CONDUCTORS ONLY.
 - INCOMING WIRE SIZE RANGE FOR TERMINAL BLOCK WITH MCA UP TO 175 AMPS IS 14 AWG TO 2/0 FOR 10-60 TON CHILLERS.
 - INCOMING WIRE SIZE RANGE FOR TERMINAL BLOCK WITH MCA FROM 175.1 AMPS TO 335 AMPS IS 6 AWG TO 400 KCMIL FOR 10-60 TON CHILLERS.
 - INCOMING WIRE SIZE RANGE FOR TERMINAL BLOCK WITH MCA UP TO 420 AMPS IS 2 AWG TO 600KCMIL FOR 70-150 TON CHILLER.
 - INCOMING WIRE SIZE RANGE FOR TERMINAL BLOCK WITH MCA FROM 420.1 AMPS TO 760 AMPS IS 6 AWG TO 500 KCMIL(TWO OPENINGS PER POLE) FOR 70-150 TON CHILLERS.
 - INCOMING WIRE SIZE RANGE FOR NON-FUSED DISCONNECT WITH MCA UP TO 100 AMPS IS 14AWG TO 3/0.
 - INCOMING WIRE SIZE RANGE FOR NON-FUSED DISCONNECT WITH MCA FROM 100.1 AMPS TO 250 AMPS IS 6AWG TO 350 KCMIL.
 - INCOMING WIRE SIZE RANGE FOR NON FUSED DISCONNECT WITH MCA FROM 250.1 TO 600 AMPS IS 3/0 AWG TO 500KCMIL (TWO OPENINGS PER POLE)
- REFER TO CERTIFIED DIMENSIONAL DRAWINGS FOR EXACT LOCATIONS OF THE MAIN POWER AND CONTROL POWER ENTRANCE LOCATIONS.
- TERMINALS 21 AND 25 OF THE LVT ARE FOR CONTROL OF CHILLED WATER PUMP1 (CWP1) STARTER. TERMINALS 21 AND 24 OF THE LVT ARE FOR CONTROL OF CHILLED WATER PUMP2 (CWP2) STARTER. THE MAXIMUM LOAD ALLOWED FOR THE CHILLED WATER PUMP RELAY IS 5 VA SEALED, 10 VA INRUSH AT 24 V. FIELD POWER SUPPLY IS NOT REQUIRED.
- TERMINALS 18 AND 21 OF LVT ARE FOR AN ALARM RELAY. THE MAXIMUM LOAD ALLOWED FOR THE ALARM RELAY IS 5 VA SEALED, 10 VA INRUSH AT 24V. FIELD POWER SUPPLY IS NOT REQUIRED.
- MAKE APPROPRIATE CONNECTIONS TO LVT AS SHOWN FOR ENERGY MANAGEMENT BOARD OPTIONS. THE CONTACTS FOR DEMAND LIMIT AND ICE DIONE OPTIONS MUST BE RATED FOR DRY CIRCUIT APPLICATION CAPABLE OF HANDLING A 24VAC LOAD UP TO 50 MA. INSTALLATION OF OPTIONAL ENERGY MANAGEMENT BOARD REQUIRED.
- REMOVE JUMPER BETWEEN TERMINALS 11 AND 17 WHEN FIELD CWP1 IS INSTALLED.
- TERMINALS 13 & 14 OF TR5 ARE FOR FIELD EXTERNAL CONNECTIONS FOR REMOTE ON-OFF. THE CONTACTS MUST BE RATED FOR DRY CIRCUIT APPLICATION CAPABLE OF HANDLING A 24VAC LOAD UP TO 50MA.

LEGEND:

- ALM R - ALARM RELAY (24V) 5 VA MAX
- AWG - AMERICAN WIRE GAUGE
- CWP - CHILLED WATER PUMP
- CWP1 - CHILLED WATER PUMP INTERLOCK
- EMM - ENERGY MANAGEMENT MODULE
- LVT - LOW VOLTAGE TERMINAL STRIP
- SPT - SPACE TEMPERATURE

- FIELD POWER WIRING
- FIELD CONTROL WIRING
- FACTORY INSTALLED WIRING
- FACTORY INSTALLED OPTION

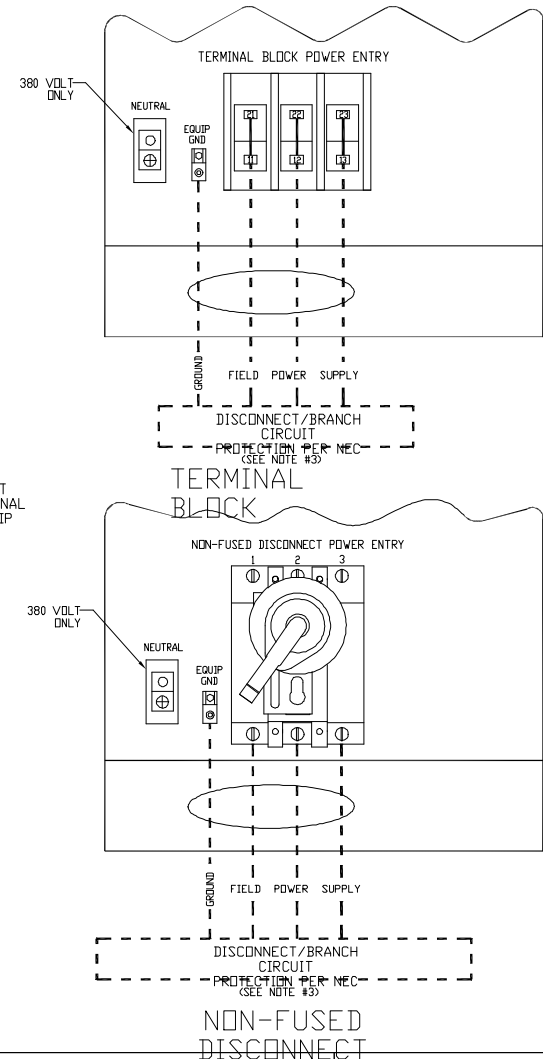


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DATE	SUPERCEDES	30RAP010-150 ELECTRICAL	30RA555560	REV
11/04/11	03/07/11			D

Detailed Performance Summary For ACCH-1

Project: DC Station 2
Prepared By:

03/16/2018
02:38PM



AquaSnap™ Air-Cooled Scroll Chiller



Unit Information

Tag Name: **ACCH-1**
Model Number: **30RAP035**
Condenser Type: **Air Cooled**
Compressor Type: **Scroll**
Nameplate Voltage: **208/230-3-60** V-Ph-Hz
Quantity: **1**
Manufacturing Source: **Charlotte, NC USA**
ASHRAE 90.1: **2013/2016, 2010, 2007**
Refrigerant: **R-410A**
Capacity Control Steps: **5**
Minimum Capacity: **8.56** %
Shipping Weight: **3055** lb
Operating Weight: **2850** lb
Refrigerant Weight (Circuit A): **16** lb
Refrigerant Weight (Circuit B): **16** lb
Unit Length: **89** in
Unit Width: **93** in
Unit Height: **67** in
Minimum Outdoor Operating Temp: **32.0** °F
Chiller Pressure Drop*: **16.4** ft H₂O

*Use Chiller Pressure Drop for sizing pumps. This value includes losses due to chiller piping, fittings, 40 mesh factory supplied strainer and BPHX.

Fluid Flow Min: **41.00** gpm
Fluid Flow Max: **164.0** gpm
*Refer to Chiller Pressure Drop for sizing pumps.
Evaporator Pressure Drop*: **5.93** ft H₂O
*Refer to Chiller Pressure Drop for sizing pumps.

Condenser Information

Altitude: **0.000** ft
Number of Fans: **3**
Total Condenser Fan Air Flow: **29,600** CFM
Entering Air Temperature: **95.0** °F

Performance Information

Cooling Capacity: **34.85** Tons
Total Compressor Power: **35.71** kW
Total Fan Motor Power: **3.827** kW
Pump Power: **3.441** kW
Total Unit Power (without pump): **39.54** kW
Total Unit Power (with pump): **42.98** kW
Efficiency (without pump) (EER): **10.58** BTU/Wh

Evaporator Information

Fluid Type: **Fresh Water**
Fouling Factor: **0.000100** (hr-sqft-F)/BTU
Leaving Temperature: **44.00** °F
Entering Temperature: **54.00** °F
Fluid Flow: **83.34** gpm

Detailed Performance Summary For ACCH-1

Project: DC Station 2
Prepared By:

03/16/2018
02:38PM

Accessories and Installed Options

Evaporator Heater
Micro Channel
Low Sound
Dual Pump, 5 HP High Head
Hot Gas Bypass
Single Point
Fixed Speed Condenser Fan
Vibration Isolation Package

Unit Voltage:.....**208/230-3-60** V-Ph-Hz
Connection Type:.....**Single Point**

Amps	Electrical Circuit 1	Electrical Circuit 2
MCA	178.0	---
MOCP	200.0	---
ICF	372.2	---
Rec Fuse Size	200.0	

Electrical Information

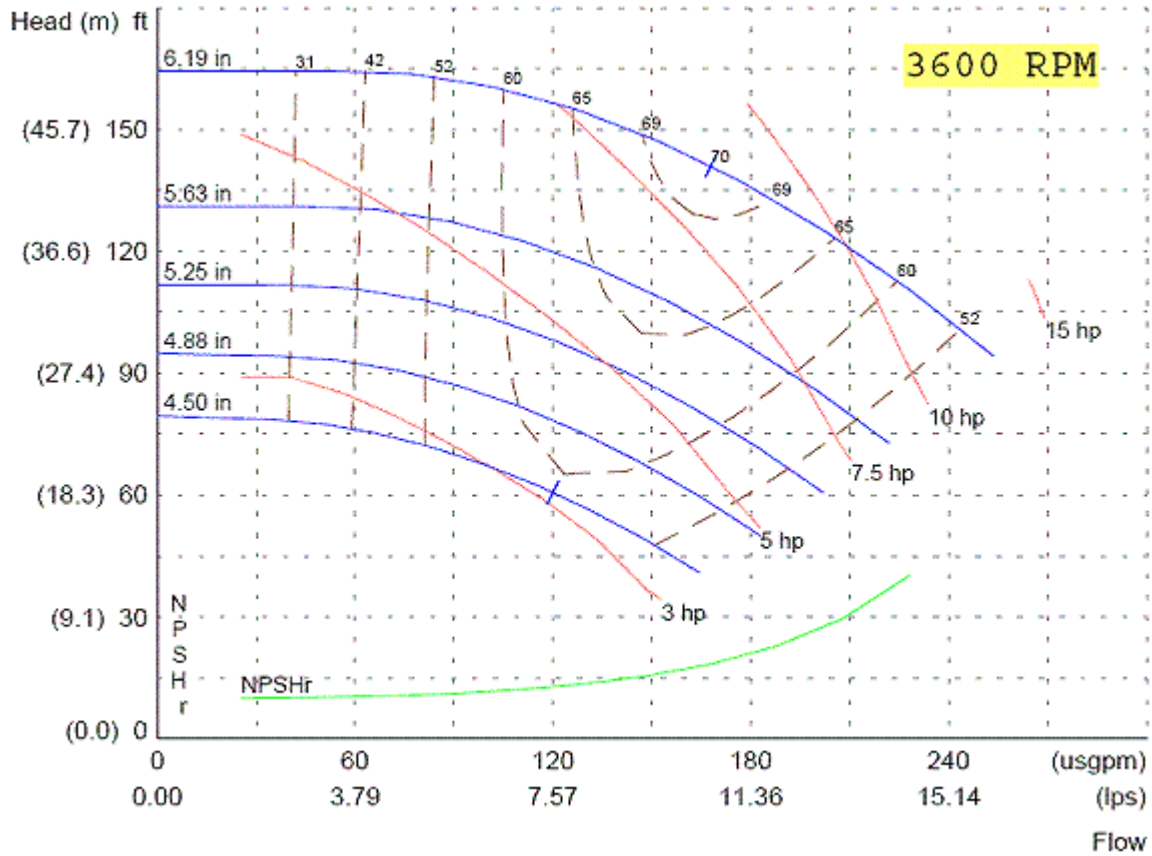
Detailed Performance Summary For ACCH-1

Project: DC Station 2
Prepared By:

03/16/2018
02:38PM

Integrated Pump Information

Dynamic Head At Pump:.....89.0 ft
Dynamic Head External To Chiller:.....72.6 ft



Detailed Performance Summary For ACCH-1

Project: DC Station 2
Prepared By:

03/16/2018
02:38PM

Integrated Part Load Value (AHLI)

IPLV:.....15.18 BTU/Wh

Unit Performance				
Percent of Full Load Capacity, %	100.00	75.00	50.00	25.00
Percent of Full Load Power, %	100.00	55.77	31.68	20.03
Unloading Sequence	A	A	A	A
Cooling Capacity, Tons	34.85	26.14	17.43	8.713
Total Unit Power, kW	39.54	22.05	12.52	7.918
Efficiency (EER), BTU/Wh	10.58	14.23	16.70	13.20
Evaporator Data				
Fluid Entering Temperature, °F	54.00	51.49	48.99	46.50
Fluid Leaving Temperature, °F	44.00	44.00	44.00	44.00
Fluid Flow Rate, gpm	83.34	83.34	83.34	83.34
Fouling Factor, (hr-sqft-F)/BTU	0.000100	0.000100	0.000100	0.000100
Condenser Data				
Entering Air Temperature, °F	95.0	80.0	65.0	55.0

For some 75% operating points, the efficiency may be calculated at a condenser inlet air operating temperature as much as 0.8 degrees higher.

All performance efficiency data are without pump.

An uncoated Novation condenser coil was selected for this product. This is based on an installed location with postal code 20001 and a non-corrosive localized environment.

Sound power measured in accordance with ANSI/AHRI Standard 370-2015.



Certified in accordance with the AHRI Air-Cooled Water-Chilling Packages Certification Program, which is based on AHRI Standard 550/590 (I-P) and AHRI Standard 551/591 (SI). Certified units may be found in the AHRI Directory at www.ahridirectory.org.

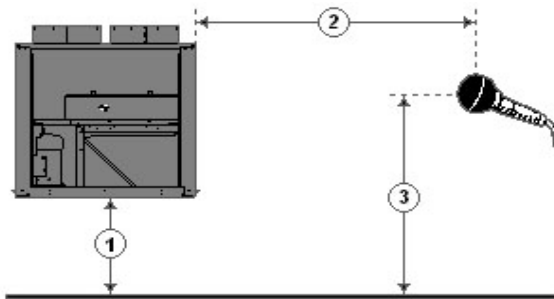
Detailed Performance Summary For ACCH-1

Project: DC Station 2
Prepared By:

03/16/2018
02:38PM

Unit Parameters

Tag Name: ACCH-1
Model Number: 30RAP035
Condenser Type: Air Cooled
Compressor Type: Scroll
Chiller Nameplate Voltage: 208/230-3-60 V-Ph-Hz
Quantity: 1
Manufacturing Source: Charlotte, NC USA
Refrigerant: R-410A
Shipping Weight: 3055 lb
Operating Weight: 2850 lb
Refrigerant Weight (Circuit A): 16 lb
Refrigerant Weight (Circuit B): 16 lb
Unit Length: 89 in
Unit Width: 93 in
Unit Height: 67 in



1 - Chiller Height Above Ground
2 - Horizontal Distance From Chiller to Receiver
3 - Receiver Height Above Ground
(See Note 3)

Accessories and Installed Options

Evaporator Heater
Micro Channel
Low Sound
Dual Pump, 5 HP High Head
Hot Gas Bypass
Single Point
Fixed Speed Condenser Fan
Vibration Isolation Package

Acoustic Information

Table 1. A-Weighted Sound Power Levels (dB re 1 picowatt). See note #1.

Octave Band Center Frequency, Hz	31	63	125	250	500	1k	2k	4k	8k	Overall
100% Load	38	61	70	78	84	84	83	79	72	90
75% Load	39	61	70	78	85	85	83	78	70	90
50% Load	37	59	68	76	83	84	82	76	68	88
25% Load	34	56	65	73	80	81	79	73	65	85

Table 2. A-Weighted Sound Pressure Levels (dB re 20 micropascals) calculated based upon user defined input for dimensions 1, 2 and 3 as shown in above diagram. See note #2 and #3.

Octave Band Center Frequency, Hz	31	63	125	250	500	1k	2k	4k	8k	Overall
100% Load	10	33	42	50	56	56	55	50	44	62
75% Load	11	33	42	50	57	57	55	50	41	62
50% Load	9	31	40	48	55	56	54	48	40	60
25% Load	6	28	37	45	52	53	51	45	37	57

Notes: (1) Measurements performed in accordance with AHRI Standard 370-2015 for air cooled Chillers.
(2) Chiller is assumed to be a point source on a reflecting plane.
(3) Without user defined input, the default dimensions used to construct Table 2 are as follows:
1 - Chiller Height Above Ground = 0.0 ft
2 - Horizontal Distance From Chiller to Receiver = 30.0 ft
3 - Receiver Height Above Ground = 3.0 ft



Chilled Water Buffer Tank

Total System Efficiency

Lochinvar Chilled Water Buffer Tanks are designed to create volume in a chilled water system when the system and associated piping can not provide the chiller with the volume required for efficient operation. To meet this criteria, Lochinvar has designed a Chilled Water Buffer Tank that is an ASME certified vessel and is available in various custom configurations and tank sizes.

Chiller manufacturers recommend a specific volume of water per ton of chiller capacity to maintain water temperature stability. These recommendations range from 3 to 5 gallons of system volume per ton of chiller capacity when used in a comfort cooling application to system volumes of 6 to 10 gallons per ton when used in a process cooling application where temperature stability is critical.

Selecting the right tank is easy. After determining how much additional volume the tank will provide, select the size and configuration of the system connections that will best connect the tank to the chilled water system.

Outstanding Features:

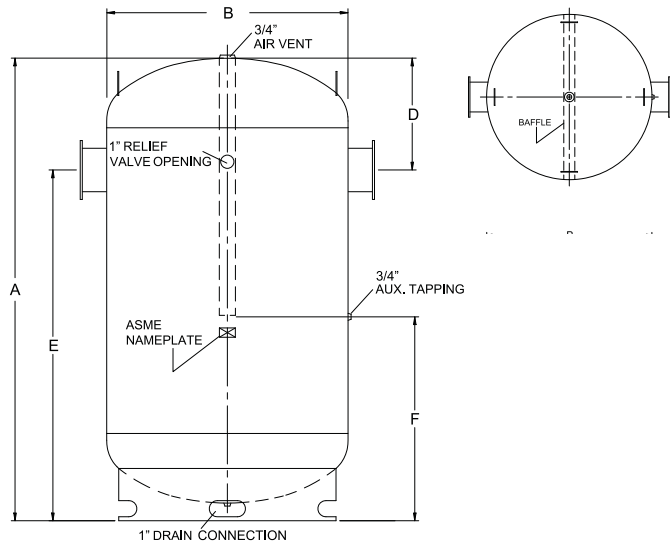
- **Vertical Internal Baffle to encourage proper mixing of fluid**
- **125 PSI Working Pressure**
- **ASME Sec VIII, U-Stamped Vessel**
- **Five Year Limited Warranty**
- **Flanged Connections**
- **Lifting Lugs**
- **Red Oxide Paint**

Optional Equipment:

- **“R-12” Spray Foam insulation with UV Resistant Exterior**
- **12” x 16” Manway (300 and above)**
- **4” x 6” Hand Hole**
- **Automatic Air Vent**
- **Temperature and Pressure Gauge**



Chilled Water Buffer Tank w/Upper Connections

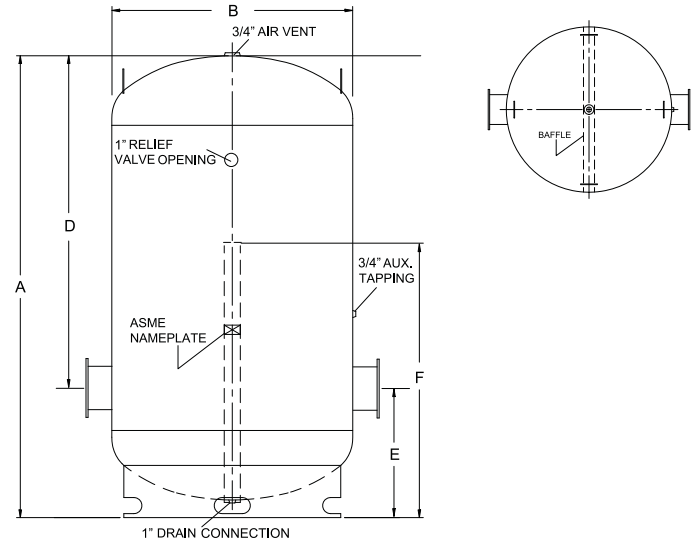


Model Number	Gallon Capacity	A	B	D	E	F	Max. Connection Diameter*	Weight (lbs.)
CVU120	120	56"	28"	20"	36"	19"	6"	298
CVU200	200	86"	28"	20"	66"	29"	6"	430
CVU300	300	76"	36"	23"	53"	25"	8"	533
CVU400	400	76"	42"	25"	52"	25"	8"	818
CVU500	500	87"	42"	25"	62"	29"	8"	930
CVU750	750	100"	48"	27"	73"	33"	8"	1430
CVU1000	1000	124"	48"	27"	97"	41"	8"	1733

Notes: * For Larger Sizes Consult Factory

Custom Sizes and Configurations are Available. Consult Factory for details

Chilled Water Buffer Tank w/Lower Connections



Model Number	Gallon Capacity	A	B	D	E	F	Max. Connection Diameter*	Weight (lbs.)
CVL120	120	56"	28"	32"	24"	37"	6"	298
CVL200	200	86"	28"	62"	24"	57"	6"	430
CVL300	300	76"	36"	49"	27"	50"	8"	533
CVL400	400	76"	42"	48"	29"	50"	8"	818
CVL500	500	87"	42"	58"	29"	58"	8"	930
CVL750	750	100"	48"	69"	31"	66"	8"	1430
CVL1000	1000	124"	48"	93"	31"	82"	8"	1733

Notes: * For Larger Sizes Consult Factory

Custom Sizes and Configurations are Available. Consult Factory for details

When ordering it is necessary to specify a water connection size and type.

Buffer Tank Sizing Formula:

$$\text{Buffer Tank Size} = (\text{Required System Volume}) - (\text{Actual System Volume})$$



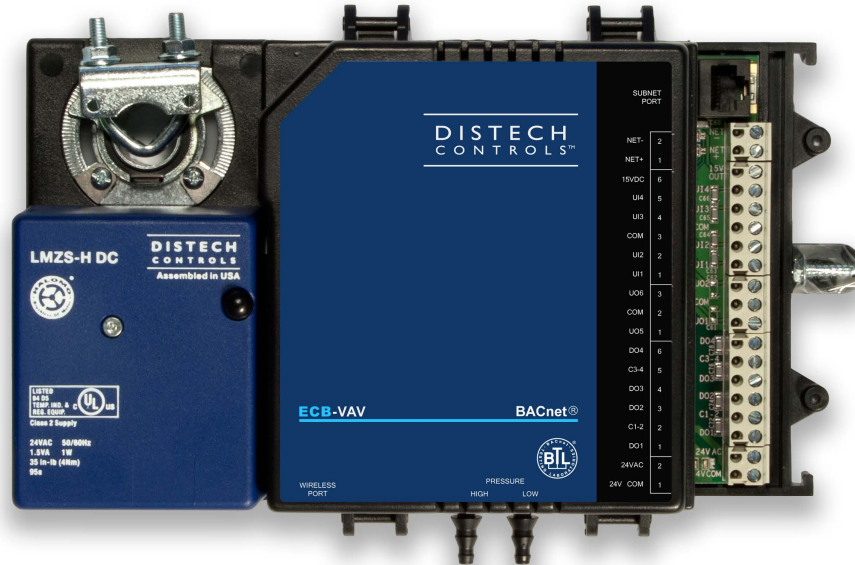
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Lebanon, Tennessee 37090
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ECB-VAV Series

BACnet B-ASC Single Duct VAV / VVT Controllers



Overview

The ECB-VAV Series controllers are microprocessor-based programmable variable air volume (VAV) controllers designed to control any variable air volume box. Each controller uses the BACnet® MS/TP LAN communication protocol and is BTL®-Listed as BACnet Application Specific Controllers (B-ASC).



Applications

These controllers meet the requirements of the following applications:

- ☐ Cooling Only VAV Boxes
- ☐ Cooling with Reheat VAV Boxes
- ☐ Parallel Fan VAV Boxes
- ☐ Series Fan VAV Boxes
- ☐ Dual-Duct VAV Systems

Features & Benefits

Flexible Inputs and Outputs

This controller has various input types including resistance, voltage, and digital-based ones. Moreover, it provides digital, floating, pulse width modulation, and proportional control outputs for valves, heating elements, fans, and lighting applications. This controller covers all industry-standard HVAC unitary applications.

Highly Accurate Universal Inputs

Highly accurate universal inputs support thermistors and resistance temperature detectors (RTDs) that range from 0 Ohms to 350,000 Ohms, as well as support for inputs requiring 0 to 10VDC or 0 to 20mA with an external resistor. This provides the freedom of using your preferred or engineer-specified sensors, in addition to any existing ones.

Rugged Inputs/Outputs

Rugged hardware inputs and outputs eliminate need for external protection components, such as diodes for 12V DC relays.

Preloaded Applications

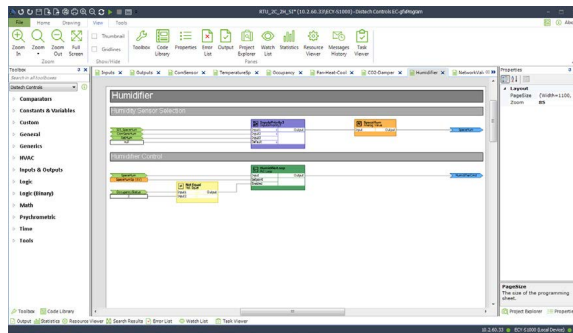
Factory preloaded applications allow these controllers, straight out of the box, to operate standard VAV equipment with a proven energy-efficient sequence of operation thereby eliminating the need for programming. The preloaded application can be selected using an Allure EC-Smart-View sensor even before the network has been installed for rapid deployment or through the EC-Net^{AX}™ solution using Distech Controls' *dcgfx* Applications.

Integrated VPACC

Integrated VAV Performance Assessment Control Charts (VPACC) control sequences, provides a means of automatically detecting when the VAV is operating outside of its design parameters including: Persistent High/Low Space Temperature, Persistent High/Low Discharge Temperature, Persistent High/Low Air Flow, and Unstable Air Flow.

Programmability

Supports Distech Controls' *EC-gfx* Program, which makes Building Automation System (BAS) programming effortless by allowing you to visually assemble building blocks together to create a custom control sequence for any HVAC / building automation application.



Increased Energy Efficiency

Improves energy efficiency when combined with:

- ☐ Motion detectors to automatically adjust a zone's occupancy mode from standby to occupied when presence is detected
- ☐ CO₂ sensors as part of a demand-controlled ventilation strategy that adjusts the amount of fresh air intake according to the number of building occupants
- ☐ Light switches to control both lighting and a room's HVAC occupancy / standby mode setting

On-Board Air Flow Sensor

The controllers (except for the VVTS model) are equipped with an accurate on-board air flow sensor for precise air flow monitoring and control at low and high air flow rates, allowing the design for maximum energy efficiency while maintaining an optimal comfort level

The on-board air flow sensor has a range of 0 to 2 inches of water column (500 Pascal).

Built-in Actuator

A built-in actuator with a brushless motor and integrated position feedback system eliminates periodic damper re-initialization and ensures worry-free operation, providing increased occupant comfort and extended service life (except VAV-N models).

The built-in actuator for precise damper positioning used for loads requiring up to 35 inch-pounds (4 Newton-meters) of torque.

Optimized Air Balancing

Optimized air balancing process saves time during commissioning: the flow sensor requires no zero flow calibration, and its variable-speed motor goes to minimum and maximum flow position in half the time of typical VAV actuators.

Smart Room Control Support

The Smart Room Control solution is an end-to-end system for the control of HVAC equipment, lighting, and shades/sunblinds, achieving the highest levels of comfort for occupants while cutting costs from installation time and wiring/material requirements to energy consumption. This solution combines:

- ☐ Lighting and shade/sunblind expansion modules to control lights (DALI, on/off or dimming) and shades/sunblinds (up/down and angle rotation).
- ☐ Multi-sensor combining motion and luminosity (Lux) sensors and equipped with an Infrared receiver that works with a convenient remote control.
- ☐ Wireless (infrared) personal remote control for increased occupant comfort.
- ☐ Allure™ Series Communicating Sensors for increased occupant comfort settings.

Open-to-Wireless™ Solution



The controllers are Open-to-Wireless™ ready, and when paired with the Wireless Receiver, work with a variety of wireless battery-less sensors and switches, to reduce the cost of installation and minimize the impact on existing partition walls. For supported frequencies in your area, refer to the [Open-to-Wireless Solution Guide](#).

Available with an optional Wireless Receiver that supports up to 18 wireless inputs to create wire-free installations.

Allure™ Series Communicating Sensor Support

These controllers work with a wide range of sensors, such as the Allure Series Communicating Sensors that are designed to provide intelligent sensing and control devices for increased user experience and energy efficiency.

- Allure EC-Smart-View sensors feature a backlit-display and graphical menus that provide precise environmental zone control, with any combination of the following: temperature, humidity, CO₂, and motion sensor.
- Allure EC-Smart-Comfort sensors feature colored LED indicators to provide user feedback, rotary knobs to adjust the setpoint offset and fan speed, and an occupancy override push button. This sensor can also be expanded with a combination of up to 4 add-on push button modules for lighting and shade/ sunblind control.
- Allure EC-Smart-Air sensors combine precise environmental sensing in a discreet and alluring enclosure for temperature, humidity, and CO₂.



UUKL Smoke Control System

The Distech Controls UUKL Smoke Control System is designed to protect occupants and buildings in the event of a building fire by maintaining tenable evacuation routes and containing smoke within the fire area. It is a unique NiagaraAX-based system that complies with the Underwriters Laboratories Inc® (UL) requirements for UL 864 UUKL 9th Edition Smoke Control Listing.

For detailed specifications, requirements, and procedures for installing, wiring, and operating UUKL Listed equipment, refer to the Distech Controls UUKL Listed documentation on Smart-Source: Smoke Control Design Guide (05DI-UGULDES-10) and the Smoke Control Application Guide (05DI-UGULAPP-10).

Supported Platforms



EC-Net^{AX} Solution







The EC-Net^{AX} multi-protocol integration solution is web-enabled and powered by the Niagara^{AX} Framework, establishing a fully Internet-enabled, distributed architecture for real-time access, automation and control of devices. The EC-Net^{AX} open framework solution creates a common development and management environment for integration of LONWORKS®, BACnet® and other protocols. Regardless of manufacturer and protocol, the EC-Net^{AX} system provides a unified modeling of diverse systems and data, providing one common platform for development, management and enterprise applications.

VAV Terminal Block Cover

A cover designed to conceal the wire terminals. Required to meet local safety regulations in certain jurisdictions.



Model Selection

						
Model	ECB-VAVS-O	ECB-VAVS	ECB-VAV	ECB-VVTS	ECB-VAV-N	ECB-VAV-UUKL
Points	5-Point VAV	7-Point VAV	12-Point VAV	6-Point VAV	11-Point VAV	12-Point VAV
Universal hardware inputs	0	2	4	2	4	4
Built-in flow sensor	■	■	■		■	■
Wireless inputs ¹	18	18	18	18	18	18
15 Vdc Power Supply			■		■	■
Digital (Triac) outputs	2	2	4	2	4	4
Universal outputs	1	1	2	1	2	2
Built-in actuator	■	■	■	■		■
UL 864, 9th Edition, UUKL Listed Smoke Control Equipment ²						■
California State Fire Marshal Listed						■

1. All controllers are Open-to-Wireless ready. Available when an optional Wireless Receiver is connected to the controller. Some wireless sensors may use more than one wireless input from the controller.
2. The UL 864 UUKL Listed Smoke Control Equipment is used only in Distech Controls' UUKL smoke control system. For detailed specifications, requirements and procedures for installing and operating UUKL Listed equipment refer to the Distech Controls' UUKL Smoke Control documentation on SmartSource.

Recommended Applications

Model	ECB-VAVS-O	ECB-VAVS	ECB-VAV	ECB-WTS	ECB-VAV-N	ECB-VAV-UUKL
Cooling Only VAV Box	■	■		■		■
Cooling w/ Reheat VAV Box	■	■		■		■
Cooling w/ Reheat VAV Box & Perimeter Heating			■			■
Parallel Fan VAV Box			■			■
Series Fan VAV Box			■			■
Dual Duct VAV Box ^{1,3}	■	■				■
Large Damper VAV Box ²					■	■
Existing Damper Actuator					■	■
Room Pressurization			■			■
Smart Room Control support for HVAC, light, and shades/sunblinds			■			■
Exhaust fan						■

1. Two controllers are required or one controller with an external flow sensor and actuator.

2. Requiring more than 35 in-lb (4 Nm) actuator torque.

3. This configuration is not supported by factory preloaded applications. Programming is required.

BACnet Objects List

BACnet Objects List	
BACnet Calendar Objects	1
□ Events per calendar	50
BACnet Schedule Objects	2
□ Special events per schedule	5
BACnet PID Loop Objects	8
BACnet BV Objects:	
□ Commandable	10
□ Non-Commandable	40
BACnet MSV Objects:	
□ Commandable	10
□ Non-Commandable	40
BACnet AV Objects:	
□ Commandable	25
□ Non-Commandable	75

Product Specifications

Power Supply Input

Voltage Range	24VAC/DC; $\pm 15\%$; Class 2
Frequency Range	50/60Hz
Overcurrent Protection	Field replaceable fuse
Fuse Type	2.0A
	3.0A (for triacs when using the internal power supply)
Power Consumption	10 VA typical plus all external loads ¹ , 85 VA max. (including powered triac outputs)

1. External loads must include the power consumption of any connected modules such as an Allure Series Communicating Sensor. Refer to the respective module's datasheet for related power consumption information.

Communications

Communication Bus	BACnet MS/TP
BACnet Profile	B-ASC ¹
EOL Resistor	Built-in, jumper selectable
Baud Rates	9600, 19 200, 38 400, or 76 800 bps
Addressing	Dip switch or Configurable with the Allure Series Communicating Sensors

1. Refer to Distech Controls' Protocol Implementation Conformity Statement for BACnet.

Hardware

Processor	STM32 (ARM Cortex™ M3) MCU, 32 bit
CPU Speed	68 MHz
Memory	384 kB Non-volatile Flash (applications)
	1 MB Non-volatile Flash (storage)
	64 kB RAM
Real Time Clock (RTC)	Built-in Real Time Clock without battery
	Network time synchronization is required at each power-up cycle before the RTC become available
Status Indicator	Green LEDs: power status & LAN Tx
	Orange LEDs: controller status & LAN Rx

Subnetwork

Communication	RS-485
Cable	Cat 5e, 8 conductor twisted pair
Connector	RJ-45
Connection Topology	Daisy-chain Configuration
Maximum number of supported devices per controller combined	4 ¹
<input type="checkbox"/> Allure EC-Smart-Vue Series	Up to 4
<input type="checkbox"/> Allure EC-Smart-Comfort Series (not supported by UUKL)	Up to 4
<input type="checkbox"/> Allure EC-Smart-Air Series (not supported by UUKL)	Up to 4
<input type="checkbox"/> For the ECB-VAV Model Only ² :	
– EC-Multi Sensor	Up to 4
– ECx-Light-4 / ECx-Light-4D	Up to 2
– ECx-Blind-4 / ECx-Blind-4LV	Up to 2

1. A controller can support a maximum of two Allure Series Communicating Sensor models equipped with a CO₂ sensor. The remaining connected Allure Series Communicating Sensor models must be without a CO₂ sensor.

2. For supported quantities, see the [VAV-Smart Room Control Device Calculator.xlsm](#) spreadsheet file available for download from SmartSource.

Wireless Receiver¹

Communication Protocol _____ EnOcean wireless standard

Number of Wireless Inputs² _____ 18

Supported Wireless Receivers _____ Refer to the Open-to-Wireless Solution Guide

Cable _____ Telephone cord

☐ Connector _____ 4P4C modular jack

☐ Length (maximum) _____ 6.5ft; 2m



1. Available when an optional external Wireless Receiver module is connected to the controller. Refer to the Open-to-Wireless Solution Guide for a list of supported EnOcean wireless modules.

2. Some wireless modules may use more than one wireless input from the controller.

Integrated Damper Actuator

Motor _____ Belimo LMZS-H brushless DC motor

Torque _____ 35 in-lb, 4 Nm

Degrees of Rotation _____ 95° adjustable

Fits Shaft Diameter _____ 5/16 to 3/4"; 8.5 to 18.2mm

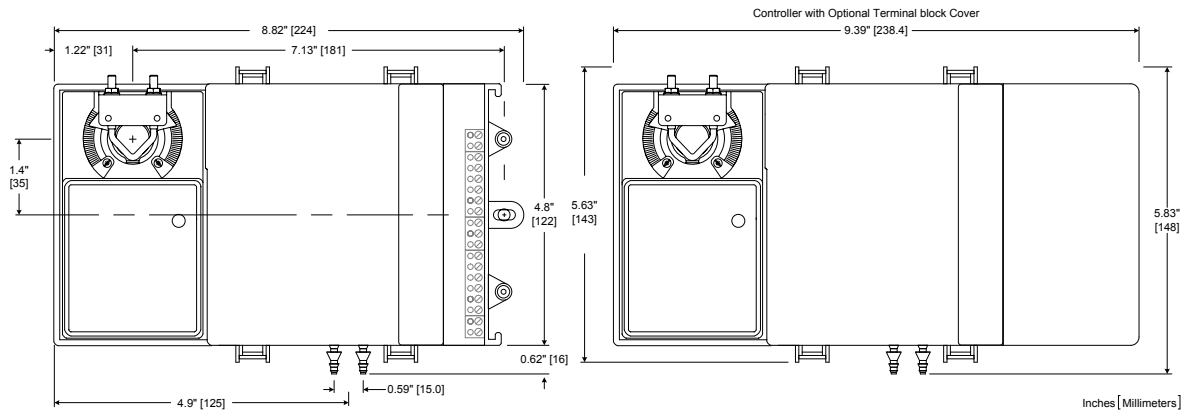
Acoustic Noise Level _____ < 35 dB (A) @ 95° rotation in 95 seconds

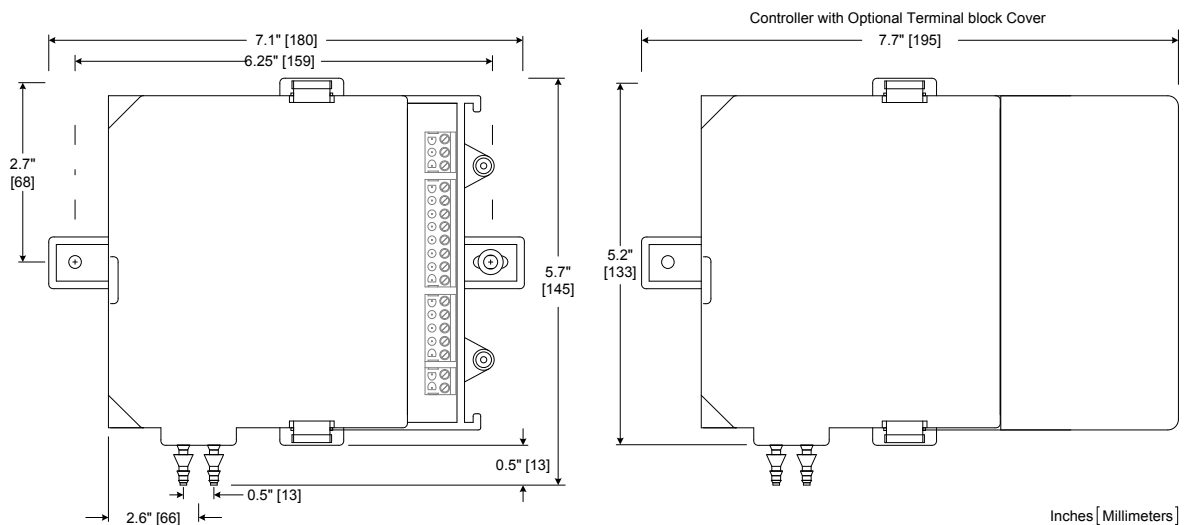
Mechanical

Dimensions (H × W × D):

☐ ECB-VAV-N _____ 145 × 180 × 54.0mm (5.7 × 7.1 × 2.13")

☐ Other Models _____ 5.83 × 8.82 × 2.56" (148 × 224 × 65.0mm)





Shipping Weight:

- ☐ ECB-VAV-N _____ 0.92lbs (0.42kg)
- ☐ Other Models _____ 2.03lbs (1.05kg)

Enclosure Material¹ _____ FR/ABS

Enclosure Rating _____ Plastic housing, UL94-5VB flammability rating
Plenum rating per UL1995

Color _____ Black & blue casing & grey connectors

1. All materials and manufacturing processes comply with the RoHS directive and are marked according to the Waste Electrical and Electronic Equipment (WEEE) directive

Environmental

Operating Temperature _____ 32°F to 122°F; 0°C to 50°C

Storage Temperature _____ -4°F to 122°F; -20°C to 50°C

Relative Humidity _____ 0 to 90% Non-condensing

Standards and Regulations

CE:

- ☐ Emission _____ EN61000-6-3: 2007; A1:2011; Generic standards for residential, commercial and light-industrial environments
- ☐ Immunity _____ EN61000-6-1: 2007; Generic standards for residential, commercial and light-industrial environments

FCC _____ This device complies with FCC rules part 15, subpart B, class B

UL Listed (CDN & US) _____ UL916 Energy management equipment

UL 864 _____ UL 864, 9th Edition, UUKL Listed Smoke Control Equipment
(ECB-VAV UUKL model only)¹

California State Fire Marshal Listing _____ CSFM: 7300-2187:0100
(ECB-VAV UUKL model only)¹

CEC Appliance Database _____ Appliance Efficiency Program²

1. For detailed specifications regarding the ECB-VAV UUKL model, refer to the Distech Controls UUKL Smoke Control Design Guide.

2. California Energy Commission's Appliance Efficiency Program: The manufacturer has certified this product to the California Energy Commission in accordance with California law.



Specifications - On-Board Air Flow Sensor

Range ————— 0-2.0 in. W.C. (0-500 Pa)
Input Resolution ————— 0.00007 in. W.C. (0.0167 Pa)
Air Flow Accuracy ————— $\pm 4.0\%$ @ > 0.05 in. W.C. (12.5 Pa)
————— $\pm 1.5\%$ once calibrated through air flow balancing @ > 0.05 in. W.C. (12.5 Pa)

Specifications - Universal Inputs (UI)

General

Input Type ————— Universal; software configurable
Input Resolution ————— 16-bit analog / digital converter
Power Supply Output ————— 15VDC; maximum 80mA

Contact

Type ————— Dry contact

Counter

Type ————— Dry contact
Maximum Frequency ————— 1Hz maximum,
Minimum Duty Cycle ————— 500milliseconds On / 500milliseconds Off

0 to 10VDC

Range ————— 0 to 10VDC (40k Ω input impedance)

0 to 5VDC

Range ————— 0 to 5VDC (high input impedance)

0 to 20mA

Range ————— 0 to 20mA
————— 249 Ω external resistor wired in parallel

Resistance/Thermistor

Range ————— 0 to 350 K Ω
Supported Thermistor Types ————— Any that operate in this range

Pre-configured Temperature Sensor Types:

- ☐ Thermistor ————— 10K Ω Type 2, 3 (10K Ω @ 77°F; 25°C)
- ☐ Platinum ————— Pt1000 (1K Ω @ 32°F; 0°C)
- ☐ Nickel ————— RTD Ni1000 (1K Ω @ 32°F; 0°C)
————— RTD Ni1000 (1K Ω @ 69.8°F; 21°C)

Specifications - Universal Outputs (UO)

General

Output Type	Universal; software configurable
Output Resolution	10-bit digital to analog Converter
Output Protection	Built-in snubbing diode to protect against back-EMF, for example when used with a 12VDC relay Output is internally protected against short circuits
Load Resistance	Minimum 600 Ω for 0-10VDC and 0-12VDC outputs Maximum 500 Ω for 0-20mA output
Auto-reset fuse	Provides 24VAC over voltage protection

0 or 12VDC (On/Off)

Range	0 or 12VDC
Source Current	Maximum 20 mA at 12VDC (minimum load resistance 600 Ω) ¹

1. Relays equipped with coil that consume between 20 and 35mA can be used with up to 2 Universal Outputs when the 15V Power Supply Output is de-rated to supply 50mA maximum current.

PWM

Range	Adjustable period from 2 to 65seconds
Thermal Actuator Management	Adjustable warm up and cool down time

Floating

Minimum Pulse On/Off Time	500milliseconds
Drive Time Period	Adjustable

0 to 10VDC

Voltage Range	0 to 10VDC linear
Source Current	Maximum 20 mA at 10VDC (minimum load resistance 600 Ω)

Specifications - Digital Output (DO)

General

Output Type ————— 24VAC Triac; software configurable

Maximum Current per Output ————— 0.5A continuous

————— 1A @ 15% duty cycle for a 10-minute period

Power Source ————— External or internal power supply (jumper selectable)

0 or 24VAC (On/Off)

Range ————— 0 or 24VAC

PWM

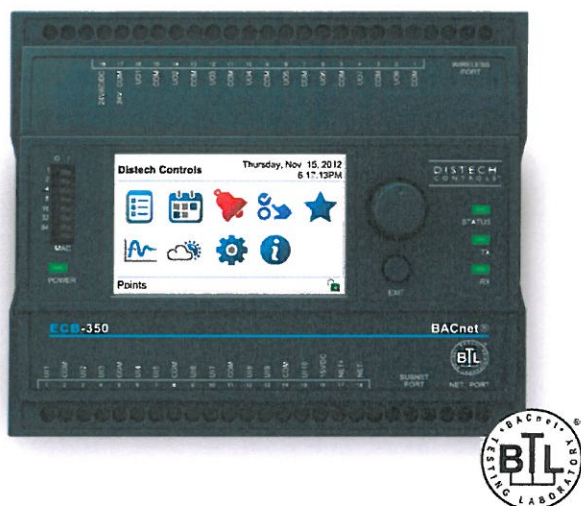
Range ————— Adjustable period from 2 to 65seconds

Floating

Minimum Pulse On/Off Time ————— 500milliseconds

Drive Time Period ————— Adjustable

Power Source ————— External or internal power supply (jumper selectable)



Overview

The **ECB-300 Series** are microprocessor-based programmable controllers designed to control equipment such as air handling units, chillers, boilers, pumps, and cooling towers. The ECB-300 can also be used for lighting control and power measurement applications. This controller uses the BACnet® MS/TP LAN communication protocol and is BTL®-Listed as BACnet Advanced Application Controllers (B-AAC).

This series contains two models as follows: ECB-300 and ECB-350. The ECB-300 series models have universal inputs and outputs that are ideal for controlling a wide range of HVAC equipment. The ECB-350 model has a full-color backlit-display and a jog dial for turn and select navigation to access a wide range of internal controller functions: view, edit, and override values, tune PID loops with system response graphing, view schedule status, and acknowledge alarms.

These controllers work with a wide range of sensors, such as those in the Allure™ EC-Smart-Vue series of communicating room sensors that feature a backlit-display and graphical menus. These sensors are used for indoor temperature measurement, setpoint adjustment, fan speed selection, and occupancy state override. In addition, this controller is Open-to-Wireless™ ready, and when paired with the Wireless Receiver, it works with a variety of wireless battery-less sensors and switches.

Custom program this controller using EC-gfxProgram through EC-Net^{AX} Pro which is powered by the Niagara^{AX} Framework®. This allows you to quickly and easily create your own control sequences capable of meeting the most demanding requirements of any engineering specification.

Applications

- Meets the requirements of the following applications:
 - Air Handling Units
 - Chillers
 - Boilers
 - Cooling Towers
 - Heat-Exchangers
 - Pumps
 - Lighting Control
- Improves energy efficiency when combined with:
 - CO₂ sensors as part of a demand-controlled ventilation strategy that adjusts the amount of fresh air intake according to the number of building occupants
 - Variable-frequency drives to adjust motor speed according to the instantaneous demand of the application
- Works with a wide range of wireless battery-less sensors

Features & Benefits

- Use the EC-gfxProgram's state-of-the-art visual programming wizard to customize controller operation to meet specific engineering requirements. EC-gfxProgram is accessible through EC-Net^{AX} Pro which is powered by the Niagara^{AX} Framework-based management platform.
- Accelerate custom programming development by using pre-built HVAC control sequences supplied with EC-gfxProgram.
- Available with an optional Wireless Receiver that supports up to 28 wireless inputs, letting you create wire-free installations and use various wireless battery-less sensors and switches.
- BTL B-AAC-listed, guaranteeing interoperability with other manufacturers' BTL listed controllers.
- With 10 software configurable universal inputs and 8 software configurable universal outputs, this controller covers all small to medium-size industry-standard HVAC applications. Four of these inputs also support fast pulse count reading up to 50 Hz frequency for gas, water, and electric meters.
- 0-20mA inputs and outputs have a jumper that eliminates the need for external resistors.
- Highly accurate universal inputs support thermistors and resistance temperature detectors (RTDs) that range from 0 Ohms to 350 000 Ohms, giving you the freedom of using your preferred or engineer-specified sensors, in addition to any existing ones.
- Rugged hardware inputs and outputs eliminate need for external protection components, such as diodes for 12V DC relays.

ECB-300 Series Controllers



Model	ECB-300	ECB-350
Points	18-Point Controller	18-Point Controller with Color Display
Universal hardware inputs	10 ¹	10 ¹
Allure EC-Smart-Vue sensor ²	12	12
Wireless inputs ³	28	28
15 Vdc Power Supply	■	■
Universal outputs	8	8
Operator interface: interactive color display to monitor and override controller parameters		■

1. The first four inputs are software configurable for pulse counting up to 50 Hz and are compatible with an S0 rated (optically-isolated) output.
2. A controller can support a maximum of two Allure EC-Smart-Vue models equipped with a CO₂ sensor. The remaining connected Allure EC-Smart-Vue models must be without a CO₂ sensor.
3. All controllers are Open-to-Wireless ready. Available when an optional Wireless Receiver is connected to the controller. Some wireless sensors may use more than one wireless input from the controller.

Recommended Applications

Model	ECB-300	ECB-350
Air Handling Unit	■	■
Chiller	■	■
Boiler	■	■
Cooling Tower	■	■
Pumps	■	■

BACnet Objects List

BACnet Calendar Objects	2
BACnet Schedule Objects	10
BACnet PID Loop Objects	40
BACnet Input Objects (AI, BI, MSI) ¹	62 ²
BACnet Output Objects (AO, BO) ¹	8 ³
BACnet BV Objects	
- Commandable ¹	15
- Non-Commandable	60
BACnet MSV Objects	
- Commandable ¹	15
- Non-Commandable	60
BACnet AV Objects	
- Commandable ¹	35
- Non-Commandable	100
BACnet Alarm Notification Classes	5

1. Supports object internally-generated alarms (intrinsic reporting).
2. This consists of Hardware Inputs, Allure EC-Smart-Vue inputs, and Open-To-Wireless inputs.
3. This consists of Hardware Outputs.

Additional Features & Benefits for the ECB-350 Model



The ECB-350 has a large color backlit-display that allows an operator to have immediate access to internal controller data.

- View, edit, and override values. The status is color coded to show if the value is in alarm or overridden.
- Visually tune PID loops with system response graphing.
- View active alarm list including details and acknowledge alarms.
- View schedule status.
- Create a list of favorites to provide quick access to commonly-used values.
- Multi-User access management.
- Multilingual interface: English, French, German, etc.

Open-to-Wireless Series – Controller Wireless Receiver Add-on



To reduce the cost of installation, and minimize the impact on existing partition walls, the Wireless Receiver enables these controllers to communicate with a line of wireless battery-less room sensors and switches. These Wireless Receivers are available in EnOcean 315MHz and 868.3MHz versions.

Note that controllers have one wireless port to support a single Wireless Receiver.

For more information about the EnOcean and Open-to-Wireless technologies, refer to the Open-to-Wireless Solution Guide. For more information about the Wireless Receiver module, refer to the [Wireless Receiver Datasheet](#). These documents can be found on our web site.

Supported Platforms

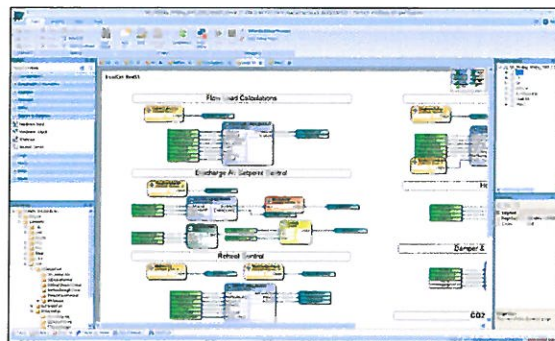


EC-Net^{AX} Solution

The EC-Net^{AX} multi-protocol integration solution is web-enabled and powered by the Niagara^{AX} Framework, establishing a fully Internet-enabled, distributed architecture for real-time access, automation and control of devices. The EC-Net^{AX} open framework solution creates a common development and management environment for integration of LONWORKS®, BACnet® and other protocols. Regardless of manufacturer and protocol, the EC-Net^{AX} system provides a unified modeling of diverse systems and data, providing one common platform for development, management and enterprise applications.

EC-Net^{AX} Wizards

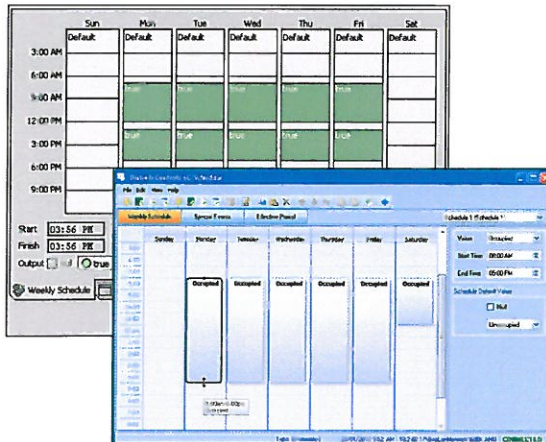
EC-gfxProgram Graphical Programming Interface (GPI)



Distech Controls' EC-gfxProgram is a programming tool that allows you to quickly create control sequences by "dragging and dropping" block objects and then linking the objects with a simple "click, select and release". Select objects from an extensive library of over 100 commonly used functions as well as create your own custom blocks. With a user-friendly interface and intuitive programming environment, HVAC programming could not be easier. Refer to the EC-gfxProgram datasheet for more information.

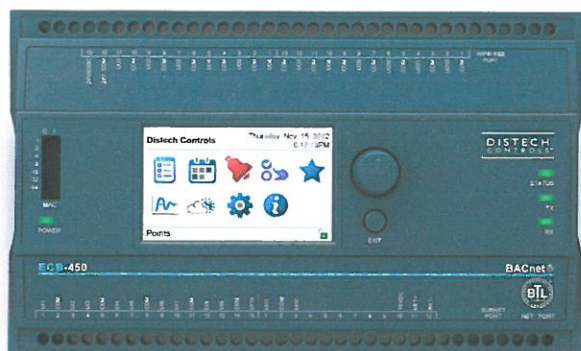
- Program both ECP and ECL Series LONWORKS and ECB Series BACnet controllers with the same tool.
- Supplied as freeware – there are no associated licensing costs.
- Live debugging allows user to view code execution, input/output values and to detect errors in real-time.
- A code library for managing your favorite or most commonly used code or code sections.

EC-Net^{AX} Scheduling / EC-gfxProgram EC-Schedule



Configure the controller's built-in schedules and holidays from the EC-Net^{AX} solution (ECB and ECL series controllers), or directly from within EC-gfxProgram (ECB and ECL series controllers) with an easy-to-use point, drag, and click interface. It features a weekly schedule for regular, repeating, events by "time-of-day" and "day-of-week", while a holiday schedule is available to define events for specific days.

- Easily configure schedules using a graphical slider.
- Allows you to easily copy and paste entries. Duplicate a schedule entry for Monday to Friday.
- Special events allow you to set exceptions such as holidays to a schedule.
- Holidays can be set for recurring events such as the 9th day, or the 3rd Thursday of a given month.
- A schedule has an effective period during which it is active.
- Schedule provides Next State and Time to Next State that are ideal for use with programming functions such as Optimum Start or Morning Warm Up.



Applications

- Meets the requirements of the following applications:
 - Air Handling Units
 - Multi-Zone Applications
 - Chillers
 - Boilers
 - Cooling Towers
 - Roof Top Units
- Improves energy efficiency when combined with:
 - CO₂ sensors as part of a demand-controlled ventilation strategy that adjusts the amount of fresh air intake according to the number of building occupants
 - Variable-frequency drives to adjust motor speed according to the instantaneous demand of the application
- Works with a wide range of wireless battery-less sensors

Features & Benefits

- Use the EC-gfxProgram's state-of-the-art visual programming wizard to customize controller operation to meet specific engineering requirements. EC-gfxProgram is accessible through EC-Net^{AX} Pro which is powered by the Niagara^{AX} Framework -based management platform.
- Accelerate custom programming development by using pre-built HVAC control sequences supplied with EC-gfxProgram.
- Available with an optional Wireless Receiver that supports up to 28 wireless inputs, letting you create wire-free installations and use various wireless battery-less sensors and switches.
- BTL B-AAC-listed, guaranteeing interoperability with other manufacturers' BTL listed controllers.
- With 12 software configurable universal inputs and 12 software configurable outputs, this controller series covers all medium to large-size industry-standard HVAC applications. Four of these inputs also support fast pulse count reading up to 50 Hz frequency for gas, water, and electric meters.
- 0-20mA inputs and outputs use an internal jumper that eliminates the need for external resistors.
- Highly accurate universal inputs support thermistors and resistance temperature detectors (RTDs) that range from 0 Ohms to 350 000 Ohms, giving you the freedom of using your preferred or engineer-specified sensors, in addition to any existing ones.
- Supervised HOA switches and potentiometers, allowing you to override control actions for testing purposes or when performing equipment maintenance.
- Rugged hardware Inputs and Outputs eliminate need for external protection components, such as diodes for 12V DC relays.

Overview

The **ECB-400 Series** are microprocessor-based programmable controllers designed to control various building automation applications such as air handling units, multi-zone applications, chillers, boilers, pumps, cooling towers, and roof top units. The ECB-400 Series can also be used for lighting control applications. This controller uses the BACnet[®] MS/TP LAN communication protocol and is BTL[®]-Listed as BACnet Advanced Application Controllers (B-AAC).

This series contains six models: ECB-400, ECB-403, ECB-410, ECB-413, ECB-450, and ECB-453. These models have universal inputs and outputs that are ideal for controlling a wide range of HVAC equipment. The ECB-450 and ECB-453 models have a full-color backlit-display and a jog dial for turn and select navigation to access a wide range of internal controller functions: view, edit, and override values, tune PID loops with system response graphing, view schedule status, and acknowledge alarms.

These controllers work with a wide range of sensors, such as those in the Allure[™] EC-Smart-View series of communicating room sensors that feature a backlit-display and graphical menus. These sensors are used for indoor temperature measurement, setpoint adjustment, fan speed selection, and occupancy state override. In addition, these controllers are Open-to-Wireless[™] ready, and when paired with the Wireless Receiver, they work with a variety of wireless battery-less sensors and switches.

Custom program these controllers using EC-gfxProgram through EC-Net^{AX} Pro which is powered by the Niagara^{AX} Framework[®]. This allows you to quickly and easily create your own control sequences capable of meeting the most demanding requirements of any engineering specification.

ECB-400 Series Controllers



Model	ECB-400	ECB-403	ECB-410	ECB-413	ECB-450	ECB-453
Points	24-Point Controller	24-Point Controller	24-Point Controller with HOA	24-Point Controller with HOA	24-Point Controller with Color Display	24-Point Controller with Color Display
Universal hardware inputs	12 ¹	12 ¹	12 ¹	12 ¹	12 ¹	12 ¹
Allure EC-Smart-Vue ²	12	12	12	12	12	12
Wireless inputs ³	28	28	28	28	28	28
15 Vdc Power Supply	■	■	■	■	■	■
Digital (triac) outputs		8		8		8
Universal outputs	12	4	12	4	12	4
HOA switch & potentiometer			■	■		
Operator interface: interactive color display to monitor and override controller parameters					■	■

- The first four inputs are software configurable for pulse counting up to 50 Hz and are compatible with an S0 rated (optically-isolated) output.
- A controller can support a maximum of two Allure EC-Smart-Vue models equipped with a CO₂ sensor. The remaining connected Allure EC-Smart-Vue models must be without a CO₂ sensor.
- All controllers are Open-to-Wireless ready. Available when an optional Wireless Receiver is connected to the controller. Some wireless sensors may use more than one wireless input from the controller.

Recommended Applications

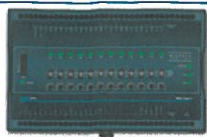
Model	ECB-400	ECB-403	ECB-410	ECB-413	ECB-450	ECB-453
Roof Top		■		■		
Air Handling Unit	■	■	■	■	■	■
Multi-zone Application	■		■		■	■
Chiller	■	■	■	■	■	■
Boiler	■	■	■	■	■	■
Cooling Tower	■	■	■	■	■	■

BACnet Objects List

Model	ECB-400	ECB-403	ECB-410	ECB-413	ECB-450	ECB-453
BACnet Calendar Objects	2	2	2	2	2	2
BACnet Schedule Objects	10	10	10	10	10	10
BACnet PID Loop Objects	30	30	30	30	30	30
BACnet Input Objects (AI, BI, MSI) ¹	64 ²	64 ²	64 ²	64 ²	64 ²	64 ²
BACnet Output Objects (AO, BO) ¹	12 ³	4 ³	12 ³	4 ³	12 ³	4 ³
BACnet BV Objects						
- Commandable ¹	20	20	20	20	20	20
- Non-Commandable	55	55	55	55	55	55
BACnet MSV Objects						
- Commandable ¹	20	20	20	20	20	20
- Non-Commandable	55	55	55	55	55	55
BACnet AV Objects						
- Commandable ¹	35	35	35	35	35	35
- Non-Commandable	115	115	115	115	115	115
BACnet Alarm Notification Classes	5	5	5	5	5	5

- Supports object internally-generated alarms (intrinsic reporting) which are dynamically instantiated upon object creation.
- This consists of Hardware Inputs, Allure EC-Smart-Vue inputs, and Open-To-Wireless inputs.
- This consists of Hardware Outputs.

Additional Features & Benefits for the ECB-410, ECB-413, ECB-450, and ECB-453 Models



The ECB-410 and ECB-413 have supervised Hand-Off-Auto (HOA) switches and potentiometers that provide feedback of an operator's manual override of an output to the controller's code. HOA switches are ideal for testing purposes or when performing equipment commissioning and maintenance.



The ECB-450 and ECB-453 have a large color backlit-display that allows an operator to have immediate access to internal controller data.

- View, edit, and override values. The status is color coded to show if the value is in alarm or overridden.
- Visually tune PID loops with system response graphing.
- View active alarm list including details and acknowledge alarms.
- View schedule status.
- Create a list of favorites to provide quick access to commonly-used values.
- Multi-User access management.
- Multilingual interface: English, French, German, etc.

Open-to-Wireless Series – Controller Wireless Receiver Add-on



To reduce the cost of installation, and minimize the impact on existing partition walls, the Wireless Receiver enables these controllers to communicate with a line of wireless battery-less room sensors and switches. These Wireless Receivers are available in EnOcean 315MHz and 868.3MHz versions.

Note that controllers have one wireless port to support a single Wireless Receiver.

For more information about the EnOcean and Open-to-Wireless technologies, refer to the Open-to-Wireless Solution Guide. For more information about the Wireless Receiver module, refer to the [Wireless Receiver Datasheet](#). These documents can be found on our web site.

Supported Platforms

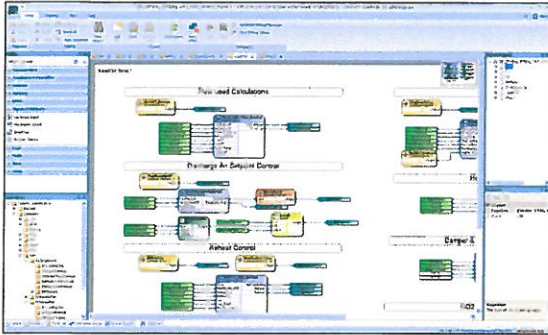


EC-Net^{AX} Solution

The EC-Net^{AX} multi-protocol integration solution is web-enabled and powered by the Niagara^{AX} Framework, establishing a fully Internet-enabled, distributed architecture for real-time access, automation and control of devices. The EC-Net^{AX} open framework solution creates a common development and management environment for integration of LONWORKS®, BACnet® and other protocols. Regardless of manufacturer and protocol, the EC-Net^{AX} system provides a unified modeling of diverse systems and data, providing one common platform for development, management and enterprise applications.

EC-Net^{AX} Wizards

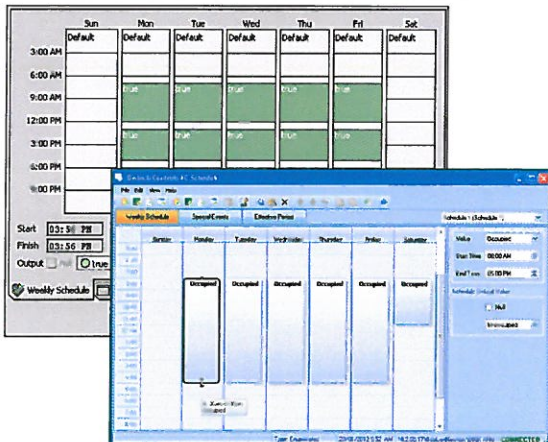
EC-gfxProgram Graphical Programming Interface (GPI)



Distech Controls' EC-gfxProgram is a programming tool that allows you to quickly create control sequences by "dragging and dropping" block objects and then linking the objects with a simple "click, select and release". Select objects from an extensive library of over 100 commonly used functions as well as create your own custom blocks. With a user-friendly interface and intuitive programming environment, HVAC programming could not be easier. Refer to the EC-gfxProgram datasheet for more information.

- Program both ECP and ECL Series LONWORKS and ECB Series BACnet controllers with the same tool.
- Supplied as freeware – there are no associated licensing costs.
- Live debugging allows user to view code execution, input/output values and to detect errors in real-time.
- A code library for managing your favorite or most commonly used code or code sections.

EC-Net^{AX} Scheduling / EC-gfxProgram EC-Schedule



Configure the controller's built-in schedules and holidays from the EC-Net^{AX} solution (ECB and ECL series controllers), or directly from within EC-gfxProgram (ECB and ECL series controllers) with an easy-to-use point, drag, and click interface. It features a weekly schedule for regular, repeating, events by "time-of-day" and "day-of-week", while a holiday schedule is available to define events for specific days.

- Easily configure schedules using a graphical slider.
- Allows you to easily copy and paste entries. Duplicate a schedule entry for Monday to Friday.
- Special events allow you to set exceptions such as holidays to a schedule.
- Holidays can be set for recurring events such as the 9th day, or the 3rd Thursday of a given month.
- A schedule has an effective period during which it is active.
- Schedule provides Next State and Time to Next State that are ideal for use with programming functions such as Optimum Start or Morning Warm Up.



EC-BOS-8

Multi-protocol Web Building Controller



Overview

The EC-BOS-8 is a compact, embedded controller and server platform for connecting multiple and diverse devices and sub-systems. With Internet connectivity and Webserving capability, the EC-BOS-8 provides integrated control, supervision, data logging, alarming, scheduling and network management. It streams data and graphical displays to a standard Web browser via an Ethernet or wireless LAN, or remotely over the Internet.

The EC-BOS-8 operates with EC-Net™ 4 web-based building management platform powered by the Niagara Framework®. The EC-BOS-8 can also run EC-Net^{AX} Security for managing access control systems.

Applications

- Network management of field controllers and devices
- Integration of various field buses and communication protocols
- Web serving capabilities that allow remote monitoring and management of network
- Scalable licensing model and modular hardware make the EC-BOS-8 suitable for installation in small buildings, as well as large multi-unit campuses when combined with EC-Net 4 Supervisor

Features & Benefits

Hardware Platform

Optimized for EC-Net 4

- 2GB user storage can carry the load of EC-Net 4 and more user data
- 1000MHz processor with secure boot feature offers fast performance and authentication of data storage prior to station startup
- USB port offers support for station backup and restore
- Backward compatibility allows the EC-BOS-8 to run an EC-Net^{AX} station (minimum requirement is 3.8.111)

Modern Design for

Simplified Installation and Integration

- The new, modular design of the EC-BOS-8 makes it easy to install, integrate and deploy.
- Two on-board isolated RS-485 ports for connecting BACnet MS/TP and Modbus RTU devices.
- Users can easily check system status by glancing at the front panel LEDs to diagnose network issues.

- No need for an additional voltage transformer since EC-BOS-8 is powered directly by global standard 24VAC/DC power supply.

Wireless Capability

Standard Wi-Fi offers enhanced wireless capability when interfacing with the next generation of wireless sensors and devices. The EC-BOS-8 is also configurable as an access point so that mobile phones and tablets can display information and advanced graphics. Expansion also is available when interfacing with other wireless field buses seen in connected buildings.

Expandable with Up to Four Option Modules

Option modules directly attach to the controller for additional communications ports, including types for LONWORKS®, RS 232 and RS 485 networks.

Controller and option modules are designed for easy mounting on a 35mm-wide DIN rail.

Capacity-Based Licensing Model

The licensing model for the EC-BOS-8 is simplified and includes standard open protocol drivers (e.g., BACnet®, LonWorks®, Modbus®) by default along with optional field bus expansion modules for ultimate flexibility and expandability.

Determine the number of points that will be integrated and select the right capacity license from the start. License upgrades can be purchased in the future as your needs grow.

Model Selection

EC-BOS-8 Series

Model	Product Description
EC-BOS-8 with US WiFi	EC-BOS-8 includes two isolated RS485 ports, two 10/100MB Ethernet ports, USB Backup & Restore and Wi-Fi connectivity. US WiFi setting for enabling WiFi on EC-BOS-8 units installed in the US.
EC-BOS-8 with Worldwide WiFi	EC-BOS-8 includes two isolated RS485 ports, two 10/100MB Ethernet ports, USB Backup & Restore and Wi-Fi connectivity. Worldwide WiFi setting for enabling WiFi on EC-BOS-8 units installed anywhere in the world except the US.
EC-BOS-8 with Permanently Disabled WiFi	EC-BOS-8 includes two isolated RS485 ports, two 10/100MB Ethernet ports and USB Backup & Restore. WiFi setting for permanently disabling WiFi on EC-BOS-8 units.

EC-BOS-8 Core Software

Model	Product Description
EC-BOS-8 Core - 5 Devices/250 Points	EC-BOS-8 core software. Includes standard open drivers. Supports up to 5 devices and 250 points. Requires EC-Net 4.1 or higher. Software Maintenance Agreement (SMA) must be purchased in conjunction with core software.
EC-BOS-8 Core - 10 Devices/500 Points	EC-BOS-8 core software. Includes standard open drivers. Supports up to 10 devices and 500 points. Requires EC-Net 4.1 or higher. Software Maintenance Agreement (SMA) must be purchased in conjunction with core software.
EC-BOS-8 Core - 25 Devices/1250 Points	EC-BOS-8 core software. Includes standard open drivers. Supports up to 25 devices and 1250 points. Requires EC-Net 4.1 or higher. Software Maintenance Agreement (SMA) must be purchased in conjunction with core software.
EC-BOS-8 Core - 100 Devices/5000 Points	EC-BOS-8 core software. Includes standard open drivers. Supports up to 100 devices and 5000 points. Requires EC-Net 4.1 or higher. Software Maintenance Agreement (SMA) must be purchased in conjunction with core software.
EC-BOS-8 Core - 200 Devices/10000 Points	EC-BOS-8 core software. Includes standard open drivers. Supports up to 200 devices and 10000 points. Requires EC-Net 4.1 or higher. Software Maintenance Agreement (SMA) must be purchased in conjunction with core software.
EC-BOS-8 Core - Demo	EC-BOS-8 core software. Includes all available drivers. Supports up to 500 devices and 25000 points. Runs on EC-Net 4.1 or higher and EC-Net ^{AX} (minimum v3.8.111). Note: This license expires annually and its renewal is covered by the EC-Net Support Fee.

EC-BOS-8 Device Integration Pack

Model	Product Description
EC-BOS-8 Device Integration Pack - 10	EC-BOS-8 device integration pack purchased in conjunction with initial core software. Adds support for additional 10 devices and 500 points to core software.
EC-BOS-8 Device Integration Pack - 25	EC-BOS-8 device integration pack purchased in conjunction with initial core software. Adds support for additional 25 devices and 1250 points to core software.
EC-BOS-8 Device Integration Pack - 50	EC-BOS-8 device integration pack purchased in conjunction with initial core software. Adds support for additional 50 devices and 2500 points to core software.

EC-BOS-8 Device Upgrade Pack

Model	Product Description
EC-BOS-8 Device Upgrade Pack - 10	EC-BOS-8 device upgrade pack purchased any time after initial core software purchase. Adds support for additional 10 devices and 500 points to core software.
EC-BOS-8 Device Upgrade Pack - 25	EC-BOS-8 device upgrade pack purchased any time after initial core software purchase. Adds support for additional 25 devices and 1250 points to core software.
EC-BOS-8 Device Upgrade Pack - 50	EC-BOS-8 device upgrade pack purchased any time after initial core software purchase. Adds support for additional 50 devices and 2500 points to core software.

EC-BOS-8 Software Maintenance Agreement

Software maintenance is required when purchasing an EC-BOS-8. The minimum initial software maintenance plan is 18 months. Optional 3 or 5 year maintenance may be substituted.

If Maintenance coverage is not purchased for any period, the price of Maintenance for the next period for which it is purchased will be (a) the Maintenance fee for the period(s) for which Maintenance was not purchased, up to a maximum of 5 years; and (b) the Maintenance fee for the next year.

These software maintenance plans are ordered separately according the EC-BOS-8 model chosen. See the price list for more details.

Model	Product Description
EC-BOS-8 (5 Device Core) 18 month SMA	EC-BOS-8 (5 Device Core) initial 18 month software maintenance agreement. Must be purchased in conjunction with initial core software. Optional 3 or 5 year maintenance may be substituted.
EC-BOS-8 (5 Device Core) 1 year SMA	EC-BOS-8 (5 Device Core) 1 year software maintenance agreement (includes new and interim releases).
EC-BOS-8 (5 Device Core) 3 year SMA	EC-BOS-8 (5 Device Core) 3 year software maintenance agreement (includes new and interim releases).
EC-BOS-8 (5 Device Core) 5 year SMA	EC-BOS-8 (5 Device Core) 5 year software maintenance agreement (includes new and interim releases).
EC-BOS-8 (10 Device Core) 18 month SMA	EC-BOS-8 (10 Device Core) initial 18 month software maintenance agreement. Must be purchased in conjunction with initial core software. Optional 3 or 5 year maintenance may be substituted.
EC-BOS-8 (10 Device Core) 1 year SMA	EC-BOS-8 (10 Device Core) 1 year software maintenance agreement (includes new and interim releases).
EC-BOS-8 (10 Device Core) 3 year SMA	EC-BOS-8 (10 Device Core) 3 year software maintenance agreement (includes new and interim releases).
EC-BOS-8 (10 Device Core) 5 year SMA	EC-BOS-8 (10 Device Core) 5 year software maintenance agreement (includes new and interim releases).