

# NATURAL REFRIGERANTS

TEMP.		REFRIGERANT						TEMP.		REFRIGERANT						TEMP.		REFRIGERANT					
°F	°C	170	290	441A	600a	717	744	°F	°C	170	290	441A	600a	717	744	°F	°C	170	290	441A	600a	717	744
-50	-45.6	78.9	4.3	21.1	23.6	14.3	103.4	10	-12.2	239.7	31.8	5.8	0.5	23.8	345.7	60	15.6	480.9	93.0	77.9	23.5	92.9	733.1
-45	-42.8	88.1	0.9	19.7	22.6	11.7	116.6	11	-11.7	243.5	32.7	6.3	0.0	24.7	351.5	62	16.7	493.2	96.3	80.6	24.9	96.9	753.2
-40	-40.0	98.1	1.4	18.1	21.4	8.8	131.0	12	-11.1	247.2	33.6	6.8	0.4	25.6	357.4	64	17.8	505.7	99.7	83.4	26.3	101.1	773.8
-35	-37.2	108.7	3.4	16.3	20.2	5.4	146.5	13	-10.6	251.1	34.5	7.2	0.7	26.5	363.4	65	18.3	512.1	101.4	84.7	27.0	103.2	784.2
-34	-34.4	120.0	5.7	14.3	18.8	1.6	163.1	14	-10.0	254.9	35.4	7.7	1.0	27.5	369.5	66	18.9	518.5	103.1	86.2	27.7	105.3	794.8
-29	-33.9	122.4	6.1	13.8	18.5	0.8	166.6	15	-9.4	258.8	36.3	8.2	1.4	28.4	375.6	68	20.0	531.4	106.6	89.0	29.1	109.7	816.2
-28	-33.3	124.7	6.6	13.4	18.1	0.0	170.1	16	-8.9	262.7	37.2	8.7	1.7	29.4	381.8	70	21.1	544.7	110.2	91.9	30.6	114.2	838.1
-27	-32.8	127.1	7.1	12.9	17.8	0.4	173.7	17	-8.3	266.7	38.2	9.2	2.1	30.4	388.0	72	22.2	558.2	113.9	94.9	32.2	118.8	860.5
-26	-32.2	129.6	7.6	12.5	17.5	0.8	177.3	18	-7.8	270.7	39.2	9.7	2.4	31.4	394.3	74	23.3	571.9	117.6	97.9	33.7	123.5	883.3
-25	-31.7	132.1	8.1	12.1	17.2	1.2	180.9	19	-7.3	274.7	40.2	10.2	2.7	32.4	400.4	76	24.4	585.7	121.3	100.9	35.2	128.3	906.7
-24	-31.1	134.6	8.6	11.7	16.9	1.6	184.5	20	-6.8	278.7	41.2	10.7	3.0	33.4	406.5	78	25.5	599.5	125.0	104.1	36.7	133.3	930.5
-23	-30.6	137.1	9.1	11.3	16.7	2.0	188.1	21	-6.3	282.7	42.2	11.2	3.3	34.4	412.6	80	26.6	613.3	128.7	107.3	38.2	138.4	954.9
-22	-30.0	139.7	9.6	10.9	16.5	2.4	191.7	22	-5.8	286.7	43.2	11.7	3.6	35.4	418.7	82	27.7	627.1	132.4	110.5	39.7	143.7	979.8
-21	-29.4	142.3	10.2	10.5	16.3	2.8	195.3	23	-5.3	290.7	44.2	12.2	3.9	36.4	424.8	84	28.8	640.9	136.1	113.7	41.2	149.1	1005.4
-20	-28.9	144.9	10.7	10.1	16.1	3.2	198.9	24	-4.8	294.7	45.2	12.7	4.2	37.4	430.9	86	29.9	654.7	139.8	116.9	42.7	154.6	1031.6
-19	-28.3	147.6	11.3	9.7	15.9	3.6	202.5	25	-4.3	298.7	46.2	13.2	4.5	38.4	437.0	88	31.0	668.5	143.5	120.1	44.2	160.3	*
-18	-27.8	150.3	11.8	9.3	15.7	4.0	206.1	26	-3.8	302.7	47.2	13.7	4.8	39.4	443.1	90	32.1	682.3	147.2	123.3	45.7	166.1	*
-17	-27.2	153.0	12.4	8.9	15.5	4.4	209.7	27	-3.3	306.7	48.2	14.2	5.1	40.4	449.2	92	33.2	696.1	150.9	126.5	47.2	172.0	*
-16	-26.7	155.7	13.0	8.5	15.3	4.8	213.3	28	-2.8	310.7	49.2	14.7	5.4	41.4	455.3	94	34.3	709.9	154.6	129.7	48.7	178.1	*
-15	-26.1	158.5	13.6	8.1	15.1	5.2	216.9	29	-2.3	314.7	50.2	15.2	5.7	42.4	461.4	96	35.4	723.7	158.3	132.9	50.2	184.2	*
-14	-25.6	161.4	14.2	7.7	14.9	5.6	220.5	30	-1.8	318.7	51.2	15.7	6.0	43.4	467.5	98	36.5	737.5	162.0	136.1	51.7	190.3	*
-13	-25.0	164.2	14.8	7.3	14.7	6.0	224.1	31	-1.3	322.7	52.2	16.2	6.3	44.4	473.6	100	37.6	751.3	165.7	139.3	53.2	196.4	*
-12	-24.4	167.1	15.4	6.9	14.5	6.4	227.7	32	-0.8	326.7	53.2	16.7	6.6	45.4	479.7	102	38.7	765.1	169.4	142.5	54.7	202.5	*
-11	-23.9	170.0	16.1	6.5	14.3	6.8	231.3	33	-0.3	330.7	54.2	17.2	6.9	46.4	485.8	104	39.8	778.9	173.1	145.7	56.2	208.6	*
-10	-23.3	173.0	16.7	6.1	14.1	7.2	234.9	34	0.2	334.7	55.2	17.7	7.2	47.4	491.9	106	40.9	792.7	176.8	148.9	57.7	214.7	*
-9	-22.8	176.0	17.4	5.7	13.9	7.6	238.5	35	0.7	338.7	56.2	18.2	7.5	48.4	498.0	108	42.0	806.5	180.5	152.1	59.2	220.8	*
-8	-22.2	179.0	18.0	5.3	13.7	8.0	242.1	36	1.2	342.7	57.2	18.7	7.8	49.4	504.1	110	43.1	820.3	184.2	155.3	60.7	226.9	*
-7	-21.7	182.1	18.7	4.9	13.5	8.4	245.7	37	1.7	346.7	58.2	19.2	8.1	50.4	510.2	112	44.2	834.1	187.9	158.5	62.2	233.0	*
-6	-21.1	185.2	19.4	4.5	13.3	8.8	249.3	38	2.2	350.7	59.2	19.7	8.4	51.4	516.3	114	45.3	847.9	191.6	161.7	63.7	239.1	*
-5	-20.6	188.3	20.1	4.1	13.1	9.2	252.9	39	2.7	354.7	60.2	20.2	8.7	52.4	522.4	116	46.4	861.7	195.3	164.9	65.2	245.2	*
-4	-20.0	191.5	20.8	3.7	12.9	9.6	256.5	40	3.2	358.7	61.2	20.7	9.0	53.4	528.5	118	47.5	875.5	199.0	168.1	66.7	251.3	*
-3	-19.4	194.7	21.5	3.3	12.7	10.0	260.1	41	3.7	362.7	62.2	21.2	9.3	54.4	534.6	120	48.6	889.3	202.7	171.3	68.2	257.4	*
-2	-18.9	197.9	22.2	2.9	12.5	10.4	263.7	42	4.2	366.7	63.2	21.7	9.6	55.4	540.7	122	49.7	903.1	206.4	174.5	69.7	263.5	*
-1	-18.3	201.2	22.9	2.5	12.3	10.8	267.3	43	4.7	370.7	64.2	22.2	9.9	56.4	546.8	124	50.8	916.9	210.1	177.7	71.2	269.6	*
0	-17.8	204.5	23.7	2.1	12.1	11.2	270.9	44	5.2	374.7	65.2	22.7	10.2	57.4	552.9	126	51.9	930.7	213.8	180.9	72.7	275.7	*
1	-17.2	207.9	24.5	1.7	11.9	11.6	274.5	45	5.7	378.7	66.2	23.2	10.5	58.4	559.0	128	53.0	944.5	217.5	184.1	74.2	281.8	*
2	-16.7	211.3	25.2	1.3	11.7	12.0	278.1	46	6.2	382.7	67.2	23.7	10.8	59.4	565.1	130	54.1	958.3	221.2	187.3	75.7	287.9	*
3	-16.1	214.7	26.0	0.9	11.5	12.4	281.7	47	6.7	386.7	68.2	24.2	11.1	60.4	571.2	132	55.2	972.1	224.9	190.5	77.2	294.0	*
4	-15.6	218.2	26.8	0.5	11.3	12.8	285.3	48	7.2	390.7	69.2	24.7	11.4	61.4	577.3	134	56.3	985.9	228.6	193.7	78.7	300.1	*
5	-15.0	221.7	27.6	0.1	11.1	13.2	288.9	49	7.7	394.7	70.2	25.2	11.7	62.4	583.4	136	57.4	999.7	232.3	196.9	80.2	306.2	*
6	-14.4	225.2	28.4	-0.3	10.9	13.6	292.5	50	8.2	398.7	71.2	25.7	12.0	63.4	589.5	138	58.5	1013.5	236.0	200.1	81.7	312.3	*
7	-13.9	228.8	29.2	-0.7	10.7	14.0	296.1	51	8.7	402.7	72.2	26.2	12.3	64.4	595.6	140	59.6	1027.3	239.7	203.3	83.2	318.4	*
8	-13.3	232.4	30.1	-1.1	10.5	14.4	299.7	52	9.2	406.7	73.2	26.7	12.6	65.4	601.7	142	60.7	1041.1	243.4	206.5	84.7	324.5	*
9	-12.8	236.0	30.9	-1.5	10.3	14.8	303.3	53	9.7	410.7	74.2	27.2	12.9	66.4	607.8	144	61.8	1054.9	247.1	209.7	86.2	330.6	*

# Cascade CO2 Low Temp Retrofit

**Brad Person SEER<sup>2</sup>**  
**Mike Hoffman Zero Zone**  
**Russell Diehl SEER<sup>2</sup>**



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TEMP.		REFRIGERANT	TEMP.		REFRIGERANT	TEMP.		REFRIGERANT						
F	C		F	C		F	C							
-50	-45.6		87	1.7	29.4	381.8	70	21.1	544.7	110.2	91.9	30.6	114.2	838.1
-45	-42.8		82	2.1								22.2	118.8	860.5
-40	-40.0		77	2.4								23.7	123.5	883.3
-35	-37.2		73	2.8								24.5	125.9	894.9
-30	-34.4		68	3.2								25.3	128.3	906.7
-29	-33.9		63	3.5								27.0	133.3	930.5
-28	-33.3		59	3.9								28.7	138.4	954.9
-27	-32.8		55	4.3								30.4	143.7	979.8
-26	-32.2		50	4.7								32.2	149.1	1005.4
-25	-31.7		46	5.1								33.1	151.8	1018.4
-24	-31.1		42	5.5								34.0	154.6	1031.6
-23	-30.6		38	5.9								35.9	160.3	*
-22	-30.0		34	6.3								37.8	166.1	*
-21	-29.4		30	6.8								39.7	172.0	*
-20	-28.9		26	7.2								41.7	178.1	*
-19	-28.3		23	7.6								42.7	181.2	*
-18	-27.8		19	8.1	47.6	450.6	96	35.6		164.3	139.3	53.7	184.4	*
-17	-27.2		16	8.5	48.9	498.3	98	36.7	*	169.1	139.3	55.8	190.8	*
-16	-26.7		12	9.0	50.2	505.8	100	37.8	*	173.9	143.2	57.9	197.3	*
-15	-26.1		9	9.4	51.6	513.4	102	38.9	*	178.9	147.2	60.1	204.0	*
-14	-25.6		6	9.9	52.9	521.2	104	40.0	*	183.0	151.2	62.3	210.9	*
-13	-25.0		3	10.4	54.3							63.5	214.4	*
-12	-24.4		0	10.9	55.7							64.6	217.9	*
-11	-23.9		7	11.4	57.2							66.9	225.1	*
-10	-23.3		4	11.9	58.6							69.3	232.5	*
-9	-22.8		2	12.4	60.1							71.7	240.0	*
-8	-22.2		9	12.9	61.6							74.2	247.7	*
-7	-21.7		7	13.4	63.1							75.5	251.6	*
-6	-21.1		4	14.0	64.7							82.0	271.9	*
-5	-20.6		2	14.5	66.3							88.8	293.3	*
-4	-20.0		0	15.0	67.9							95.9	315.8	*
-3	-19.4		6	16.2	71.1							103.5	339.6	*
-2	-18.9		3	17.3	74.5							111.4	364.7	*
-1	-18.3		7	18.5	78.0	656.5	145	62.8	*	310.2	250.5	119.6	391.0	*
0	-17.8		2	19.7	81.6	675.0	150	65.6	*	328.9	264.9	128.3	418.7	*
1	-17.2		4	20.3	83.4	684.5	155	68.3	*	348.4	279.9	137.4	447.8	*
2	-16.7		7	20.9	85.2	694.0	160	71.1	*	368.7	295.5	146.9	478.3	*
3	-16.1		7	22.2	89.0	713.3	165	73.9	*	389.9	311.6	156.8	510.2	*
4	-15.6													
5	-15.0													
6	-14.4													
7	-13.9													
8	-13.3													
9	-12.8													

## Other issues:

- Existing 2004 RTU's running on R-22 and past their useful life
- Existing 2004 exhaust fans and makeup air units are experiencing maintenance issues
- Existing 1992 main air handler 5H compressor failed





# NATURAL REFRIGERANTS

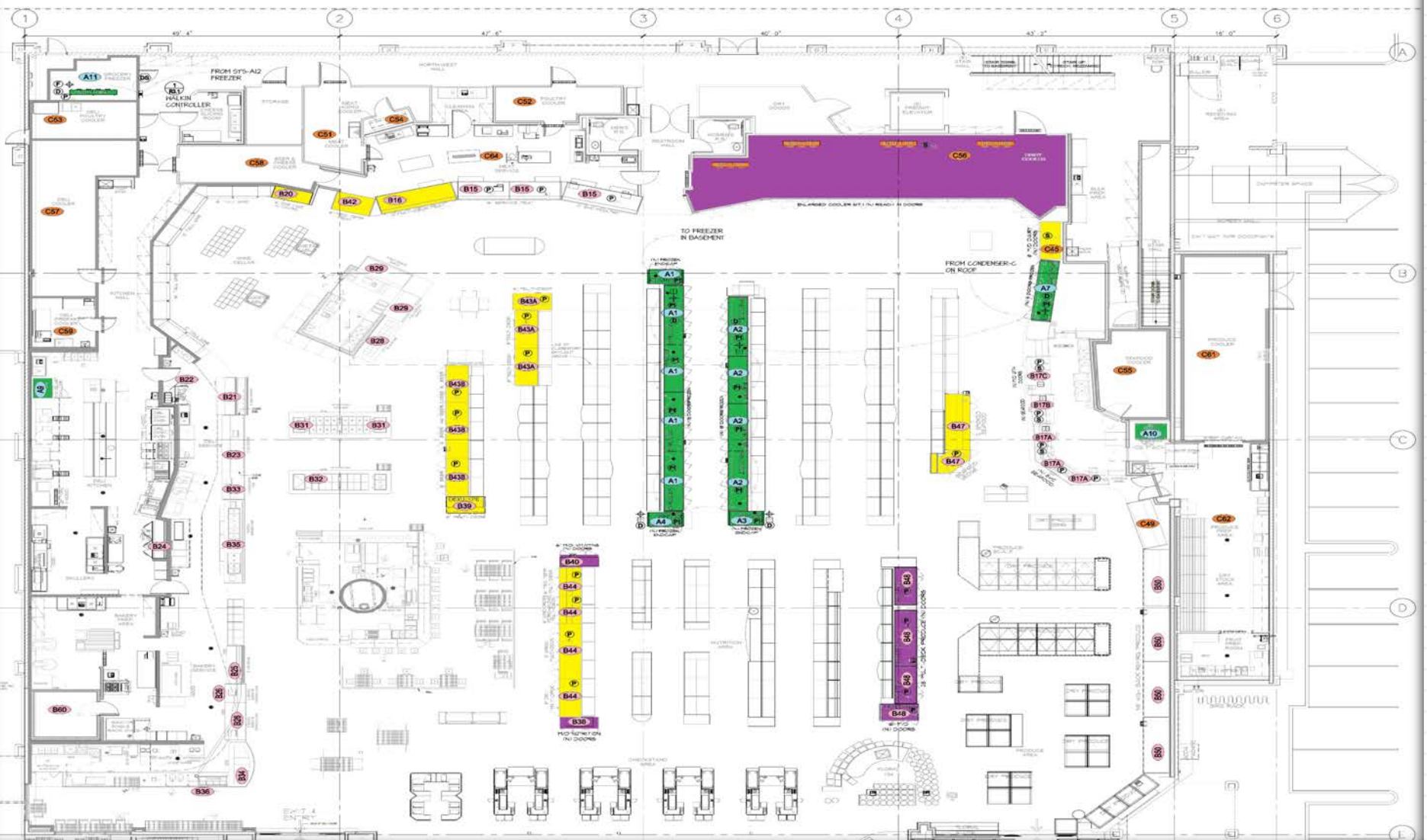
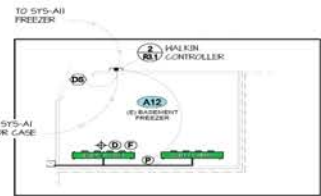
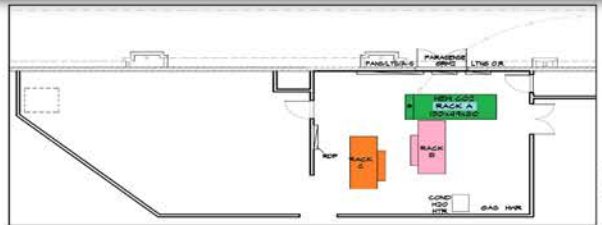
Reduce load on existing medium temp rack by adding doors. Then used excess capacity for cascade CO2 low temp system.

Rack	New Sys #	REFRIGERATED FIXTURES & WALK-INS										SYSTEM LOADS				DEFROST		REQUIRED LINE SIZING				TEMPERATURE CONTROLS				QTY OF EMS PROBES	- Total 115v/1ph Case Elect. -				Elect. Defrost		- Total Coil Elect. -		Remarks								
		12/5D/ Len	10/7/ Wid	8/4D/ Hgt	6/3D/ Sq Ft	4/2D/	Cv/D Wge	Make	Description	Refrig	Total Fv/Dr	Case/Coil Model	Coil Qty	Coil T.D.	TXV Model	Btu/Hr	Total (BTUH)	Tons	Evap Temp	Disch Temp	Defr Type	Time	Defr Term	Ref. Lines Type	(N/E)		Suction Line	Liquid Line	Suction Riser	(N)=New (R)=Reuse/Relocate Existing (E)=Existing	Constant On Fans	Cycling ASH	ASH	Lights		Other	1 Ph	3 Ph	Amps	Dm Pan	Volts		
		(N) - NEW, (E) - EXISTING (R) - RELOCATED (M) - MODIFIED																																									
(N) R-744 CASCADE RACK "A" IN EQUIP. ROOM	A1	3	1	1			ZERO-ZONE	IC/FF REACH-IN (N)	744	21	RHZC30T				1106	23,220	1.94	-16	-12	ED	1 X 45	TEMP	BR.	(N)	7/8	3/8	5/8	(N) TEMP PROBES, CASE CONTROLLERS BY MFG.	5	6.30	16.00	3.15			34.6 / 31.2				(N) CASES, BR. LINES & CONTROLS.				
	A2	2	2				ZERO-ZONE	IC/FF REACH-IN (N)	744	18	RHZC30T				1102	19,840	1.85	-16	-12	ED	1 X 45	TEMP	BR.	(N)	7/8	3/8	5/8	(N) TEMP PROBES, CASE CONTROLLERS BY MFG.	4	5.40	16.74	2.70			31.2 / 31.2				(N) CASES, BR. LINES & CONTROLS.				
	A3				1		ZERO-ZONE	FRZ FOOD END CAP (N)	744	2	RHZC30T				1065	2,130	0.18	-7	-3	ED	1 X 45	TEMP	BR.	(N)	1/2	3/8	3/8	(N) TEMP PROBE, CASE CONTROLLER BY MFG.	1	0.60	1.96	0.30		8.00					(N) CASE, BR. LINES & CONTROLS.				
	A4				1		ZERO-ZONE	FRZ FOOD END CAP (N)	744	2	RHZC30T				1065	2,130	0.18	-7	-3	ED	1 X 45	TEMP	BR.	(N)	1/2	3/8	3/8	(N) TEMP PROBE, CASE CONTROLLER BY MFG.	1	0.60	1.96	0.30		8.00					(N) CASE, BR. LINES & CONTROLS.				
	A5							SPARE	744																																		
	A6							SPARE	744																																		
	A7	1						ZERO-ZONE	FRZ FISH REACH-IN (N)	744	5	RHZC30T				1010	5,050	0.42	-7	-3	ED	1 X 45	TEMP	BR.	(N)	1/2	3/8	3/8	(N) TEMP PROBE, CASE CONTROLLER BY MFG.	1	1.50	4.64	0.75		20.00					(N) CASE, BR. LINES & CONTROLS.			
	A8							SPARE	744																																		
	A9							TRAUlsen	BLAST CHILLER (N)	744		TCB1H				18,700	1.56	-10			N/A			BR.	(N)	7/8	3/8	5/8	(N) CONTROLS BY MFG.													(N) CHILLER, BR. LINES & CONTROLS.	
	A10							HOWE	ICE FLAKER (N)	744		4000RL				34,100	2.84	-5			N/A			BR.	(N)	1-1/8	1/2	7/8	(N) CONTROLS BY MFG.													(N) FLAKER, BR. LINES & CONTROLS.	
	A11	14	9	9				BOHN	GROCERY FZR (E)	744		LLEC-138B (N)	1	7.53	FACTORY	10,246	0.85	-20	-12	ED	2 X 30	TEMP	BR.	(N)	5/8	3/8	1/2	(N) TEMP PROBE, COIL CONTROLLER BY MFG.	1					15.70		2.00		208V		(EM) WALK-IN, (N) COIL, BR. LINES & CONTROLS.			
	A12	22	16	8				BOHN	BASEMENT FRZ (E)	744		LLEC-138B (N)	2	7.34	FACTORY	19,966	1.66	-20	-12	ED	2 X 30	TEMP	BR.	(N)	7/8	3/8	5/8	(N) TEMP PROBE, COIL CONTROLLERS BY MFG.	1					15.7 / 15.7		4.00		208V		(EM) WALK-IN, (N) COILS, BR. LINES & CONTROLS.			
	A13							SPARE	744																																		
A							RACK "A" MAIN	744							135,382	11.28	-20					MAIN	(N)	1-3/8	5/8	7/8																	
															159,273																												
EXISTING PARALLEL RACK "B" IN EQUIP. ROOM	B15	1	2				HILL-PHOENIX	SERVICE MEAT (E)	446A	28	S259C				365	10,220	0.85	20	28	OT	1 X 60	TIME	BR.	(E)	7/8	1/2	5/8	RE-USE EXISTING	1	8.00		4.92	15.00								ADD TEMPERATURE PROBES.		
	B16	1					HUSSMANN	M.D. MEAT (E)	446A	12	C6XLEP WDRS				494	5,810	0.48	28	31	OT	3 X 45	TIME	BR.	(E)	7/8	1/2	5/8	RE-USE EXISTING	1	1.90		2.31									NO CHANGE		
	B17A		1				2-W	HUSSMANN	SERVICE FISH (N)	446A	10'-W	DSFN				4,900	0.41	28	32	OT	3 X 48	TIME	BR.	(N)	5/8	3/8	5/8	(N) TEMP PROBES, (N) SSSV AT CASES	3	3.80	0.90		15.00								(N) CASES, BR. LINES & CONTROLS		
	B17B			1				HUSSMANN	SERVICE FISH (N)	446A	6	Q3-DV				465	2,430	0.20	20	28	OT	3 X 45	TIME	BR.	(N)	5/8	3/8	1/2	(N) TEMP PROBE, SSSV AT CASE	1	5.05		0.56	15.00								(N) CASE, BR. LINES & CONTROLS	
	B17B			1				HUSSMANN	SMOKED FISH (N)	446A	8	IDD6SU				340	2,720	0.23	32	35	OT	1 X 40	TIME	BR.	(N)	5/8	3/8	1/2	(N) TEMP PROBE, LLSV AT CASE	1	0.80		0.76									(N) CASE, BR. LINES & CONTROLS	
	B17							NA	SYS B17 SUB-MAIN (ER)	446A						10,050	0.84	20					SUB	(ER)	1-1/8	1/2	7/8													(E) MAIN LINES RE-USE			
	B18							SPARE	446A																																		
	B19							SPARE	446A																																		
	B20			1				HUSSMANN	WINE (EM)	446A	6	RGD-3083 WDRS				600	3,600	0.30	20	28	OT	4 X 30	TIME	BR.	(ER)	5/8	3/8	1/2	(ER) PROBE, LLSV AT CASE	1	0.60		1.00										(EM) CASE, ADD DOORS, (ER) LINES & CONTROLS.
	B21			1				HUSSMANN	SUSHI (E)	446A	8	Q3-SP				985	7,890	0.66	20	24	OT	4 X 30	TIME	BR.	(E)	7/8	1/2	5/8	RE-USE EXISTING	1	0.48		1.56	15.00									NO CHANGE
	B22				1			HUSSMANN	SUSHI STORAGE (E)	446A	4	SPECIAL				200	800	0.07	20	30	OT	4 X 30	TIME	BR.	(E)	1/2	1/2	3/8	RE-USE EXISTING	1												NO CHANGE	
	B23	1						HUSSMANN	SERVICE DELI (E)	446A	12	Q3-DS				650	7,800	0.65	20	28	OT	3 X 45	TIME	BR.	(E)	7/8	1/2	5/8	RE-USE EXISTING	1	0.96		1.17	15.00									NO CHANGE
	B24			1				HUSSMANN	SANDWICH STORAGE (E)	446A	4	SPECIAL				200	1,600	0.13	20	30	OT	4 X 30	TIME	BR.	(E)	1/2	1/2	3/8	RE-USE EXISTING	1												NO CHANGE	
	B25			1				HUSSMANN	BAKERY M.D. (E)	446A	8	ISLA-IM-24				950	7,800	0.63	24	30	OT	6 X 45	TIME	BR.	(E)	7/8	1/2	5/8	RE-USE EXISTING	1	1.24		2.07									NO CHANGE	
	B26	1						HUSSMANN	SERVICE BAKERY (E)	446A	12	SG8				565	6,780	0.57	22	30	OT	6 X 30	TIME	BR.	(E)	7/8	1/2	5/8	RE-USE EXISTING	1	3.13		2.78	15.00									NO CHANGE
	B27							SPARE	446A																																		
	B28			1				AMTEKCO	OLIVE BAR (E)	446A	8	SPECIAL				803	6,428	0.54	22	30	OT	8 X 15	TIME	BR.	(E)	5/8	1/2	5/8	RE-USE EXISTING	1												NO CHANGE	
	B29	1		1				HUSSMANN	S.S. CHEESE (E)	446A	20	Q1-SS				570	11,400	0.95	20	26	OT	4 X 40	TIME	BR.	(E)	7/8	1/2	7/8	RE-USE EXISTING	1	0.72		1.16									NO CHANGE	
	B30							SPARE	446A																																		
	B31			2				AMTEKCO	HOT/COLD BAR (E)	446A	16	SPECIAL				195	3,126	0.26	25	35	OT	8 X 15	TIME	BR.	(E)	5/8	1/2	1/2	RE-USE EXISTING	1													NO CHANGE
	B32			2				AMTEKCO	SALAD BAR (E)	446A	16	SPECIAL				740	11,844	0.99	25	35	OT	6 X 15	TIME	BR.	(E)	7/8	1/2	7/8	RE-USE EXISTING	1												NO CHANGE	
	B33				1			HILL-PHOENIX	CHACUTERIE (E)	446A	6	GMD				650	3,900	0.33	20	28	OT	3 X 45	TIME	BR.	(E)	5/8	1/2	1/2	RE-USE EXISTING	1	0.30		0.80	15.00								NO CHANGE	
	B34							AMTEKCO	ICED FOOD BAR (E)	446A	IRREG.	SPECIAL				5,188	0.43	25	35	OT	8 X 15	TIME	BR.	(E)	5/8	1/2	5/8	RE-USE EXISTING	1												NO CHANGE		
	B35			1				AMTEKCO	BURRITO BAR (E)	446A	8	SPECIAL				849	6,788	0.57	22	30	OT	3 X 45	TIME	BR.	(E)	7/8	1																

# NATURAL REFRIGERANTS

TEMP.		170	290
°F	°C		
-50	-45.6	78.9	4.3
-45	-42.8	88.1	0.9
-40	-40.0	98.1	1.4
-35	-37.2	108.7	3.4
-30	-34.4	120.0	5.7
-25	-31.7	127.1	7.1
-20	-28.9	134.6	8.6
-15	-26.1	142.3	10.2
-10	-23.3	149.9	11.7
-5	-20.6	157.6	13.3
0	-17.8	165.3	14.9
5	-15.0	173.0	16.5
10	-12.2	180.7	18.1
15	-9.4	188.4	19.7
20	-6.7	196.1	21.3
25	-3.9	203.8	22.9
30	-1.1	211.5	24.5
35	1.7	219.2	26.1
40	4.4	226.9	27.7
45	7.2	234.6	29.3
50	10.0	242.3	30.9

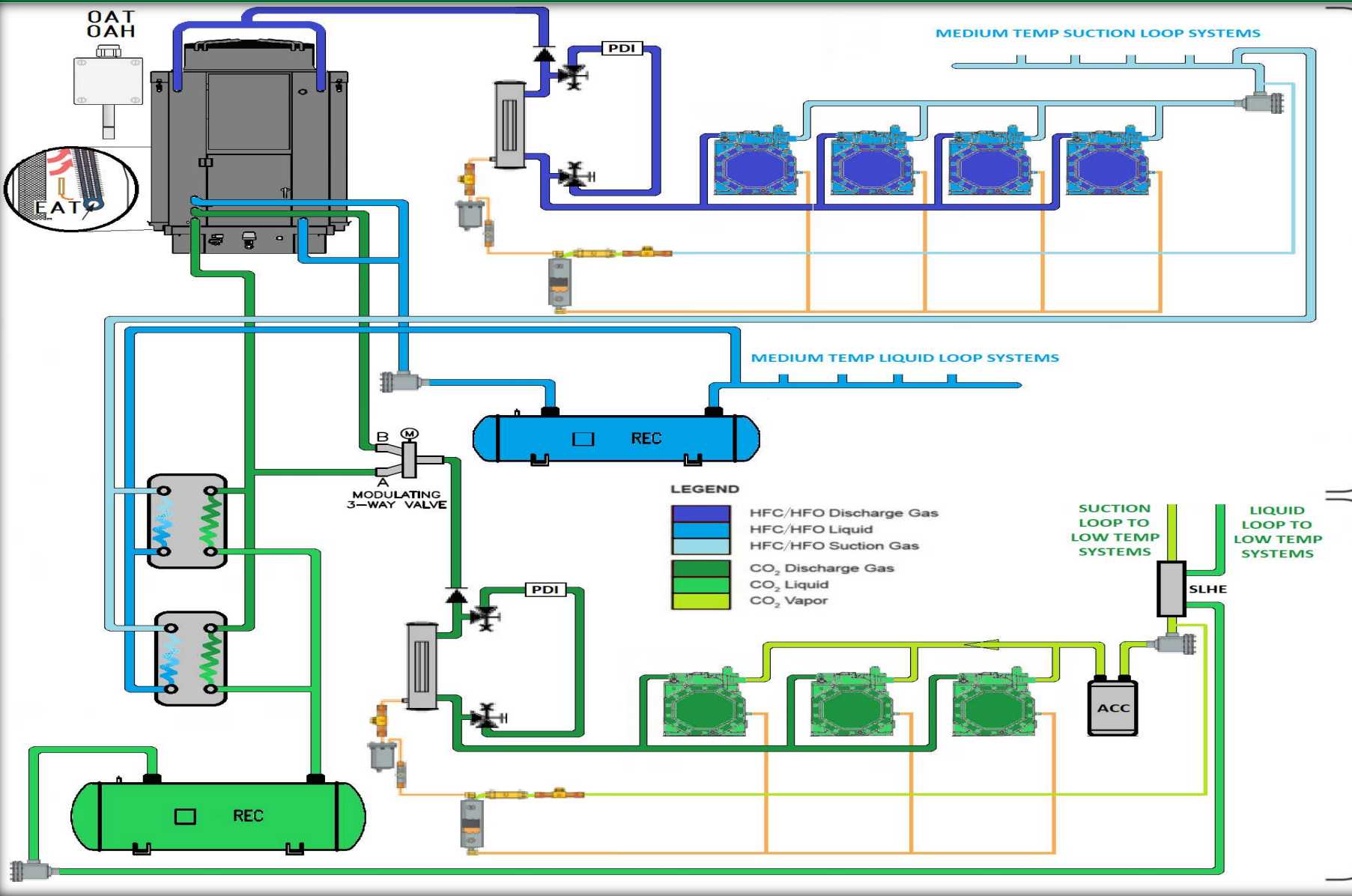
- Rack A
- Rack B
- Rack C
- CO2
- Added Doors
- Existing Doors



ANT		
600a	717	744
23.5	92.9	733.1
24.9	96.9	753.2
26.3	101.1	773.8
27.0	103.2	784.2
27.7	105.3	794.8
29.1	109.7	816.2
30.6	114.2	838.1
32.2	118.8	860.5
33.7	123.5	883.3
34.5	125.9	894.9
35.3	128.3	906.7
37.0	133.3	930.5
38.7	138.4	954.9
40.4	143.7	979.8
42.2	149.1	1005.4
43.1	151.8	1018.4
44.0	154.6	1031.6
45.9	160.3	*
47.8	166.1	*
49.7	172.0	*
51.7	178.1	*
52.7	181.2	*
53.7	184.4	*
55.8	190.8	*
57.9	197.3	*
60.1	204.0	*
62.3	210.9	*
63.5	214.4	*
64.6	217.9	*
66.9	225.1	*
69.3	232.5	*
71.7	240.0	*
74.2	247.7	*
75.5	251.6	*
82.0	271.9	*
88.8	293.3	*
95.9	315.8	*
103.5	339.6	*
111.4	364.7	*
119.6	391.0	*
128.3	418.7	*
137.4	447.8	*
146.9	478.3	*
156.8	510.2	*

# NATURAL REFRIGERANTS

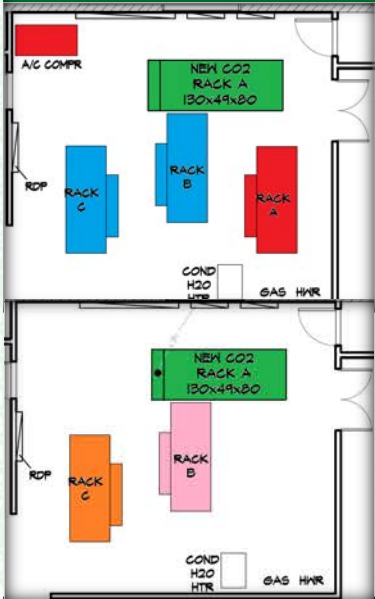
## System Diagram



TEMP.		
°F	°C	170
-50	-45.6	78.9
-45	-42.8	88.1
-40	-40.0	98.1
-35	-37.2	108.7
-30	-34.4	120.0
-25	-31.7	127.1
-20	-28.9	134.6
-15	-26.1	142.3
-10	-23.3	147.6
-5	-20.6	153.0
0	-17.8	155.7
5	-15.0	158.5
10	-12.2	161.4
15	-9.4	164.2
20	-6.7	167.1
25	-4.0	170.0
30	-1.3	173.0
35	1.4	176.0
40	4.1	179.0
45	6.8	182.1
50	9.5	185.2
55	12.2	188.3
60	14.9	191.5
65	17.6	194.7
70	20.3	197.9
75	23.0	201.2
80	25.7	204.5
85	28.4	207.9
90	31.1	211.3
95	33.8	214.7
100	36.5	218.2
105	39.2	221.7
110	41.9	225.2
115	44.6	228.8
120	47.3	232.4
125	50.0	236.0

717	744
92.9	733.1
96.9	753.2
101.1	773.8
103.2	784.2
105.3	794.8
109.7	816.2
114.2	838.1
118.8	860.5
123.5	883.3
125.9	894.9
128.3	906.7
133.3	930.5
138.4	954.9
143.7	979.8
149.1	1005.4
151.8	1018.4
154.6	1031.6
160.3	*
166.1	*
172.0	*
178.1	*
181.2	*
184.4	*
190.8	*
197.3	*
204.0	*
210.9	*
214.4	*
217.9	*
225.1	*
232.5	*
240.0	*
247.7	*
251.6	*
271.9	*
293.3	*
315.8	*
339.6	*
364.7	*
391.0	*
418.7	*
447.8	*
478.3	*
510.2	*

## Completed Project



744

733.1

753.2

773.8

784.2

794.8

816.2

838.1

859.5

884.9

906.7

930.5

954.9

979.8

1005.4

1018.4

1031.6

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# Lessons Learned

- **Coordination for CO2 equipment required extra time.**
  - Adding desuperheater loop to condenser
  - Ice machines
- **Controls install and coordination**
  - Case controls
  - Cascade heat exchangers
- **Must include energy design initiatives (ie. CTC, Adiabatic, Commissioning, etc.) to achieve energy parity**

Circuit Name	Circuit Group	Project Start Date	Project End Date	Start Date for Energy Analysis	Updated Week # Date	Total Weeks POST Energy Project Works	Average Weekly Savings kWh Post Lockdown	Average Weekly Savings % Post Lockdown Complete	Extrapolated Annual Savings kWh @ 100%	Store Energy Rate X.XX\$/kWh	Extrapolated Annual Savings \$
Main Feed	Main	02/01/19	11/10/19	01/01/18	12/29/19	8	5596	15.0	290992	\$ 0.145	\$ 42,193.84
Rack A	Refrig	02/01/19	11/10/18	01/01/18	12/29/19	8	153	6.3	7956	\$ 0.145	\$ 1,153.62
Rack B	Refrig	02/01/19	10/01/19	01/01/18	12/29/19	13	524	15.5	27248	\$ 0.145	\$ 3,950.96
Rack C - MT R448A	Refrig	02/01/19	10/01/19	01/01/18	12/29/19	13	1614	49.1	83928	\$ 0.145	\$ 12,169.56
Panel HA - Sales Area Ltg	Lights	04/28/19	06/07/19	01/01/18	12/29/19	30	1443	34.8	75036	\$ 0.145	\$ 10,880.22

## Commissioning Savings Range -4% to 31% Average 9.3%

Rack C Power Calculations	%	Reduction %	Range
<b>Base Power %</b>	<b>100.0%</b>		
<b>Load Reduction % for RLDY</b>	<b>79.0%</b>	<b>21.0%</b>	
<b>Commissioning Reduction</b>	<b>71.7%</b>	<b>9.3%</b>	
<b>Refrigerant Reduction</b>	<b>64.5%</b>	<b>10.0%</b>	<b>5% to 15%</b>
<b>Adiabatic Reduction</b>	<b>56.7%</b>	<b>12.0%</b>	
<b>Calculated Reduction</b>	<b>43.3%</b>		
<b>Actual Reduction</b>	<b>49.1%</b>		

**5.8% Better than calculated**

Rack B Power Calculations	%	Reduction %	Range
<b>Base Power %</b>	<b>100.0%</b>		
<b>Load Increase (THR 51%-14% CTC)</b>	<b>137.0%</b>	<b>37.0%</b>	
<b>Commissioning Reduction</b>	<b>124.3%</b>	<b>9.3%</b>	
<b>Refrigerant Reduction</b>	<b>111.8%</b>	<b>10.0%</b>	<b>5% to 15%</b>
<b>Adiabatic Reduction</b>	<b>98.4%</b>	<b>12.0%</b>	
<b>Calculated Reduction</b>	<b>1.6%</b>		
<b>Actual Reduction</b>	<b>15.5%</b>		

**13.9% Better than calculated**

2	-16.7	211.3	25.2	2.5	5.3	17.2
3	-16.1	214.7	26.0	2.9	4.8	18.0
4	-15.6	218.2	26.8	3.3	4.2	18.8
5	-15.0	221.7	27.6	3.7	3.6	19.6
6	-14.4	225.2	28.4	4.1	3.0	20.4
7	-13.9	228.8	29.2	4.5	2.4	21.2
8	-13.3	232.4	30.1	5.0	1.8	22.1
9	-12.8	236.0	30.9	5.5	1.2	22.9

Rack A Power Calculations	%	Reduction %	Range
<b>Base Power %</b>	<b>100.0%</b>		
<b>Load Reduction % for RLDY</b>	<b>90.0%</b>	<b>10.0%</b>	
<b>Actual Reduction</b>	<b>6.3%</b>		
<b>Actual % of Base</b>	<b>93.7%</b>		

**-3.7% Less than calculated**

*	258.7	210.3	95.9	315.8	*
*	275.1	223.1	103.5	339.6	*
*	292.3	236.5	111.4	364.7	*
*	310.2	250.5	119.6	391.0	*
*	328.9	264.9	128.3	418.7	*
*	348.4	279.9	137.4	447.8	*
*	368.7	295.5	146.9	478.3	*
*	389.9	311.6	156.8	510.2	*

## Possible Future Project

**Convert medium temp to cascade CO2 (90% Natural Refrigerants):**

**Set new cascade CO2 rack where original low temp rack was and use rack C for cascade**

**All walk-ins could be swapped with coil replacements for initial load**

**System could be swapped over during remodels or as needed**

TEMP.	F	C
-50	-45	
-45	-42	
-40	-40	
-35	-37	
-34	-34	
-29	-33	
-28	-33	
-27	-32	
-26	-32	
-25	-31	
-24	-31	
-23	-30	
-22	-30	
-21	-29	
-20	-28	
-19	-28	
-18	-27	
-17	-27	
-16	-26	
-15	-26	
-14	-25	
-13	-25	
-12	-24	
-11	-23	
-10	-23	
-9	-22	
-8	-22	
-7	-21	
-6	-21	
-5	-20	
-4	-20	
-3	-19	
-2	-18	
-1	-18	
0	-17	
1	-17	
2	-16	
3	-16	
4	-15	
5	-15	
6	-14	
7	-13	
8	-13	
9	-12	

129.6	7.6	12.5	17.5	0.8	177.3	18	-7.8	270.7	39.2	9.7	2.4	31.4	394.3	74	23.3	571.9	117.6	97.9	33.7	123.5	744
132.1	8.1	12.0	17.2	1.3	181.0	19	-7.2	274.8	40.1	10.3	2.8	32.4	400.7	75	23.9	578.9	119.5	99.5	34.5	125.9	733.1
134.6	8.6	11.5	16.8	1.7	184.8	20	-6.7	278.9	41.1	10.8	3.2	33.5	407.2	76	24.4	585.9	121.4	101.0	35.3	128.3	753.2
137.1	9.1	11.0	16.5	2.2	188.5	21	-6.1	283.0	42.1	11.3	3.5	34.6	413.8	78	25.6	600.2	125.4	104.2	37.0	133.3	773.8
139.7	9.6	10.5	16.2	2.6	192.4																784.2
142.3	10.2	10.0	15.8	3.1	196.3																794.8
144.9	10.7	9.5	15.4	3.6	200.2																816.2
147.6	11.3	9.0	15.1	4.1	204.2																838.1
150.3	11.8	8.4	14.7	4.6	208.3																860.5
153.0	12.4	7.9	14.3	5.1	212.4																883.3
155.7	13.0	7.3	13.9	5.6	216.5																894.9
158.5	13.6	6.7	13.5	6.2	220.8																906.7
161.4	14.2	6.1	13.1	6.7	225.0																930.5
164.2	14.8	5.5	12.7	7.3	229.4																954.9
167.1	15.4	4.9	12.2	7.8	233.8																979.8
170.0	16.1	4.3	11.8	8.4	238.2																1005.4
173.0	16.7	3.7	11.4	9.0	242.7																1018.4
176.0	17.4	3.0	10.9	9.6	247.3																1031.6
179.0	18.0	2.4	10.4	10.3	251.9																*
182.1	18.7	1.7	10.0	10.9	256.6																*
185.2	19.4	1.0	9.5	11.5	261.3																*
188.3	20.1	0.3	9.0	12.2	266.1																*
191.5	20.8	0.2	8.5	12.9	271.0																*
194.7	21.5	0.6	8.0	13.6	275.9																*
197.9	22.2	0.9	7.5	14.3	280.9																*
201.2	22.9	1.3	7.0	15.0	285.9																*
204.5	23.7	1.7	6.4	15.7	291.0																*
207.9	24.5	2.1	5.9	16.4	296.2																*
211.3	25.2	2.5	5.3	17.2	301.5																*
214.7	26.0	2.9	4.8	18.0	306.8																*
218.2	26.8	3.3	4.2	18.8	312.1																*
221.7	27.6	3.7	3.6	19.6	317.6																*
225.2	28.4	4.1	3.0	20.4	323.1																*
228.8	29.2	4.5	2.4	21.2	328.6																*
232.4	30.1	5.0	1.8	22.1	334.2	55	12.8	451.2	85.1	71.4	20.3	83.4	684.5	155	68.3	348.4	279.9	137.4	447.8	*	
236.0	30.9	5.5	1.2	22.9	339.9	56	13.3	457.1	86.7	72.7	20.9	85.2	694.0	160	71.1	368.7	295.5	146.9	478.3	*	
						58	14.4	468.9	89.8	75.3	22.2	89.0	713.3	165	73.9	389.9	311.6	156.8	510.2	*	

