



Energy Savings Potential

Energy Saving Ideas in Refrigeration

2021 Tech Talk 101 for Evergy

Presenter

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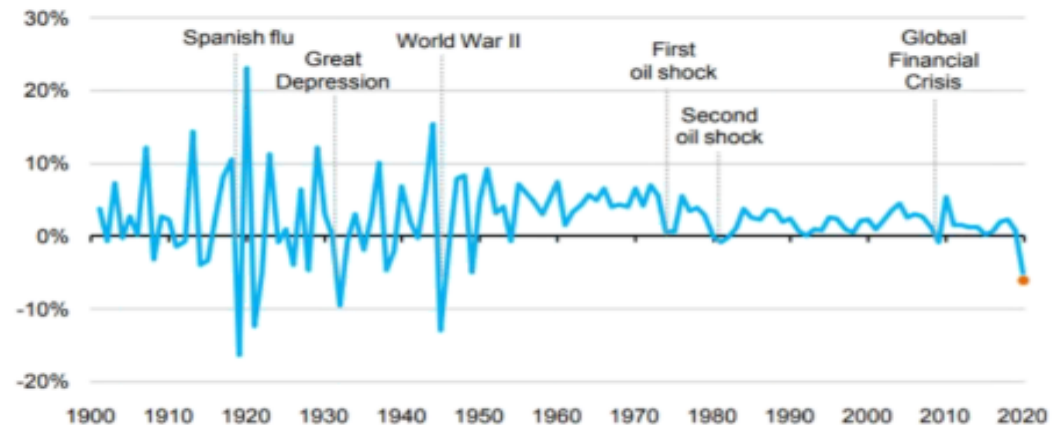


Global Energy Demand

GLOBAL ENERGY DEMAND*

- Dropped by **3.8%** in the First Quarter of 2020.
- **DROPPED** **7%** overall in 2020 which represents the Largest Drop in History and the steepest decline in 70 years.

Rate of change in global primary energy demand, 1900-2020

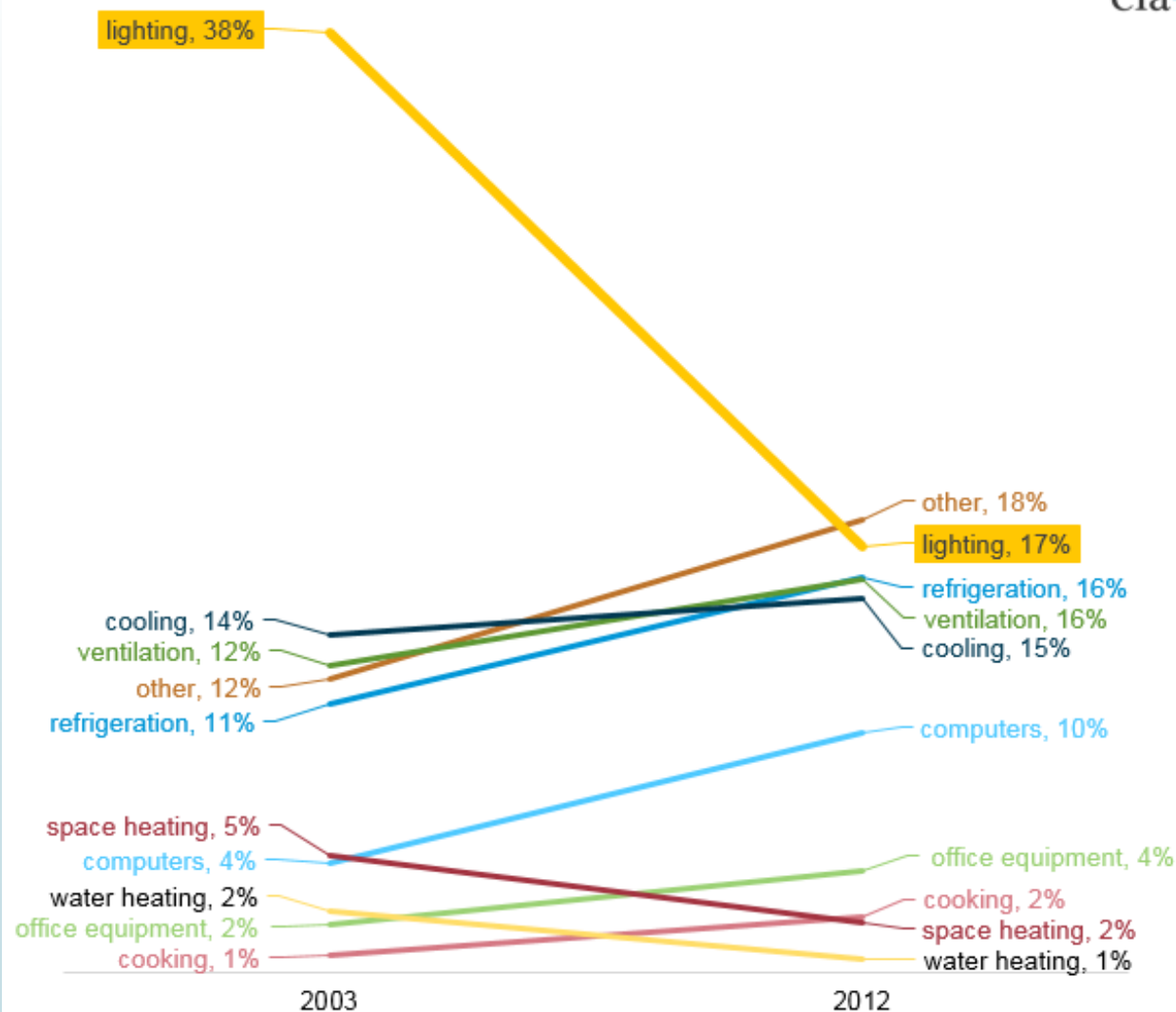


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* International Energy Agency furnished data

Electrical Usage in Commercial Buildings

Figure 4: In the commercial sector, lighting is no longer the largest end use as a share of total electricity consumption



Commissioning pays!

- Retro-commissioning results in average annual energy cost savings \$0.15 per sf.

6.1 times the annual
energy production of
the Hoover Dam



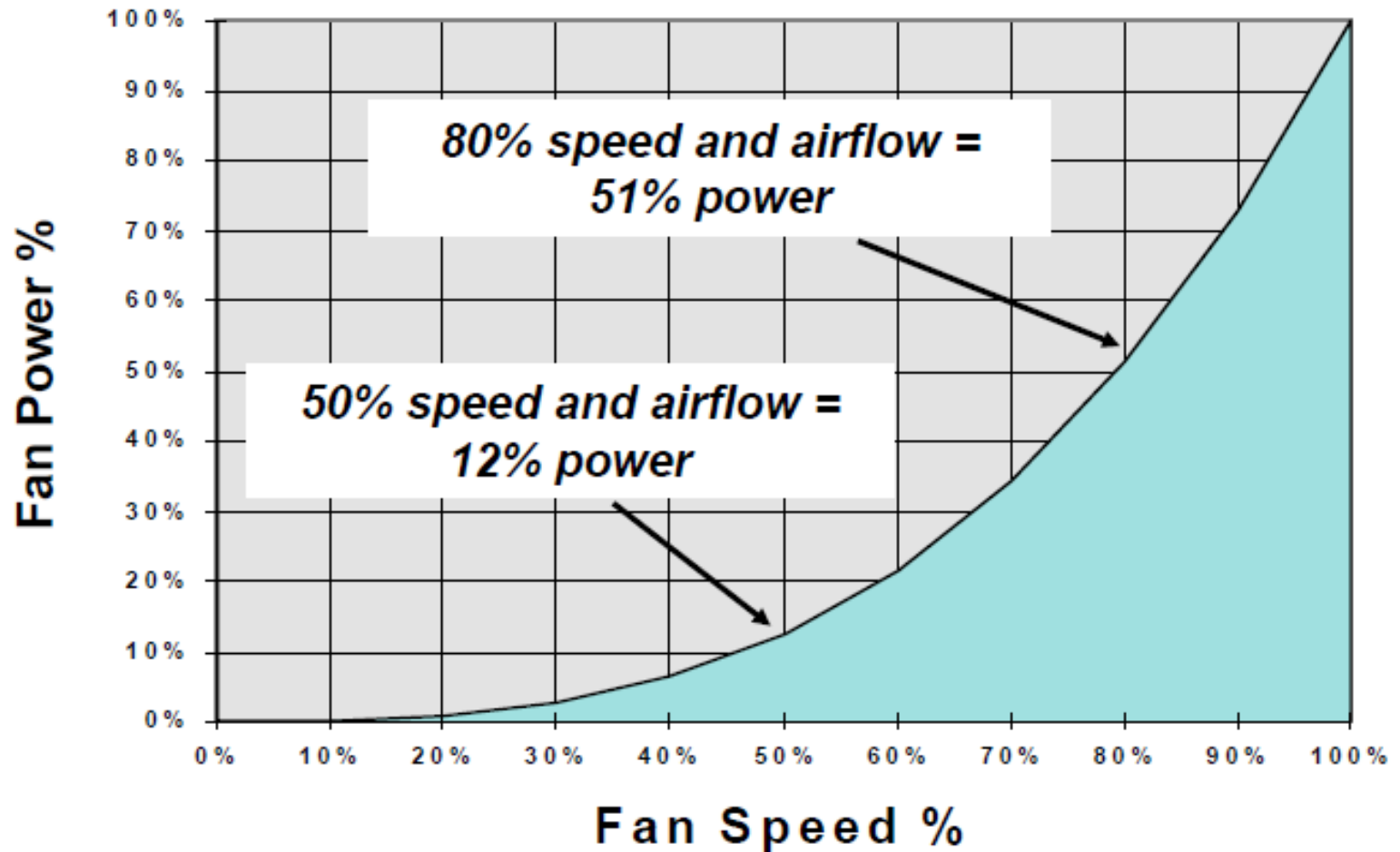
- ROI for an investment in retro-commissioning is 115%



Variable Speed Fan Control

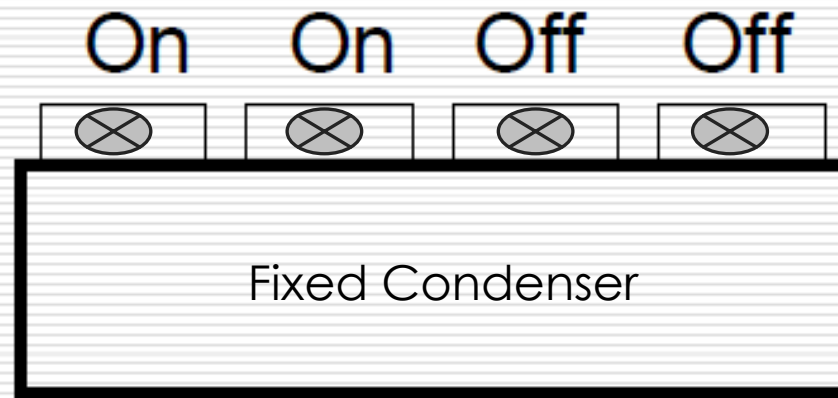
Third power relationship “Affinity law”

- Airflow varies directly with change in speed
- Air pressure varies with the square of change in speed
- Fan power varies with the cube of change in speed



Variable Speed Fan Control

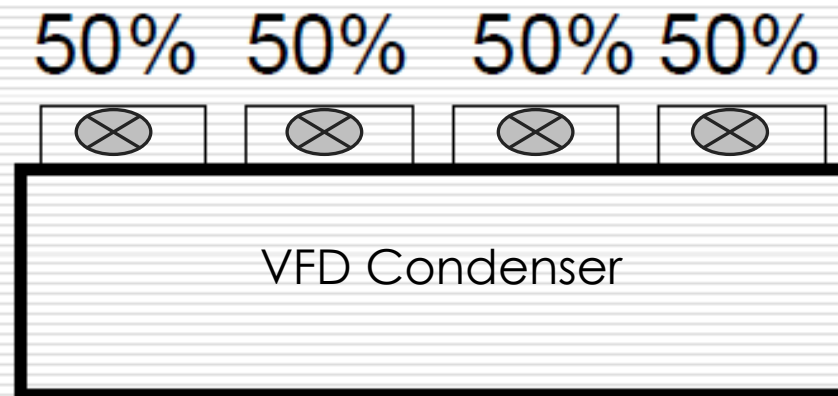
Third power relationship "Affinity law"



50% capacity

50% power

80 BTUH/Watt



50% capacity

12% power

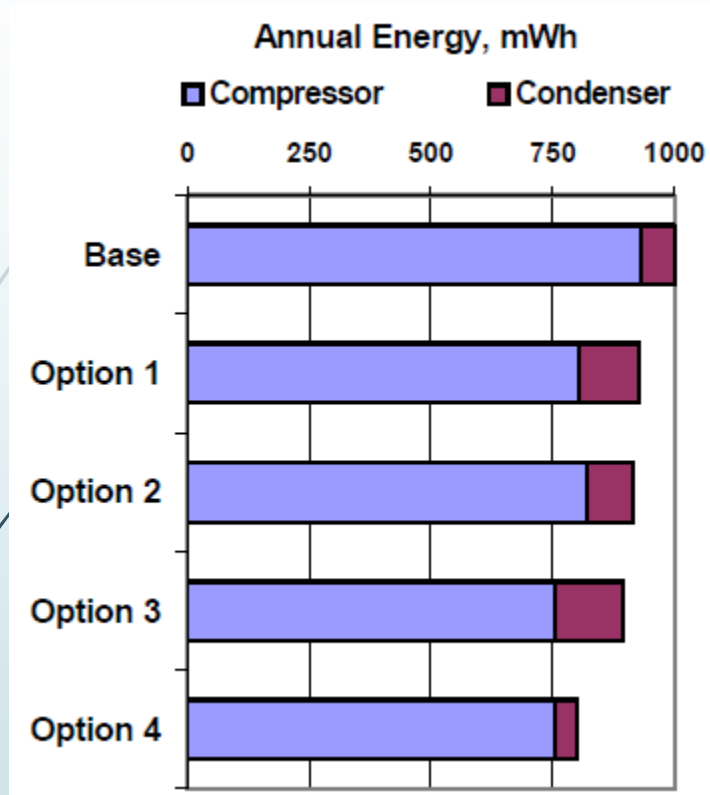
330 BTUH/Watt

FHP Case Study

- Cold storage warehouse, in Stockton, California
- Evaporative condenser, average efficiency
- Hourly analysis
- Fixed setpoint
- Analysis options
 - Fixed setpoint
 - Variable setpoint
 - Variable speed
 - Variable speed with variable setpoint



Results – Variable SP & Speed



Control Options				Savings	Payback	NPV
FHP	FSP	VSP	VFD			
X	X			\$ 6,400	0.3	\$ 63,500
X		X		\$ 8,400	0.6	\$ 80,300
X	X		X	\$ 9,100	4.4	\$ 52,900
X		X	X	\$ 21,600	2.1	\$ 175,300

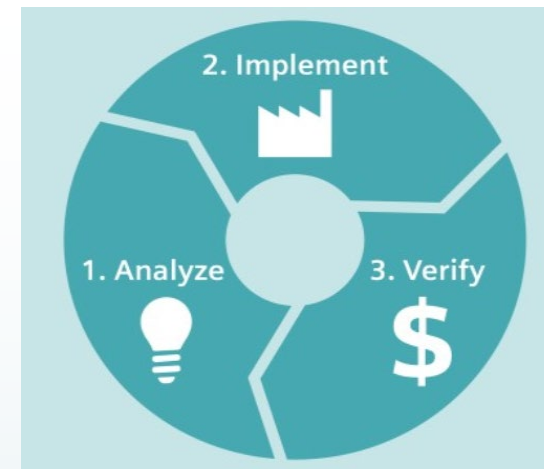
FHP – Fixed head pressure

FSP – Fixed setpoint

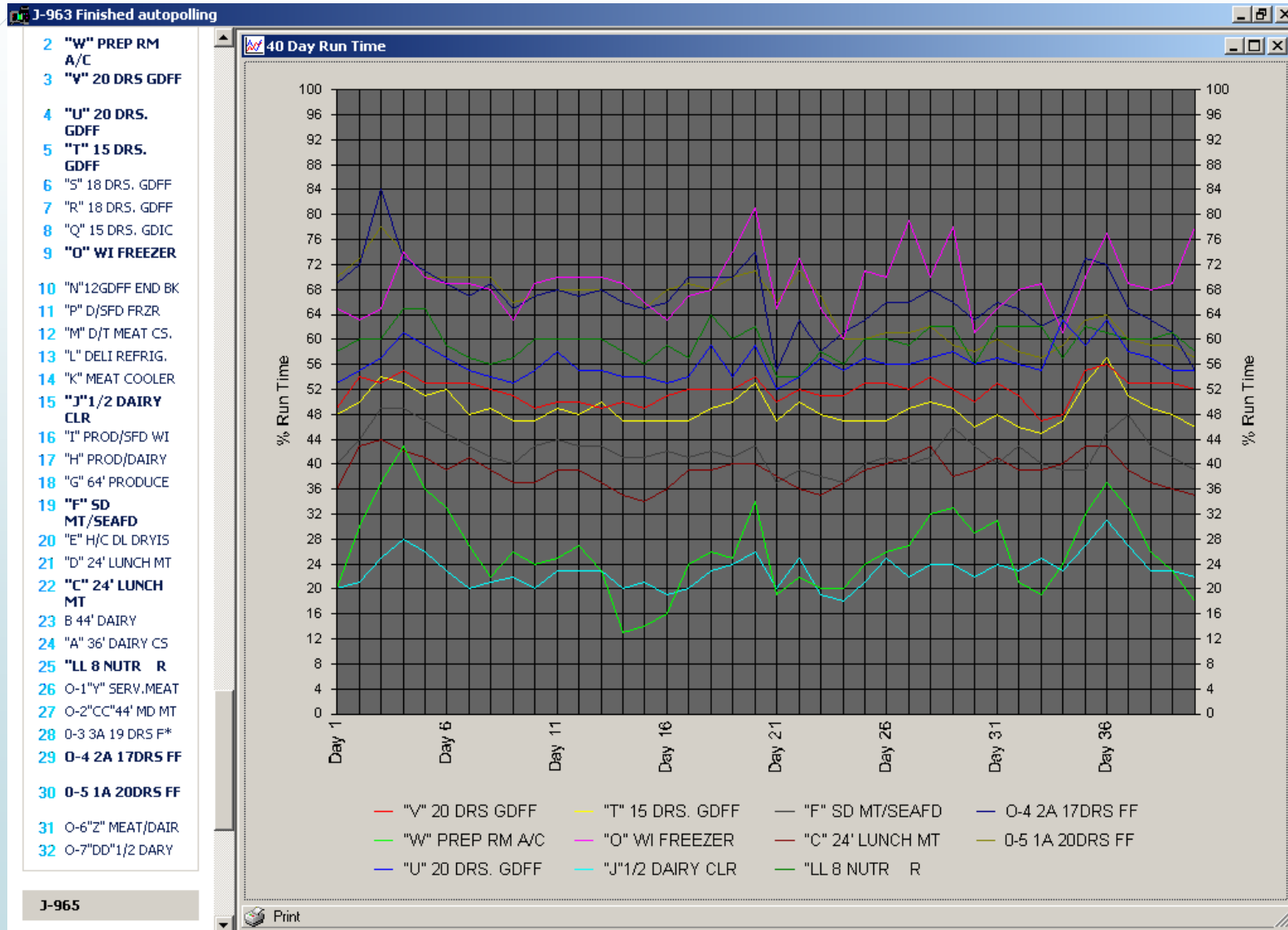
VSP – Variable setpoint

VFD – Variable frequency drive

Xprt-1 Settings for Case Type	Case / T1 Temp.	Defrost Number / Fail Safe Min. / Termination °	R12	39 or 401	R22	R502	80 or 402	10 or 408	62 or 404
3 Deck Meat Impact	28	Four / 35 / 48°	30	28	57				72
5 Deck Produce Impact	38/33	Four / 35 / 48°	35	33	66				82
Cheese Case Old Style	34/29	Three / 50 / 48°	32	30	60				76
Cheese Case Impact	34/29	Four / 30 / 48°	32	30	60				76
D/T Case	-5	Two / 60 / 52°			20	27	31	24	29
Dairy Case Old Style	36/31	Four / 50 / 48°	33	31	62				78
Dairy Case Impact	36/31	Four / 40 / 48°	33	31	62				78
Dairy WI	36	Two / 60 / 48°	33	31	62				78
Deli Refrigeration/Beer	37/32	Three / 50 / 48°	35	33	65				81
Deli WI Freezer	-5	Four / 35			20	27	31	24	29
Floral	40/35	Two / 60 / 48°	38	37	70				87
GDFF Old Style	-2	One / 75 / 52°			21	29	34	27	32
GDFF Impact	-2	One / 40 / 48°			21	29	34	27	32
GDIC Old Style	-7	One / 75 / 52°			19	25	29	23	27
GDIC Impact	-7	One / 40 / 48°			19	25	29	23	27
Juice/Beverage/Nutrition	36/31	Four / 40 / 48°	33	31	62				78
Lunch Meat Old Style	34/29	Four / 50 / 48°	32	30	60				76
Lunch Meat Impact	34/29	Three / 35 / 48°	32	30	60				76
Meat A/C	55	One / 120 / 70°	52	52	93				115
Meat WI	31	Two / 45 / 48°	29	27	56				71
Produce A/C	60	One / 120 / 70°	58	58	102				125
Produce Case Old Style	38/33	Two / 60 / 48°	35	33	66				82
Produce Island Impact	38/33	Four / 45 / 48°	35	33	66				82
Produce Green Impact	38/33	Four / 30 / 48°	35	33	66				82
Produce WI	37	One / 60 / 48°	34	32	65				81
Retarder	37	Two / 60 / 48 °	34	32	65				81
SD Meat (Fresh)	25	Three / 50 / 48°	24	22	49				62
SD Seafood	31/26	Three / 50 / 48°	29	27	56				71
SDFF	-5	Two / 60 / 52°			20	27	31	24	29
Service Meat R3 Impact	28	Four / 40 / 48°							
Service Meat	31	One / 110	29	27	56				71
Self Service 3 Dk Meat	28	Four / 30 / 48°	30	28	57				72
WI Freezer	-9	Two / 35			18	23	27	21	25
Temperature control lower the CI 5# and change timing to 4 minute cycle on, center temp. 1° above and 1° below T1 setpoint.									
Enable the thermostat			R12	39 or 401	R22	R502	80 or 402	10 or 408	62 or 404
Condensing Med Temp	70°	Cut-in / Cut-out	90/70	105/85	141/121				168/148
Condensing Low Temp	65°	Cut-in / Cut-out	85/65	100/80	131/111	145/125	170/150	145/125	156/136
Condensing Gas Defrost	80°	Cut-in / Cut-out			164/144	192/172	210/190	180/160	194/174
Shift for reclaim Center on Throttle or Range	95°	Cut-in / Cut-out	120/100	140/120	190/170	210/190	240/220	210/190	230/210
	20#								
Defrost Termination	42°		39	40	72	84	95	81	89
Defrost Termination	48°		44	50	80	94	107	91	99
Defrost Termination	52°		48	65	87	101	120	98	109
Rack Settings									
Suction Group Set Point			R12	39 or 401	R22	R502	80 or 402	10 or 408	62 or 404
Dead Band 0.2	+22°/+16°			19 / 17	44 / 40		62 / 57	51 / 46	57 / 53
	-14°/-22°				12 / 10		21 / 18	16 / 13	20 / 17
A8 settings	10°	Below condensing setpoint							
A9 settings	4#	Below A8 settings							
Hot water Reclaim	130°-126°	Altech / CPC Temp	Alarms	10°	above	set point	for 90 min		
Hot water Gas	125°-120°	E1 / E2 Temp	Alarms	10°	above	set point	for 60 min		



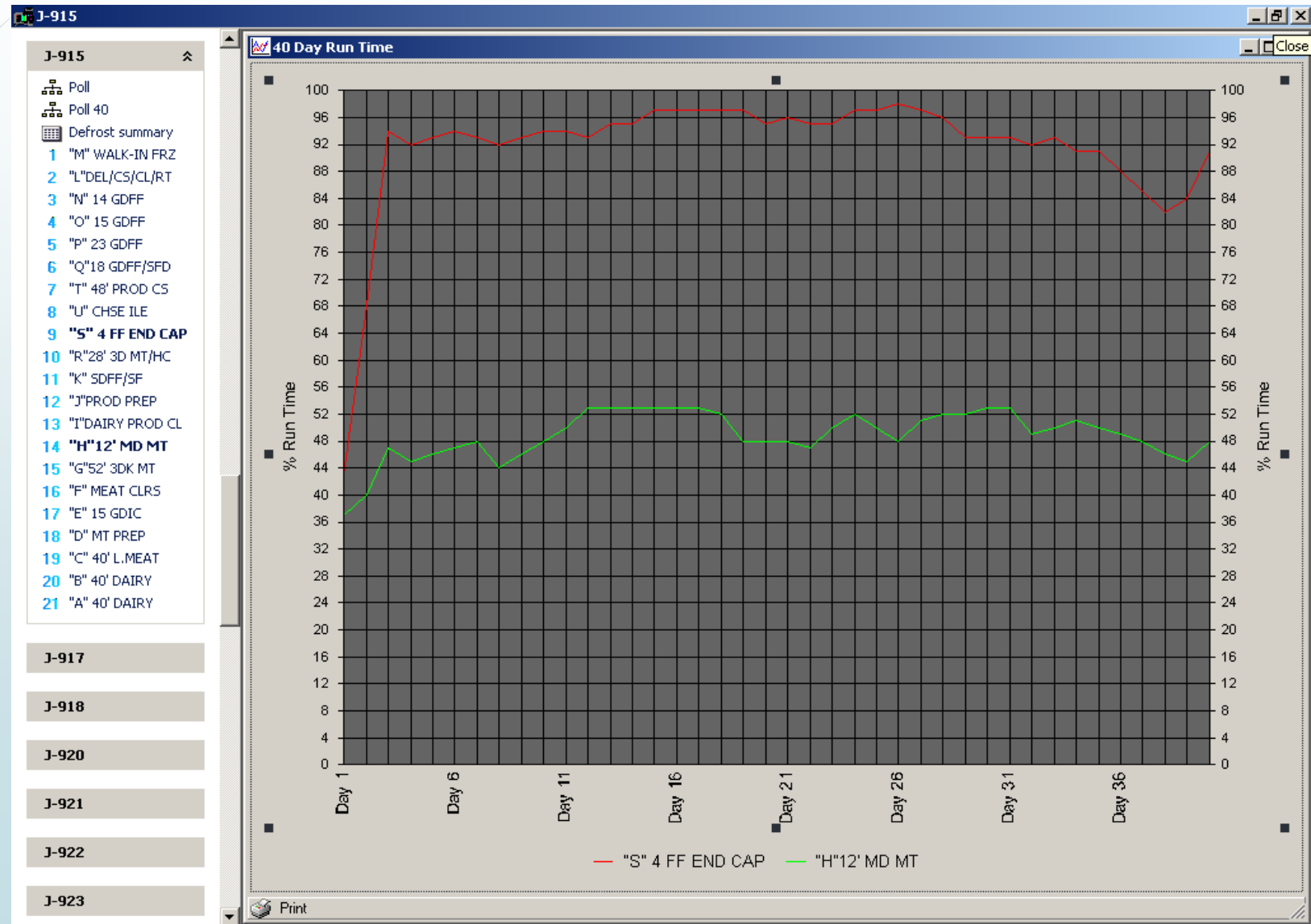
Optimize Setpoints



What Might Have Caused This?



Optimize Setpoints



Optimize Setpoints

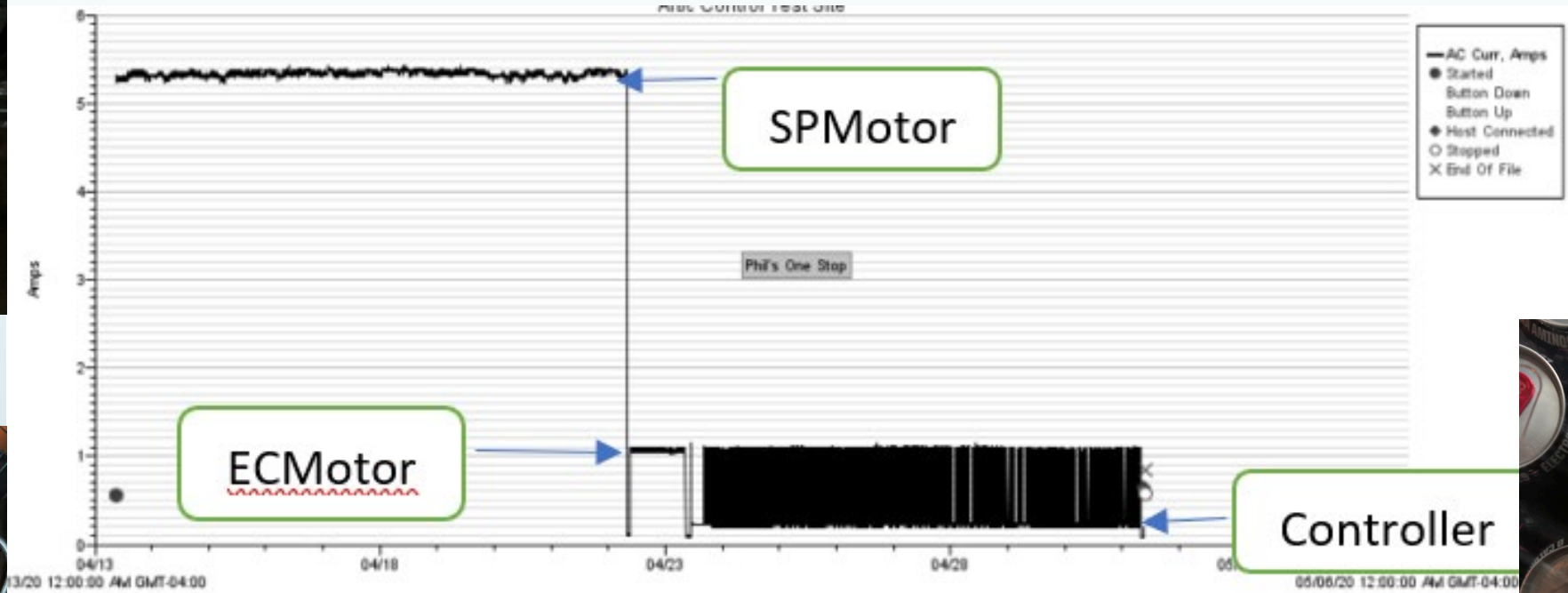


Variable Air Volume at the Evaporator

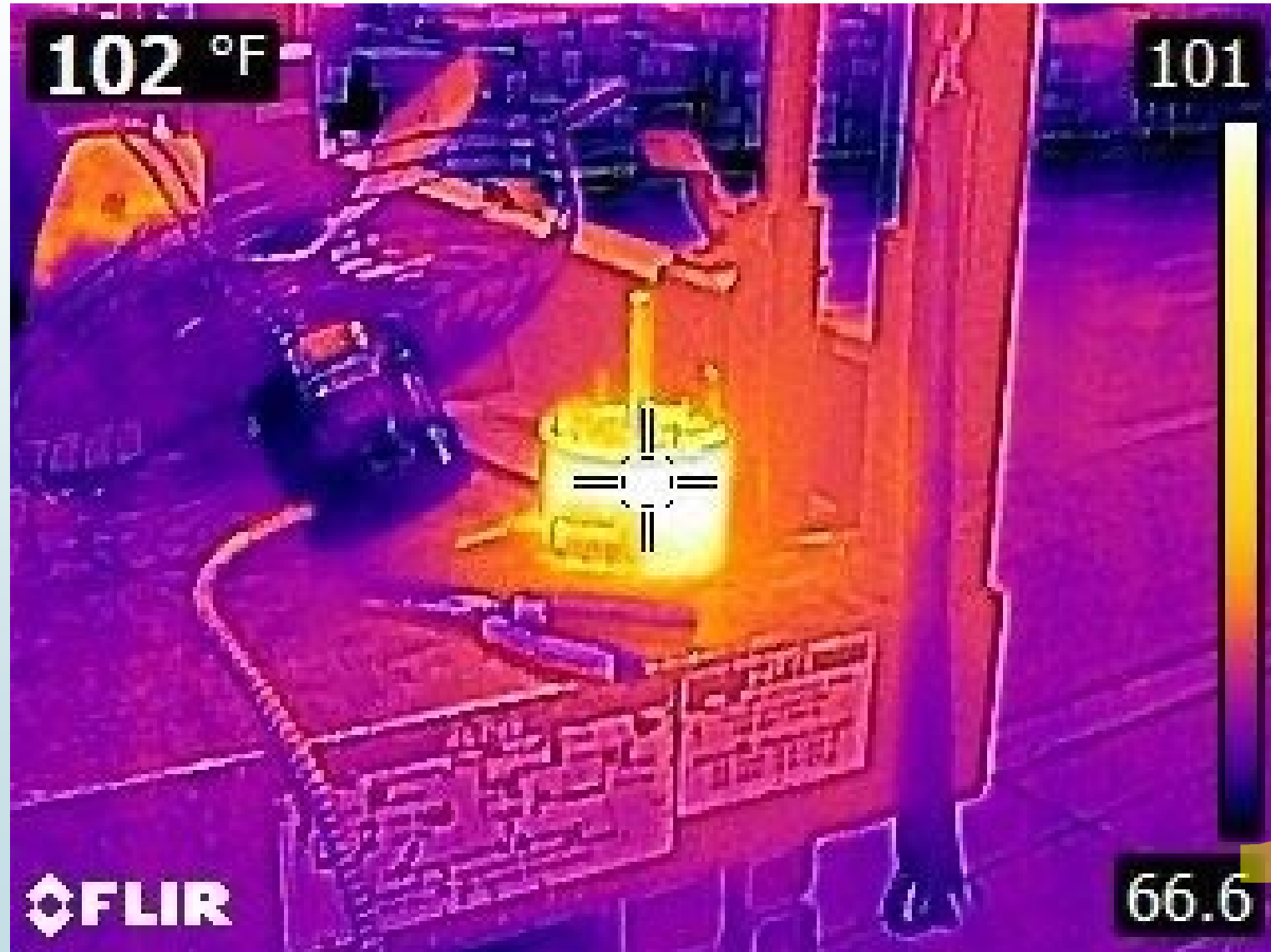
- Vary the fan speed in the cooler
 - Reduce speed and float suction up
- Cycle fans with the temp control
 - All or part of the fans to keep stratification from occurring
- Savings from:
 - Reduced fan energy
 - Reduced cooling load



Cycling Fans with Refrigeration Cycle



Reduced Cooling Load

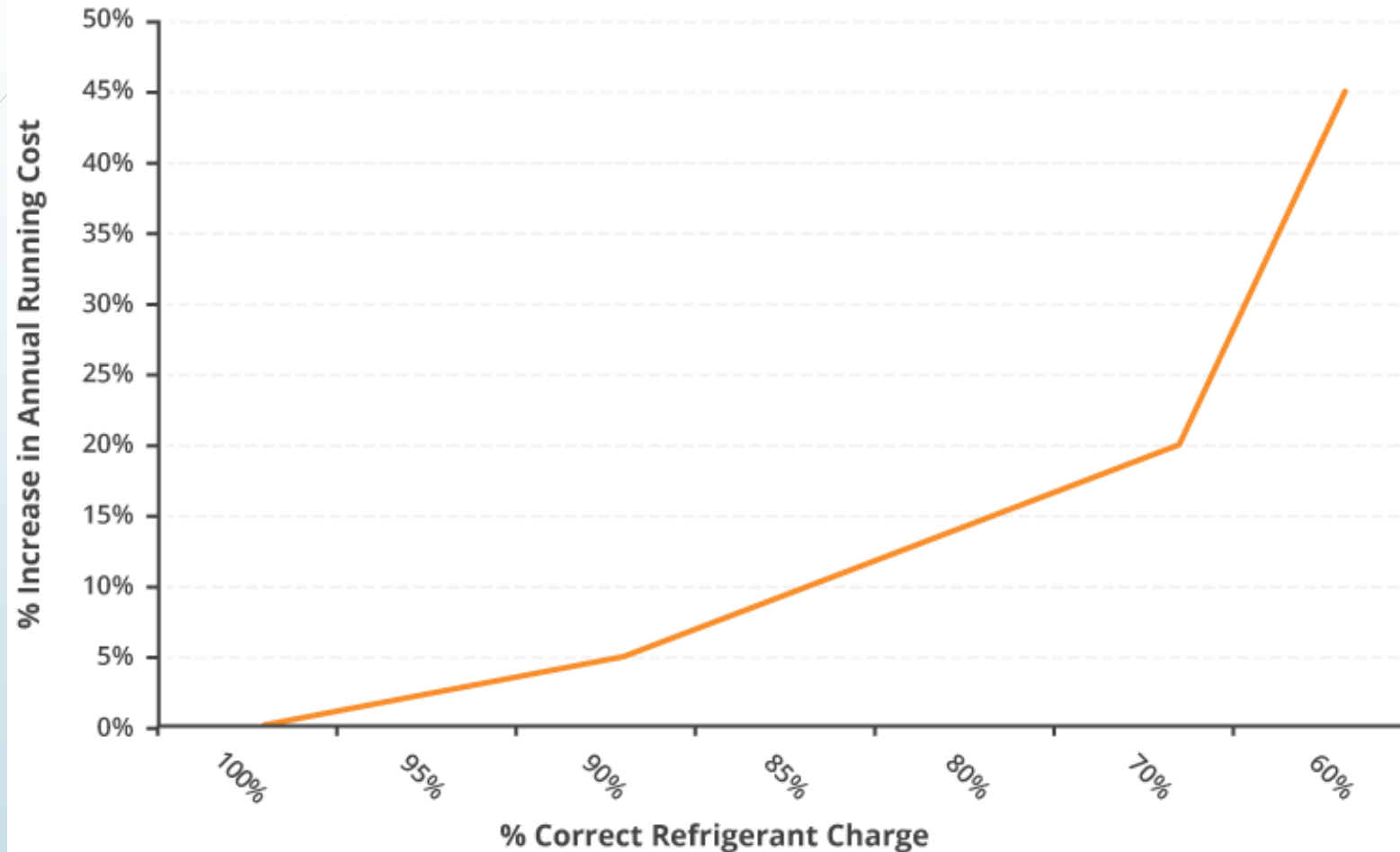


Utility Presented \$39,607 incentive to Grocer



- Utility company presented grocer with a check for \$39,607 for saving close to 900,000 kilowatt hours per year by upgrading their refrigeration control and energy management systems at their cold storage distribution center.
- The refrigeration project, which included the cycling of evaporator fans, floating head pressure and floating suction controls to help reduce energy usage.

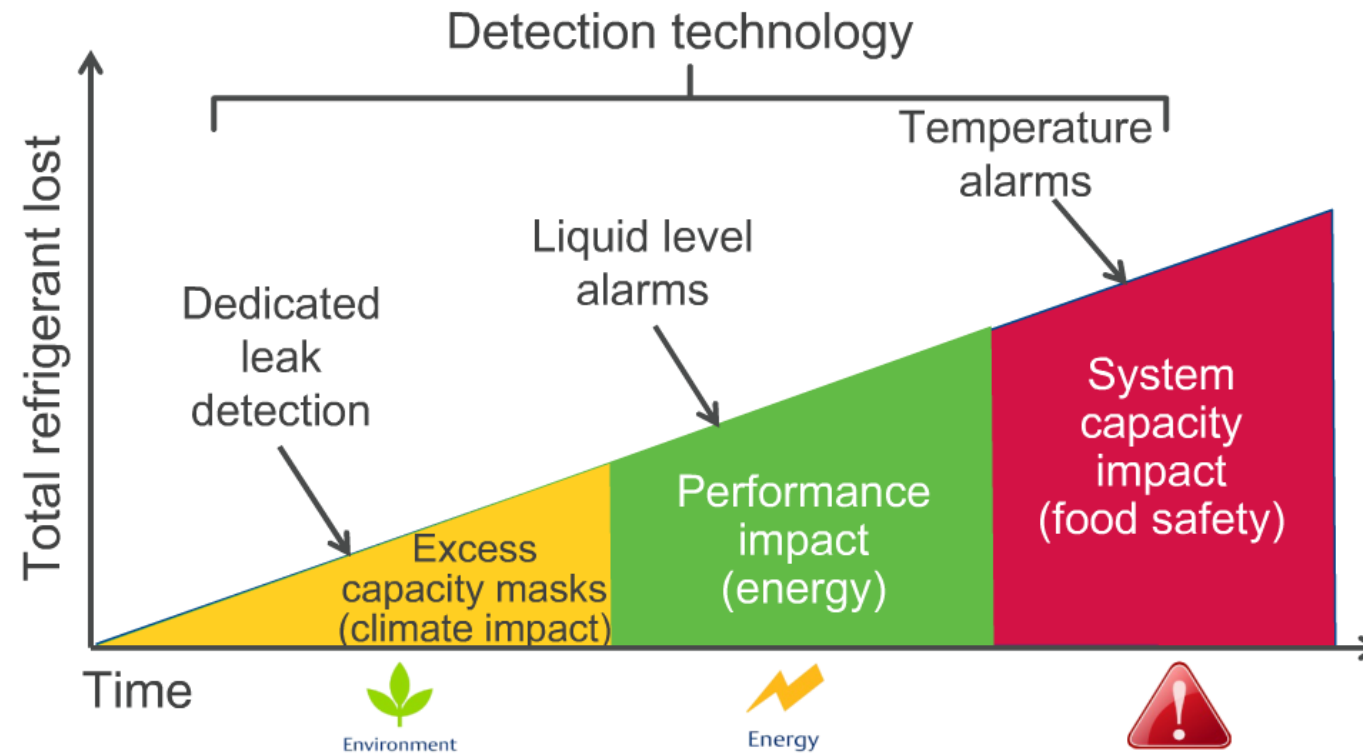
Refrigerant Level Charge – Runtime Penalty



*Bostock, David. "Refrigerant Loss, System Efficiency and Reliability – A Global Perspective." Institute of Refrigeration Annual Conference 2013.

Refrigerant Level Charge

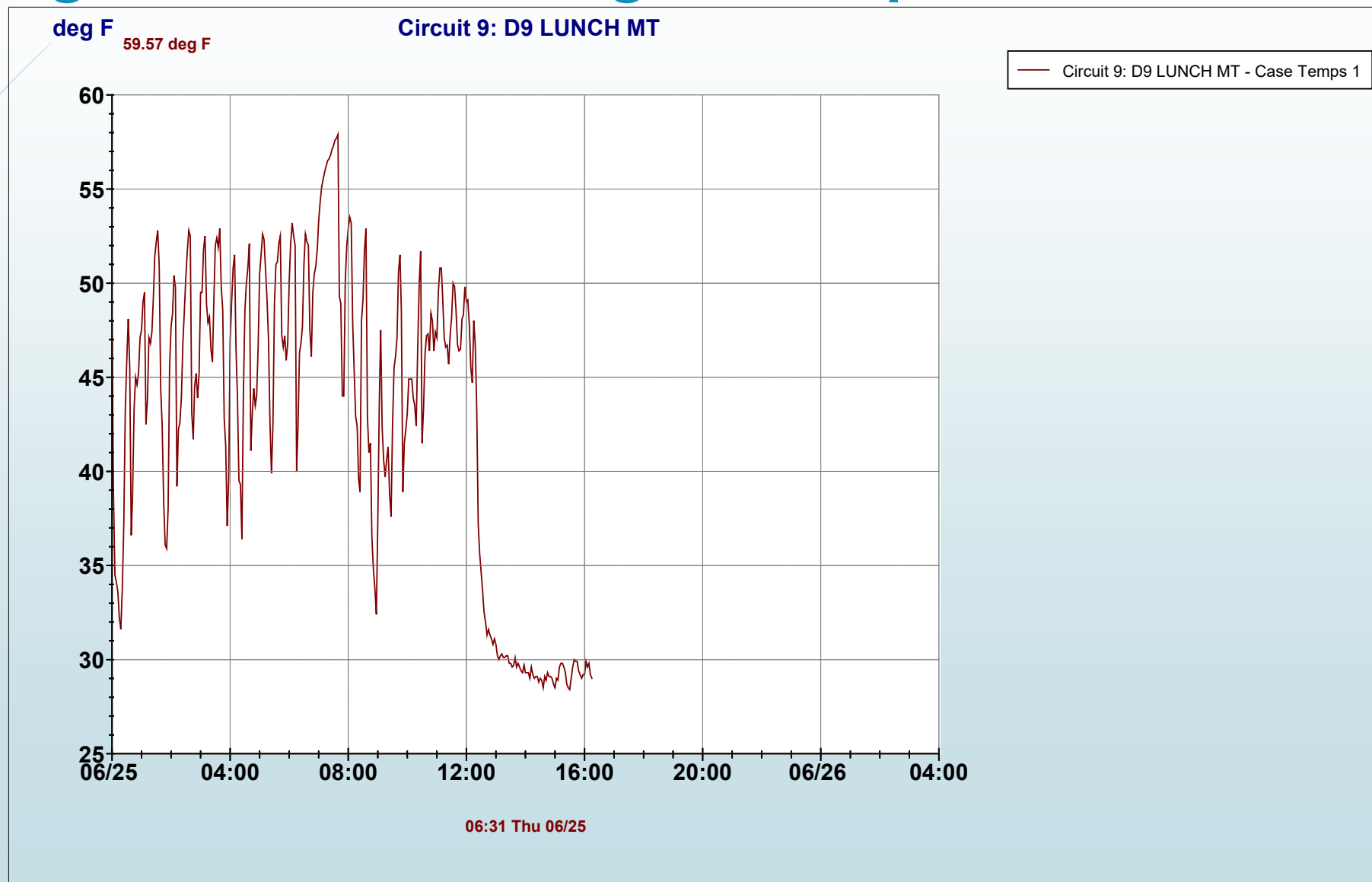
The Benefits of Detecting a Leak Early



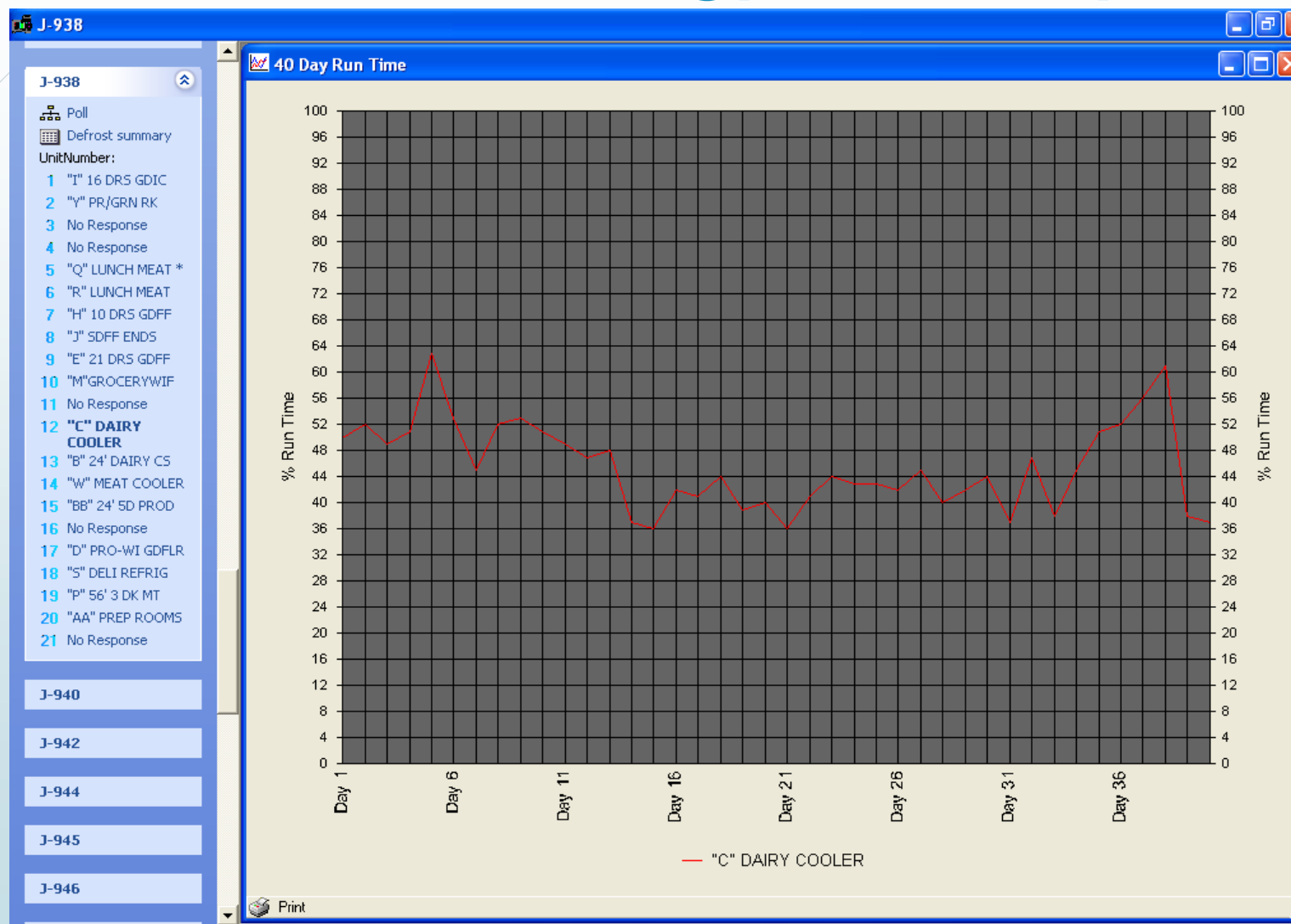
Refrigerant Level Charge

1) Cost to Replace Leaked Refrigerant			2) Sales/Profit		
1. Refrigerant type:	R-404A	click inside the yellow box and select the refrigerant from the drop-down menu	1. Item to be sold (milk, frozen peas, hotdogs, etc.)	milk	type the name of the product in the yellow space
2. Amount of refrigerant leaked (in pounds):	100	type number of pounds in yellow box	2. Units (gallons, pounds, packs, ounces, etc.)	gallons	type the unit of the product in the yellow space
3. Price per pound that you pay for refrigerant:	\$6.83	for \$7.00, type in 7.00	3. Sales price per unit	\$3.50	for \$3.50, type in 3.50
			4. Profit margin per unit sold (in percent):	1.00	for 1%, type in 1; for 2.03%, type in 2.03
Cost to replace leaked refrigerant: <u>\$683</u>			You have to sell <u>19,514</u> gallons of milk to pay the replacement cost of <u>100</u> pounds of refrigerant		

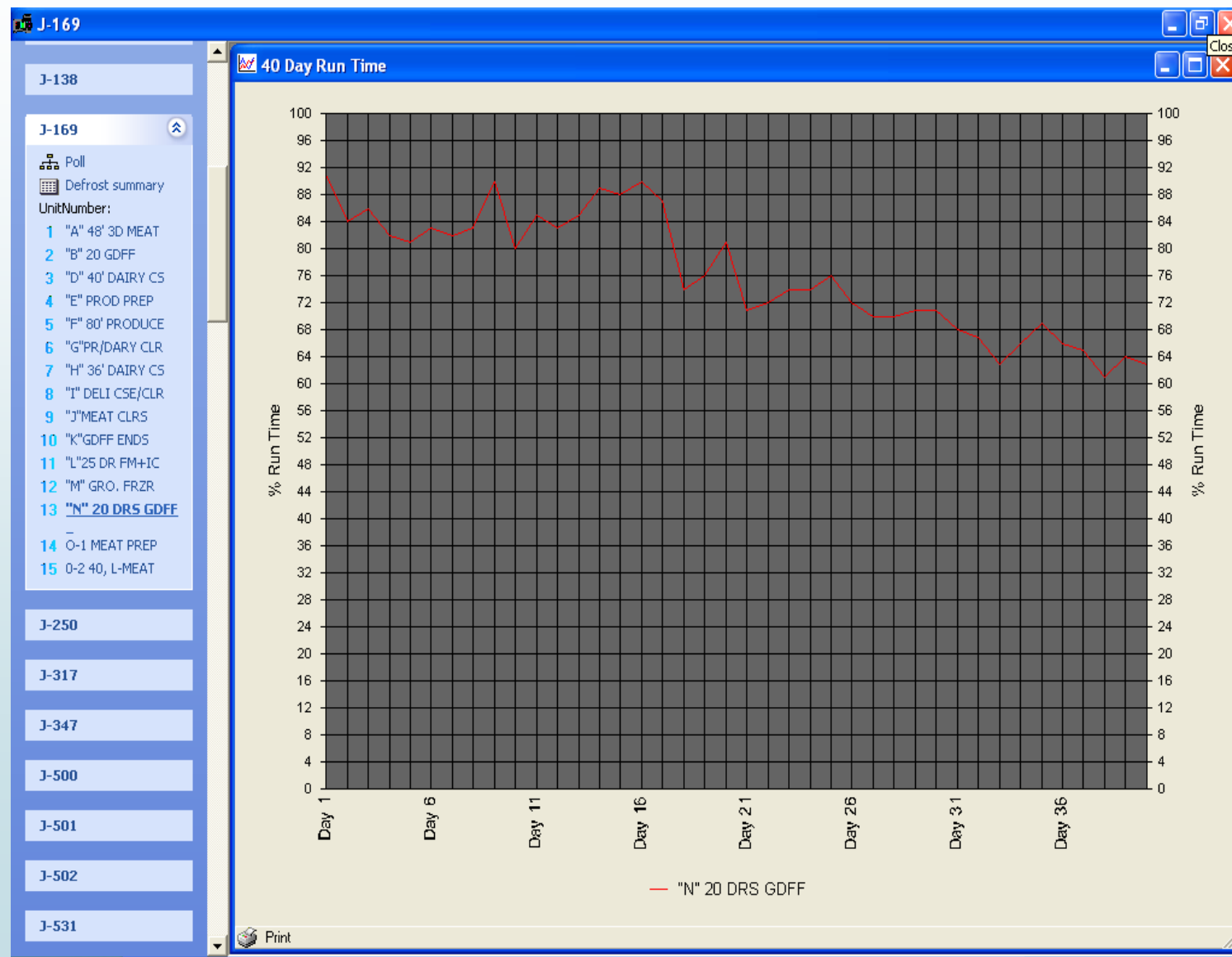
Refrigerant Level Charge - Temperature



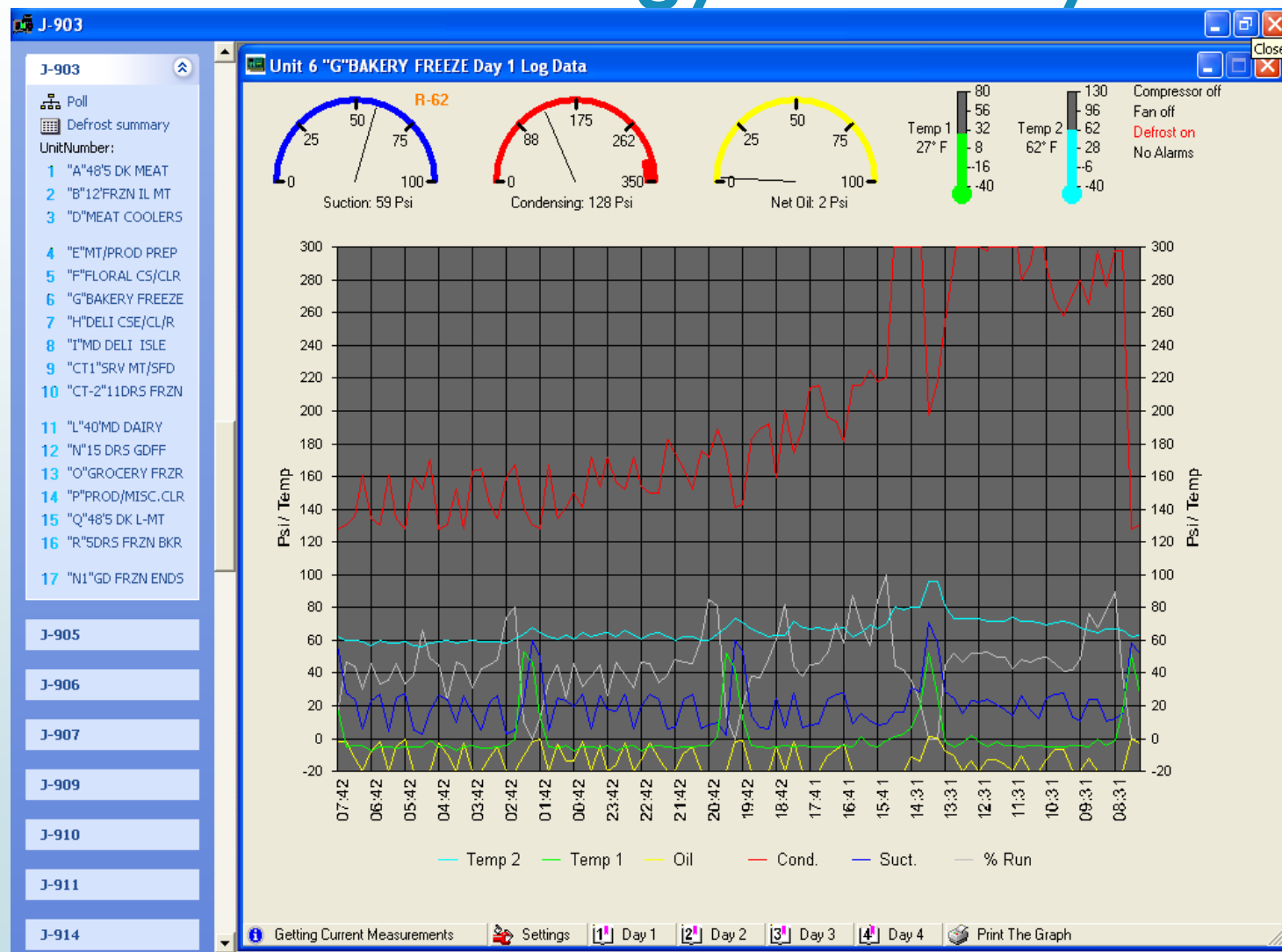
Maintenance and Energy Efficiency



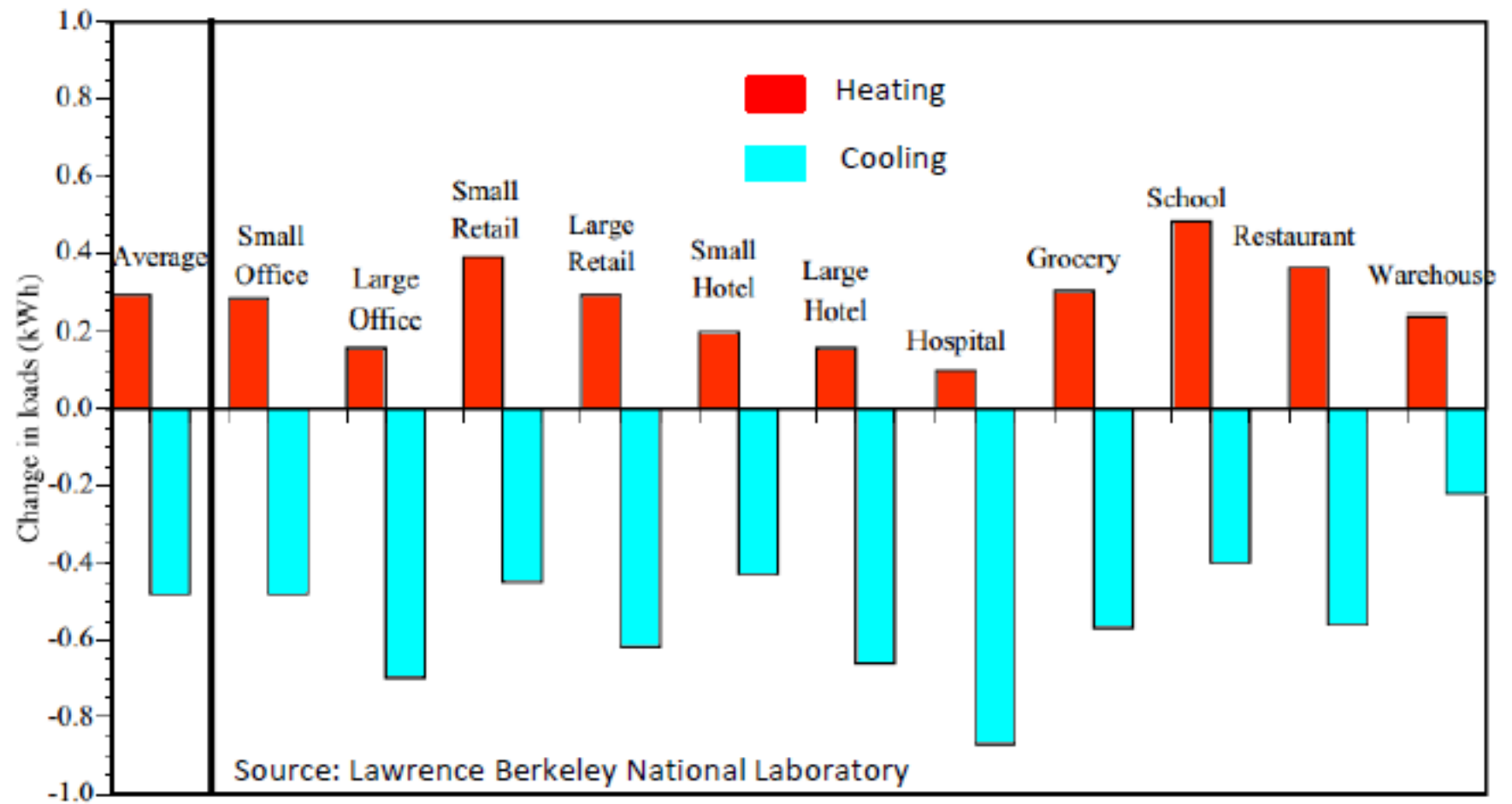
Maintenance and Energy Efficiency



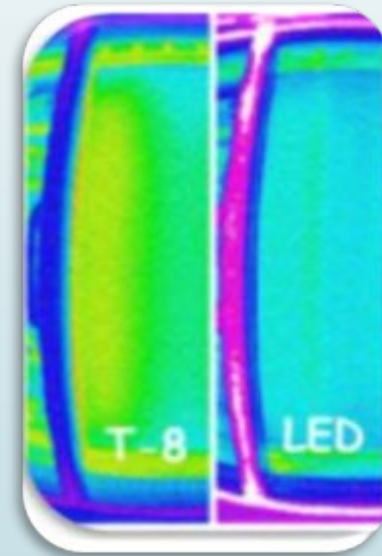
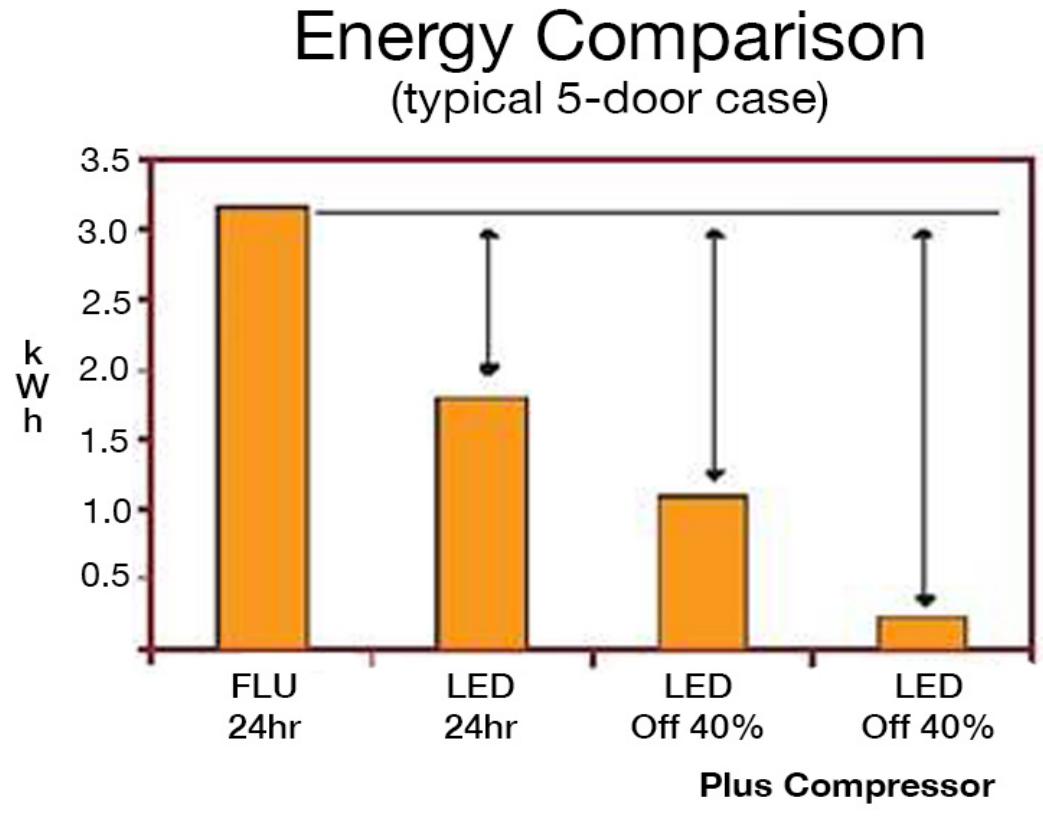
Maintenance and Energy Efficiency



Effects of Lighting Reduction on HVAC



LED Light Savings



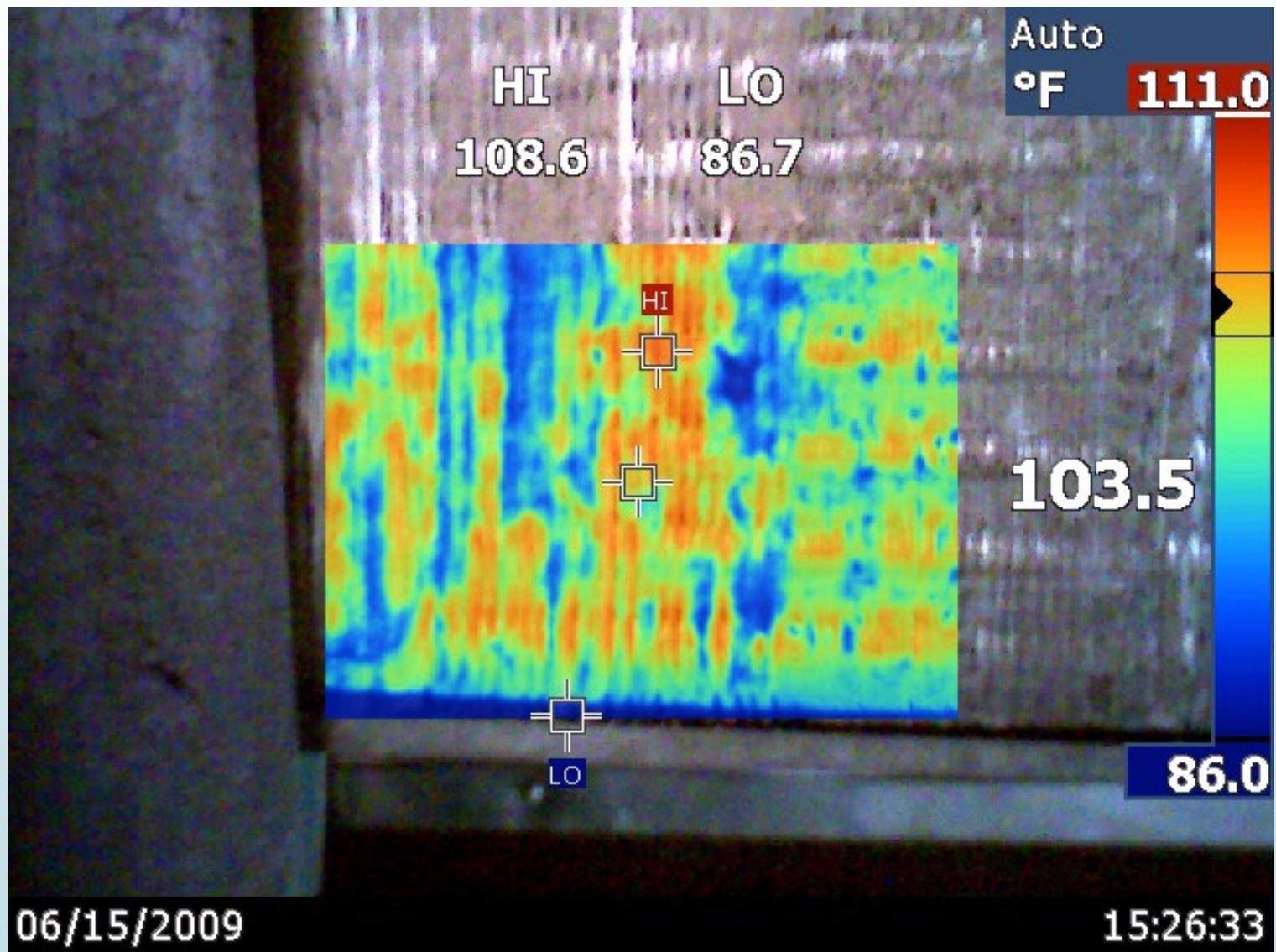
Coil Cleaning

- Reduced electrical usage
- Reduced service calls
- Prolonged equipment life
- Electric savings of 46 – 50%

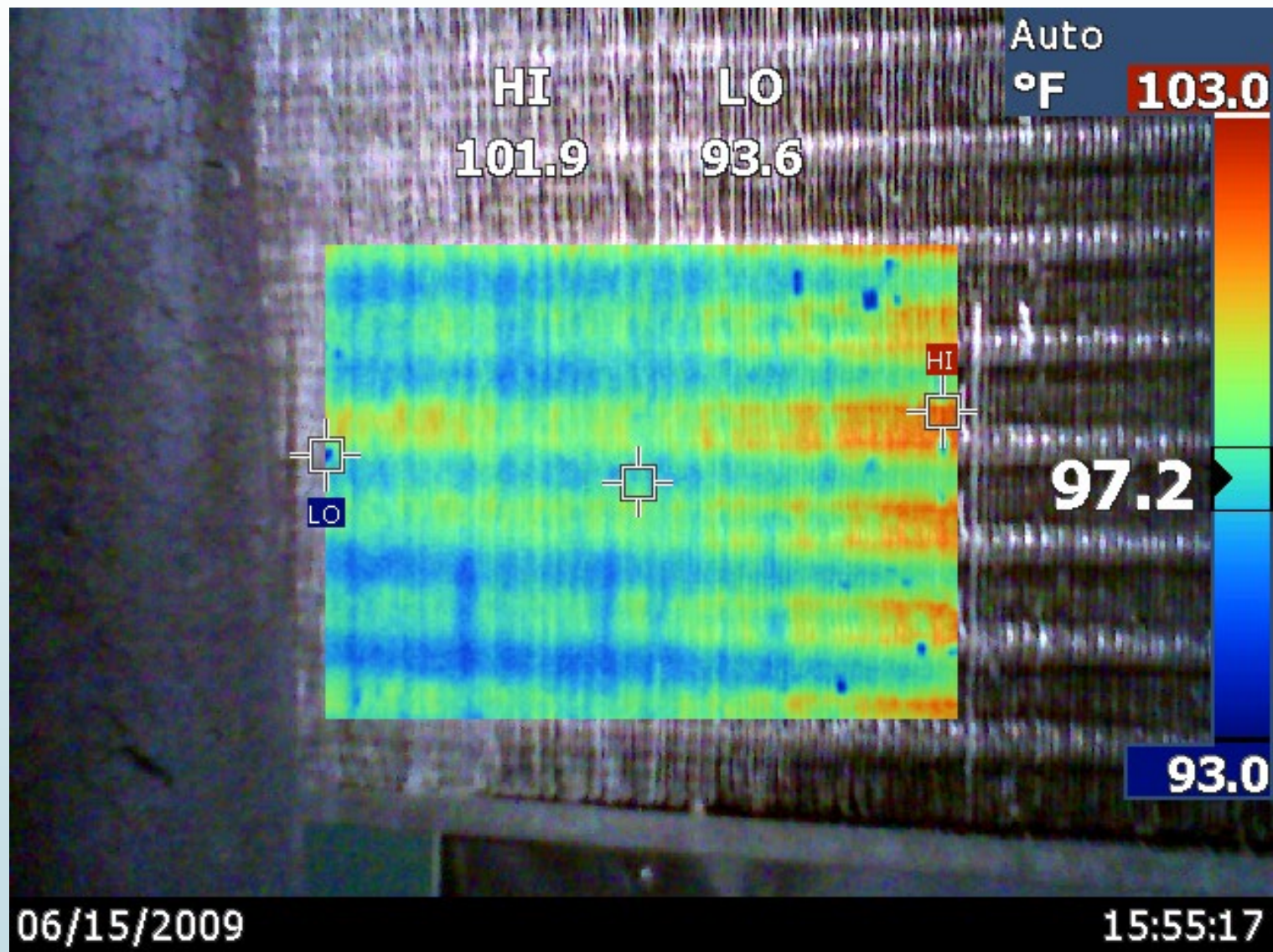
■ *Source Cool Savings Project – FSTC and the City of San Francisco



Maintenance and Energy Efficiency



Maintenance and Energy Efficiency



Maintenance and Energy Efficiency



Maintenance and Energy Efficiency

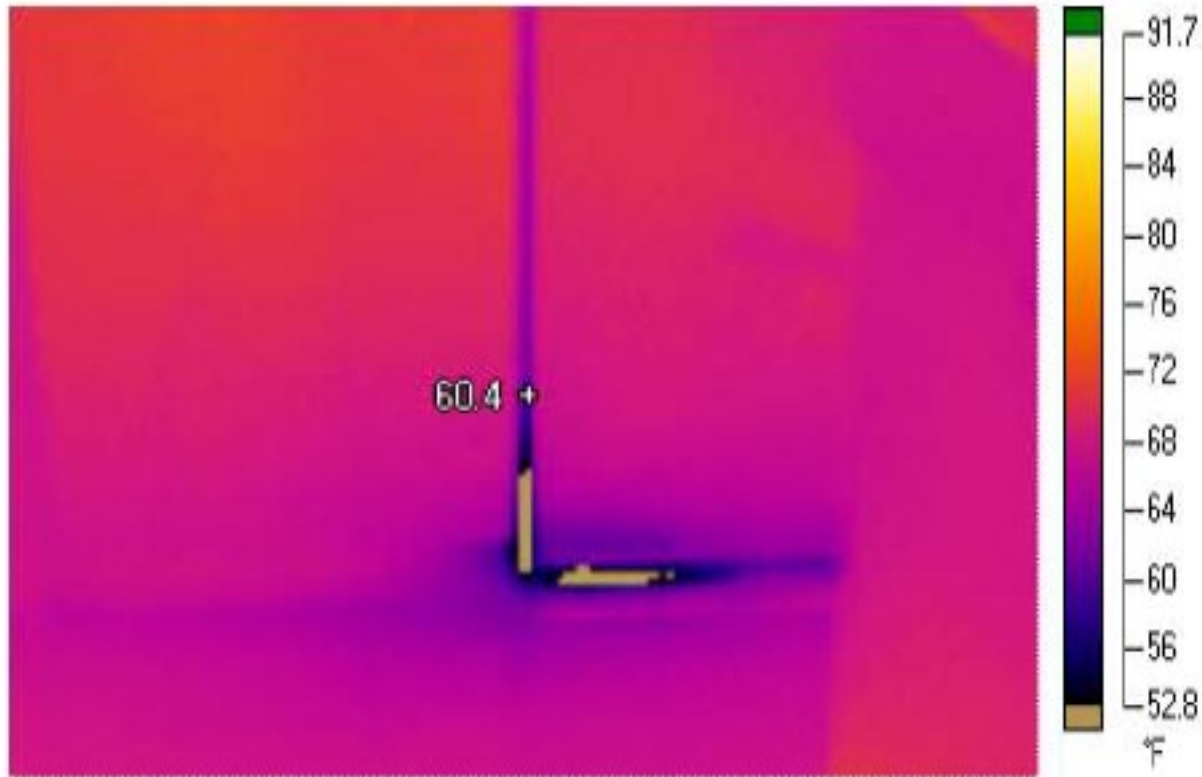


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Visible Light Reference

Maintenance and Energy Efficiency



Economic Analysis for Reach-in Refrigerators

Technology Option	Energy Savings kWh/Year	Energy Savings Percent	Simple Payback \$.1627/kWh
ECM Evap Fan Motor (9W, 2 fan)	454	18%	0.6
ECM Cond Fan Motor (20W)	359	14%	0.5
High Efficiency Compressor	171	7%	0.8
ECM Compressor	288	12%	4.8
Variable Speed Compressor	331	13%	3.7
High Efficiency Fan Blade	171	7%	0.2

*U.S DoE, commercial refrigeration equipment research opportunities

Anti-Sweat Heater Controls

Refrigeration Measures & Specifications	Incentive	Quantity	Extended Incentive
Anti-Sweat Heater Controls to Low temp case (below 0F,)	\$21	145'	\$3,045
	per linear foot of door width		
T8 to LED Lights, Side bar (single), Reach-In Cooler / Freezer	\$5	440'	\$2,200
	per linear foot of lamping		
Motion Sensors on LED cases, Side bar (single), Reach-In Cooler / Freezer	\$1	440'	\$440
	per linear foot of lamping		
Totals Saving over \$10,000 on the electric bill. <small>Based on .09 cents.</small>	Total kWh Savings		\$5,685
	121,410		



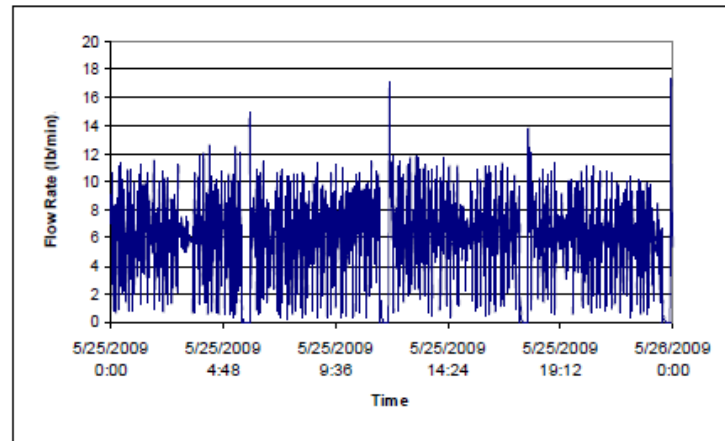
Add Doors to Open Dairy Case



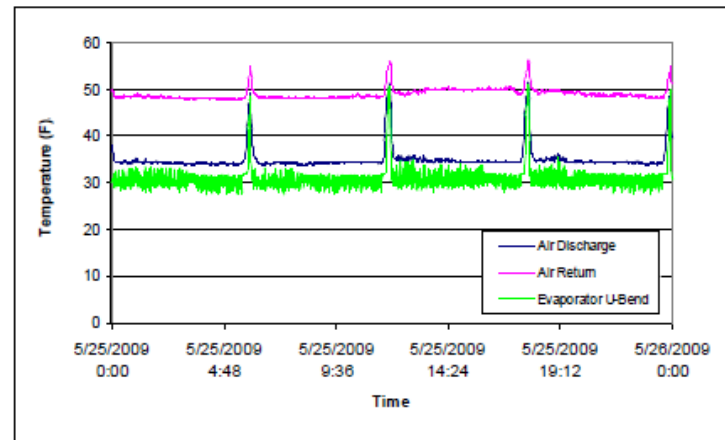
*University of Missouri, Kansas City

Energy Related Data

– New Open Case Line-Up –

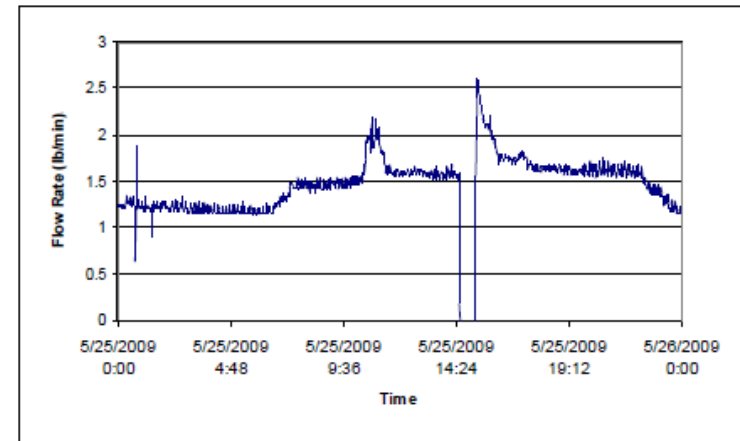


Refrigerant Flow Rate

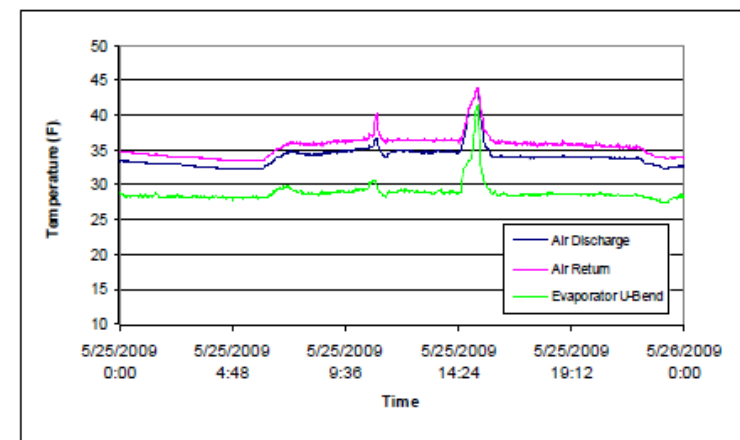


Display Case Temperatures

– New Doored Case Line-Up –



Refrigerant Flow Rate



Display Case Temperatures

Energy Related Data

Mean Electrical Energy Consumption of the Open and Doored Display Case Line-Ups Calculated using ARI/ANSI Standard 1200-2006.

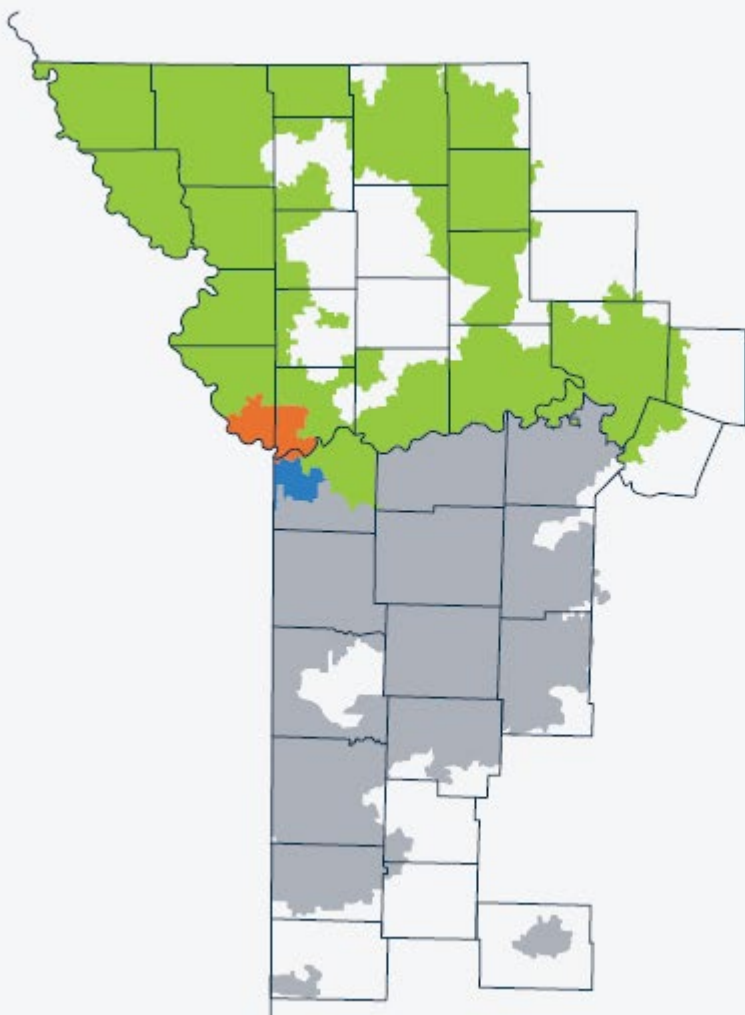
Electrical Energy Consumption	Open Display Case Line-Up	Doored Display Case Line-Up
Compressors (kWh/day)	42.20	11.70
Lights (kWh/day)	5.18	11.93
Fans (kWh/day)	5.69	4.58
Anti-Sweat Heaters (kWh/day)	--	15.50
Total (kWh/day)	53.07	43.72
Total (kWh/day per ft)	2.21	1.71

Without Anti-sweat Heaters





Energy Savings Potential



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