On Balance:

Heat Rejection Control

a Packaged Solution

Echelon Americas
Channel Partner Conference
March 11, 2005

Presented by
Doug Scott
VaCom Technologies
La Verne, California

Opportunity

An integrated packaged control with:

- Broad applicability
- Value to end users
- Value to integrators
- Open systems benefits

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Description

One-box integration of:

- Variable speed drives
- Bypass controls
- Controller
- User interface
- Energy efficiency
- Communications

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Application

Any type of heat rejection to ambient:

- Air-cooled condensers
- Evaporative-cooled condensers
- Fluid coolers (evap or air-cooled)
- Cooling towers

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Value to Owners

- Lower installed cost
- Lower operating costs
- Reliability
- Serviceability
- Easier life-cycle cost maintenance

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Value to Integrators

- Higher delivered value to owner
  - Differentiation with life cycle cost
- Save cost and time vs. custom build
- New business
  - Retrofit previous projects
  - First opportunity for new customers
  - Leverage utility incentives

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Add to Open Systems Value

- Subsystem control example:
  - Integrate subsystem elements
  - Built-in energy efficiency optimization
  - Push intelligence closer to end-use
- Information = service opportunity
  - Manufacturers monitor during warranty
  - Third party service and monitoring
- Flexibility: integrate now or later

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Energy Background

- Concepts
  - Vapor compression cycle
  - Lift and floating head pressure
  - Variable speed – affinity laws
  - System balance

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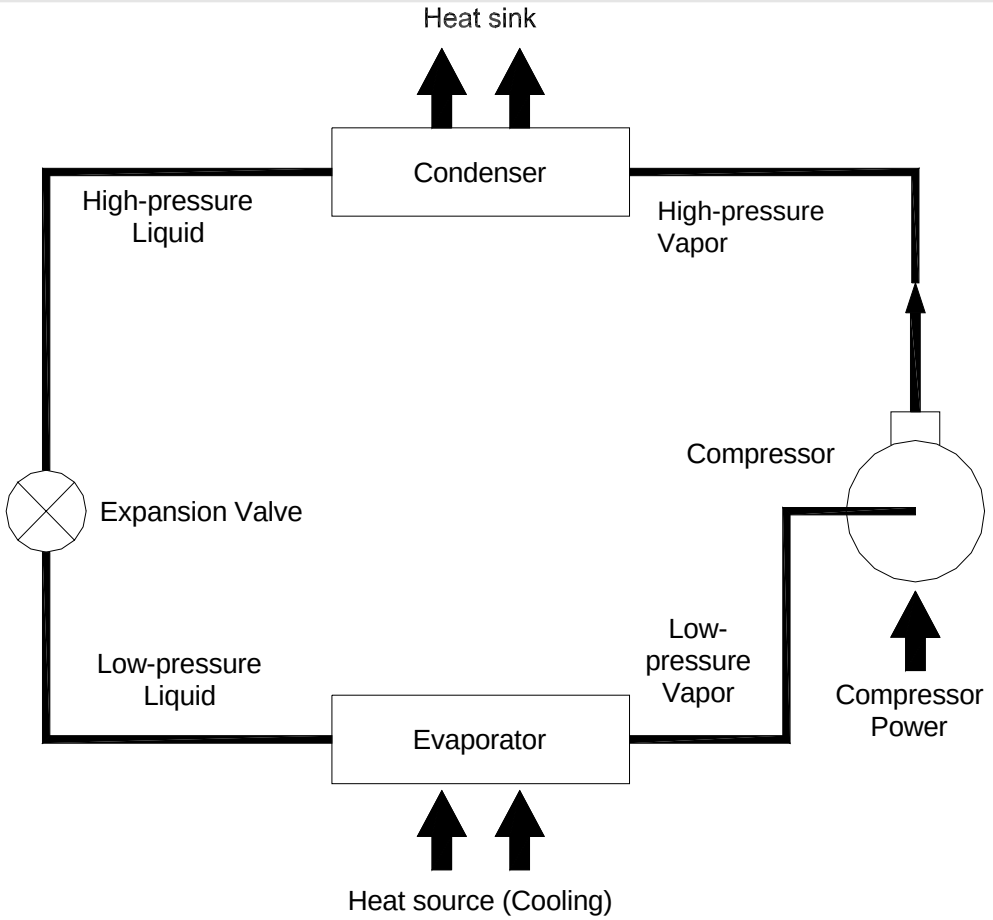
Vapor Compression Cycle

BASIC CONCEPTS

- **Energy is conserved -- energy in equals energy out.**
- **Compressor pumps vapor; refrigerant has the cooling effect: Lb/Hr X BTU/Lb= BTU/Hr**



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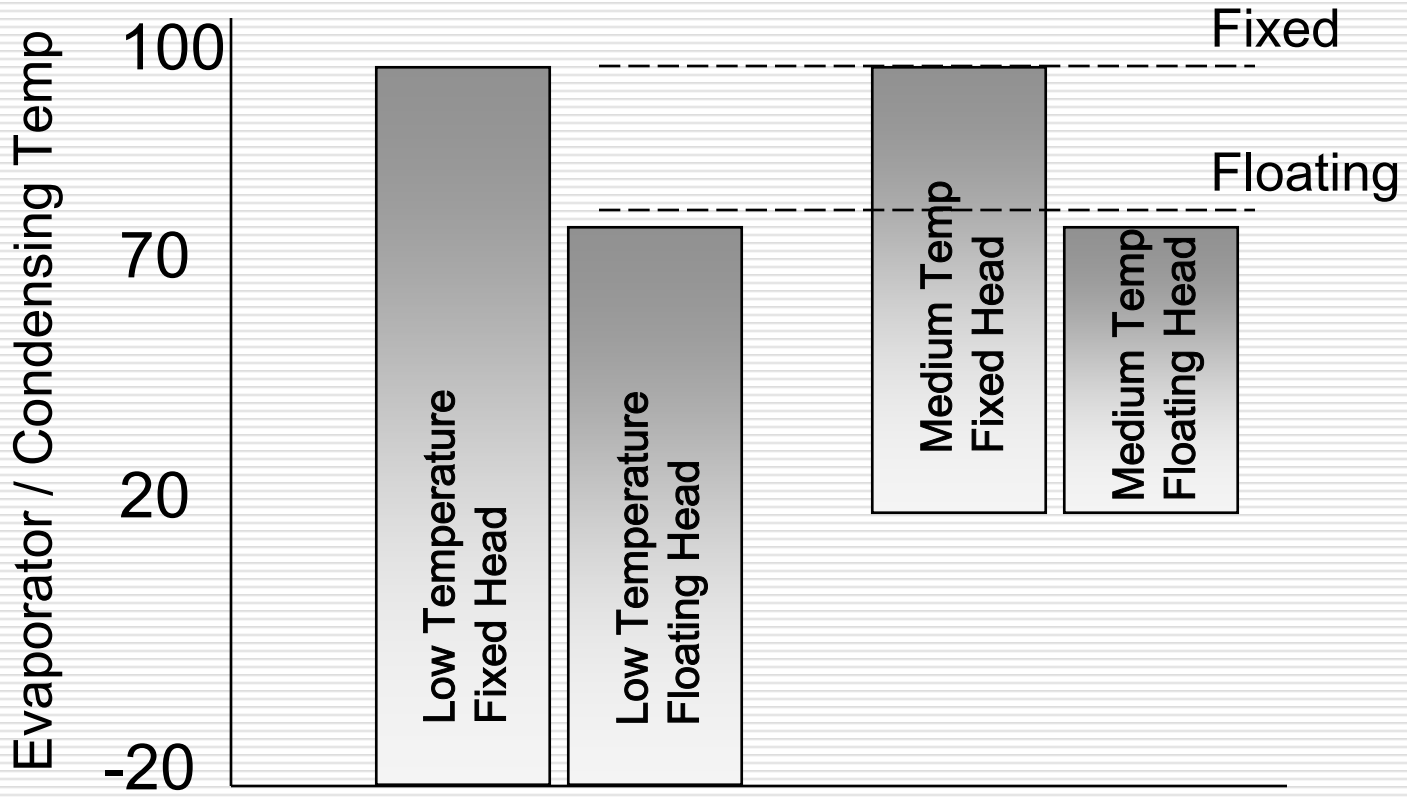
Cooling System “Lift”



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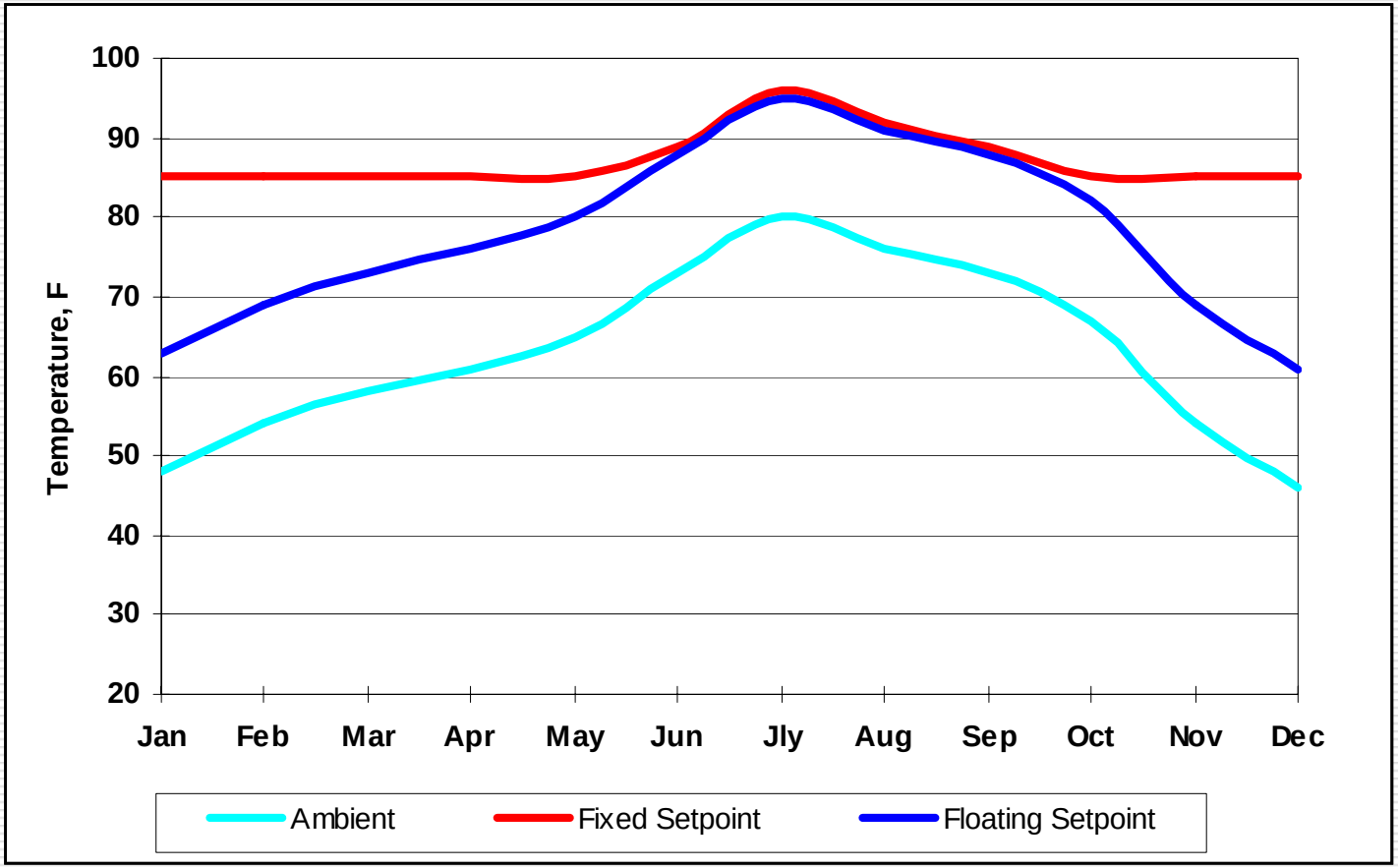
Fixed vs. Floating Head Pressure



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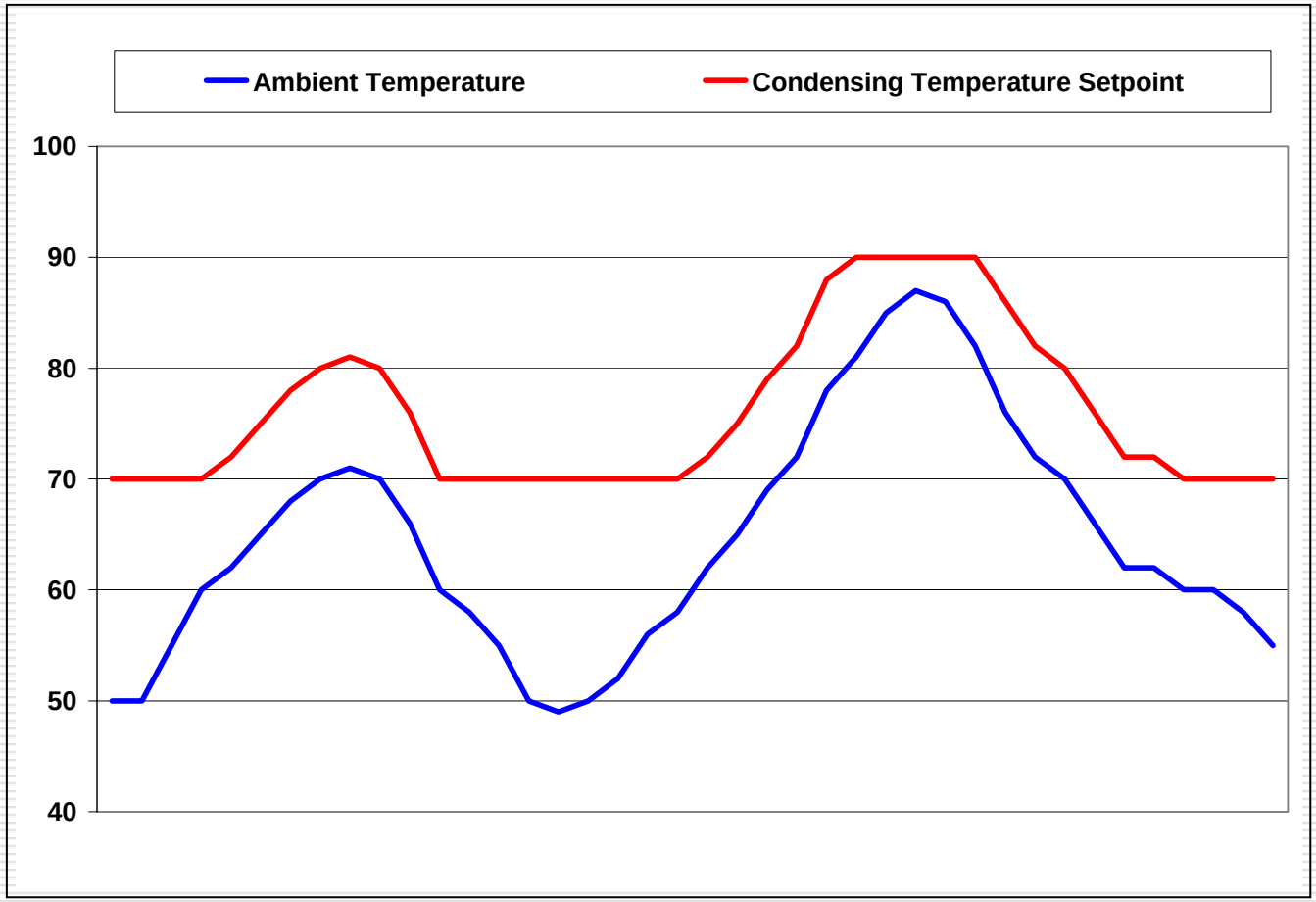
Variable Setpoint Control



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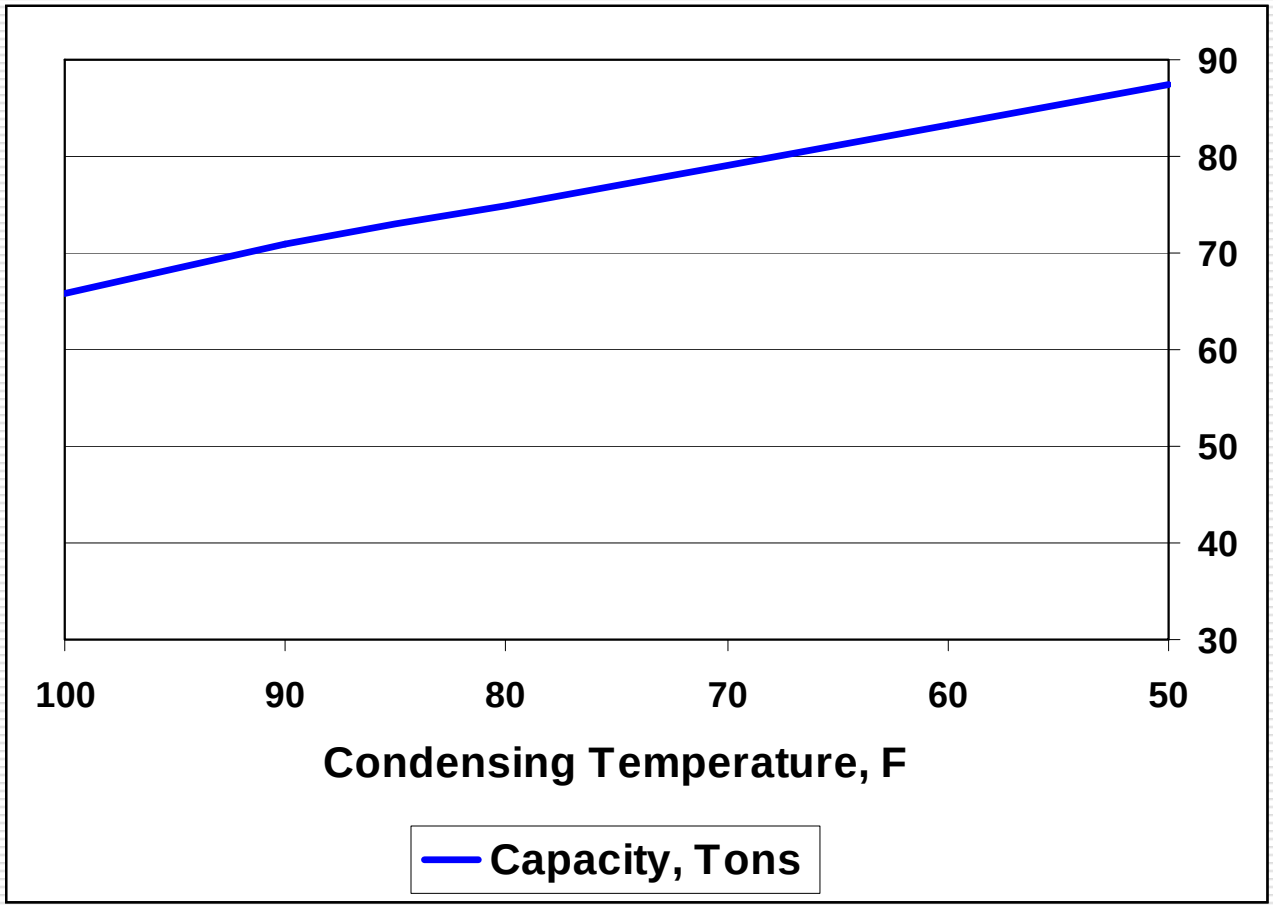
Floating Head Pressure –
Impact on capacity



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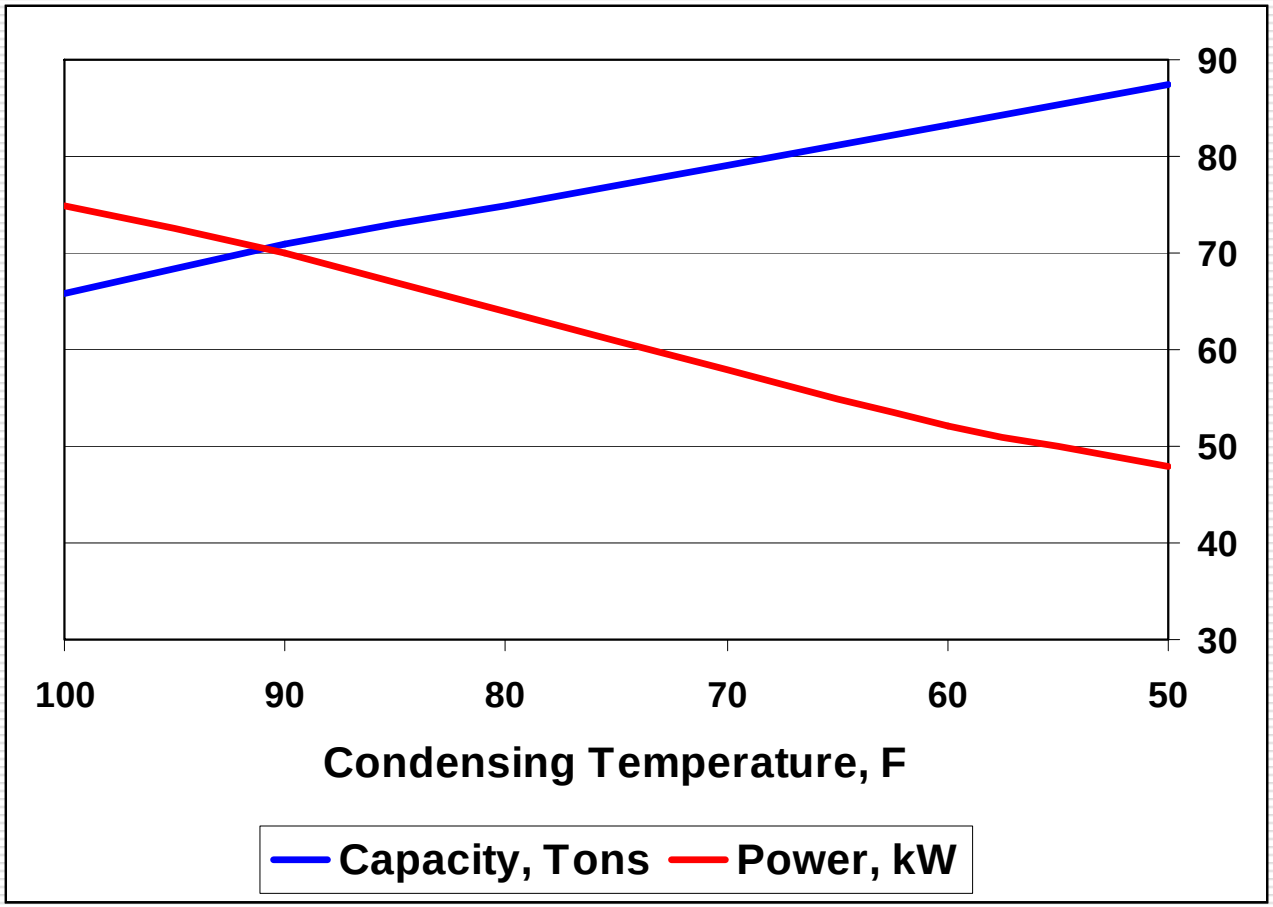
Floating Head Pressure –
Impact on capacity and power



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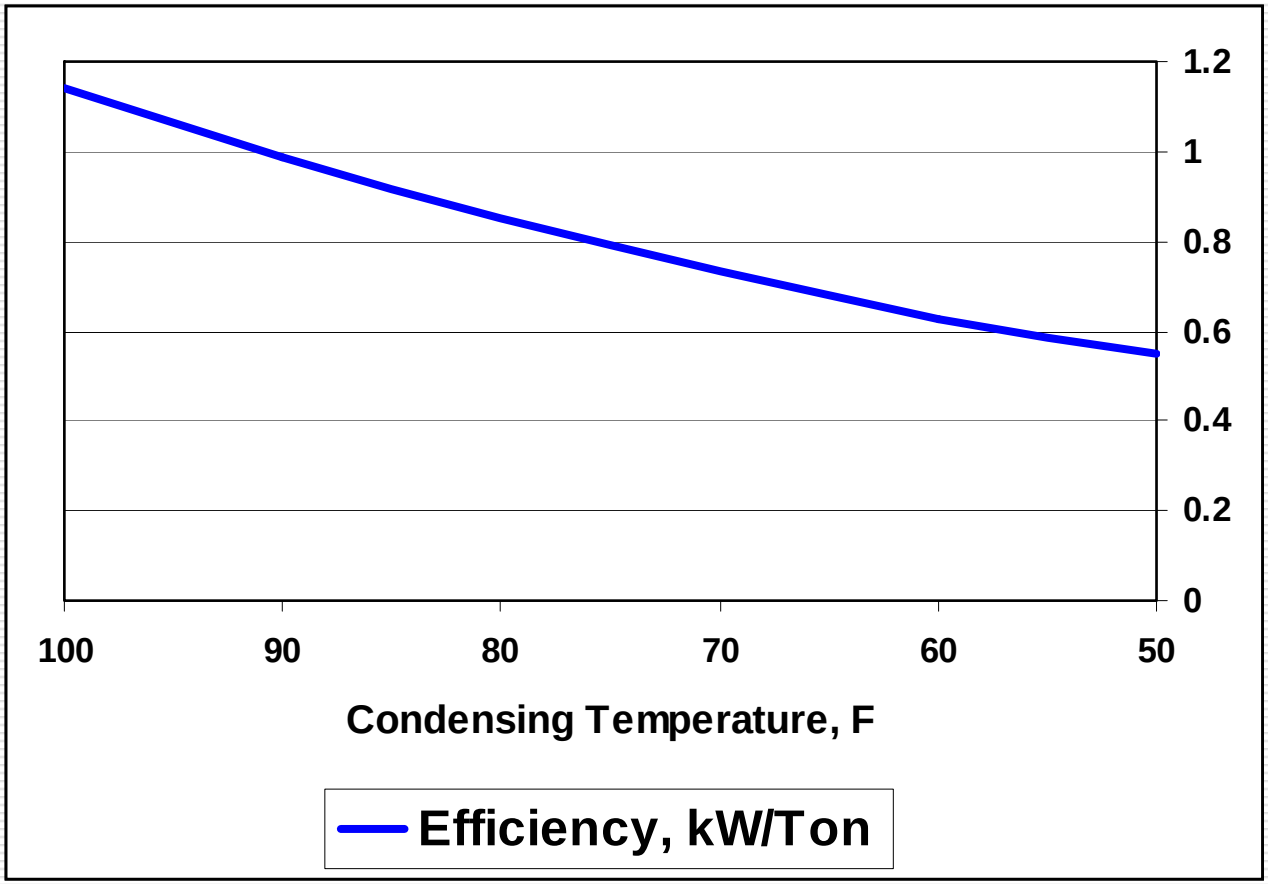
Floating Head Pressure –
Net effect on efficiency



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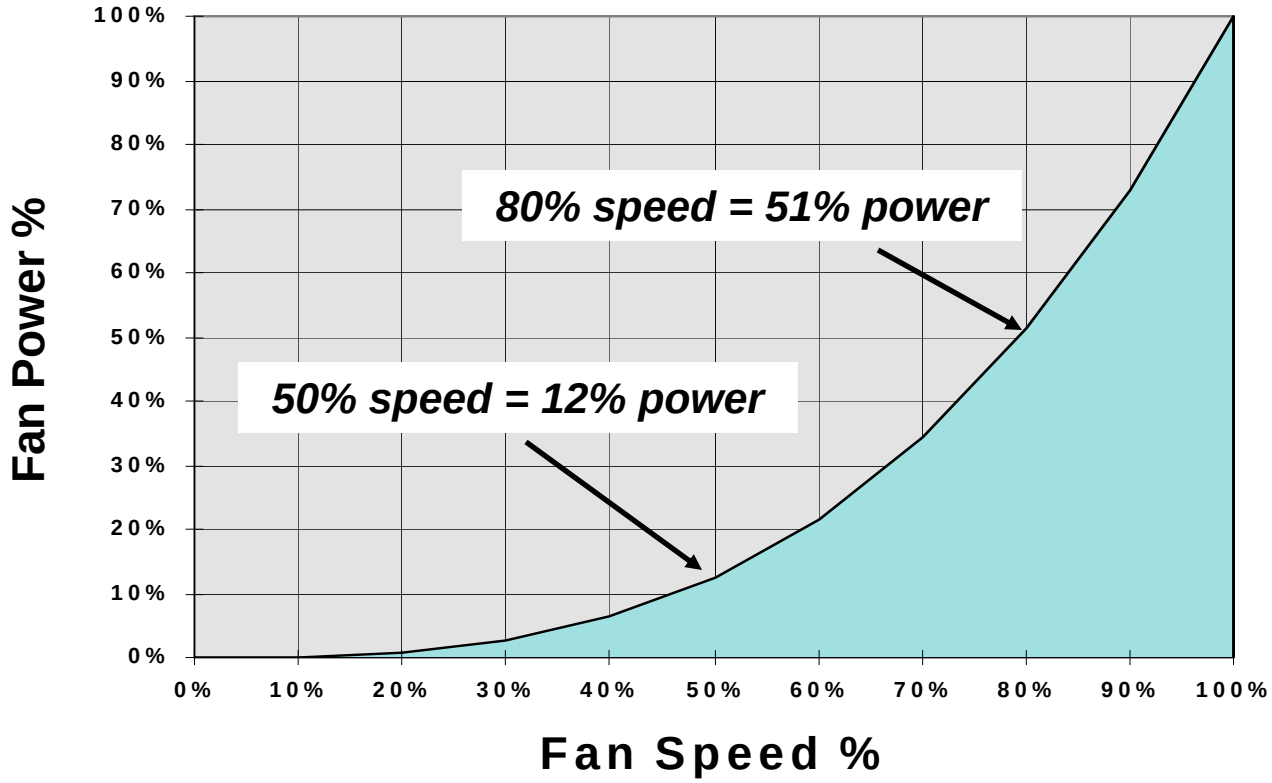
Variable Speed Fan Control
Third power relationship

Capacity varies directly with change in airflow

Fan power varies with cube of change in airflow



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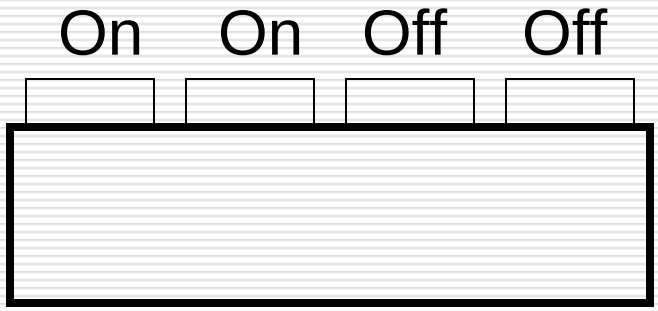
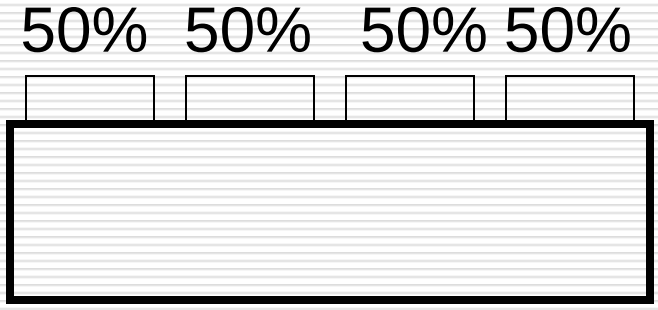
Part Load Performance
Variable speed vs. fan cycling



50% capacity
50% power

80 BTUH/Watt



50% capacity
12% power

330 BTUH/Watt

Specific efficiency increased by 300% with variable speed

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Energy Savings

Energy Savings come from:

- Lower head pressure
- Lower fan power
  - Variable speed
  - Variable setpoint
- System stability
- Overall: optimum system balance

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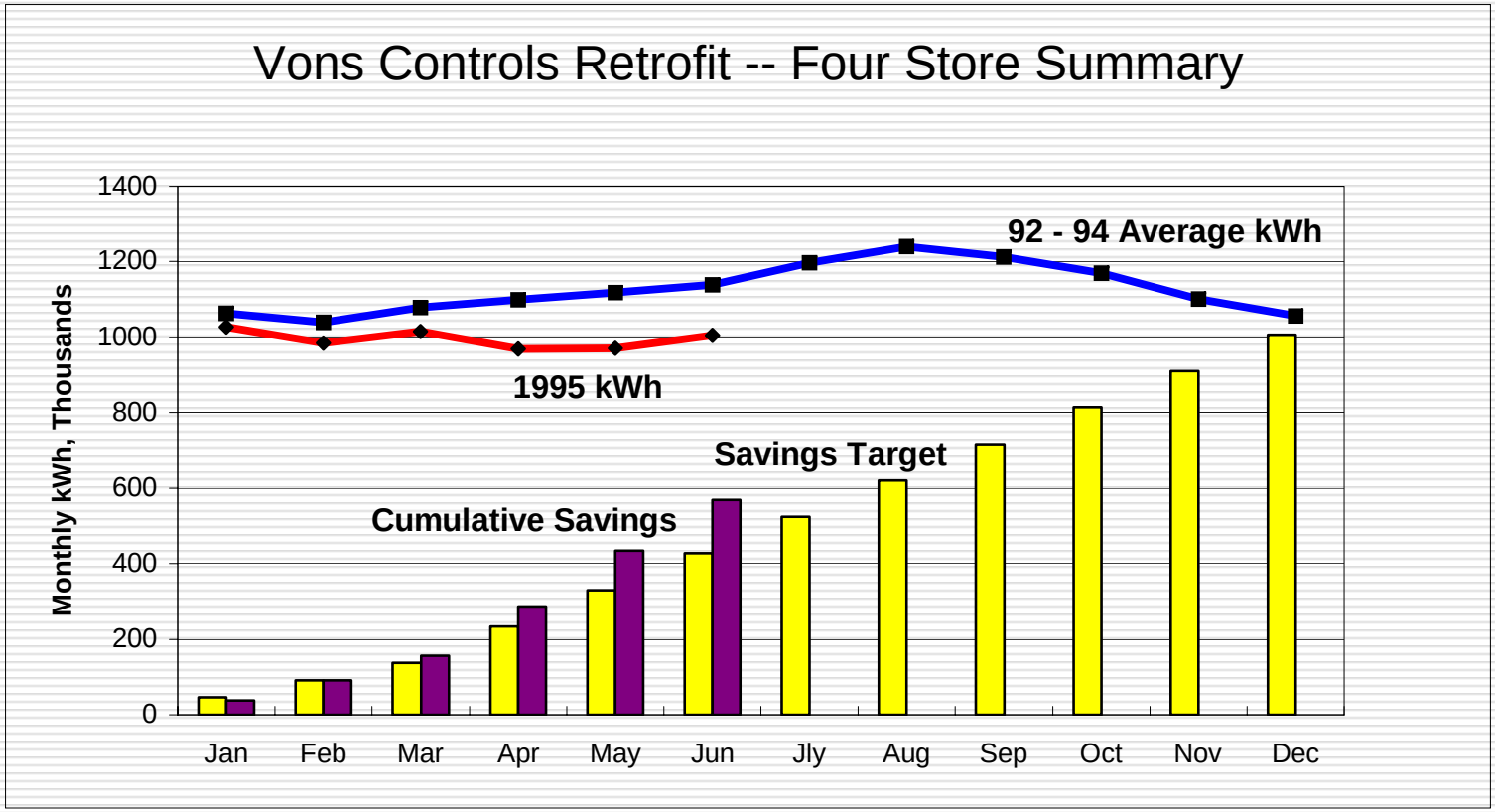
Early Experience
Successful supermarket trial



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Case Study

- Cold storage warehouse in Stockton
- Evaporative condenser
- Base case = fixed SCT at 85 F
- Options
  - Float SCT using fixed setpoint
  - Add variable setpoint
  - Add variable speed with fixed setpoint
  - Add variable speed with variable setpoint

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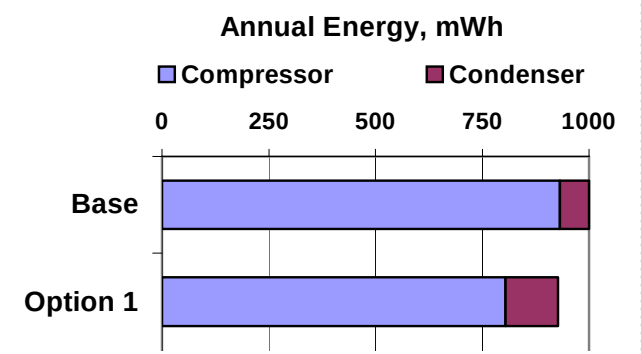
Results



Control Options						
FHP	FSP	VSP	VFD	Savings	Payback	NPV
X	X			$ 6,400	0.3	$ 63,500

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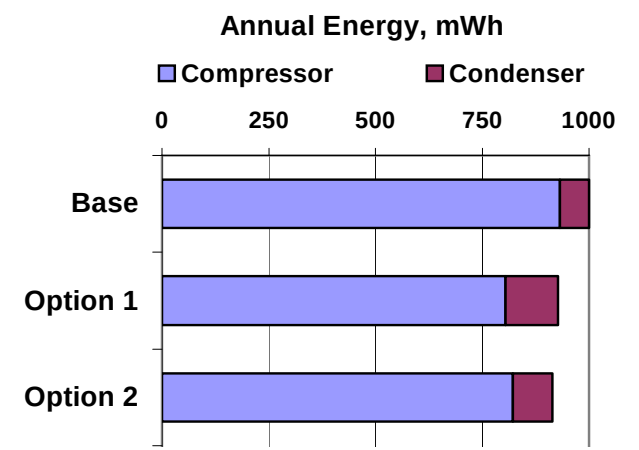
Results



Control Options						
FHP	FSP	VSP	VFD	Savings	Payback	NPV
X	X			$ 6,400	0.3	$ 63,500
X		X		$ 8,400	0.6	$ 80,300

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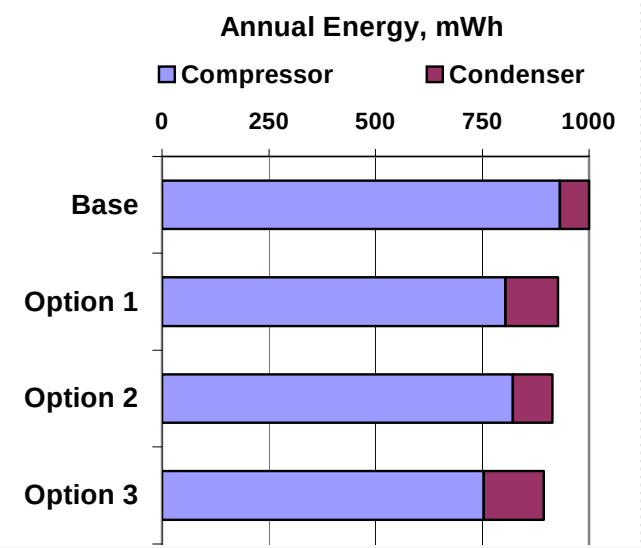
Results



Control Options						
FHP	FSP	VSP	VFD	Savings	Payback	NPV
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

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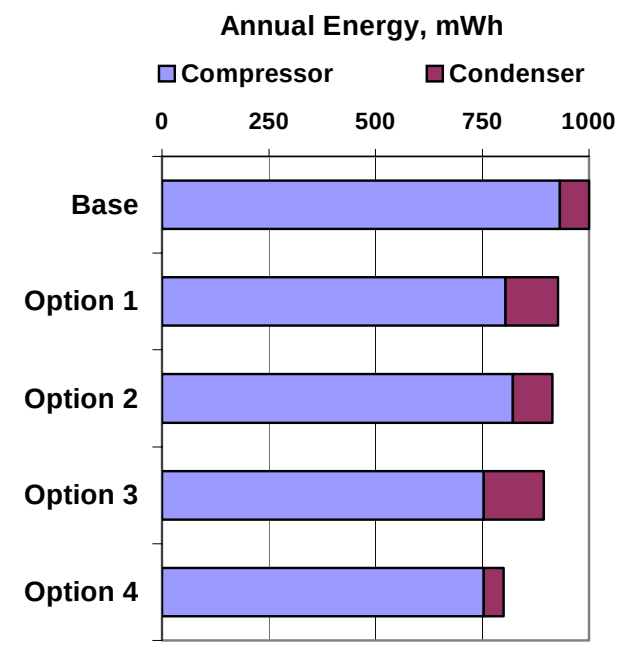
Results



Control Options						
FHP	FSP	VSP	VFD	Savings	Payback	NPV
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

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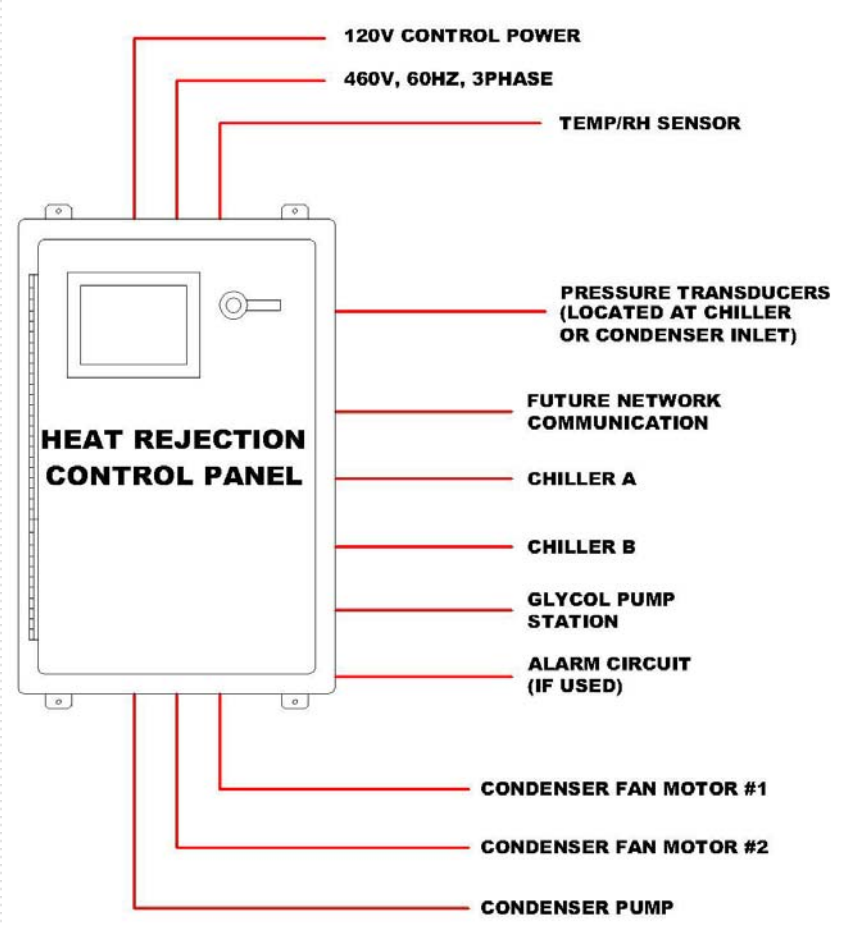
Example System



75 Ton condenser for two glycol chillers with four separate high sides

Estimated first cost savings:

$3,000 savings in reduced custom programming

$2,500 savings in reduced on-site electrical installation cost and MCC hardware

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Typical Panel

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Controller I/O

- Analog inputs
  - Ambient DBT
  - Ambient RH
  - Discharge pressures
- Digital inputs
  - Fan enables
  - VFD status
  - Override status
  - Pump proof
  - Defrost monitor
- Digital outputs
  - VFD enable
  - VFD auto bypass
  - Pump enable
  - Emergency spray
- Analog outputs
  - VFD speed

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Controller Functions

- Capability
  - Up to four separate pressures or temperature inputs
  - Two VFDs per controller
- VFD control
  - Auto, bypass and service modes
  - Automatic restarts
  - Automatic bypass
- Control logic
  - Fixed setpoint
  - Variable setpoint using DBT or WBT
  - PID control
  - SCT calculation for different refrigerants
- Other features
  - Emergency spray control
  - Run time and cycle monitoring

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Communications Interface

- i.LON100 used for:
  - Initial setup
  - Current status
  - Setpoints
  - Alarms and datalogging
- Use web browser for setup, setpoint adjustments and current status

http://63.110.57.69/forms/main.htm

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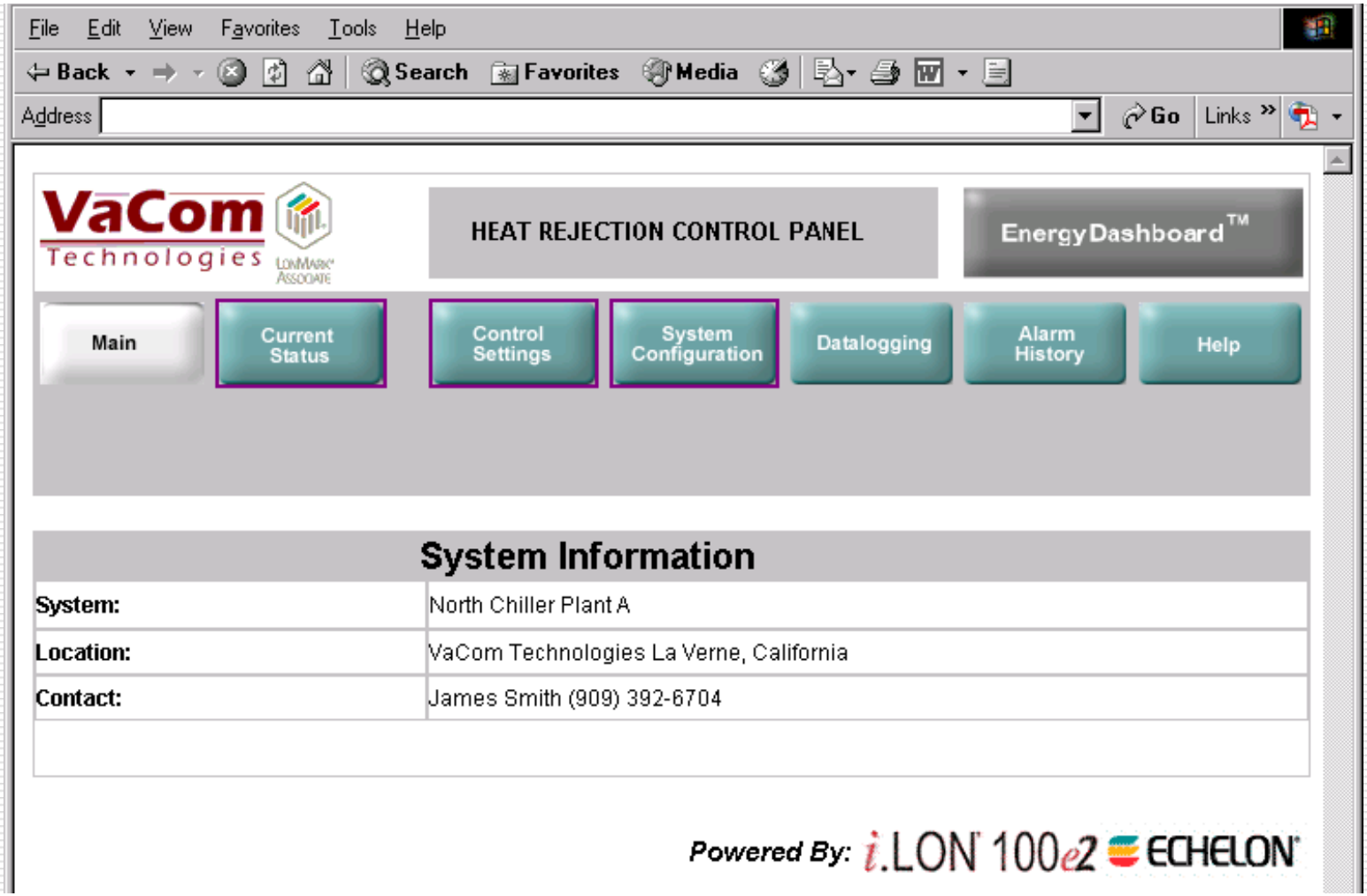
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Address
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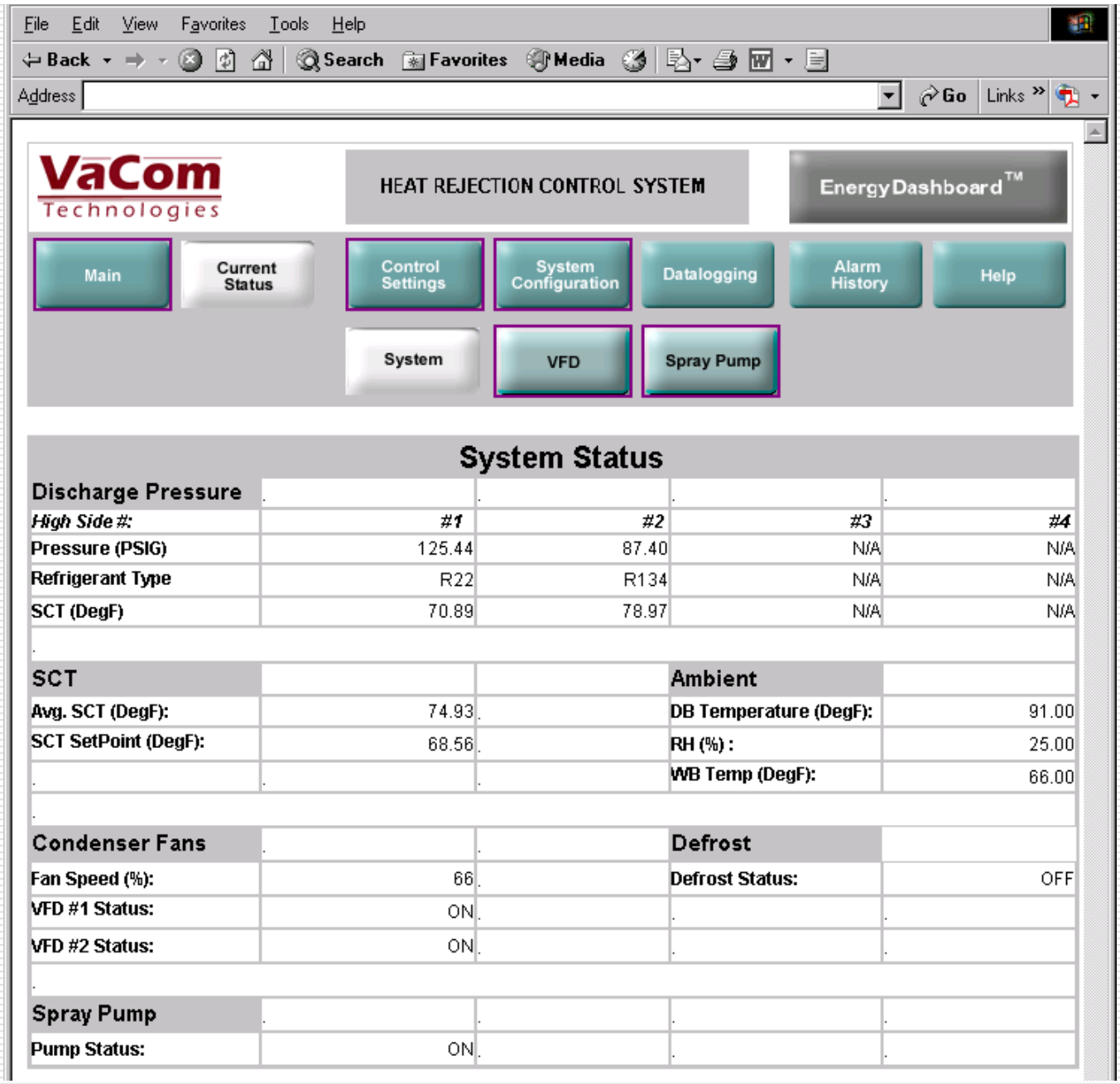
LONMARK ASSOCIATE
HEAT REJECTION CONTROL PANEL
Energy Dashboard™
Main
Current Status
Control Settings
System Configuration
Datalogging
Alarm History
Help
System Information
System: North Chiller Plant A
Location: VaCom Technologies La Verne, California
Contact: James Smith (909) 392-6704
Powered By: i.LON 100e2 ECHELON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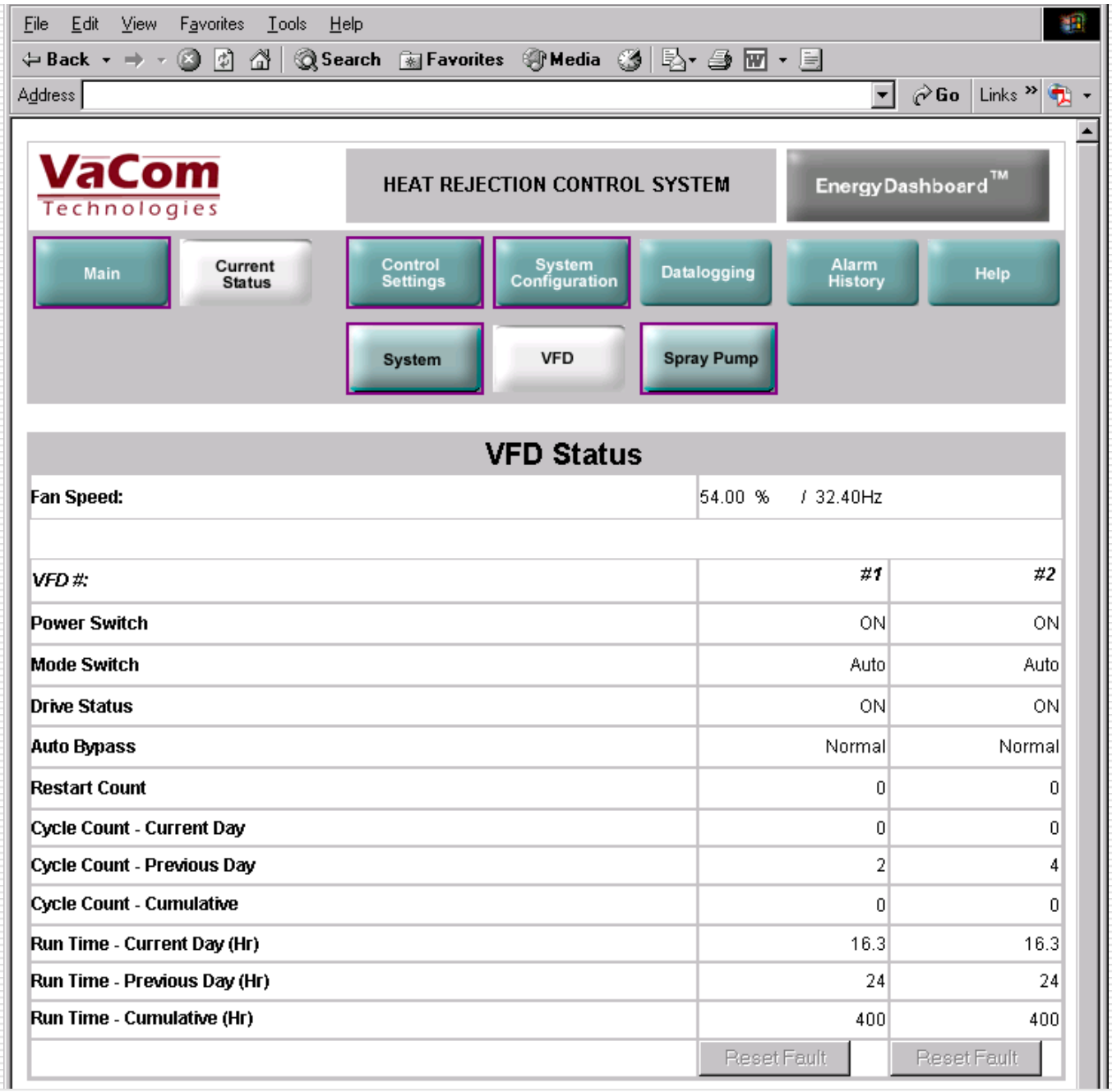
HEAT REJECTION CONTROL SYSTEM
Energy Dashboard™
Main
Current Status
Control Settings
System Configuration
Datalogging
Alarm History
Help
System
VFD
Spray Pump
System Status
Discharge Pressure
High Side #: #1 #2 #3 #4
Pressure (PSIG) 125.44 87.40 N/A N/A
Refrigerant Type R22 R134 N/A N/A
SCT (DegF) 70.89 78.97 N/A N/A
SCT
Avg. SCT (DegF): 74.93
SCT SetPoint (DegF): 68.56
Ambient
DB Temperature (DegF): 91.00
RH (%) : 25.00
WB Temp (DegF): 66.00
Condenser Fans
Fan Speed (%): 66
VFD #1 Status: ON
VFD #2 Status: ON
Defrost
Defrost Status: OFF
Spray Pump
Pump Status: ON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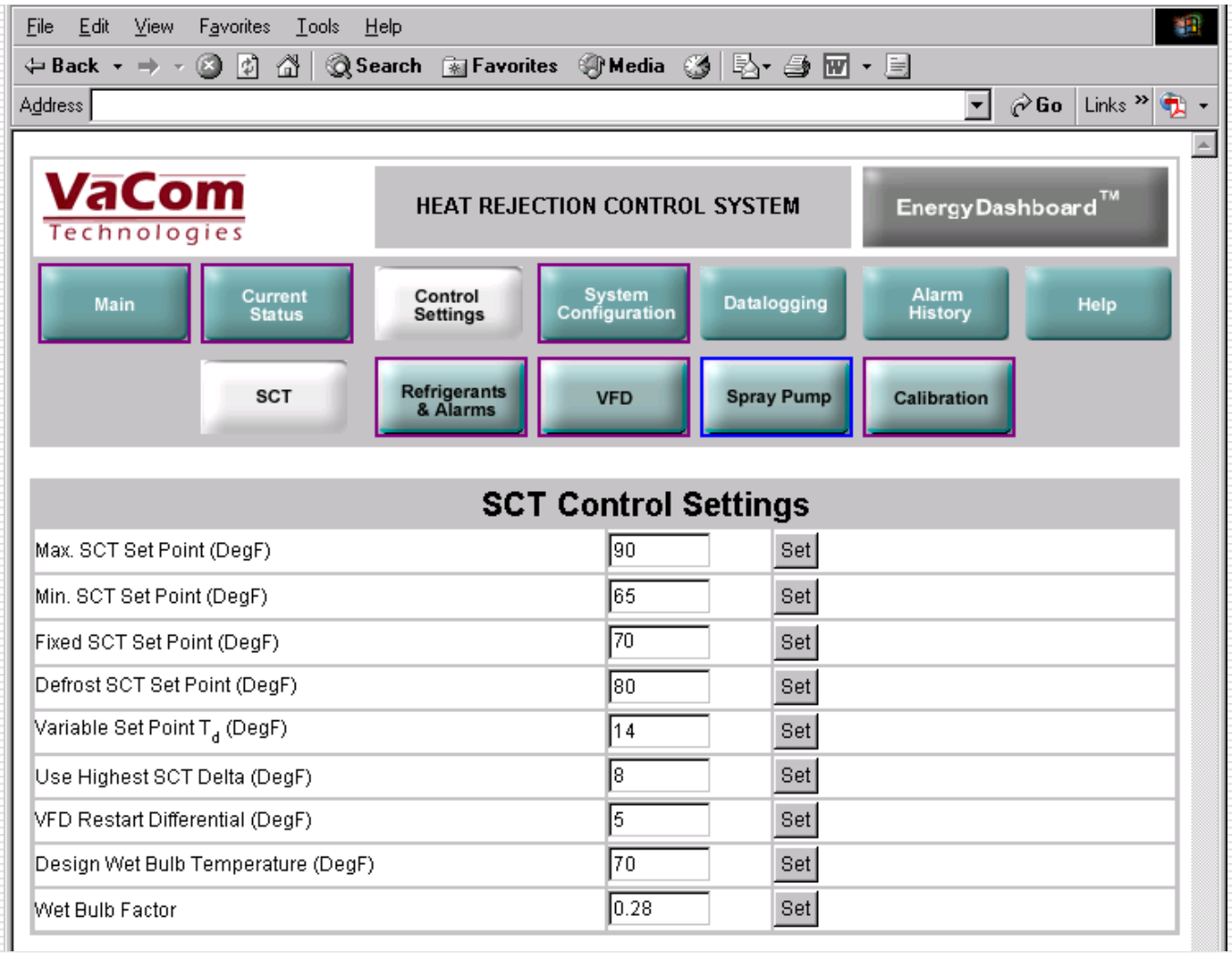
HEAT REJECTION CONTROL SYSTEM
Energy Dashboard™
Main
Current Status
Control Settings
System Configuration
Datalogging
Alarm History
Help
System
VFD
Spray Pump
VFD Status
Fan Speed: 54.00 % / 32.40Hz
VFD #: #1 #2
Power Switch ON ON
Mode Switch Auto Auto
Drive Status ON ON
Auto Bypass Normal Normal
Restart Count 0 0
Cycle Count - Current Day 0 0
Cycle Count - Previous Day 2 4
Cycle Count - Cumulative 0 0
Run Time - Current Day (Hr) 16.3 16.3
Run Time - Previous Day (Hr) 24 24
Run Time - Cumulative (Hr) 400 400
Reset Fault
Reset Fault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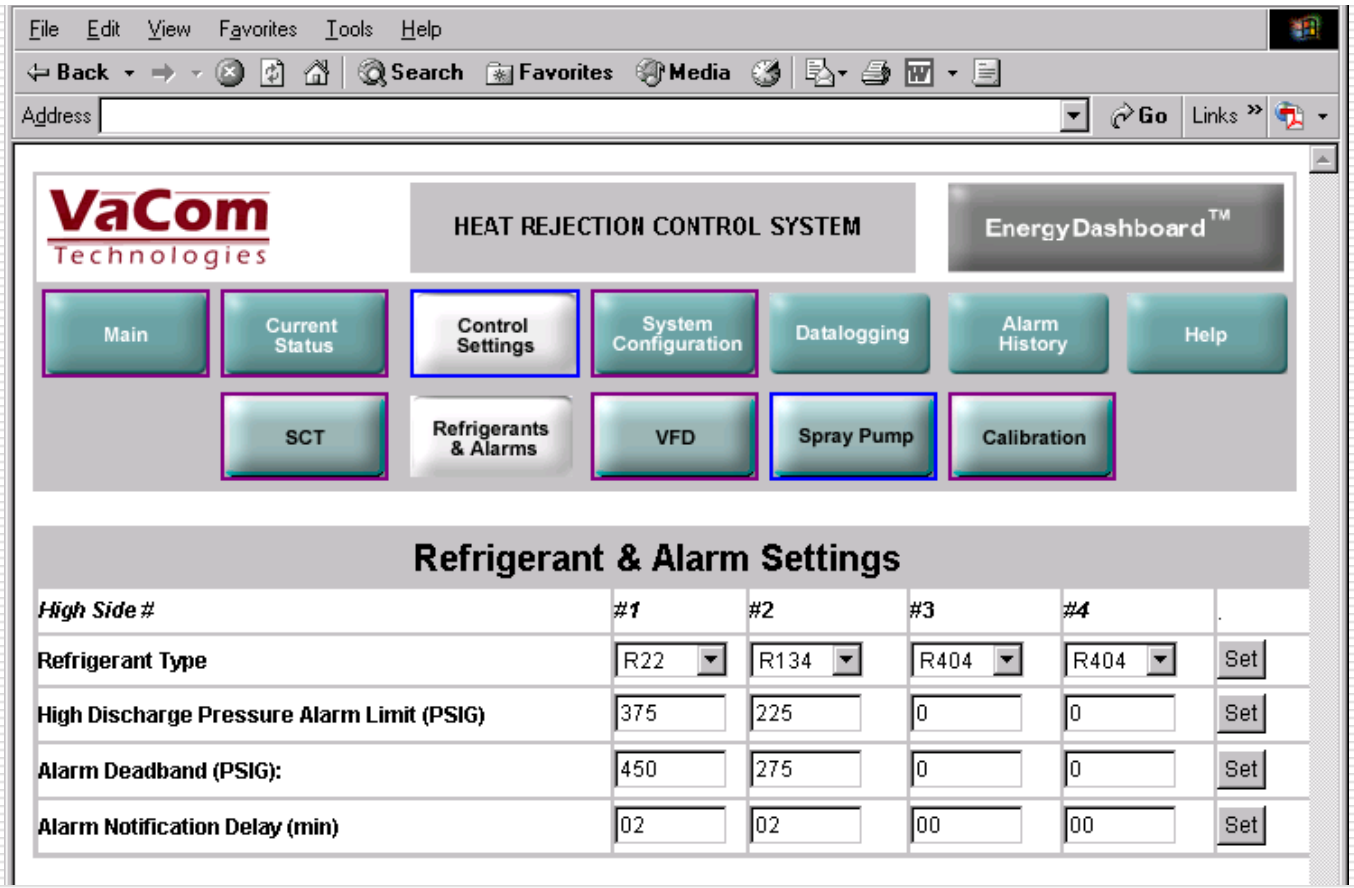
Energy Dashboard™
Main
Current Status
Control Settings
System Configuration
Datalogging
Alarm History
Help
SCT
Refrigerants & Alarms
VFD
Spray Pump
Calibration
SCT Control Settings
Max. SCT Set Point (DegF) 90 Set
Min. SCT Set Point (DegF) 65 Set
Fixed SCT Set Point (DegF) 70 Set
Defrost SCT Set Point (DegF) 80 Set
Variable Set Point T_d (DegF) 14 Set
Use Highest SCT Delta (DegF) 8 Set
VFD Restart Differential (DegF) 5 Set
Design Wet Bulb Temperature (DegF) 70 Set
Wet Bulb Factor 0.28 Set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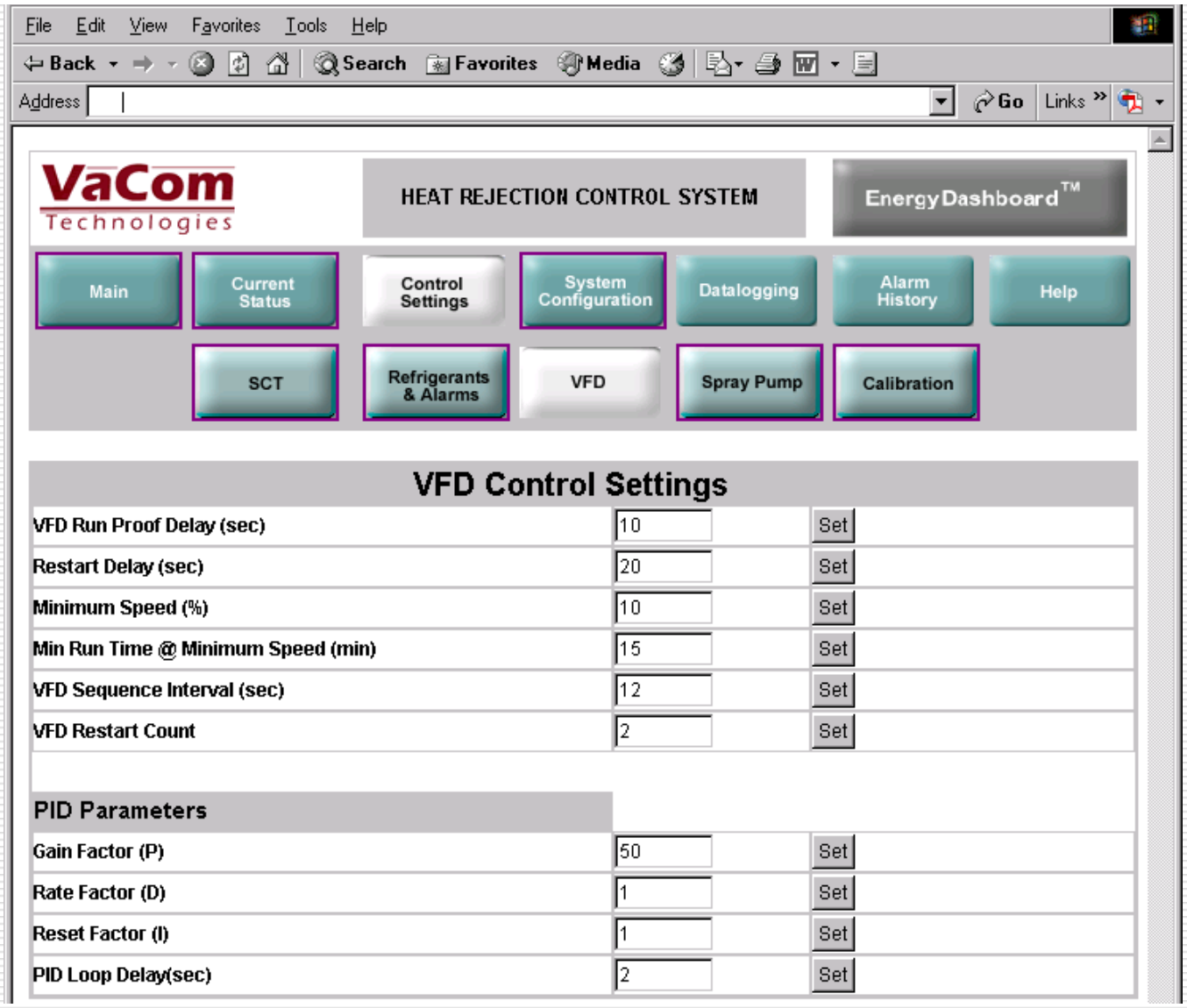
Current Status
Control Settings
System Configuration
Datalogging
Alarm History
Help
SCT
Refrigerants & Alarms
VFD
Spray Pump
Calibration
Refrigerant & Alarm Settings
High Side #
#1
#2
#3
#4
Refrigerant Type
R22
R134
R404
R404
Set
High Discharge Pressure Alarm Limit (PSIG)
375
225
0
0
Set
Alarm Deadband (PSIG):
450
275
0
0
Set
Alarm Notification Delay (min)
02
02
00
00
Set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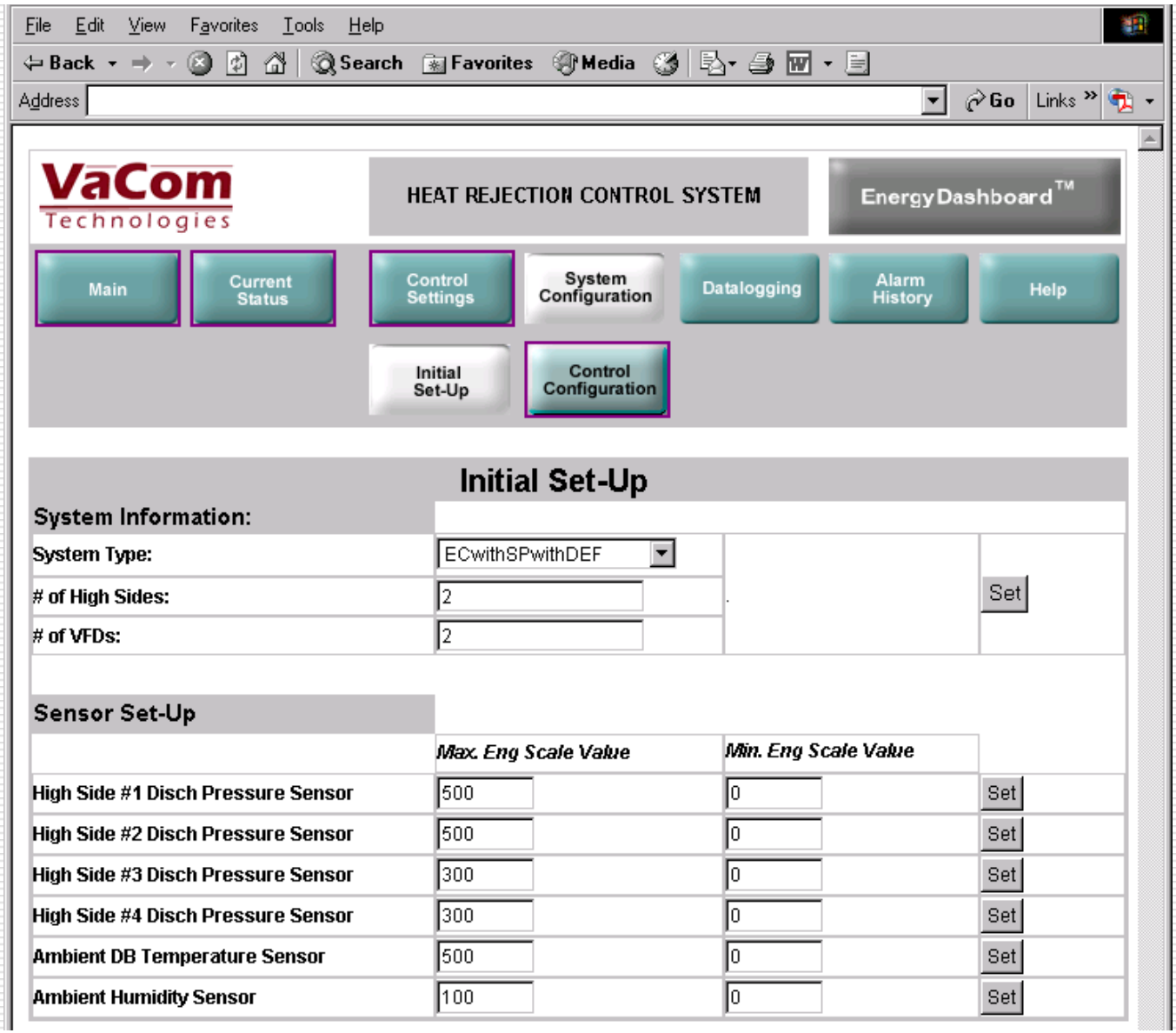
Control Settings
System Configuration
Datalogging
Alarm History
Help
SCT
Refrigerants & Alarms
VFD
Spray Pump
Calibration
VFD Control Settings
VFD Run Proof Delay (sec) 10 Set
Restart Delay (sec) 20 Set
Minimum Speed (%) 10 Set
Min Run Time @ Minimum Speed (min) 15 Set
VFD Sequence Interval (sec) 12 Set
VFD Restart Count 2 Set
PID Parameters
Gain Factor (P) 50 Set
Rate Factor (D) 1 Set
Reset Factor (I) 1 Set
PID Loop Delay(sec) 2 Set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HEAT REJECTION CONTROL SYSTEM
Energy Dashboard™
Main
Current Status
Control Settings
System Configuration
Datalogging
Alarm History
Help
Initial Set-Up
Control Configuration
Initial Set-Up
System Information:
System Type:
ECwithSPwithDEF
# of High Sides:
2
# of VFDs:
2
Set
Sensor Set-Up
Max. Eng Scale Value
Min. Eng Scale Value
High Side #1 Disch Pressure Sensor
500
0
Set
High Side #2 Disch Pressure Sensor
500
0
Set
High Side #3 Disch Pressure Sensor
300
0
Set
High Side #4 Disch Pressure Sensor
300
0
Set
Ambient DB Temperature Sensor
500
0
Set
Ambient Humidity Sensor
100
0
Set

Performance Monitoring using EnergyDashboard™

- Remote efficiency monitoring
  - Real time, continuous performance analysis
  - Web based results presentation
- High level performance metrics
  - Energy efficiency: kW/Ton, $/Ton-Hr
  - Maintenance indicators
  - Trends (e.g. refrig. level, inventory)

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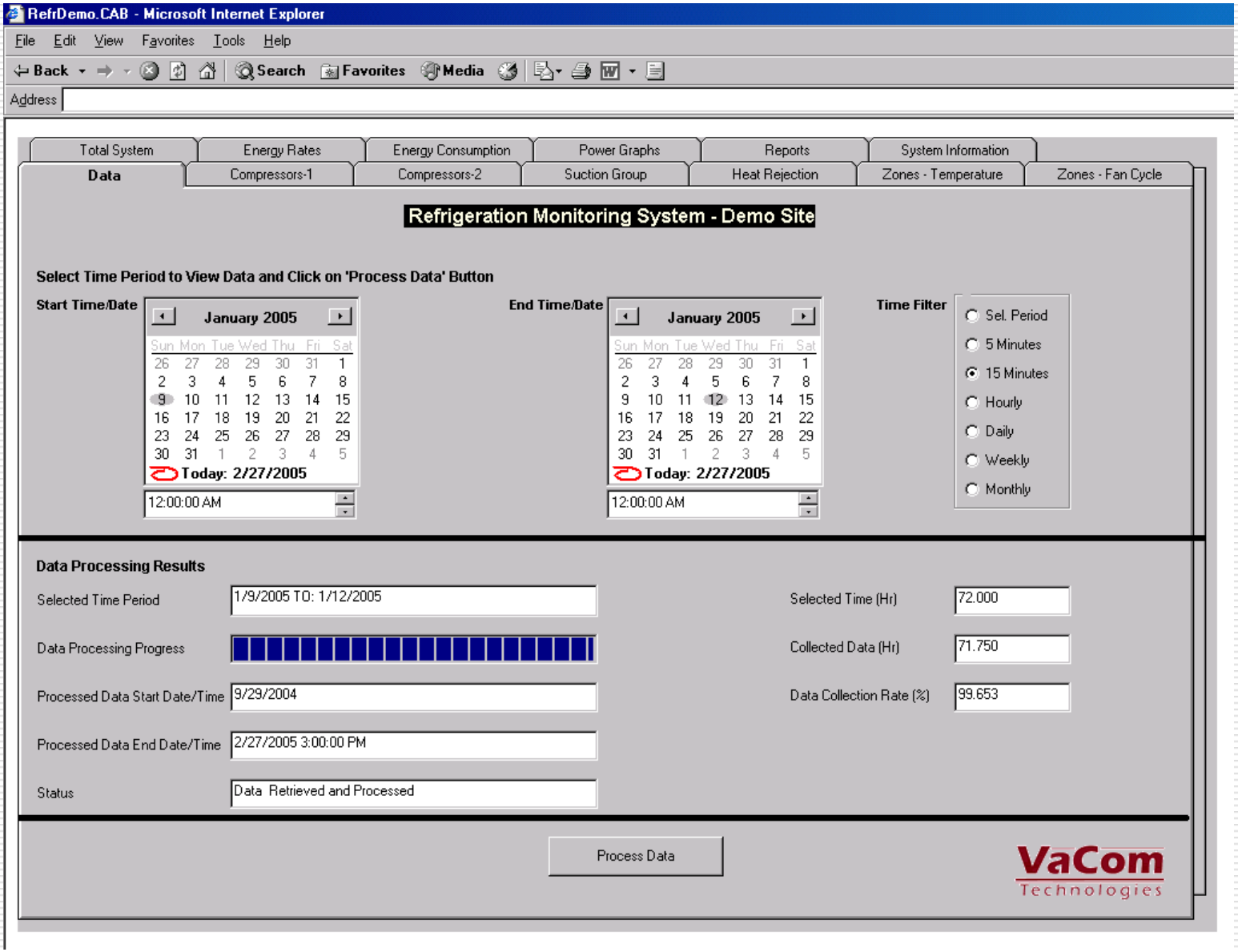
RefrDemo.CAB - Microsoft Internet Explorer
File Edit View Favorites Tools Help
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Address
Total System
Energy Rates
Energy Consumption
Power Graphs
Reports
System Information
Data
Compressors-1
Compressors-2
Suction Group
Heat Rejection
Zones - Temperature
Zones - Fan Cycle
Refrigeration Monitoring System - Demo Site
Select Time Period to View Data and Click on 'Process Data' Button
Start Time/Date
January 2005
Sun Mon Tue Wed Thu Fri Sat
26 27 28 29 30 31 1
2 3 4 5 6 7 8
9 10 11 12 13 14 15
16 17 18 19 20 21 22
23 24 25 26 27 28 29
30 31 1 2 3 4 5
Today: 2/27/2005
12:00:00 AM
End Time/Date
January 2005
Sun Mon Tue Wed Thu Fri Sat
26 27 28 29 30 31 1
2 3 4 5 6 7 8
9 10 11 12 13 14 15
16 17 18 19 20 21 22
23 24 25 26 27 28 29
30 31 1 2 3 4 5
Today: 2/27/2005
12:00:00 AM
Time Filter
Sel. Period
5 Minutes
15 Minutes
Hourly
Daily
Weekly
Monthly
Data Processing Results
Selected Time Period
1/9/2005 TO: 1/12/2005
Data Processing Progress
Processed Data Start Date/Time
9/29/2004
Processed Data End Date/Time
2/27/2005 3:00:00 PM
Status
Data Retrieved and Processed
Selected Time (Hr)
72.000
Collected Data (Hr)
71.750
Data Collection Rate (%)
99.653
Process Data
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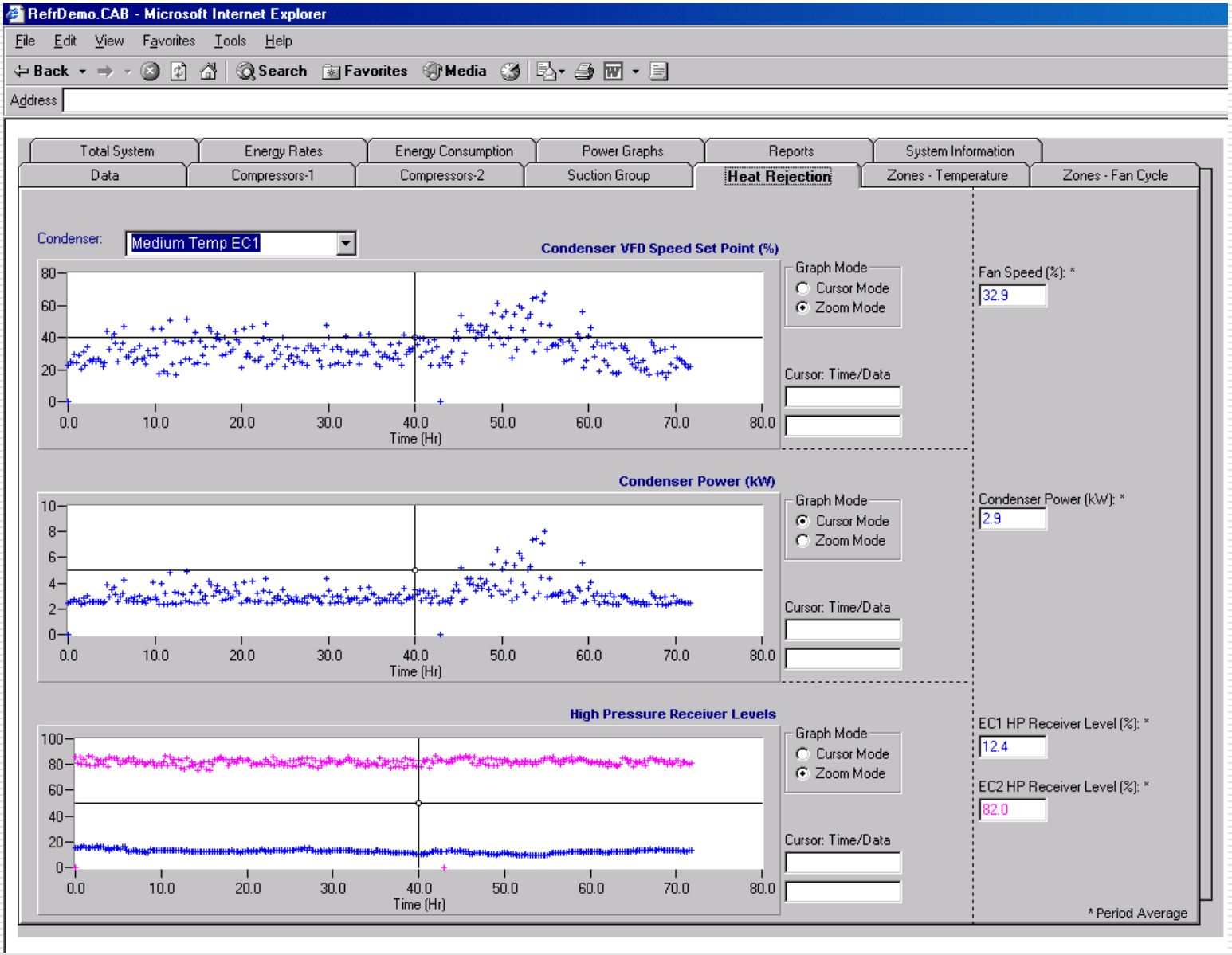
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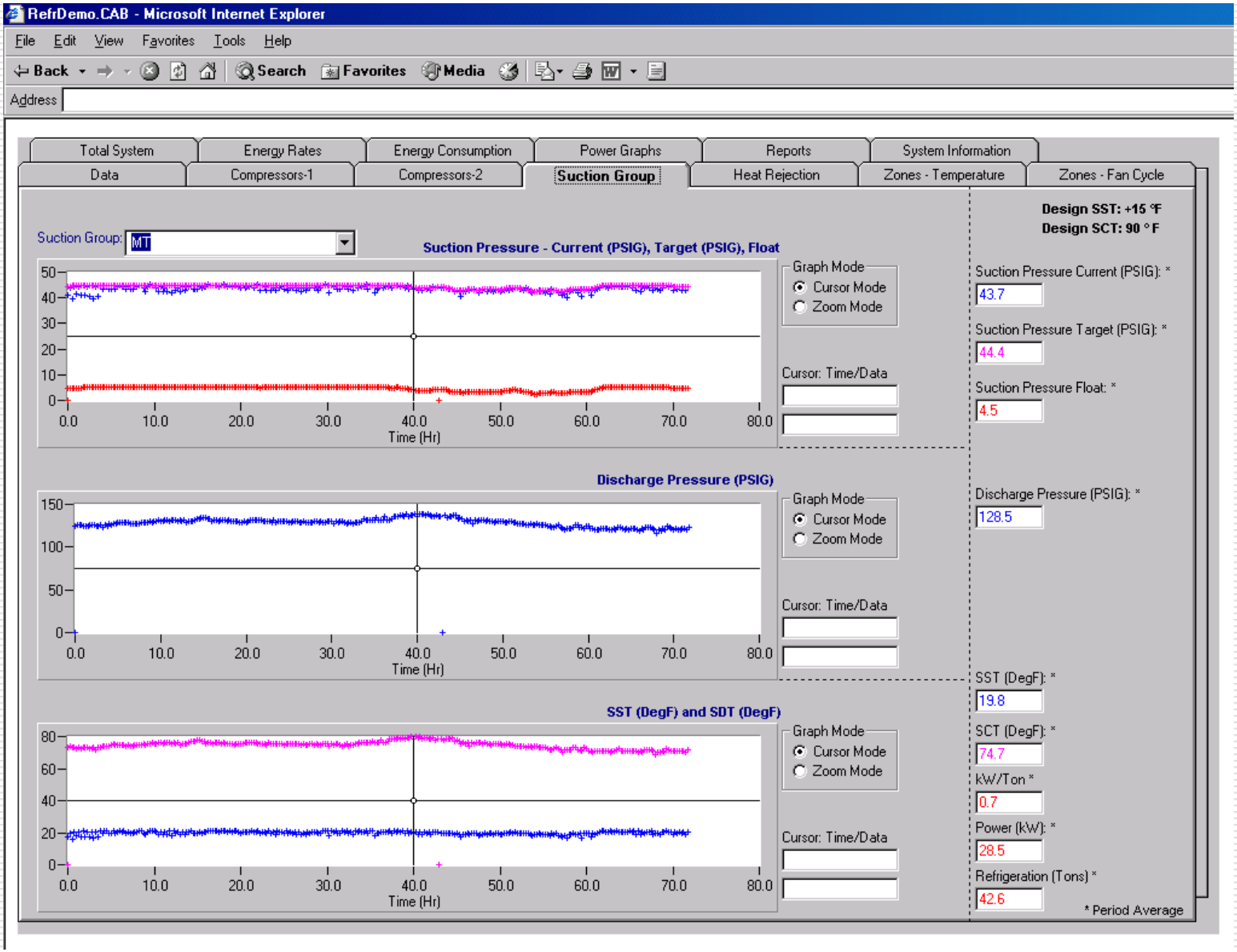
Total System
Energy Rates
Energy Consumption
Power Graphs
Reports
System Information
Data
Compressors-1
Compressors-2
Suction Group
Heat Rejection
Zones - Temperature
Zones - Fan Cycle
Condenser:
Medium Temp EC1
Condenser VFD Speed Set Point (%)
Graph Mode
Cursor Mode
Zoom Mode
Cursor: Time/Data
Time (Hr)
Fan Speed (%): *
32.9
Condenser Power (kW)
Condenser Power (kW): *
2.9
High Pressure Receiver Levels
EC1 HP Receiver Level (%): *
12.4
EC2 HP Receiver Level (%): *
82.0
* Period Average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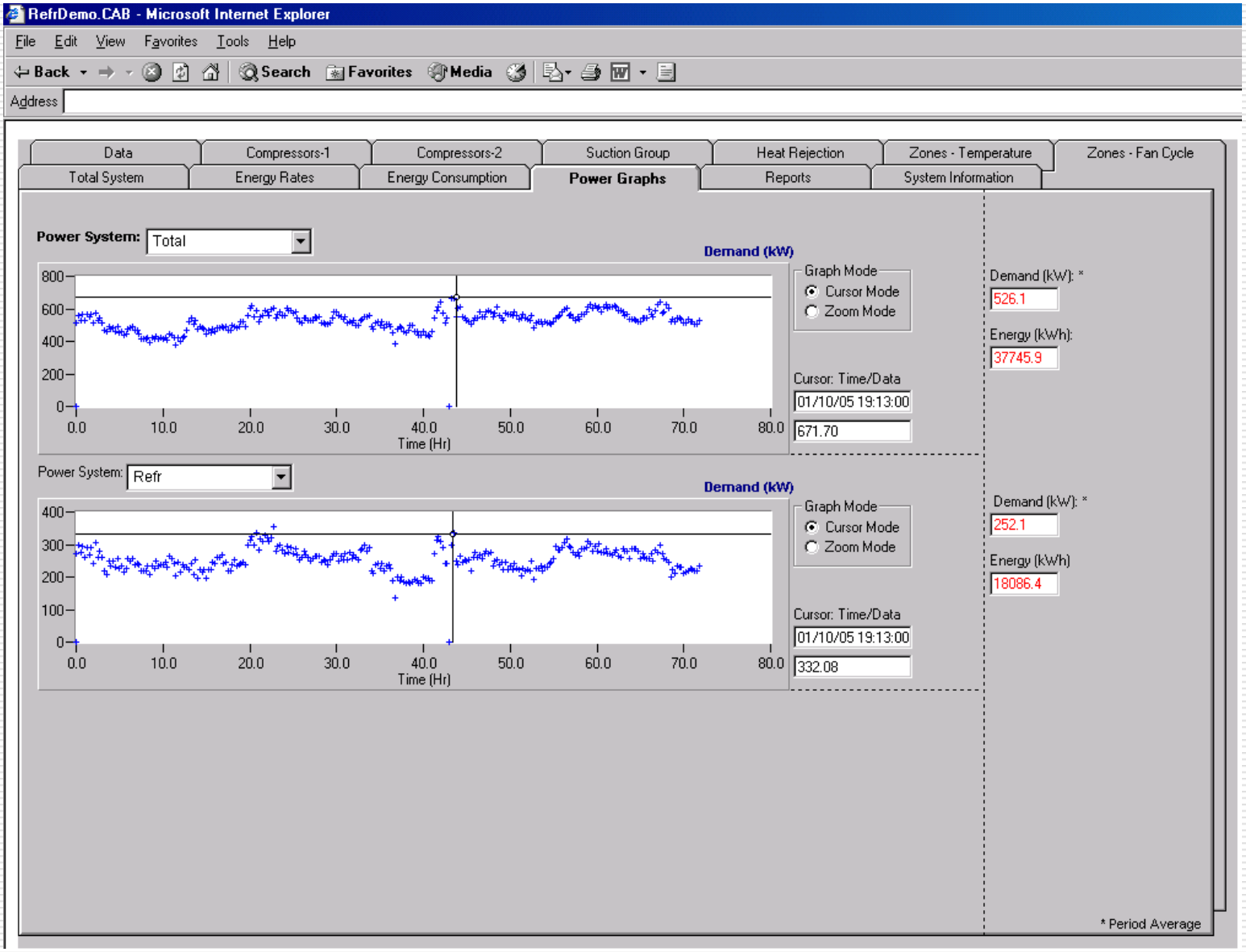
Total System
Energy Rates
Energy Consumption
Power Graphs
Reports
System Information
Data
Compressors-1
Compressors-2
Suction Group
Heat Rejection
Zones - Temperature
Zones - Fan Cycle
Design SST: +15 °F
Design SCT: 90 °F
Suction Group: MT
Suction Pressure - Current (PSIG), Target (PSIG), Float
Time (Hr)
Graph Mode
Cursor Mode
Zoom Mode
Cursor: Time/Data
Suction Pressure Current (PSIG): *
43.7
Suction Pressure Target (PSIG): *
44.4
Suction Pressure Float: *
4.5
Discharge Pressure (PSIG)
Discharge Pressure (PSIG): *
128.5
SST (DegF) and SDT (DegF)
SST (DegF): *
19.8
SCT (DegF): *
74.7
kW/Ton *
0.7
Power (kW): *
28.5
Refrigeration (Tons) *
42.6
* Period Average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Data
Compressors-1
Compressors-2
Suction Group
Heat Rejection
Zones - Temperature
Zones - Fan Cycle
Total System
Energy Rates
Energy Consumption
Power Graphs
Reports
System Information
Power System: Total
Demand (kW)
800
600
400
200
0
0.0 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0
Time (Hr)
Graph Mode
Cursor Mode
Zoom Mode
Cursor: Time/Data
01/10/05 19:13:00
671.70
Demand (kW): *
526.1
Energy (kWh):
37745.9
Power System: Refr
Demand (kW)
400
300
200
100
0
0.0 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0
Time (Hr)
Graph Mode
Cursor Mode
Zoom Mode
Cursor: Time/Data
01/10/05 19:13:00
332.08
Demand (kW): *
252.1
Energy (kWh)
18086.4
* Period Average

Questions?

Doug Scott
VaCom Technologies
(909) 392-6704
dscott@vacomtech.com

VaCom Technologies