

Real-Time Centrifugal Chiller Diagnostician

Part and full load diagnostics
using open protocol and
DSOM subsystems

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Chiller Diagnostician

- ▶ Reason for development
 - High cost of instrumentation
 - High cost of interface units
 - Part load diagnostics not generally performed
 - Chillers normally run at part load

Chiller Diagnostician

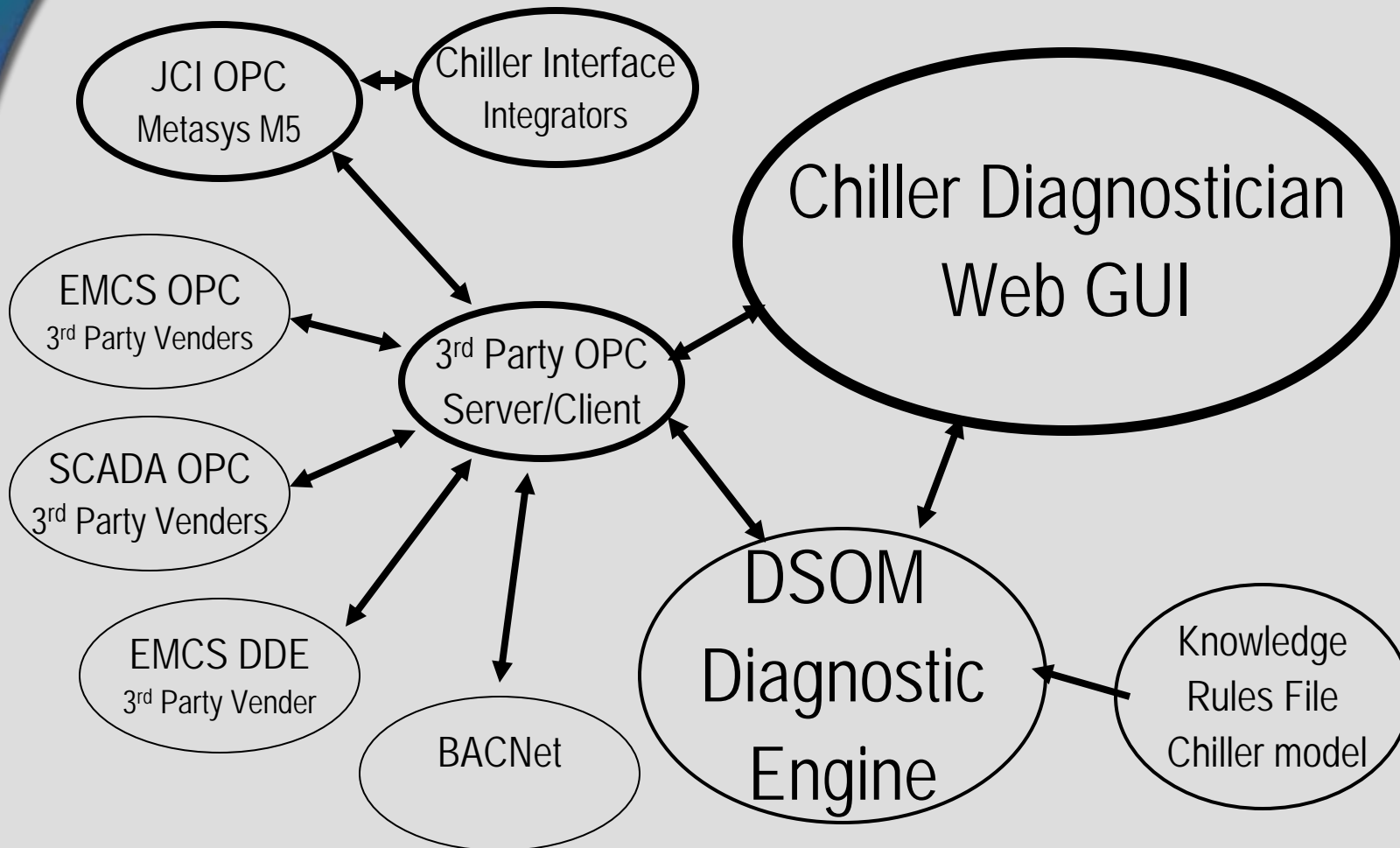
► Solution

- Use existing smart controllers on chillers
 - All existing data points from controllers. No instrumentation installed. (Water flow meter exception)
- Use existing interfaces to BMS/EMCS system
- Read all data from the network
- Install limited instrumentation, if any
- Open protocols - OPC
- Use DSOM, Decision Support for Operation and Maintenance engine (Battelle diagnostic product)
- Model based comparison for full and part loading

Chiller Diagnostician

- ▶ Diagnostics and operation support
 - All points fully trended
 - All points banded with operational parameters
 - All points alarmed

Basic Architecture Overall System



Chiller Diagnostician

- ▶ Diagnostics performed
 - Compressor high starts
 - Compressor high load
 - Evaporator high flow
 - System low charge
 - System over charge
 - Condenser high flow
 - Evaporator low flow
 - Condenser low flow
 - Evaporator fouling
 - Condenser fouling
 - Running non-condensables
 - Off-line non-condensables
 - Chiller efficiency in kW/ton

Compressor High Starts	Compressor High Load	Evaporator High Flow
System Low Charge	System Over Charge	Condenser High Flow
Evaporator Low Flow	Condenser Low Flow	Evaporator Fouling
Running Non Condensables	Off Line Non Condensables	Condenser Fouling

Chiller Diagnostician

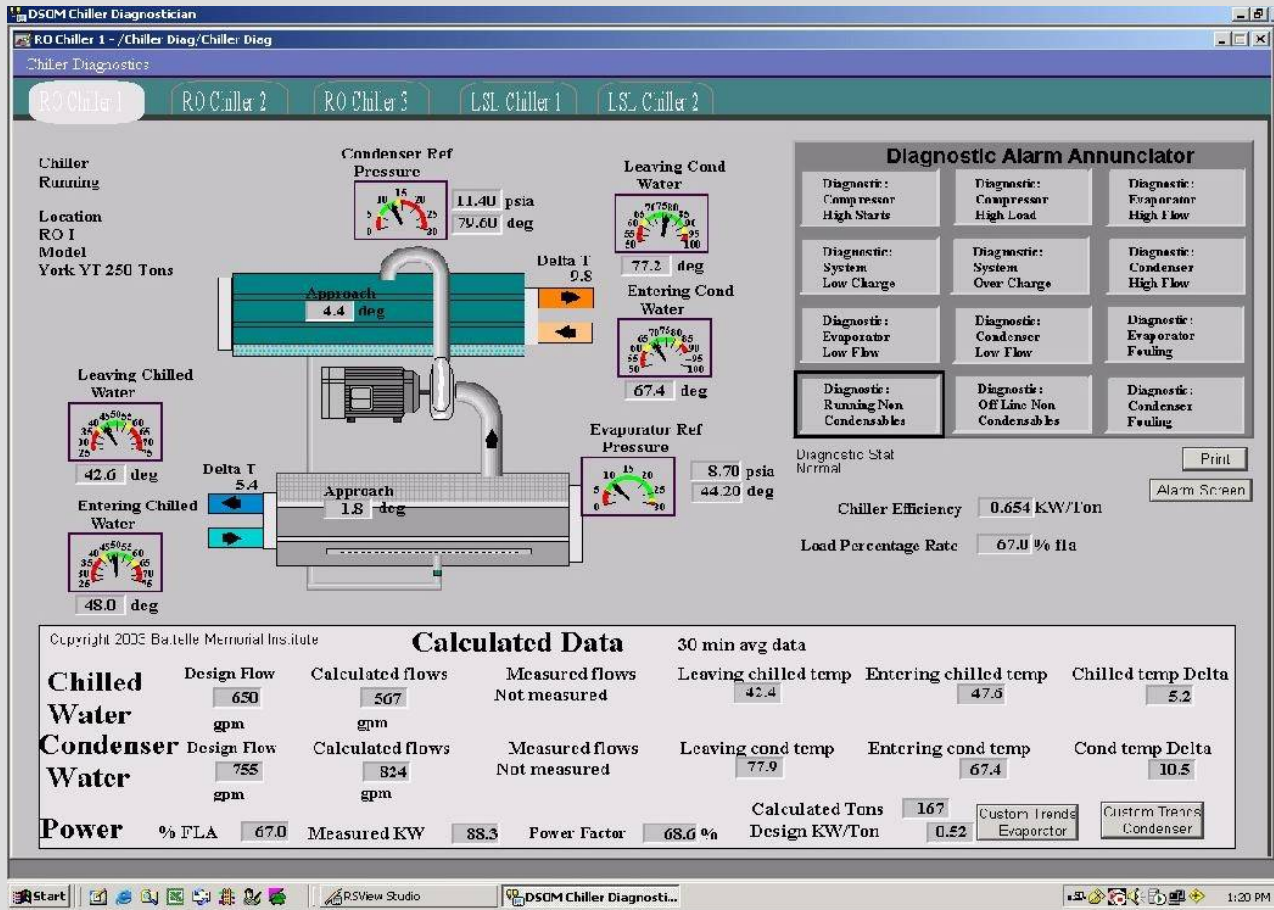
- ▶ Standard points read and alarmed
 - Chilled water in
 - Chilled water out
 - Chilled water delta temperature
 - Evaporator refrigerant pressure
 - Evaporator refrigerant temperature
 - Evaporator approach temperature
 - Condenser refrigerant pressure
 - Condenser refrigerant temperature
 - Condenser approach temperature
 - Condenser water in
 - Condenser water out
 - Condenser water delta temperature
 - Load percentage rate
 - Chilled water flow
 - Condenser water flow.

DSOM Chiller Diagnostician

- ▶ Problem Identification - what is the problem
- ▶ System Impact - what the potential impact of the problem is on the system operation
- ▶ Likely Causes - what are the three most probable causes of the problem
- ▶ Corrective Action - what are the three most probable steps the operator should take to mitigate the problem
- ▶ Actual Condition - what is the current condition
- ▶ Desired Condition - what should the current condition be

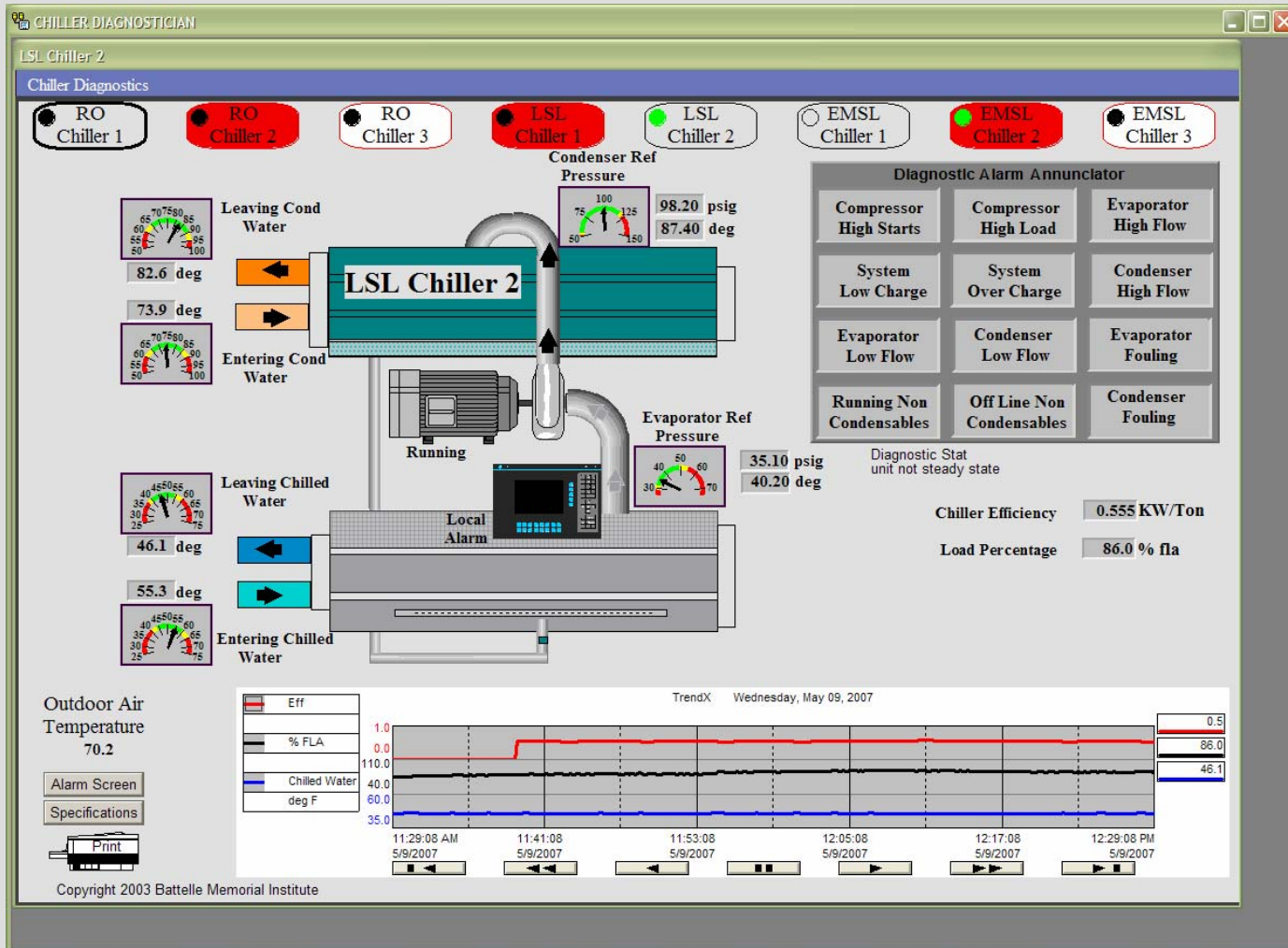
Chiller Diagnostician

▶ Single Chiller Screen with Background Data



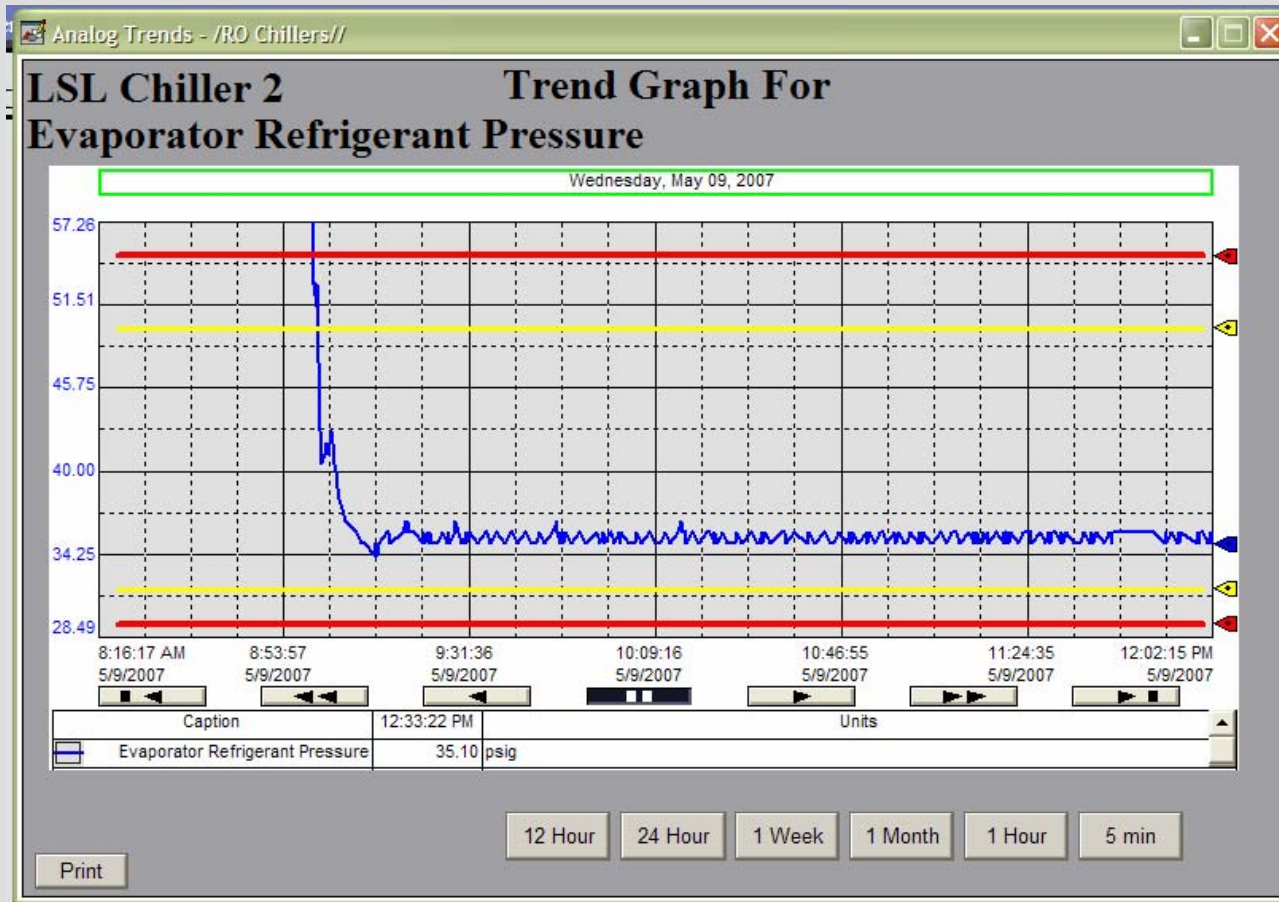
Chiller Diagnostician

▶ Standard Chiller Screen Shot



Chiller Diagnostician

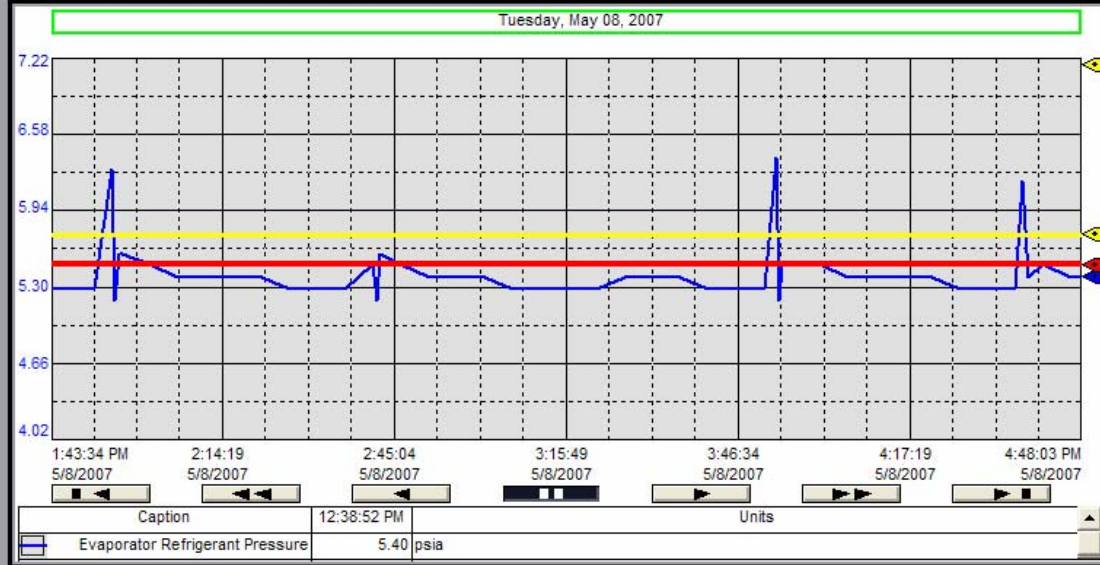
▶ Graphing with Alarm Bands



EMSL Chiller 2

Chiller Analog Trends - /RO Chillers//

EMSL Chiller 2 Trend Graph For Evaporator Refrigerant Pressure



Print

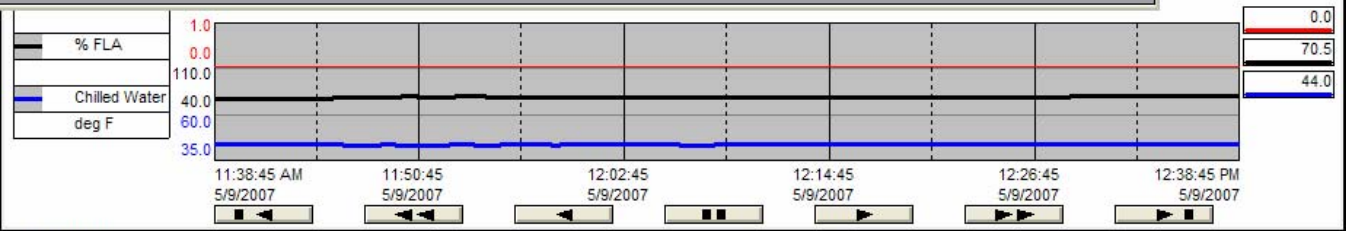
12 Hour 24 Hour 1 Week 1 Month 1 Hour 5 min

Outdoor Air Temperature 71.9

Alarm Screen Specifications



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arm

EMSL Chiller 3

- Evaporator High Flow
- Condenser High Flow
- Evaporator Fouling
- Condenser Fouling

use:

- refrigerant
- em capacity
- restricted

ded Actions:

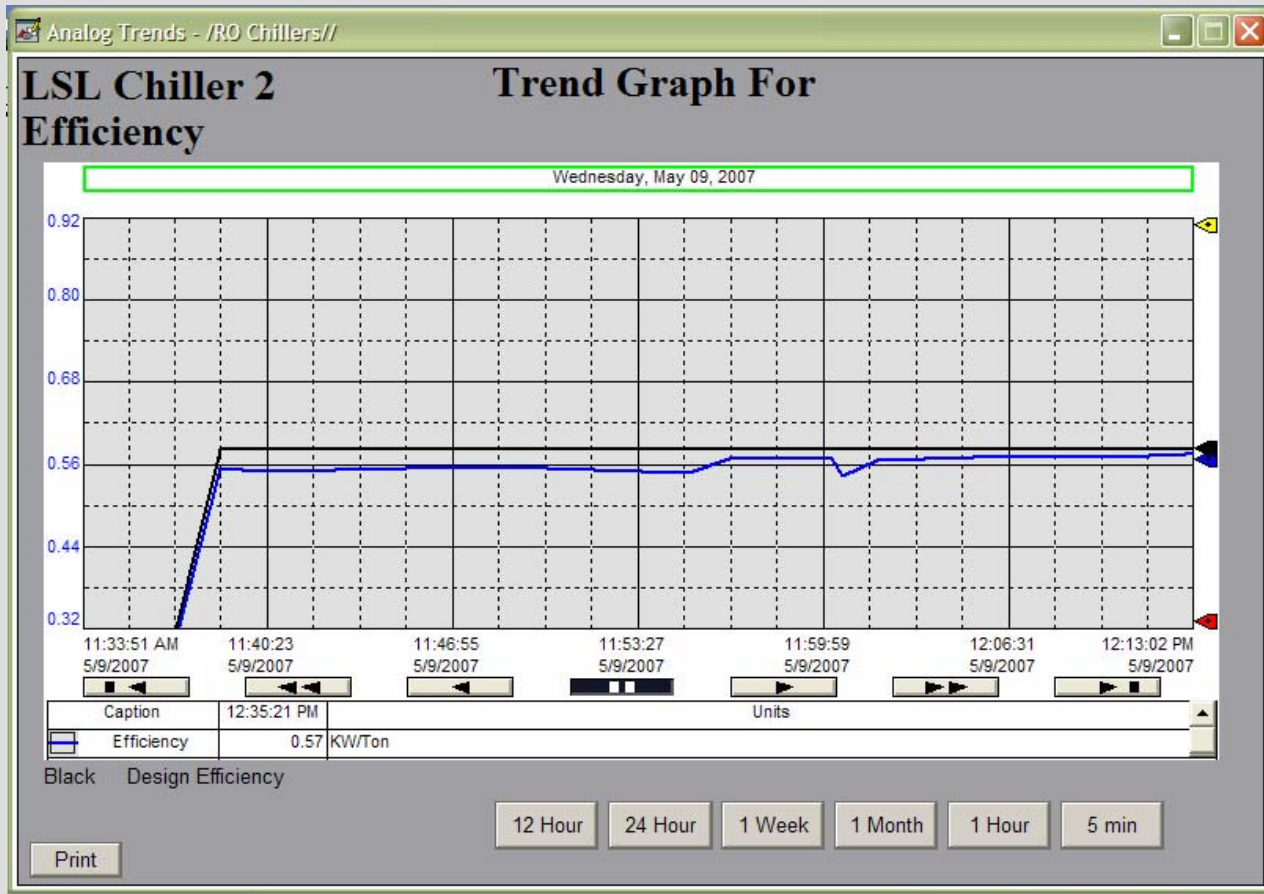
- t charge
- et low load

0.000 KW/Ton
70.7 % fla

cedure

Chiller Diagnostician

▶ Efficiency Charted Against Design



Chiller Diagnostician

▶ Alarm Screen with Action Items

Alarm Faults
DSOM Alarm Monitor **Low Alarm**

EMSL Chiller 2 **Evaporator Refrigerant Pressure**

Problem:
Evaporator refrigerant pressure is below the allowable limit

Impact:
Compressor will trip off due to low refrigerant pressure
Reduced Efficiency of Chiller unit

Likely Cause:
Insufficient charge of refrigerant
Insufficient load for system capacity
Cooler tubes dirty or restricted

Recommended Corrective Actions:
Evaluate refrigerant charge
Shut down chillers to meet low load conditions.

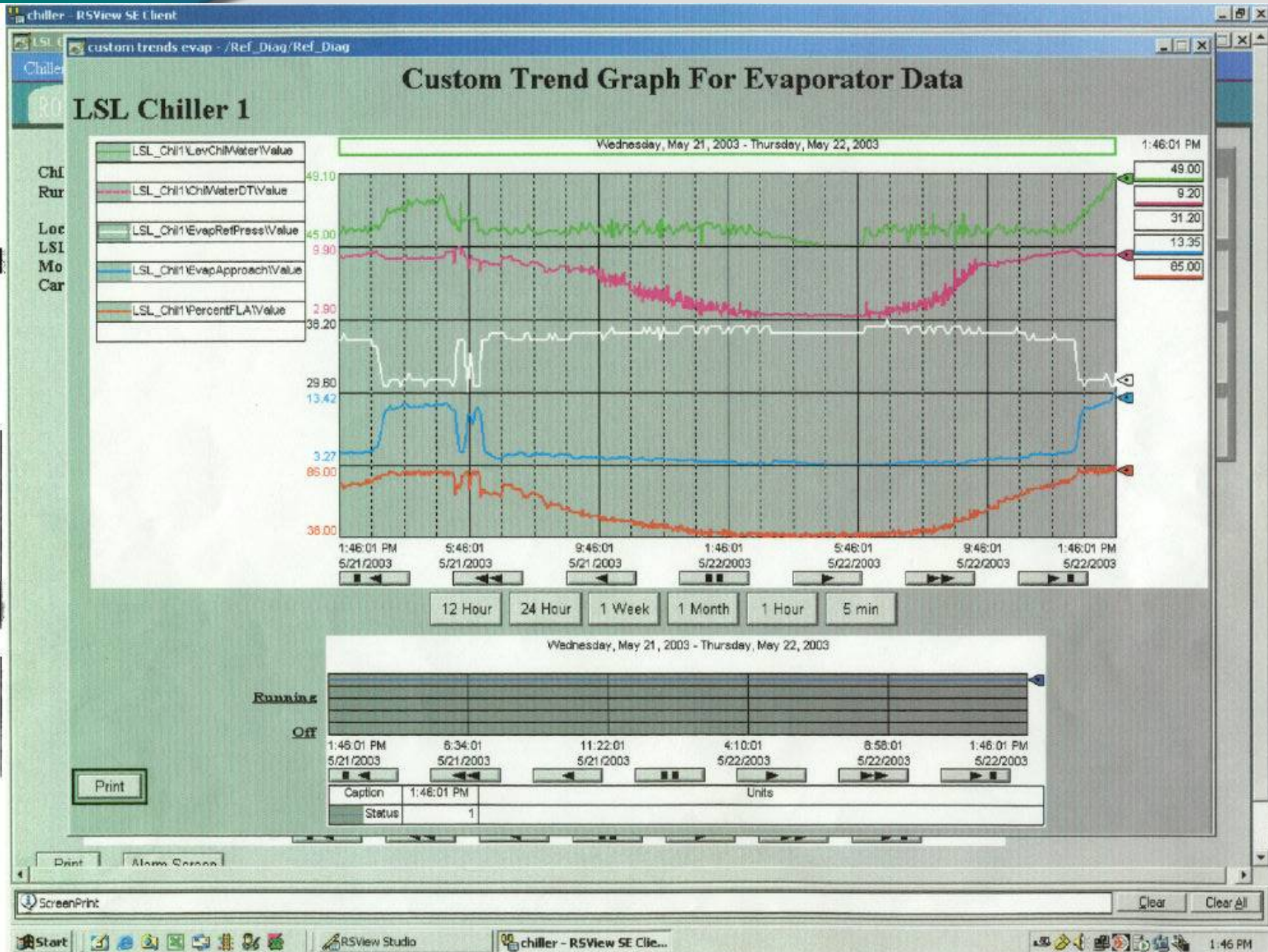
Current Setpoints

Setpoint Type	Value
High Alarm Setpoint	29.0
High Warning Setpoint	28.0
Low Warning Setpoint	5.8
Low Alarm Setpoint	5.5

Current Sensor Value
5.4 psia

EMSL_Chil2\EvapRefPress\value

Buttons: Acknowledge, **Goto Trend**, Generate Job Ticket, Procedure



Chiller Diagnostician

Diagnostic Alarm Annunciator		
Compressor High Starts	Compressor High Load	Evaporator High Flow
System Low Charge	System Over Charge	Condenser High Flow
Evaporator Low Flow	Condenser Low Flow	Evaporator Fouling
Running Non Condensables	Off Line Non Condensables	Condenser Fouling

f

35.10 psig

40.20 deg

Diagnostic Stat
unit not steady state

Chiller Efficiency

0.555 KW/Ton

▶ Q & A.