Commercial RTU Diagnostics: Transforming the HVAC service market

Todd M. Rossi, Ph.D.

Field Diagnostic Services, Inc.

Outline

- Objectives, approach and benefits
- Evolution of portable to embedded technology
- Potential energy savings
- Service Assistant portable technology
- Sentinel Embedded technology
- DSM programs and Title 24

Objective: Better control of valuable resources

Electric power

Air conditioning service labor

Field Diagnostics

Approach: Measure and improve

- Monitor HVAC equipment performance
  - When becoming inefficient
  - When small problems are growing into big ones
- Dispatch the correct skilled service labor at the right time
- Track and feedback service effectiveness
  - When training is needed

Benefits

- More reliable HVAC equipment requiring less emergency service
- More effective/productive service with better controlled cost
- Reduced annual kwh and peak kW electricity consumption

Evolutionary process of tracking and improving performance

- Portable tools and handheld computers
  - Service companies use to:
    - Find service opportunities to sell
    - Verify and communicate benefits of effective service to customers
    - Track and improve effectiveness of service work
  - Utilities use to:
    - Track effectiveness of incentive programs

Field Diagnostics

Evolutionary process of tracking and improving performance

- Embedded sensors and remote monitoring
  - Service companies use to:
    - Provide more accurate diagnostics with objective information
    - Service response when needed
  - Utilities can use to:
    - Incentivize for sustained and persistent savings

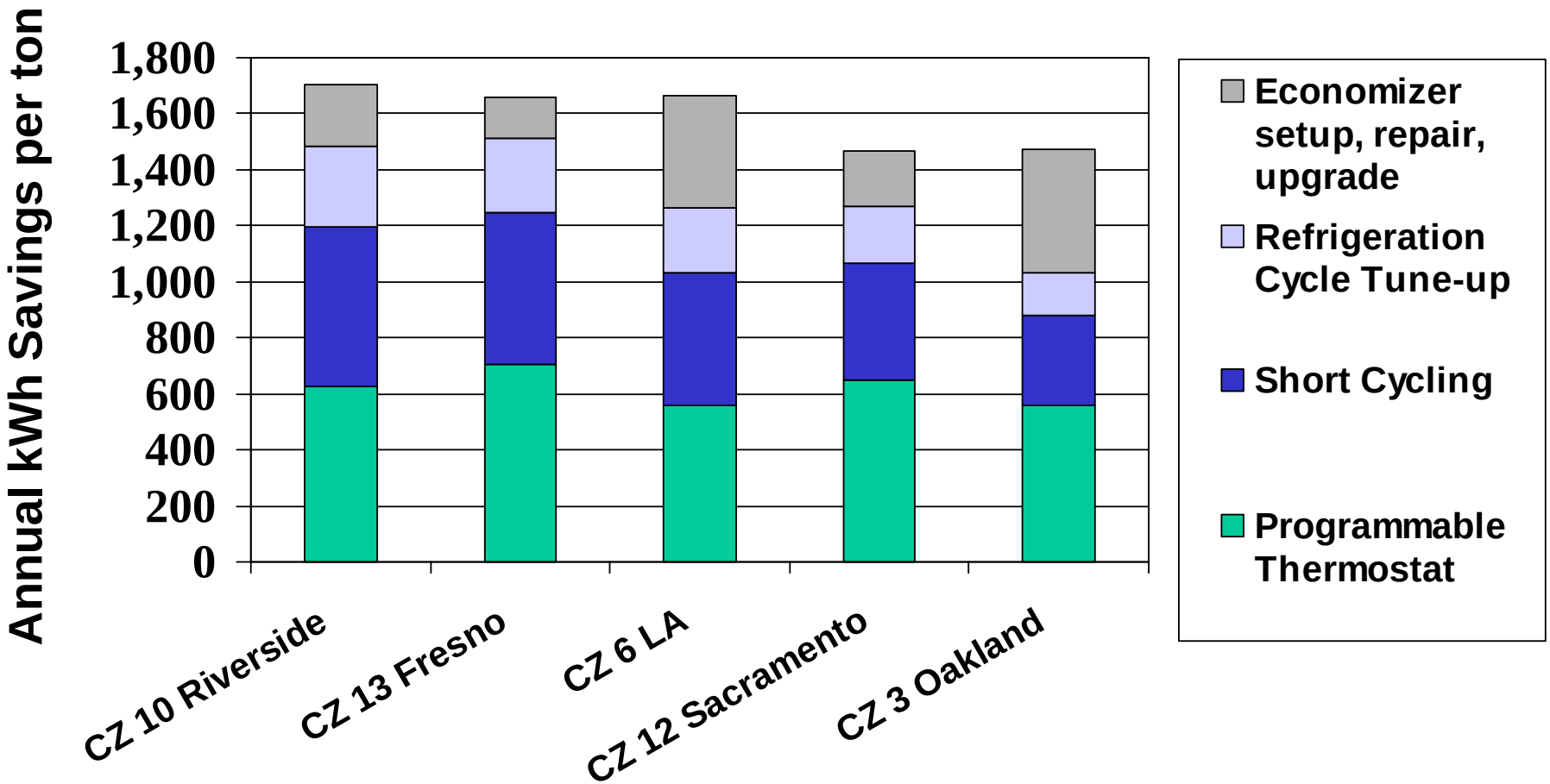
Types of savings opportunities

- Short cycling problem – significant reduction in peak kW
- Refrigeration cycle issues
  - Undercharge
  - Dirty coils
- Easy programmable thermostat corrections
  - Continuous fan operations
- Economizer functioning

Savings can be significant
5,000 and 15,000 Annual kWh
Up to 1.00 kW per unit
But they are achievable over time
Not a single point of contact

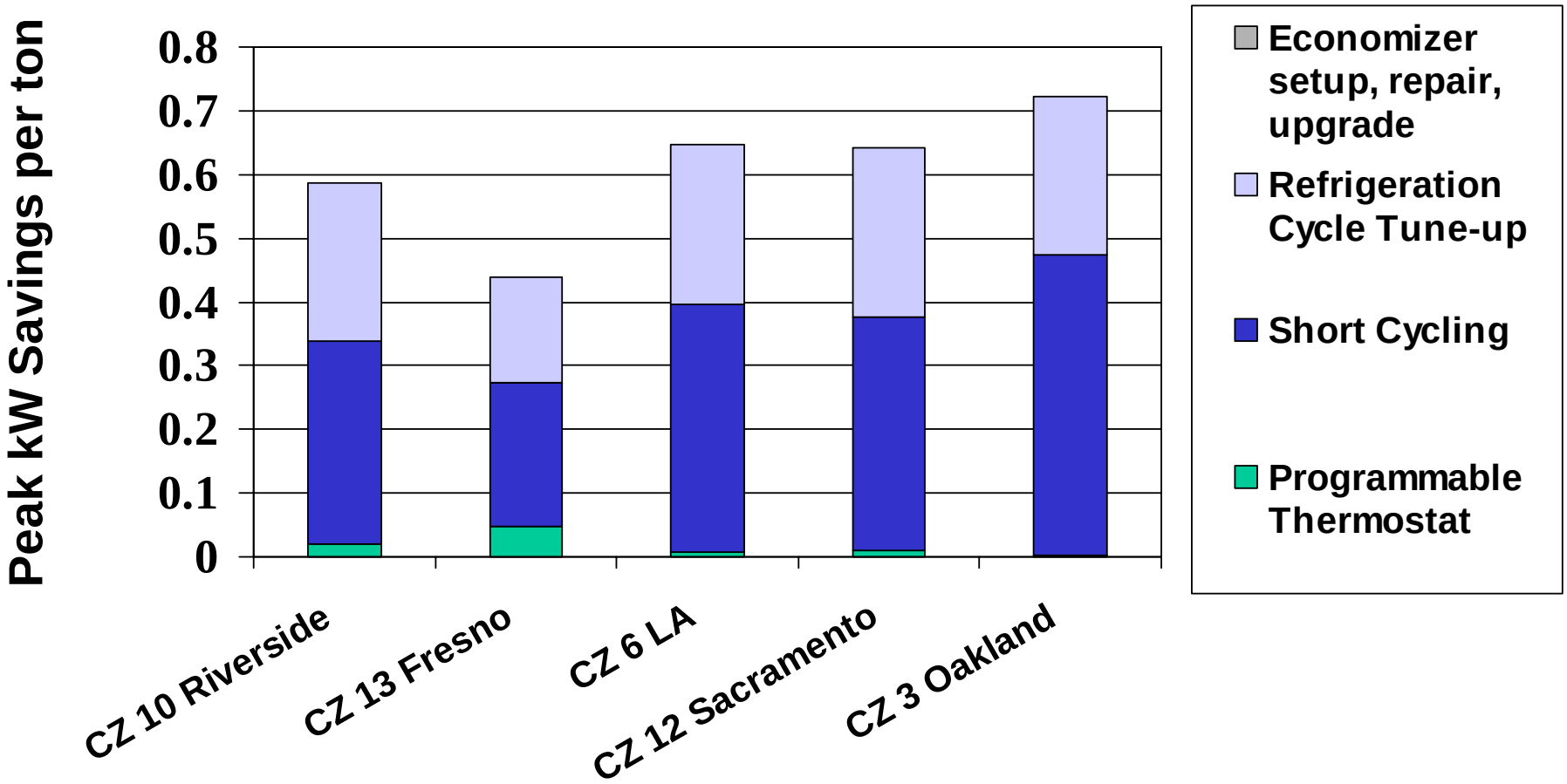
Field Diagnostics

Annual kWh/ton savings



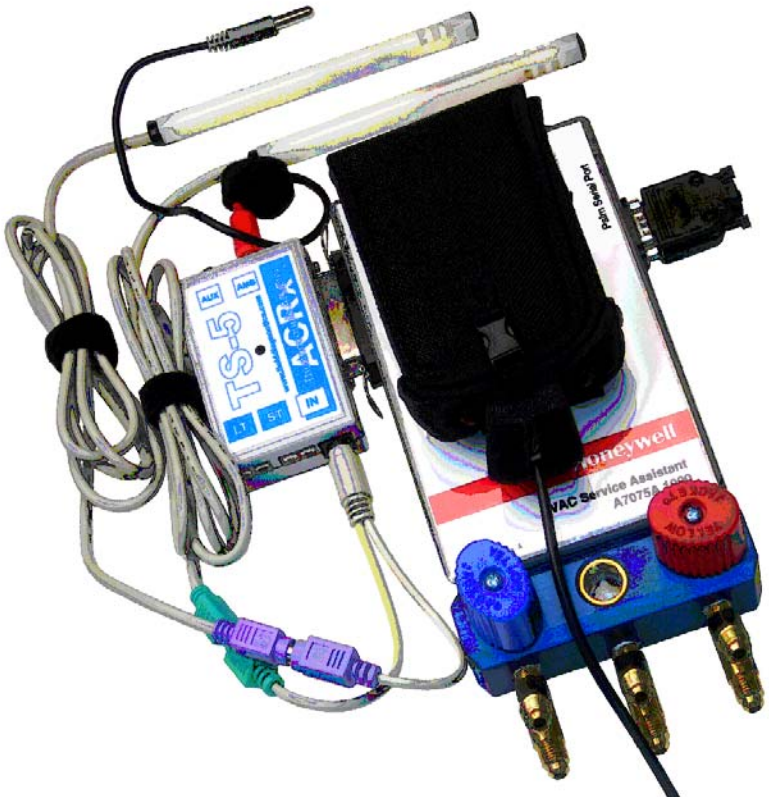
Field Diagnostics

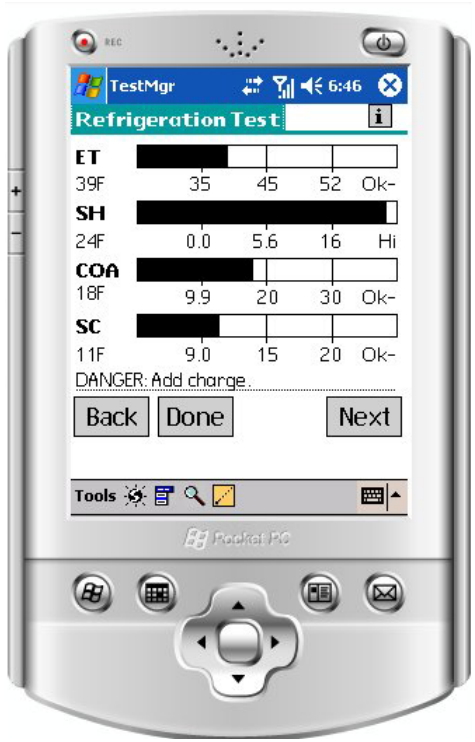
Peak kW/ton savings



Field Diagnostics

Portable technology





$3,000 package of tools …

Field Diagnostics

Portable technology

… and support services.

Detailed Unit Information

Date: 3/08/07 **Technician:** Junior Ibarra

SITE:	AIRE RITE	**Make:**	RHEEM
		Model	rrgg-10e61ckr
		Serial Number:	AYA5151 C HA A F1294
UNIT:	5	**Expansion Device:**	Fixed
		Refrigerant:	R22
		High Service Port:	Liquid line
STAGE:	1	**SEER:**	10.0
		Capacity:	6 tons

PRE-TEST DIAGNOSTICS: CAUTION/Major Repair: Non condensables or restriction because ET is low and SH and SC are high and COA is greater than goal and not high.

POST-REPAIR DIAGNOSTICS: ACCEPTABLE/No repair needed: Safe and reasonable performance because the data indicates this system is performing as expected given the conditions entered. No further system diagnostics are required.

Performance Parameter	Pre-Test Value	Post-Repair Value	Realized Savings
Efficiency Index (EI)	72%	>98%	$399
Capacity Index (CI)	64%	>98%	
Potential Annual Savings	$399	$0	

The following default values are used for Potential Annual Savings calculation if actual values are not supplied: Nominal SEER 10 BTU/h/w, Annual Runtime 1200 hrs/year, 2nd stage runtime equals 25% of 1st stage runtime, Electrical cost $0.10

Diagnostics Parameter	Goal	Pre-Test		Post-Repair	
		Value	Evaluation	Value	Evaluation
Evap Temp (ET)	40 F	24 F	Lo	48 F	Hi
Superheat (SH)	18 F	34 F	Hi	15 F	Ok-
Condenser Temp (CT)	-- F	103 F	N/A	83 F	N/A
Subcooling (SC)	17 F	31 F	Hi	13 F	Ok-
Evaporator Delta T (EDT)	17 F	17 F	Ok	18 F	Ok
Condenser Over Ambient (COA)	26 F	34 F	Ok+	15 F	Lo

Measurement	Pre-Test	Post-Repair
Suction Pressure (SP)	48 psig	80 psig
Liquid Pressure (LP)	204 psig	150 psig
Discharge Pressure (DP)	219 psig	165 psig
Suction Temp (ST)	58 F	62 F
Liquid Temp (LT)	71 F	70 F

Measurement	Pre-Test	Post-Repair
Ambient Temp (AMB)	68 F	68 F
Return Air (RA)	71 F	70 F
Supply Air (SA)	54 F	52 F
Return Air Wet Bulb Temp (RWB)	61 F	60 F
Supply Air Wet Bulb Temp (SWB)	45 F	43 F

Field Diagnostics

Portable technology Measurements

Measurement	Pre-Test	Post-Repair
Suction Pressure (SP)	48 psig	80 psig
Liquid Pressure (LP)	204 psig	150 psig
Discharge Pressure (DP)	219 psig	165 psig
Suction Temp (ST)	58 F	62 F
Liquid Temp (LT)	71 F	70 F

Measurement	Pre-Test	Post-Repair
Ambient Temp (AMB)	68 F	68 F
Return Air (RA)	71 F	70 F
Supply Air (SA)	54 F	52 F
Return Air Wet Bulb Temp (RWB)	61 F	60 F
Supply Air Wet Bulb Temp (SWB)	45 F	43 F

Field Diagnostics

Portable technology Performance Indices

Diagnostics Parameter	Goal	Pre-Test		Post-Repair	
		Value	Evaluation	Value	Evaluation
Evap Temp (ET)	40 F	24 F	Lo	48 F	Hi
Superheat (SH)	18 F	34 F	Hi	15 F	Ok-
Condenser Temp (CT)	-- F	103 F	N/A	83 F	N/A
Subcooling (SC)	17 F	31 F	Hi	13 F	Ok-
Evaporator Delta T (EDT)	17 F	17 F	Ok	18 F	Ok
Condenser Over Ambient (COA)	26 F	34 F	Ok+	15 F	Lo

Field Diagnostics

Portable technology Diagnostics and Efficiency

PRE-TEST DIAGNOSTICS: CAUTION/Major Repair: Non condensables or restriction because ET is low and SH and SC are high and COA is greater than goal and not high.

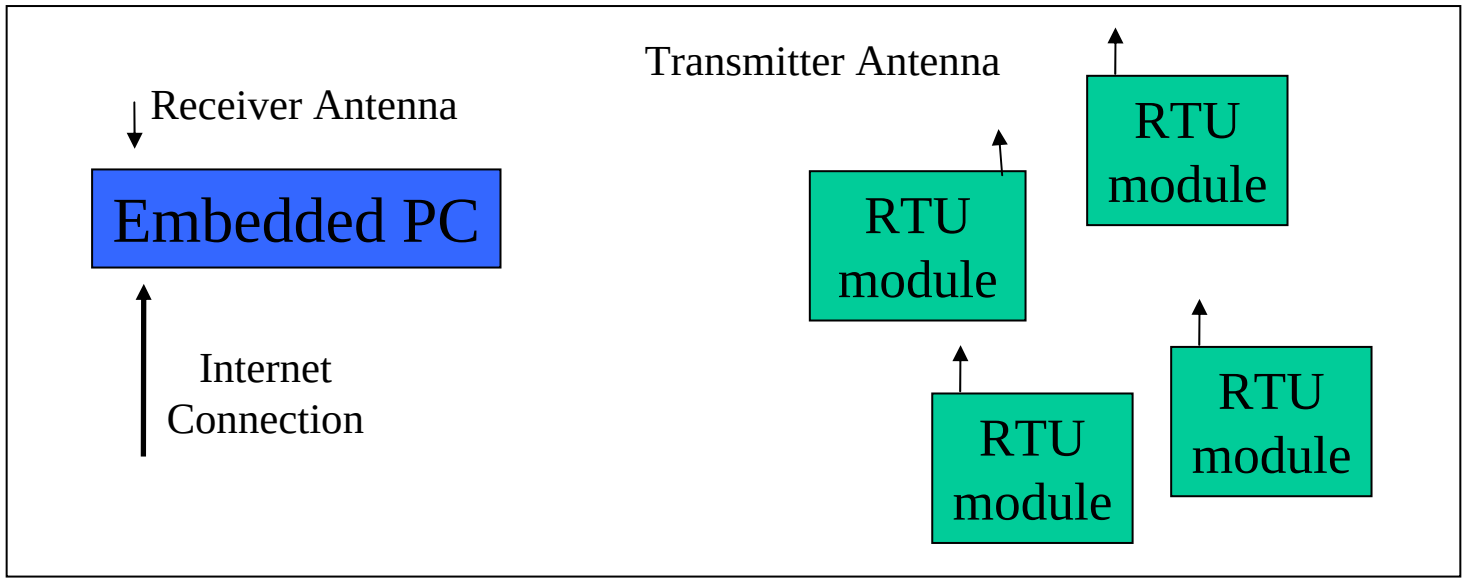
POST-REPAIR DIAGNOSTICS: ACCEPTABLE/No repair needed: Safe and reasonable performance because the data indicates this system is performing as expected given the conditions entered. No further system diagnostics are required.

Performance Parameter	Pre-Test Value	Post-Repair Value	Realized Savings
Efficiency Index (EI)	72%	>98%	$399
Capacity Index (CI)	64%	>98%	
Potential Annual Savings	$399	$0	

The following default values are used for Potential Annual Savings calculation if actual values are not supplied: Nominal SEER 10 BTU/h/w, Annual Runtime 1200 hrs/year, 2nd stage runtime equals 25% of 1st stage runtime, Electrical cost $0.10

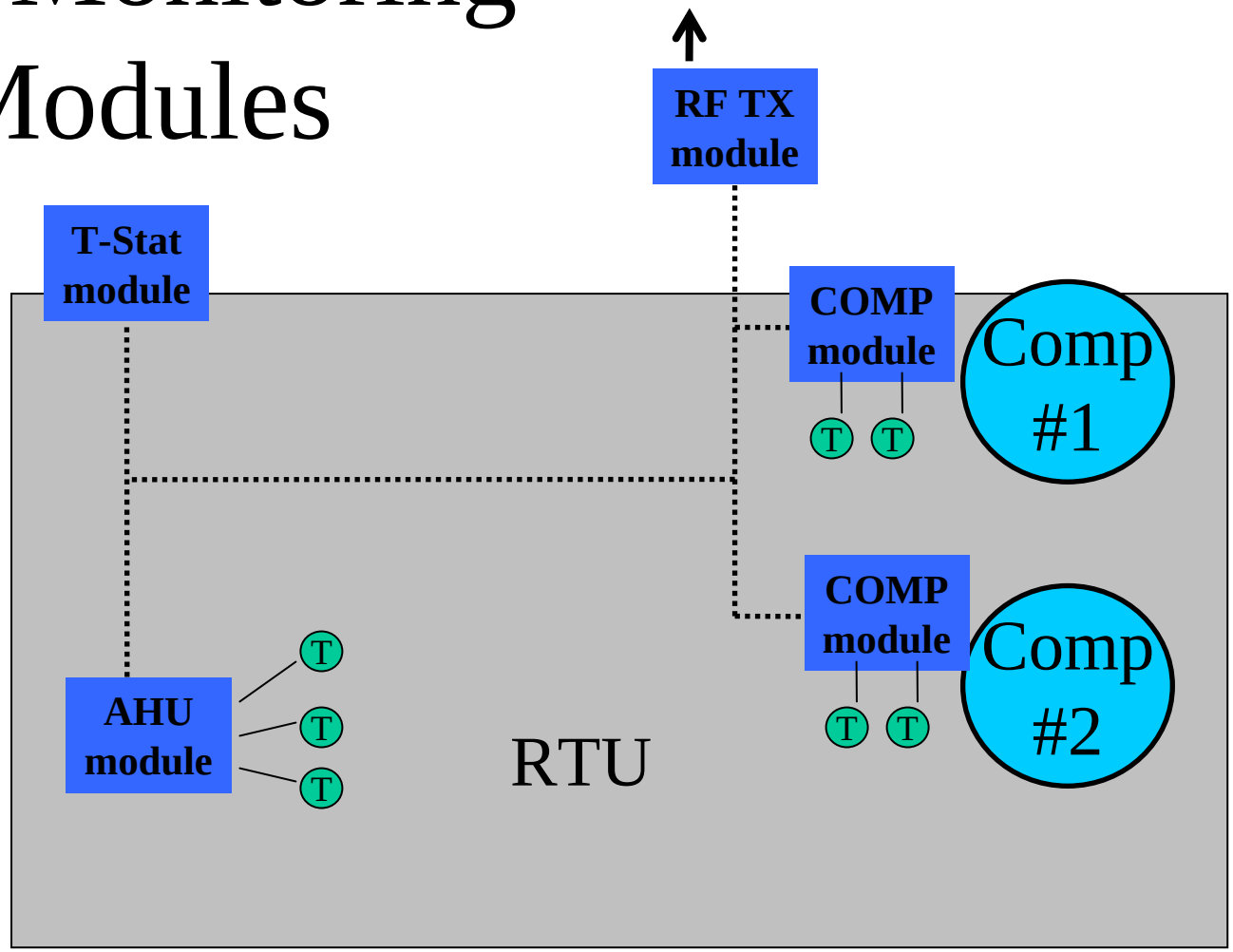
Field Diagnostics

ACRx Sentinel™ RTU Monitoring System



Costs: Starting at about $1,000 - $800 per unit and driven down with higher quantity and OEM integration

RTU Monitoring Modules



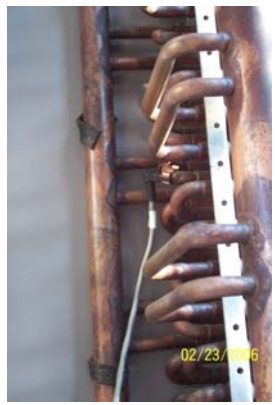
Field Diagnostics

ACRx Sentinel™ Installation

Installed on large Carrier commercial RTU

Sentinel™ modules – Cellular site interface, Thermostat and Compressor modules

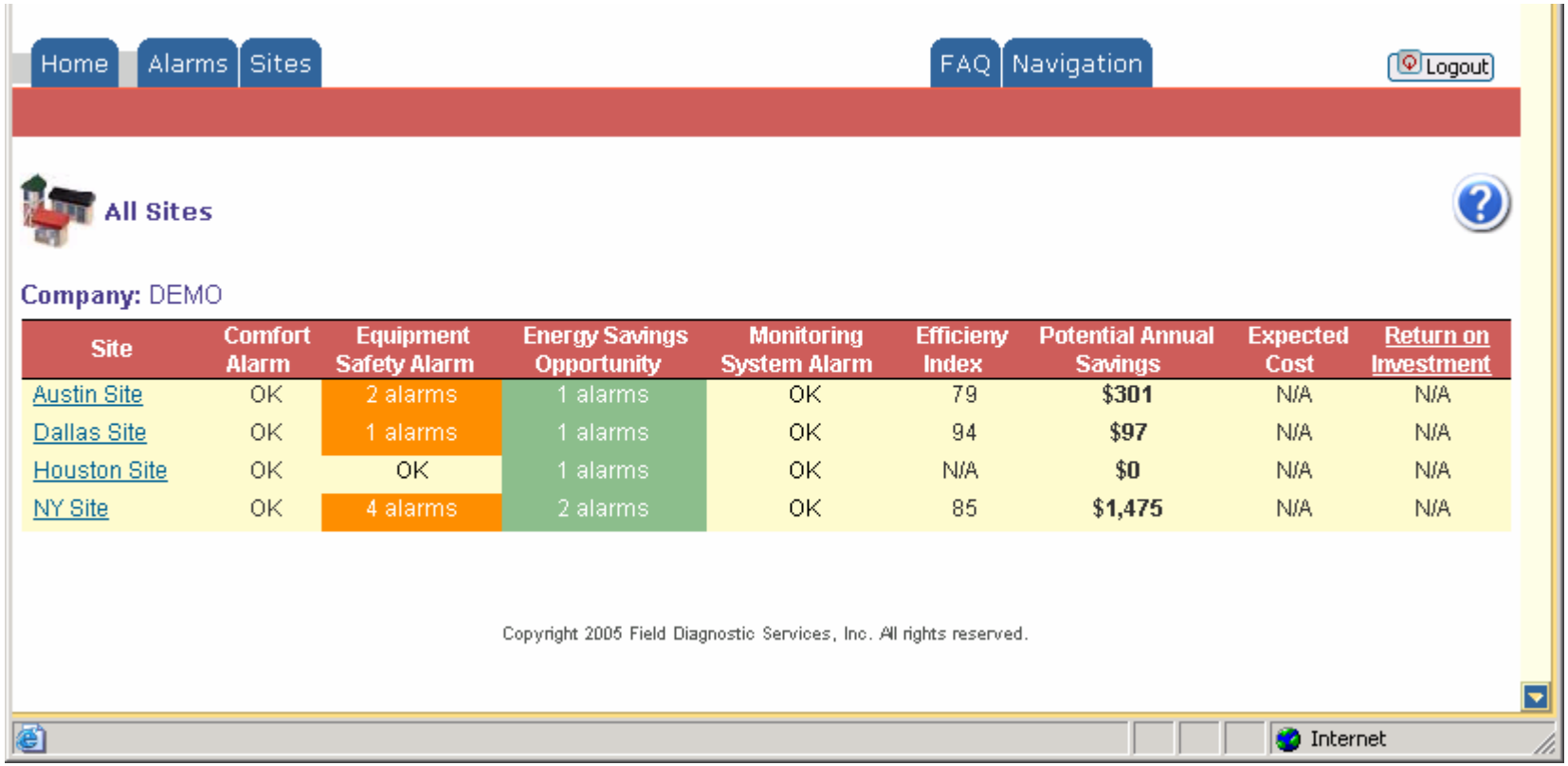
Refrigerant pipe temperature



Condensing temperature

Field Diagnostics

Web-based reports



Field Diagnostics

Comprehensive RTU monitoring

- Refrigeration cycles
- Economizer performance
  - Energy savings
  - IAQ
- Air handing unit
  - Delivering required airflow
- Gas furnaces
  - Combustion efficiency
  - Safety
- Building and internal operating controls

Field Diagnostics

DSM and Title 24

- AirWatch program use Sentinel is deployment program providing persistent and sustainable savings
- Integrated unit curtailment for demand response programs.
- Qualified embedded monitoring and diagnostic system can qualify for Title 24 compliance credits

Field Diagnostics

Conclusion

- Electric power and HVAC service resources can be better tracked and controlled with HVAC diagnostic systems
- Evolutionary technology from portable tools to embedded RTU monitoring
- Cost effective deployment in DSM programs and building codes (Title 24).