# Cromer Cycle Desiccant Based Combined System

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Trane/American Standard

# Project Team

- Jim Sand: DOE, Oak Ridge National Laboratory – DOE Technical Administration
- Charlie Cromer: FSEC/UCF – Program Administration, Product Optimization
- Art Hallstrom: Trane – Product Development and Manufacture (Ronnie Moffitt)
- Jim Hurley: Airxchange – Desiccant Wheel (Bede Wellford, Don Steele, Larry Hoagland)
- Doug Kosar: U of I at Chicago – Simulations

# Cromer Cycle

- DOE Project Name: Trane Active Cromer Cycle (TACC)
- Trane Product: CDQ™ - Cool Dry Quiet

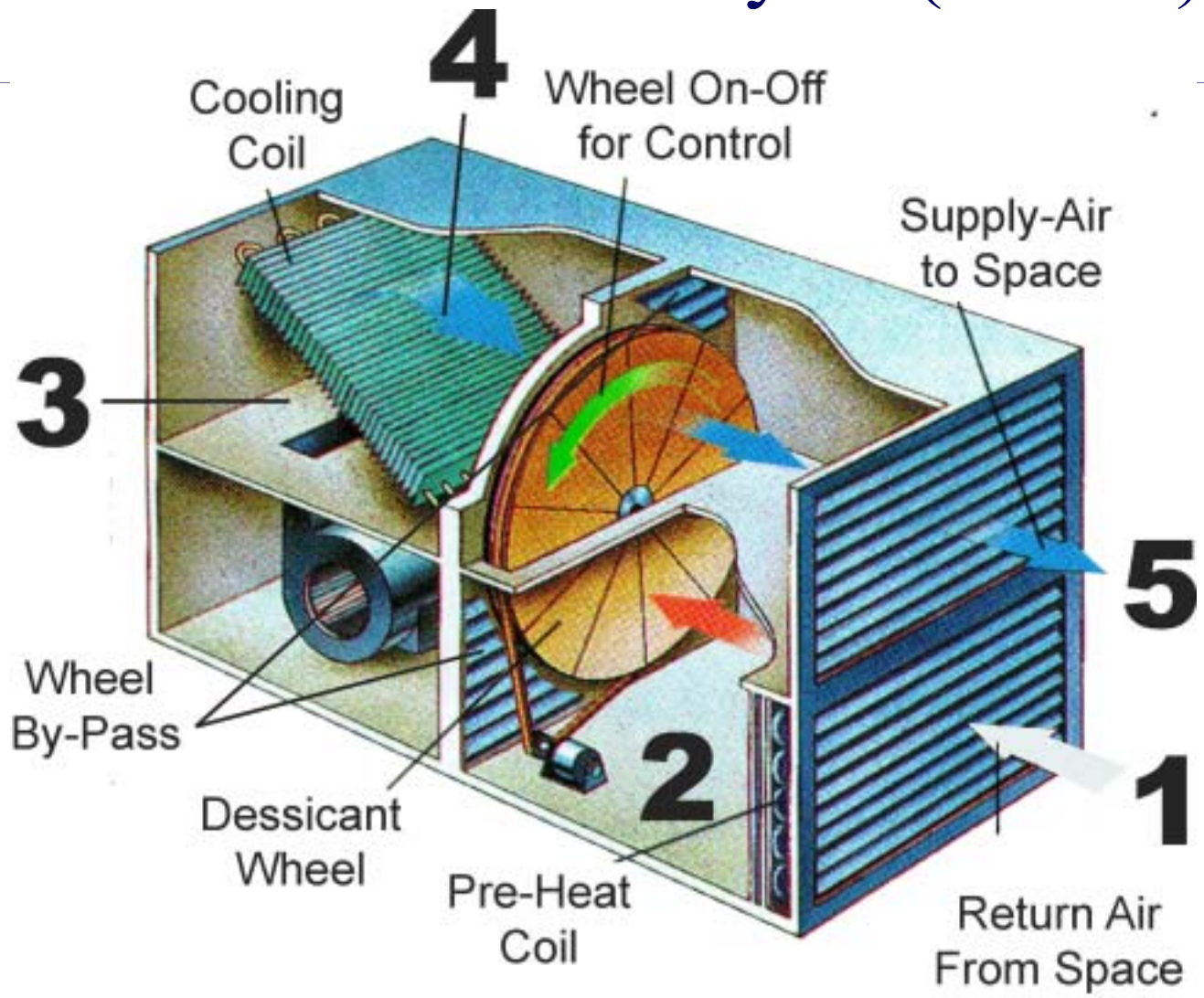
# TACC Project Objective

- Develop a option that significant enhances part load dehumidification of a standard hvac unit with low first cost and minimum added energy.
- Needs to work in any DX or CW unit.
- Prove concept with ARI test of manufacturing prototypes.
- Product and R&D development program set up with experimentally measured and computer modeled performance data.
- Experimental and Analytical bases for TACC are covered by the current program.

# DOE TACC Program

- DOE support with Trane/UIC/FSEC cost sharing keep this multi-year program on track towards a cost competitive best in class product.
- DOE support is creating an option that address a big industry problem - control of building humidity at all hours at a comparatively low operating cost.
- For best energy efficiency and enhanced performance TACC uses the LOWEST quality waste heat sources
  - return air heat first
  - compressor condenser heat second

# Trane Active Cromer Cycle (TACC)



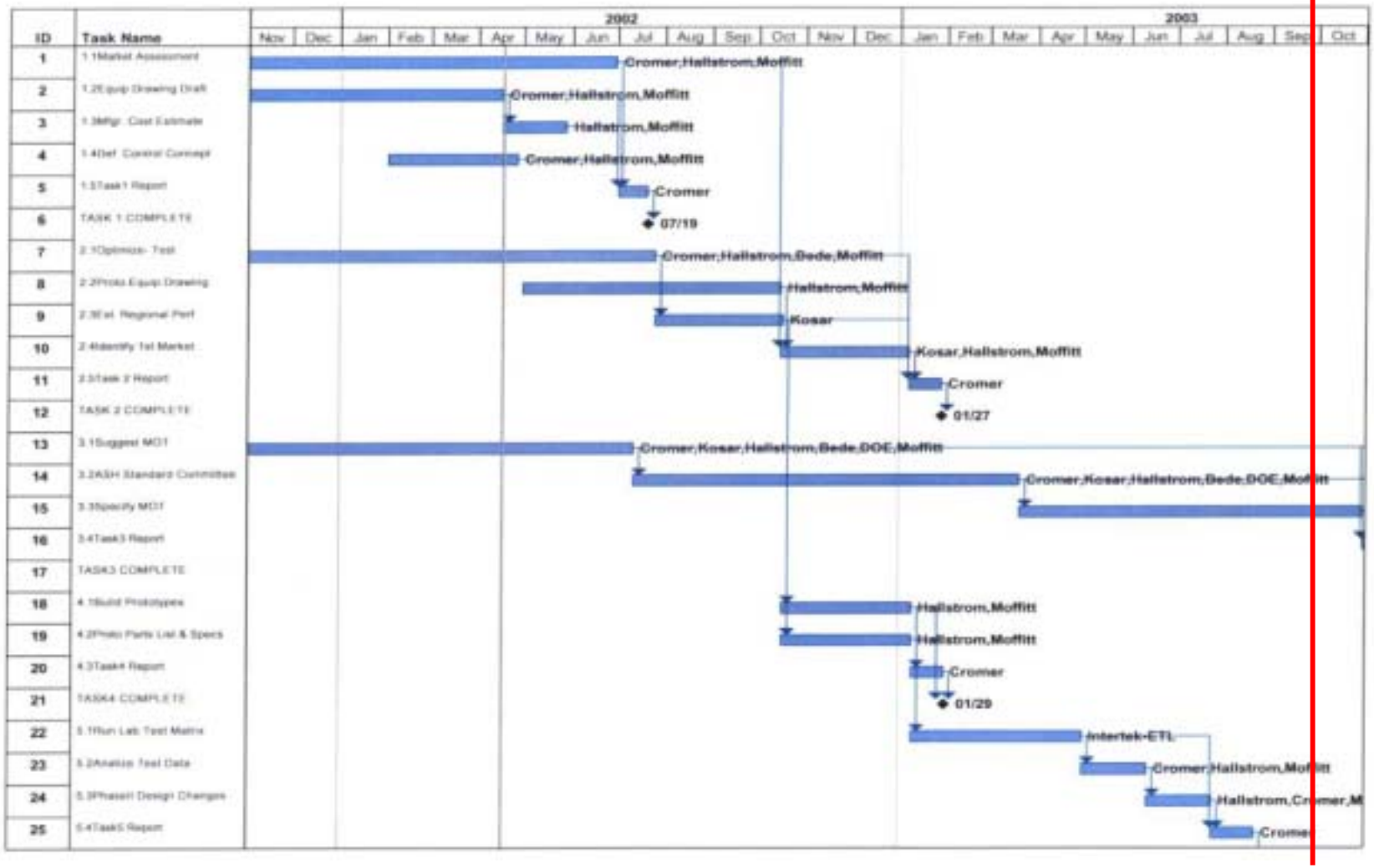
# Task Assignments For This Project:

- 1) Define Hardware Concept: Lead Trane, input from FSEC, Airxchange.
- 2) Optimize Hardware: Lead FSEC, input from Airxchange, Trane
- 3) Construct two manufactured prototypes: Trane
- 4) Define a MOT – Lead FSEC, input from Trane, Airxchange.
- 5) Independent Lab Test – Intertek ETL
- 6) Comparative Evaluation – Lead: U of Illinois at Chicago, input from Trane, FSEC.

# Completed 5 of 6 Major Milestones:

- Define Hardware Concept: a. market assessment, b. manuf. cost estimates, c. *define control concepts*.
- Optimize Hardware: a. bench testing for desiccant, b. full scale testing for performance.
- Construct two manufactured unit prototypes. *Added 2 field tests. School, conference room.*
- Define a MOT - to characterize performance. *Considers latent transfer and air side pressured drop.*
- Independent Lab Test - to verify performance targets.
- Model Market Applications - for comparisons and identification of primary markets. *Underway*

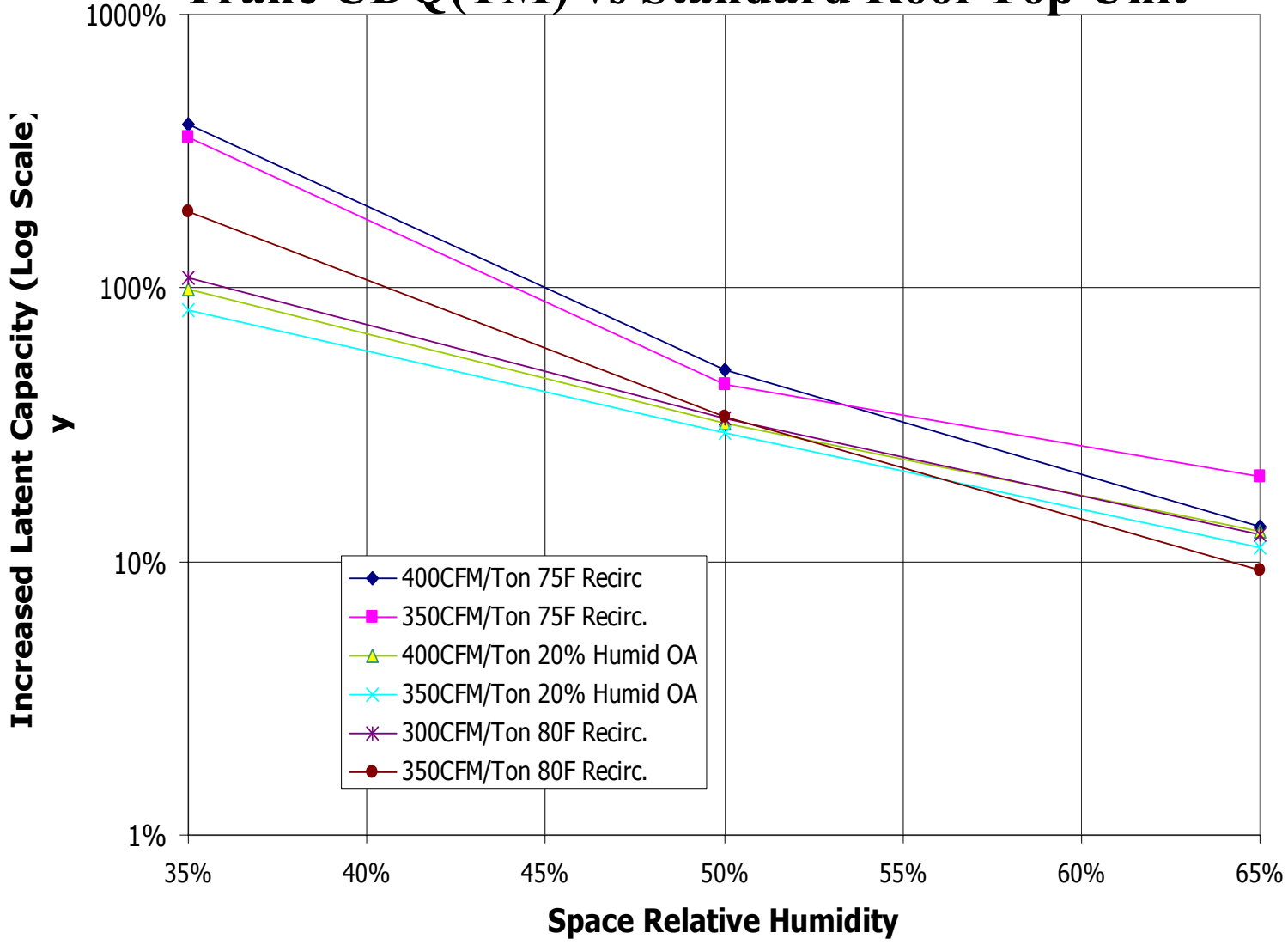
# Schedule of Tasks:

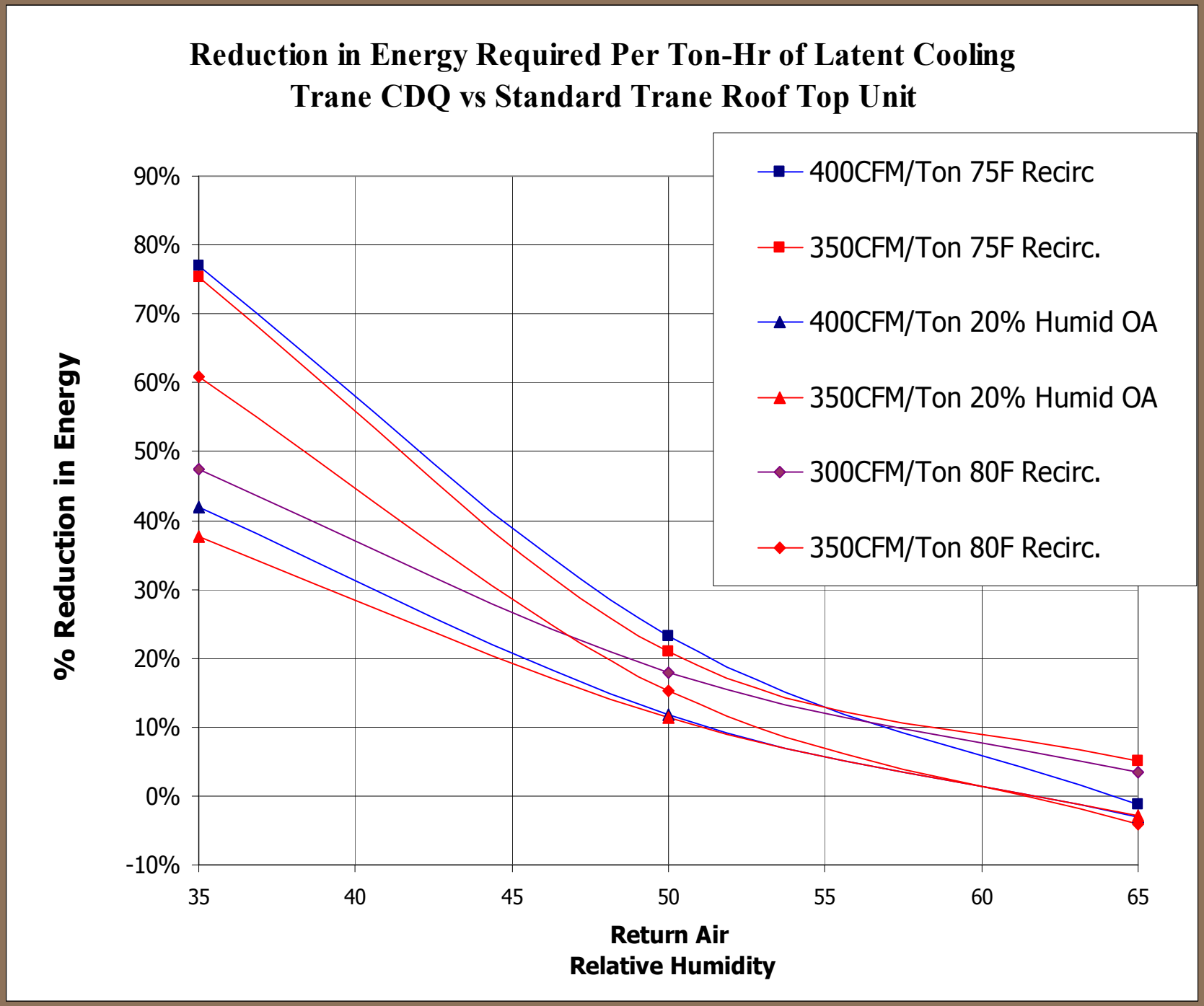


# Performance Targets:

- 1. At 380 Cfm/ton, 80F/51%RH inlet, product will provide 50% Latent Ratio (.5 SHR) (Wheel must transfer more than 10 grains/lb air).
- 2. At 380 Cfm/ton, 90F/37%RH inlet (10 degrees preheat), product will provide 60% Latent Ratio (.2 SHR) (Must xfer > 15 grains/lb air)
- 3. At 1 above, provide increased total cooling capacity (sensible + latent) over air-conditioner.
- 4. At 1 above, reduce energy use by 50% compared to reheat, 10% compared to heat pipe alternatives.

# Improvement in Moisture Removal Rate
# Trane CDQ(TM) vs Standard Roof Top Unit




Reduction in Energy Required Per Ton-Hr of Latent Cooling
Trane CDQ vs Standard Trane Roof Top Unit
% Reduction in Energy
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-10%
35
40
45
50
55
60
65
Return Air
Relative Humidity
400CFM/Ton 75F Recirc
350CFM/Ton 75F Recirc.
400CFM/Ton 20% Humid OA
350CFM/Ton 20% Humid OA
300CFM/Ton 80F Recirc.
350CFM/Ton 80F Recirc.

# Primary Technical Barrier Overcome:

Team developed a desiccant wheel that will respond well to the needed performance conditions, i.e. provide the moisture transfer targets.

Trane elected to independently improve CDQ performance by testing other desiccant CDQ wheels designs. Result - improved moisture transfer with 50% reduction in wheel air pressure drop. Current Trane CDQ wheel - APD of .4” per pass. Major positive impact on lower operating cost and allows use in small unitary rooftops.

# Two basic configurations

- CDQ is primarily a mixed air unit enhancement
- Rooftop
  - CDQ Adapter unit
    - New Projects - Replaces roof curb
    - Retrofit/Upgrade Projects - Goes between curb and rooftop
    - Simple controls - space humidistat control wheel operation
  - CDQ integrated in Rooftop airhandler
- Indoor
  - CDQ integrated into airhandler
  - Without RA preheat, Constant volume better part load RH
  - With RA preheat, low grain applications. <30 grains

# Trane funded field test:
# 3 Ton Trane CDQ being installed

# Rooftop Trane CDQ Installed

# Customer Field Test: Indoor Trane CDQ Installed at Wallace College (85 ton):

# Program Activity To Go:

- Simulate comparisons for various applications and locations.
- Finish industry accepted comparison method for electric and electric/gas fired dehumidification options

## Trane effort on the Market Survey has identified specific humidity sensitive market applications for this technology:

Schools
Office Buildings
Retail Big Box Stores
Hotels
Restaurants
Elder Care, Dormitories

CDQ Enhanced

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Museums- Libraries-Archives
Hospitals
Swimming Pools
Ice Rinks
Dry Air Storage
Laboratories

CDQ Enhanced with Return Air Preheat

# Program Summary

- Program represents development of a new "breakthrough" technology combining active desiccants with HVAC systems and using waste heat.
- This program is performance based with target performance criteria.
- This program represents a model of a working public-private partnership combining efforts of National Lab, Universities, and Private Industry.
- This program provides significant leverage of DOE $.
- This program meets the National Energy Policy Development Group priority for improving energy efficiency for higher productivity per unit energy.

# CDQ

- Fills a unique and currently important role in building HVAC equipment that is poorly filled by the other equipment available today. (Small single compressor CV Rooftops)
- Can be applied to any mixed air current, conventional Ventilation Air Handling Equipment.
- Takes advantage of higher coil leaving air temperatures at part load - allowing more efficient compressor operation
- A truly integrated energy system—using the best features of each technology to produce an efficient/effective HVAC product

# Control and Sensors

- Concepts and strategies for control and modulation of equipment capacity are evolving.

  Given: A desired SHR performance.

  Optimized parameter: efficiency/effectiveness

- Can this product address the current concern about increase quantities of outdoor air needed for increased building ventilation?

  A) OA cfm is actually trending down (62.1N)

  B) CDQ lets mixed air units control space RH. Above 30% OA, should use ATA energy recovery.

# Bottom Line

–CDQ is a relatively simple, direct solution to a difficult problem (fresh air ventilation and full time humidity control).

-Takes advantage of vapor-compression and desiccant technologies to process the air stream for temperature and dewpoint control.

–It looks like a packaged air conditioning unit from the outside, BUT it has dramatically improved and enhanced part performance over standard rooftop units. It is an all electric unit, solid desiccant dehumidification system.

# Bottom Line (2)

- Trane's involvement resulted in a product that fits the current real market. Discovered what the product performance needs to be and what customers will pay for that capability.
- Trane/UIC's/FSEC's cost sharing on the project gave DOE good $ leverage in terms of product development.
- Without DOE support, the Cromer cycle would not have been commercialized.

# Tie in to 2002 Dallas Thermally Activated Technologies (TAT) Road Mapping Exercise and Road Map Document

- Called for improved IAQ HVAC product development—humidity control/increased ventilation
- Called for products to take advantage of lowest quality waste heat to regenerate desiccant technology
- Packaged TAT Rooftop System—biggest market—biggest opportunity for National energy savings
- Major manufactures can develop, educate and supply products for variable SHR applications
- Provided practical cost effective improved performance for the active humidity control of spaces

# Next Steps

- Phase 2
  - Field tests of the 12 different applications
  - Ongoing product optimization
    - Desiccants
    - Sensors
    - Control Optimization (put the tons where needed)
    - Resolve how good is enough