Agenda

- Introductions
- BBA HVAC Research Team Updates
- Michael Deru – RTU AFDD Field Study Results
- Kyle Hopkins – H&M AFDD rollout
- Paul Johnson – Target AFDD development
HVAC Research Team Call

- September 6, 2018 1-2 ET
- Field Test Results of New HVAC Technologies
  - High performance circulator pumps
  - Air scrubber technology that removes CO$_2$ and VOCs
  - High-performance variable speed screw chillers
- Registration at
  [https://attendee.gotowebinar.com/register/775157188383295745](https://attendee.gotowebinar.com/register/775157188383295745)
What is it?
7-page reference on efficiency measures, proper maintenance, and retrofits

Who is it for?
Facility managers and Maintenance staff

Where can I get it?
betterbuildingssolutioncenter.energy.gov
HVAC Resource Map

www.HVACresourcemap.net

Quick access to
- Basic definitions
- Efficiency Measures
- O&M
- Procurement
- Case studies
Advanced RTU Campaign

2018 Recognition Awards

www.AdvancedRTU.org

Six new tool kits
RTU AFDD Landscaping Study

- Timeline: Jan 2018 through Sep 2018
- Objectives:
  - Characterize and document RTU AFDD systems
  - Identify market barriers to RTU AFDD technology
  - Identify research opportunities to improve performance
- Study participants (so far)
  - Building owners (6)
  - AFDD developers (10)
  - RTU OEMs (2)
What is AFDD?

Automated Fault Detection and Diagnostics

Continuous monitoring of the health of RTUs, diagnosing faults, and communicating the results

Types of RTU Faults

- Economizer
- Sensor failure
- Air flow restriction
- Component failure
- Refrigeration: low charge, over charge, restricted flow
## RTU AFDD Characterization

### Level of AFDD capability

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1.</td>
<td>Basic FDD and communications</td>
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<tr>
<td>2.</td>
<td>Prioritize faults, store and trend data</td>
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<td>3.</td>
<td>Estimate and trend performance, quantify impact of faults</td>
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<td>4.</td>
<td>Detect simultaneous faults, automated FDD mode, adjust operations to minimize impact of faults</td>
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### AFDD location

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<table>
<thead>
<tr>
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<tr>
<td>•</td>
<td>Embedded on-board controller</td>
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<tr>
<td>•</td>
<td>Retrofit controller</td>
</tr>
<tr>
<td>•</td>
<td>Building automation system</td>
</tr>
<tr>
<td>•</td>
<td>Cloud</td>
</tr>
<tr>
<td>•</td>
<td>Handheld device</td>
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<td>Combination of above</td>
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### RTU functions monitored

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<table>
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<tr>
<td>•</td>
<td>Economizer</td>
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<tr>
<td>•</td>
<td>Air systems</td>
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<tr>
<td>•</td>
<td>Refrigerant</td>
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<tr>
<td>•</td>
<td>Power</td>
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<tr>
<td>•</td>
<td>Sensors</td>
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<tr>
<td>•</td>
<td>Scheduling</td>
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<tr>
<td>•</td>
<td>Zone cooling/heating</td>
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AFDD Field Study Preliminary Results

AFDD Capability Level

AFDD Analysis Location

AFDD Solution for Building Owners
AFDD Field Study Preliminary Results (2)

AFDD system fault detection categories

Most common faults
1. Economizer/OA damper
2. Zone cooling/heating
Building Owner AFDD Wish List

- Impact of failures
- Manage and prioritize alarms
- Link with service providers
- Trend and save data
- Access to RTU sensor data
- Product that works with old and new RTUs and not specific to a single manufacturer
RTU Manufacturer AFDD Wish List

- Validation of performance of AFDD systems
- Standard measurement of performance
- Better understanding of the economic proposition
- Raise awareness of AFDD with owners and utilities
- Understand how owners and service providers react to faults
- Incentives for AFDD
AFDD Selection for H&M Stores

Kyle Hopkins, Energy Specialist
AFDD SELECTION FOR H&M STORES
BACKGROUND ON SELECTION

– Piloting Building Management System upgrades
  – Installing new BMS systems (HVAC and Lighting) on existing stores and new construction

– Diverse mix of system types & manufacturers
  – RTUs of varying manuf., AHUs, VAV systems, Chillers, Boilers, etc..
    – Some equipment with around 50% life remaining
    – Questionable maintenance history.
  – No standard ‘store prototype’
  – Potentially oversized units
  – Traditional ‘simple’ BMS’ systems cannot accommodate some complex system types

– Wanted to incorporate VFD, DCV, and advanced economizer control
  – Rebate-eligible
  – Systems with AFDD were not significantly more expensive (in some cases less expensive)
    – In 2017 H&M retrofitted 433 units at 91 stores with AFDD for their RTUs, and added VFDs to 237 units
    – All new stores in US are built with AFDD standard
  – By end of 2019 we will have retrofitted over 400 stores to AFDD
BENEFITS TO CHOOSING AFDD ALONGSIDE VFD / DCV / ECONOMIZER CONTROL

- Hard savings vs. soft savings
  - Existing BMS was semi-functional, needed to guarantee additional savings.
- Retail is a prime candidate for DCV with CO2 sensors, due to changing occupancy
- One major energy savings opportunity, free-cooling economizer, can be very detrimental if not properly functioning.
- Needed AFDD to verify functionality

Guess what day that is?
AFDD FAULT: DAMPER FAILURE- EXCESSIVE OUTSIDE AIR LEAKAGE

- Fault notes the potential issue with the damper
- Does not calculate energy penalty.
AFDD FAULT:
DAMPER FAILURE-
DAMPER STUCK CLOSED

Fault Detection Status

- Economizing When Shouldn’t
- Not Economizing When Should
- Damper Not Modulating
- Excess Outdoor Air
- Outside Air Sensor: 66.8 °F
- Return Sensor: 73.1 °F
- Supply Sensor: 72.4 °F

General Information
**OVERVIEW REPORT OF DAMPER PERFORMANCE AND FAILURES**

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Unit ID</th>
<th>Damper Faults</th>
<th>Average of Effectiveness</th>
<th>Average of Leakage</th>
<th>Average of Min Position</th>
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<td>10</td>
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</table>

**Platform allows us to report and sort by the amount of leakage or by the effectiveness of the damper.**

- Leakage indicates a damper that is not fully closing (higher is worse)
- Effectiveness indicates a damper that is not fully opening, or is not modulating (lower is worse)

**Typically requires on-site investigation**

- Our HVAC maintenance providers are notified of each location with potential damper failure within the Quarterly PM Work Order.
- After visiting site for PM and investigating damper function, they provide a repair quote or note if they found no issue with functionality.
ENERGY ALERTS

- **Units using more % of energy than other units at the site**
- **Unit has return air sensor fault**
- **Unit may not be entering economizer mode, thus using more energy.**

- **Other potential causes –**
  - Unit near exterior entrance.
  - Zone has large screen or lightbox
DEALING WITH ALARMS

- Inundated with alarms
  - 78 new alarms yesterday, not including old active alarms
    - Total of 106 sites with some warning or alert (out of 211 sites)
    - 17 Unit-level alarms, comfort alarms (warning and alert), energy use alarms
      - OA sensor, CO2 sensors, Damper, Drive, current transformer
- Hired a third-party BMS monitoring company to manage the alarms
  - Needed to avoid over-dispatching.
  - Non-Emergency, energy items – put note on next Quarterly PM to investigate/address
    - (Damper failure, Sensor out of range, Supply temp above threshold)
    - 3rd party receives alarms into their alarm-management-system, then dispatches using our Work Order platform
PRIORITIZING MAINTENANCE

- Recent ‘Cost savings initiative’ - where can we defer maintenance?
  - Ran a report of all units with active alarms (excluding non-urgent)
    - Those units must keep full-PM scope
    - All others can filter-change only.
- Potential to optimize full PM/Filter-change-only process
  - ‘Intelligent PM’
    - Can we do full scope PMs for spring/fall, then only do full scope on sites with alarms. Filter-change-only on all others?

<table>
<thead>
<tr>
<th>Row Labels</th>
<th>Sum of Cool Faults</th>
<th>Sum of Heat Faults</th>
<th>Sum of Drive Faults</th>
<th>Sum of Fan Faults</th>
<th>Sum of Comm Faults</th>
<th>Sum of Damper Faults</th>
<th>Include damper?</th>
<th>Can we exclude</th>
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NEXT STEPS

– How could it be improved, or what are the next steps?
  – Currently there are 2 priority levels ‘Warning’ and ‘Alert’ and there is a risk in over-dispatching
    – ‘Damper alert’ doesn’t differentiate between failed damper actuator, and a threshold alarm.
    – Cooling failure due to temp threshold, but no comfort issue.
    – FMs are being confused by the alerts and might think they need to dispatch, would prefer to keep these hidden in a separate report.

– I would like to see improvements in prioritizing and grouping alarms, (unit and site level) then recommending dispatching at a certain threshold.
AFDD Implementation for Target Stores

Paul Johnson,
Property Management

AFDD AUTO-WO
Custom Built – Driving Value
Infrastructure

- +1800 stores
- 35,000 RTUs (7 manufacturers)
- Networked – millions of points
- 18 contracted service vendors
- Work Order System
Desired Outcomes: Identify & Dispatch

• Stable Temperature and Dew point
• Identify Fast...Resolve Fast
• Value / Balance – Expense / Brand
• Brand for Analysis
Approach – Internally Develop

Options

• Existing RTU: Controller Retrofit
• New RTU: Enhanced Controller
• Internally Developed
  • 7 Different Manufacturers - Unique
  • Small DATA vs. Big DATA
  • Success Stories?
  • Minimize NOISE
  • Nimble – Ability to Alter
  • Internal Talent
Principles - Framework

- Prioritize – Critical RTUs
- Unit Performance vs. Store Conditions
- Standard Framework – Ease of Change
- Remote Reset
- Trust Data – Time / Expense
- Detailed Work Order
- Expected Results – Analyze Against
Wins

- 15 months
- ALARMS: 38% - 15%
- Store Conditions Stability
- Team Utilization
- Performance Trends – Identify Issues
- Manufacturer Engagement
Learnings: Continued Analysis / Refine

- Invent ALARM (older RTUs)
- Expect Surprises:
  - Phantom ALARMS
  - Undesired Shutdown: Mfgr Wiring
  - Premature ALARM: Mfgr Control Programing
  - Field Install Wiring Clarification
  - Enhanced Condenser Coil Cleaning
- Partnerships – Coach / Sell
Outlook

- 34% Fleet Q3-2018
- +10 year old units – new Routine
- Financial Model
- Continued Analysis – Refine
- Remote Validation
Thank you

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paul.johnson2@target.com