How to Save Energy ($) with “Proper Duct Design”
Presented by : Sterling Minter

National Sales Manager, AQC Industries
Since 2014, Sterling Minter has been the National Sales Manager of AQC Industries, Inc. located in Minneapolis, MN. Sterling is responsible for overseeing the sales team for AQC as well as account development for Manufacturer’s reps located in the US, Canada, and the Middle East.

He received his undergraduate degree in Marketing from James Madison University in Harrisonburg VA and a Master’s in Business from Eastern University in St. David’s, PA. He spent several years in the development and sales of energy efficient duct systems designed to improve both energy efficiency and indoor air quality (IAQ) while meeting code and building requirements for improved sustainability and long-term performance.

Sterling currently lives with his wife, Cyndee in New Jersey. Together, they have four children and 11 grandchildren.
Pre-Insulated Duct Systems

• **Performance**
  - Energy efficient
  - Improve IAQ
  - Minimize Leakage

• **Installation**
  - Easy to Install
  - Light weight
  - Design flexible
  - Improved site movement
AQC Offers a Complete Line of Pre-Insulated HVAC Duct Systems…

- Rooftop
- Indoor
- Underground
An introduction to the Energy Efficiency made possible with properly designed ducting!

- Air flow problems continue to plague the HVAC industry
- A look at some of the best and worst practices on the design and application HVAC duct
- A well-designed ductwork system will deliver maximum interior comfort at the lowest operating cost……while also preserving indoor air quality.
- Poorly designed ducts result in discomfort, high energy costs, bad air quality, and increased noise levels.
“Proper Duct Design”
What does it really mean???????
“Proper Duct Design”
Means this never happens!
Duct Design: “Proper Duct Design”

• Should convey specified rates of air flow to prescribed locations.

• Should be economical in **combined initial cost, operating cost and maintenance cost (or cost of no Maintenance)**

• Should be designed for “Life Safety” first!

• Should not transmit or generate objectionable noise.

• Should not transmit or generate objectionable air quality (IAQ).

• Should consider codes, space restrictions, capacity for expansion, and appearance.
Engineering Air Distribution

Building Energy (Airside)

- Maximize Supply Air Temperature
  - Supply Air Temperature Reset
- Minimize Heat Loss/Gain
  - Insulate Duct and Envelope
  - Minimize Thermal Breaks
- Minimize Fan Speed
  - Variable Frequency Drive
  - Minimize Friction Losses
  - Minimize Dynamic Losses
  - Minimize System Effect
  - Minimize Air Leakage
  - Duct Pressure Optimization

Occupant Satisfaction

- Minimize Noise
  - Lower velocity
  - Line Duct
  - Sound Attenuators
- Maximize Indoor Air Quality
  - Maximize Outside Air
  - Minimize Water Infiltration
- Maximize Occupant Comfort
HVAC Mechanical Code;
Air conditioning and heating system installation is regulated by mechanical codes in most regions of the world.

Do you know your local code?

Do you know the “Intent” of the code?
Codes

HVAC Mechanical Codes References

- Sheet metal and Air Conditioning Contractors National Association
- Underwriters Laboratories (UL181)
- American Society of Heating, Refrigeration & Air Conditioning Engineers
- American Society for Testing and Materials (ASTM E84), (ASTM 518)
- National Fire Protection Association (Life Safety 101)
Dubai Municipality Green Building Regulations & Specifications

- Forms a baseline (not a rating system such as the USGBC) of conditions to be followed in the green building standards and specifications, and Structure in the Emirate of Dubai.

- Conditions to be followed in the green building standards and specifications, and Structure in the Emirate of Dubai
Codes…and Certification

3rd Party Testing - Independent, accredited organizations

IAPMO - The International Association of Plumbing and Mechanical Officials

NSF - National Science Foundation
  - NSF P374; Thermal Distribution Efficiency (TDE) Rating

Dubai Central Laboratories
Top Faults Causing Energy Inefficiencies in Commercial Buildings

- Lights left on when space unoccupied
- Air-cooled condenser fouling
- Improper controls hardware installation
- Improper controls setup / commissioning
- Dampers not working properly
- Control component failure or degradation
- HVAC left on when space is unoccupied
- Improper refrigerant charge
- Valve leakage
- Insufficient evaporator airflow
- Airflow not balanced
- Software programming errors
- Duct leakage
# Why is leakage so important?

Top faults causing energy inefficiencies in commercial buildings (Top 13 of 100+ faults identified) *

<table>
<thead>
<tr>
<th></th>
<th>National Energy Waste (Quads, primary/year)</th>
<th>Electricity equivalent (BkWh/year)</th>
<th>Cost ($billion/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duct leakage</td>
<td>0.3</td>
<td>28.6</td>
<td>2.9</td>
</tr>
<tr>
<td>HVAC left on when space unoccupied</td>
<td>0.2</td>
<td>19.0</td>
<td>1.9</td>
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<tr>
<td>Lights left on when space unoccupied</td>
<td>0.18</td>
<td>17.1</td>
<td>1.7</td>
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<tr>
<td>Airflow not balanced</td>
<td>0.07</td>
<td>6.7</td>
<td>0.7</td>
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<tr>
<td>Improper refrigerant charge</td>
<td>0.07</td>
<td>6.7</td>
<td>0.7</td>
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<tr>
<td>Dampers not working properly</td>
<td>0.055</td>
<td>5.2</td>
<td>0.5</td>
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<tr>
<td>Insufficient evaporator airflow</td>
<td>0.035</td>
<td>3.3</td>
<td>0.3</td>
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<tr>
<td>Improper controls setup / commissioning</td>
<td>0.023</td>
<td>2.2</td>
<td>0.2</td>
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<tr>
<td>Control component failure or degradation</td>
<td>0.023</td>
<td>2.2</td>
<td>0.2</td>
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<tr>
<td>Software programming errors</td>
<td>0.012</td>
<td>1.1</td>
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<tr>
<td>Improper controls hardware installation</td>
<td>0.01</td>
<td>1.0</td>
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<tr>
<td>Air-cooled condenser fouling</td>
<td>0.008</td>
<td>0.8</td>
<td>0.1</td>
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<tr>
<td>Valve leakage</td>
<td>0.007</td>
<td>0.7</td>
<td>0.1</td>
</tr>
<tr>
<td>Total (central estimate)</td>
<td>1.0</td>
<td>94.6</td>
<td>9.6</td>
</tr>
<tr>
<td>Total (range)</td>
<td>0.34-1.8</td>
<td>32.4-171.4</td>
<td>3.3-17.3</td>
</tr>
</tbody>
</table>

Adapted from Roth et al. (2005) assuming 10,500 BTU/kWh, and $0.10/kWh

*Source: Study Done by Lawrence Berkeley National Laboratory for the Department of Energy
Dubai Green Building Evaluation System

- Section Five: Resource Effectiveness: Energy 500
  - 501.06 Air Leakage
    All new conditioned buildings with a cooling load of 1 Mega Watt (MW) or greater must be tested to demonstrate that air leakage does not exceed 10 cubic meters of air per hour for each sq. meter of building envelope.....
Leakage

- Leakage Class - As defined by SMACNA, Leakage class is the numerical rating scale of a duct systems ability to resist leakage.

  CFM lost per 100 sqft (9.29 m²) of inner duct surface area.

- Leakage of ductwork inside of a buildings results in the designed amount of CFM not arriving to its determined location, thus increasing the time for the system to reach it’s targeted equilibrium.

  However CFM leakage of outdoor ductwork results in a complete loss of both CFM, and the energy required to produce it.
Leakage

HVAC AIR DUCT LEAKAGE

CFM LOSS FOR ASSOCIATED SMACNA LEAKAGE CLASS

Leakage Factor \( f \) (CFM/1000 sq ft)

- SMACNA Leakage Class C.1
- SMACNA Leakage Class C.3
- SMACNA Leakage Class C.4
- SMACNA Leakage Class C.5

C\(_L\) = Leakage Class

\[ f = C_L \left( \frac{P}{10} \right) \]

\[ P = \text{Pressure in WG} \]

(Based on SMACNA HVAC Air Duct Leakage Test Manual, 2005 Edition, Figure 4-1 "Duct Leakage Classification")
Set Leakage Requirements?

Helps Conserve energy
As much as 10-30% of heated/cooled air lost through ductwork

Helps Prevent Poor Indoor Air Quality
Humidity problems, Mold and Mildew, Contaminants

Helps Reduce Long Term Maintenance
Continual Sealing
Replacement of Insulation
Replacement of Corroded Duct
Leakage Can Mean Wet Insulation!

R-Value may not be the answer.

Problems with Wet Insulation

- **Structural integrity.** Wet insulation is often in contact with steel structural materials as well as the duct. Structural damage occurs from rusted steel ducts, supports and flanges.

- **Energy efficiency.** Loss of thermal insulation value (as much as 85%) is a consequence of wet insulation – water conducts energy. "If insulation is wetted, it becomes a conductor of energy rather than a resister". When insulation conducts energy rather than reflects it, it results in higher heating or cooling bills.

- **Health.** Moisture caused by wet insulation contributes to mold and IAQ degradation. Mold needs mold spores, a food source, adequate temperature, and moisture to thrive; water is often the only element that can be controlled. If we control and limit water in the duct insulation by using good design, good construction, and good maintenance, there's a good chance of controlling mold growth.
Wet insulation
Why Set Leakage Requirements?

Additional Cost

- Repair/Replacement Cost
- Interim Cost
- Shutdown
- Legal Ramification
  - Owner
  - Contractor
  - Manufacturer
  - Customer/Patient

Plus LEGAL cost !!!!
Not all ducts are equal

**Location:** Indoors

**Types:** Ductboard…Flex…Galanized…Phenolic!
Not all ducts are equal

**Location:** Outdoors

**Types:**
- Galvanized – internally insulated
- Galvanized – externally insulated
- Galvanized – double wall
- Phenolic
Location, Materials, Insulation

**Location:** Underground

**Types:** BlueDuct… Fiberglass (FRP)… PVC coated galvanized
Insulation is Not the Answer!
It’s Not About the Insulation…

- It’s about duct leakage…
- It’s about uninsulated connections
- It’s about thermal bridging
- It’s about not compressing the insulation
- It’s about maintaining thermal efficiency
- It’s about keeping out the elements
- It’s about IAQ
- It’s about long term energy cost!

IT’S ABOUT HAVING CONFIDENCE!!
The Future – Underground and Phenolic Duct

- Reduces installation time compared to insulated sheet metal
- Less weight than insulated metal
- Reduced leakages
- NO additional insulation or cladding
- Saves space compared to insulated metal
- Reduces the number of duct connections
Why Underground Duct?

- Underground duct is a cost effective
- Eliminates continual insulation of exposed ducting systems.
- Utilizes the ground as a constant thermal coating.
- LEED Opportunities
Why Underground Duct?

Reduced Construction Costs

• Labor savings of underground versus exposed duct in conflict with other trades can lower the installed costs

• Ceiling height reductions / reduced building heights.

• Reduced damage by trade conflict

• Elimination of confined space conflict during the installation of internal ducting in tight zones.

• Job site mobility
Why Pre-Insulated Phenolic Duct - Indoors

Pre-insulated ductwork offers numerous benefits in comparison with insulated galvanized sheet steel and mineral fiber insulation systems.

- Light-weight.
- Installs faster
- Eliminates field applied insulation
- Closed Cell
- Pre-insulated ductwork can save space.
Why Pre-Insulated Phenolic Duct - Outdoors

- Site Mobility
- Very Low air leakage possible
- Closed Cell Insulation Material
- Reduced energy usage and running costs
- Whole life cost saving
- A fiber-free rigid insulation core
- Space Savings
- Reduced Moisture penetration
Why Pre-Insulated Phenolic Duct - Outdoors

Because the Old way does not work!
Q Duct – Patented Outdoor Phenolic

• SMACNA Approved for Interior and Exterior
  o SMACNA Phenolic Duct Construction Standards
    ANSI-SMACNA 022-2015

• Meets ASTM E84
  o 25/50 Smoke and Flame

• UL 181 Listed

• CFC free / HCFC free
  o Chlorofluorocarbon

• Commercial, Industrial & Residential
Pre-Insulated Phenolic Exterior

- QDuct
  - Patented by AQC Industries
  - Manufactured Using Kingspan Pal Phenolic
Patented QUADRUPLE SEALED JOINT For Superior IAQ

Outdoor Preinsulated Duct System

Apply sealant to the interlocking connection

Join the interlocking connection and secure with fasteners

Clad interlocking connection

Secure support stand to integrated support mount
I AM SPEAKING AT

Session Details:
Innovations in HVAC – PID
(Pre-Insulated Ductwork)
26 NOVEMBER 2019 - 13:40 - 14:10
Za’abeel Hall 5 | Dubai World Trade Centre

PAUL BARNARD,
Head of HVAC Specification – Middle East,
Kingspan

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Benjamin Franklin

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