Using UltraViolet Light in HVAC Systems

Lower Energy Consumption

Reduce Maintenance Costs

Improve Air Quality

with

UltraViolet Germicidal Irradiation (UVGI)

Presented by:
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Central Region Manager
UltraViolet Devices, Inc.

Tuesday, July 25, 2006
Issue: Hospital Energy Costs Are Rising

Acute care hospitals’ annual energy costs* per square foot (estimated)

* Energy costs include electrical, natural gas, steam, oil, cogeneration, solar, etc., but not water

- 70% are paying $3.00 per ft² or more for energy.

Percentage of change in annual energy costs from last year

- 91% have higher energy costs over the previous year, & more than half cited increases in the double-digit percentages.

Source: Health Facilities Management / ASHE 2006 Hospital Energy Survey
Issue: Maintenance Costs Are Rising

Labor Rates Continue to Rise

Maintenance Staffs Continue to be Cut

Cost of Materials Escalate
Issue: IAQ Concerns Are Increasing

More Awareness of IAQ by Public & Media

Responding to IAQ Complaints Is Costly and Time Consuming

Risk of Litigation Due to IAQ Issues
A Solution…

Installing Ultraviolet Germicidal Irradiation (UVGI) systems on new and existing HVAC equipment…

Will create significant savings in total operating expenses and create a cleaner safer indoor environment

…for any Health Care facility by maintaining and/or restoring the original design specifications of the HVAC system.
What is UVGI?

Strategies & Uses

Who needs it...

What’s next...
UltraViolet Germicidal Irradiation is...

✅ A Proven Application

✅ State-of-the-Art

✅ Low Cost & Easy To Use

✅ Becoming A Standard for HVAC Systems
Case Study #1
Four story 350,000 sq. ft.

Application Information:

• Coil Size: 58” high x 108” wide

• Fixture Location: 38” from coil

• Coverage: 2 rows of fixtures
  @ 4 fixtures / row

• Average UV-C
  On coil surface: 200 µW/cm²

• Lowest UV-C
  On coil surface: 50 µW/cm²
Case Study #1
Four story 350,000 sq. ft.

Application Results

- Reduced IAQ Complaints
- Reduced Maintenance
- Saved Significant Energy
  
  Shut Down of Add’l Chiller
  (300 tons of cooling reduction)
The Power of UV

UV “Kills”

All Living Things

& Destroys

All Organic Material

100% Effective on…

Any Surface (Coils, Filters & Processing)

Also… Air & Water
Why Is This Important?

Cleaner Air…

Healthier & Safer Indoor Environment

Significantly reduces risks of…

Contamination, Infection & Epidemic

Results…
- Less Sick Days
- Less Complaints
- Higher Productivity
Why Is This Important?

Clean Surfaces…

Cooling Coils & Drain Pans

- Control Organic Growth At The Source
- Extend Equipment Life
- Lower Operating Costs
Why Is This Important?

Cleaner Air

+ Clean Surfaces

Saves $$$$$$

Time, Hassle & Risk
What Is Ultraviolet Light?

The Light Spectrum

- **UV is invisible**
- **UV-A (315nm - 400nm)**
  - Black lights and tanning lamps, harmful to eyes
- **UV-B (280nm - 315nm)**
  - Causes sunburn and skin cancer
- **UV-C (200nm - 280nm)**
  - Germicidal - Damages DNA in cells
What Is Ultraviolet Light?

The Sun Makes All 3 Types of UV

The Earth’s Ozone Layer Filters UV-C
Protects you, me and all living things
How It Works...

任何形式的有机细胞暴露于UV-C
吸收分子级...细胞被破坏，无效。
它无法繁殖也无法传播。
它在不干扰周围任何事物的情况下死亡。

When UV-C enters a cell...
The organism is now destroyed & ineffective.
It is unable to reproduce & unable to infect.
It dies without effecting anything around it.
How Is UV-C Made?

Today…

UV-C is artificially made using specialized lamps producing UV-C at 254nm
UV-C Lamps

Useful Life of UV-C Lamps

- **Soft Glass** (Low, Normal & High Output)
  - Low Mercury Content (3 – 8 mg)
  - Less than most Fluorescent Lights

- **Hard Glass** (High Output Only)
  - High Mercury Content
  - May Need To Be Handled As Hazardous Waste

- **Hard Glass**:
  - Hard Glass (High Output Only)
  - High Mercury Content
  - May Need To Be Handled As Hazardous Waste

- **Useful Life**:
  - 80% Intensity: 8,760 Hours
  - 50% Intensity: 8,760 Hours
  - 100% Intensity: 8,760 Hours
How Much UV-C Do I Need?
# Killing Common “Bugs”

<table>
<thead>
<tr>
<th></th>
<th>µw-sec/cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Molds</strong></td>
<td></td>
</tr>
<tr>
<td>Aspergillus flavus</td>
<td>99,000</td>
</tr>
<tr>
<td>Aspergillus niger</td>
<td>330,000</td>
</tr>
<tr>
<td><strong>Bacteria</strong></td>
<td></td>
</tr>
<tr>
<td>Bacillus anthracis</td>
<td>8,700</td>
</tr>
<tr>
<td>Bacillus anthracis spores</td>
<td>146,200</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>6,600</td>
</tr>
<tr>
<td>Legionella pneumophila</td>
<td>12,300</td>
</tr>
<tr>
<td>Mycobacterium tuberculosis</td>
<td>10,000</td>
</tr>
<tr>
<td>Salmonella typhi - Typhoid Fever</td>
<td>7,000</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>6,600</td>
</tr>
<tr>
<td>Vibrio comma - Cholerae</td>
<td>6,500</td>
</tr>
<tr>
<td><strong>Virus</strong></td>
<td></td>
</tr>
<tr>
<td>Infectious Hepatitis</td>
<td>8,000</td>
</tr>
<tr>
<td>Influenza A</td>
<td>6,600</td>
</tr>
</tbody>
</table>
Calculating Dosage

DOSAGE Determines Effectiveness

= \textbf{Intensity} \times \textbf{Time}

Example:

\begin{align*}
\text{(Intensity)} & \quad 50 \, \mu\text{W/cm}^2/\text{sec.} \\
\times & \quad 60 \, \text{sec.} \\
\times & \quad 60 \, \text{min.} \\
\times & \quad 24 \, \text{Hours} \\
\text{(Dosage)} & \quad 4,320,000 \, \mu\text{W-sec/cm}^2
\end{align*}

Tech Note: A Dosage of 330,000 \, \mu\text{W/cm}^2 is required to kill Mold
Calculating Dosage

Another Example

Example:

\[
\text{Dosage} = (\text{Intensity}) \times (\text{Time})
\]

\[
10 \text{ µw/cm}^2/\text{sec.} \times 60 \text{ sec.} \times 60 \text{ min.} \times 24 \text{ Hours}
\]

Tech Note: A Dosage of 330,000 µw/cm\(^2\) is required to kill Mold
Where Does UV Work?

Strategies to Use...

UVGI
DOES NOT REPLACE FILTRATION
Using UVGI - Strategies...

“Kill on the Fly”

Moving Air Streams

Used in
Isolation Rooms, Bio-Terror, etc.
Very Specialized

Goal: 99.9% Effective Kill on 1 Pass

Requires High Output Lamps

Budget Level: High Initial Cost & High Operating Cost
Using UVGI – Strategies…
Source Control - “Capture & Kill”

Why?
Remember Dosage…
The more time you have the more dosage you deliver

Dosage Is The Most Important Factor

Budget Level: Low Initial Cost & Low Operating Cost
Uses Normal & Low Output Lamps
Where To Install UV-C

Typical Installations

Kill on the Fly

Source Control
Microbes will be partially intercepted and reproduce on the cooling coil and drain pan. UV-C will destroy them.
Case Study #2
Florida Hospital –
Goal Enhance Maintenance & Lower Operating Costs

Before...

UVGI is Installed

After...
Mold, Bio-Mass & Other Microbial Growth Eliminated by Controlling the Source

Additional Benefit:
Traditional coil cleaning is now obsolete. Cleaner coils means lower operating costs too!
Sizing An HVAC System

- **Guess**
- **Overkill**
- **The Only Answer**

**Mathematical (Scientific) Modeling**
Getting Exactly What You Need

Mathematical Modeling

Benefits of using scientific modeling...

- Get EXACTLY what’s needed
- Generate Plan & Elevation Drawings
- Develop Coverage / Dosage Graphs
- Calculate Expected ROI

Saves Time, Effort & Money

Assures you get exactly what you need to do the job right
Who Needs & Uses UV?

**Hospitals / Health Care**
- Local Hospitals
- Regional Medical Centers
- Nursing Facilities
- Doctor’s Offices
- Surgery Centers
- Psychiatric Facilities
- Outpatient Medical Facilities

**Educational Institutions**
- Universities & Colleges
- Public Schools
- Private Schools

**Gov’t Facilities, Office Buildings, & Facility Mgm’t Companies**

Common Needs:
- Lower Operating Costs
- Better IAQ
Case Study #3

Children’s Hospital - SUNY Buffalo
Neonatal Intensive Care Unit

Task:
Compare the serial bacterial and fungal cultures on HVAC system with tracheal aspirate (TA) from intubated infants

Findings:
Microbes isolated from HVAC system were identical to those in NICU and TA
- Pseudomonas, Klebsiella,
- Bacillus and Serratia

Action:
Installed UVGI lamps on AHU serving area

Results:
After UVGI was installed
Total microbial load markedly decreased

Patients did not get sick as often.

Source: Dr. C. Leach, Dr. R. Ryan – SUNY Buffalo
Case Study #3 (continued)

UVGI Reduces Microbial Contamination

“This device significantly reduced microbial contamination in our neonatal intensive care unit, and spared our tiny patients from exposure to main infection causing organisms.”

(Dr. Rita Ryan, M.D.)

Source: Dr. C. Leach, Dr. R. Ryan
Case Study #3 (continued)

UVGI Reduces Microbial Contamination

Source: Dr. C. Leach, Dr. R. Ryan
Determining UVGI Effectiveness
“Kill on the Fly”

- Scientifically Model for the “Bug”
- Do testing with a similar non-harmful microbe on actual system
  - Requires special tools and third party resources
Determining UVGI Effectiveness

Source Control – “Capture & Kill”

- Calculate Expected ROI

- Take Before & After (~30 - 45 Days)…
  - Surface Samples using Petri Dishes
    - No growth means no mold, bacteria, or virus on surface
  - System Performance Testing
    - Pressure drop expressly across the cooling coil
    - Coil CFM and note whether *VAV or constant volume.
    - Coil entering and leaving wet and dry bulb temperatures.
    - Chilled water (coolant) temperature and volume.
    - Coolant temperature differentials (at the coil).
    - Fan RPM.
    - Fan motor amp draw.
Case Study #4
St. Michael’s Hospital – Texarkana, TX (2004)

Application Information:

• DX & CW Coils
  Coil Size: 57” high x 86” wide, 8 rows deep

• 17,529 CFM

• Coverage: 2 rows of fixtures
  @ 3 fixtures / row

• Average UV-C
  On coil surface: 198 µW/cm²

• Lowest UV-C
  On coil surface: 94 µW/cm²
Case Study #4
St. Michael’s Hospital – Texarkana, TX (2004)

Application Results (Continued)

- Reduced Maintenance
- Saving Significant Energy
Case Study #4
St. Michael’s Hospital – Texarkana, TX (2004)

Application Results (Continued)

<table>
<thead>
<tr>
<th>Data Input</th>
<th>Actual Conditions</th>
<th>Estimated Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clean Coil Conditions</strong></td>
<td>Fouled</td>
<td>Clean</td>
</tr>
<tr>
<td>Clean conditions are known</td>
<td>15744 CFM</td>
<td>15744 CFM</td>
</tr>
<tr>
<td>Clean pressure drop is known</td>
<td>17529 CFM</td>
<td>17529 CFM</td>
</tr>
<tr>
<td>Fouled conditions are known</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fouled pressure drop known</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Air Flow - CFM**
- 15744
- 17529

**Inlet Air**
- **Dry Bulb Temp. °F**
  - Fouled: 66
  - Clean: 67.2
  - Estimated: 66
  - Expected: 67.2
- **Wet Bulb Temp. °F**
  - Fouled: 58
  - Clean: 60.8
  - Estimated: 60.8
  - Expected: 60.8

**Outlet Air**
- **Dry Bulb Temp. °F**
  - Fouled: 51
  - Clean: 53.2
  - Estimated: 51.0
  - Expected: 53.2
- **Wet Bulb Temp. °F**
  - Fouled: 48
  - Clean: 46.4
  - Estimated: 48.0
  - Expected: 46.4

**Pressure Drop - Across Coil**
- Fouled: 0.67
- Clean: 0.61

**Age of System**: 10

**Energy Cost**: $0.04/Kwh

**Annual Maintenance/Cleaning Cost**: $500

**Hours Cooling System Run Annually**: 8760

**Hours Fan/Air Handler Run Annually**: 8760

*NOTE: If pressure drop cannot be measured or is unknown - it can be estimated by completing the section “COIL SPECIFICATIONS” below*
### Case Study #4
St. Michael’s Hospital – Texarkana, TX (2004)

#### Application Results (Continued)

<table>
<thead>
<tr>
<th>Economic Calculations</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Annual Cooling energy Savings, $</td>
<td>$3,692</td>
</tr>
<tr>
<td>Annual Pressure Drop Energy Savings, $</td>
<td>$68</td>
</tr>
<tr>
<td>Annual Maintenance Savings:</td>
<td>$500</td>
</tr>
<tr>
<td># of UV fixtures</td>
<td>6</td>
</tr>
<tr>
<td>Lamp replacement cost (each), $</td>
<td>$35.00</td>
</tr>
<tr>
<td>Total Annual Lamp Replacement</td>
<td>$210</td>
</tr>
<tr>
<td>Initial Cost UV fixtures- Total $</td>
<td>$2,000</td>
</tr>
<tr>
<td>Cost to install system</td>
<td>$550</td>
</tr>
<tr>
<td>Total Initial investment,$</td>
<td>$2,550</td>
</tr>
<tr>
<td>Annual Energy Cost- Fixtures (8760 hours), $</td>
<td>$126</td>
</tr>
<tr>
<td>Net Annual Energy Savings,$</td>
<td>$3,634</td>
</tr>
<tr>
<td>Total Annual Savings,$</td>
<td>$3,924</td>
</tr>
<tr>
<td>Estimated payback period, yrs.</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Less Than 1 Year Payback
Case Study #4
St. Michael’s Hospital – Texarkana, TX (2004)

Application Results (Continued)

Summary

Initial Payback On Project: 7.8 Months
Annual Energy Savings: $3,634 / Yr.
Total Annual Savings: $3,924 / Yr.
1st - 5 Year Savings: $17,070
10 Year Savings: $36,690
UltraViolet Germicidal Irradiation
UVGI Advantages

Top 10 Reasons to use UVGI

10. Fully tested and validated
   - Verified by University PhD’s, 3rd party researchers & EPA

9. Independently Certified by Leading Organizations
   - Underwriters Laboratories (UL/C Listed) & CE
   - Academic Researchers

8. Produces no ozone, gases, or other noxious fumes
   - Will not harm building occupants, equipment or furnishings

7. Works in New & Existing HVAC Systems
   - Results starting from day one
UVGI Advantages (Cont.)

6. Low, Normal and High Output UV-C
   - Adaptable and easy to use for many applications or needs
   - Can meet maintenance, IAQ & safety needs

5. Low initial cost for installation
   - Very Affordable ($0.15 - $0.25 /cfm)

4. Cost effective and affordable to operate
   - Low energy usage

3. Easy Installation
   - OEM or Field Installation

2. Minimizing Risks
   - Source Control –
     Controls propagation of harmful biological contaminants
     at the source
ALTRU-V Advantages (Cont.)

And...

The #1 Reason for Using UVGI is...

Everyone will love me because they feel better and...
We’re saving a lot of money!
What’s Next?

- Decide What Strategy You Will Use
  - Source Control or “Kill on the Fly” depending on the use
  - Create A Case Study #:__________ (Your Facility)

- Install UVGI on your dirtiest coil
  - (Take pictures, surface sample or pressure drops)

- Review the results in 30 – 45 Days

- Enjoy… Low Maintenance Significant Savings &
  - A Cleaner Indoor Environment
Closing Thoughts

“If a large number of (facilities) were modified…

A number of airborne respiratory diseases could be eradicated

…by interrupting the transmission cycle. Reducing the transmission rate sufficiently would... Halt epidemics in their path.”

Dr. Wladyslaw Jan Kowalski, Architectural Engineer
Pennsylvania State University’s Indoor Environment Center
“Installation of UVGI in most (facilities)…

Could resolve work-related symptoms in about 4 million employees,

…caused by (germ) contamination of heating, ventilation, and air conditioning systems.”

Dr. Dick Menzies, Montreal Chest Institute at McGill University in Montreal, Canada.
GSA Requirement

“UVC Emitters/Lamps: Ultraviolet light (C band) emitters/lamps

Shall be incorporated downstream of all cooling coils and above all drain pans

…to control airborne and surface microbial growth and transfer. Applied fixtures must be specifically manufactured for this purpose. Safety interlocks/features shall be provided to limit hazard to operating staff.”

HVAC Systems and Components, Section Five, Sub-Section 5.9, Page 143, Revised March 2003 – PBS-P100
Closing Thoughts

“I specify UVC in every HVAC system I design…

Because I know it works

and eliminates my risk of litigation,

…in mold and other biological contamination cases involving the HVAC system.”

Consulting / Design Engineer
Iowa, USA
Questions?
Thank You

Using Ultra Violet Light in HVAC Systems

Saving Money & Reducing Risk