Health and Humidity

Fundamentals / Applications / Research

Presented by David Bennett
1. **Fundamentals of Humidity**
   - How indoor humidity changes throughout the year
   - Where humidification matters most

2. **Humidity and People**
   - Historical research
   - Impacts of moisture to the human body
   - Recent advances in humidity research

3. **Recent Research**
   - Microbiome study details
   - Example of hospital savings
   - Mayo Clinic – school study

4. **Humidifying Your Facility**
   - Technologies for Humidification

5. **Standards and Guidelines**
   - ASHRAE
What is Humidity and How Do We Measure It?

**Humidity**
- The amount of water vapor in the air
- Measured in “Absolute” or “Relative” terms

**Absolute Humidity**
- Mass of water in particular volume of air
- Expressed as mass (grains/lb$_{da}$ or g$_w$/kg$_{da}$)

**Relative Humidity**
- Amount of water vapor in the air relative to how much it can hold at a given temperature (%)
Maximum Moisture Content Of Air Depends On Air Temperature

Grains of Water / Cubic Foot of Air

Air Temperature (°F)
## Methods of Humidification

### Steam vs. Atomizing

<table>
<thead>
<tr>
<th></th>
<th>Isothermal</th>
<th>Adiabatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aseptic Humidification</td>
<td>Steam doesn’t carry bacteria</td>
<td>Water droplets introduced in the air: no recirculation Treated water</td>
</tr>
<tr>
<td>Capacity</td>
<td>Small to Medium sized loads (100s lbs/hr)</td>
<td>Small to Large sized loads (1000s lbs/hr)</td>
</tr>
<tr>
<td>Energy Consumption</td>
<td>High</td>
<td>Very low</td>
</tr>
<tr>
<td>Required Free Space</td>
<td>Steam is easily and quickly absorbed by the air</td>
<td>Minimum evaporation space ( &gt; 36” - 60” typ.)</td>
</tr>
<tr>
<td>Temperature Change</td>
<td>Temperature doesn’t change significantly</td>
<td>Yes, COOLING EFFECT</td>
</tr>
<tr>
<td>Water</td>
<td>Tap and treated (maintenance)</td>
<td>Tap and treated (maintenance)</td>
</tr>
</tbody>
</table>

*Typical for the industry*
ASHE’s Advocacy Alert – 2015

RH lower than 30% can “pose challenges” for some equipment and sterile supplies:

• Impact the shelf life and product integrity of sterile supplies

• May affect the operation of some electro-medical equipment in the OR, particularly older models

• Humidity regulation is difficult to control when weather changes occur
Typical Humidification Reasons

- Processing and Handling of Hygroscopic Materials
- Electrostatic Discharge (ESD) Management
- Human Health and Comfort
Humidity and People
SKIN

Maintaining healthy skin as a barrier is critical to wellness.

- Water content of innermost skin cells is ~70%
- Below ~30% RH conditions, the skin becomes dry\(^1\)
- Dry skin symptoms include itching and cracking.
- Skin conditions such as psoriasis may become aggravated at lower relative humidity (RH) levels

Importance of Proper Humidification for Wellness

EYES

- Low humidity causes a breakdown of the tear film
- Discomfort to the eye increases with time if the dew point is below 26 °F

\[ EYE\ COMFORT\ RANGE \]

\[
\begin{array}{c}
\text{Relative Humidity [%]} \\
\text{Temperature [°F]}
\end{array}
\]

\[ 68 \text{ °F, 31\% RH} \]

\[ J.E. \text{ Laviana, F.H. Rohles, Jr. and P.E. Bullock, Humidity Comfort and Contact Lenses (ASHRAE, 1988) 94(1), 3-11.} \]
Importance of Proper Humidification for Wellness

THROAT

- Humidity below 30% RH can irritate vocal chords
- Dryness of throat
- Increased hoarseness or laryngitis
- National Institute for Health (NIH) recommends:
  - Drink water, six to eight glasses a day
  - Use a humidifier
  - Keep relative humidity > 30% RH

Importance of Proper Humidification for Wellness

NASAL PASSAGES

• Membranes in the nose dry out quicker in low humidity\(^1\)

• Humidity above 30% RH is needed for the mucous membranes in the nose to properly filter the air we breathe

Importance of Proper Humidification for Wellness

LUNGS

- Low humidity results in breathing smaller particles\(^1\)

- Low humidity can increase creation of smaller exhaled breath aerosols that can retransmit microbes

- Greater likelihood of particles being inhaled deeply

\(^1\) ASHRAE Guideline 10-2016, Interactions Affecting the Achievement of Acceptable Indoor Environments
Mechanics of Infections: Droplets in Air

**Droplet diameter in microns (um)**

- 0.5
- 1
- 3
- 10
- 100

**Float time**

- 41 hours
- 1.5 hours
- 6 seconds

**Distance travelled:**

- 1m
- 10m+

**Image Courtesy:** Dr. Stephanie Taylor
Mechanics of Infections

Infectious particles survive longer in dry air

Bodily defenses less effective in dry air

Images Courtesy: Condair AG
Recent Humidification Research

ASHRAE Research Project 1630 completed in 2016

"Update of the Scientific Evidence for Specifying Lower Limit Relative Humidity Levels for Comfort, Health and IEQ in Occupied Spaces"

- Authors: Melanie M. Derby, Maryam Hamehkasi, Steven Eckels, Grace M. Hwang, Byron Jones, Ronaldo Maghirang

- About 600 articles were identified and 70 articles were reviewed in detail concerning effects of humidity on comfort, health, and indoor environmental quality
Findings include:

- Lower humidity decreased house dust mite allergens
- Lower humidity increased virus survival for influenza
- Health & comfort issues, skin dryness, eye irritation, and static electricity increased as humidity decreased

RP 1630 results are consistent with the updated Sterling Chart in the ASHRAE Handbook.

Low and high humidity control is important for wellness, health and comfort
Humidity plays an important role in health and comfort.

- Our bodies are ~60% water
- Our skin, eyes, and respiratory system all need proper humidity

Research shows a link between low humidity and the likelihood of flu.

- Our body defenses are stronger above 30% RH
- There is less infectious flu virus in the air at higher RH levels
- The likelihood of flu infectivity decreases at higher humidity levels
Humidification for People

Human body response

• Human body is ~60% water
• Body doesn’t sense moisture well

Humidity and respiratory infections

• Evidence of link between moisture and cold/flu transmission
• Clinical trials between 1963 and 1985 showed significant reduction of respiratory infects when mid-range humidity was maintained [1-5]

• NIOSH/CDC Research in 2013 showed reduced infectivity of flu virus aerosols with mid-range air humidity levels [6]

3. Green GH, Winter humidity and related absenteeism in Canadian hospitals, Digest of the 3rd. CMBES
4. Green GH, The effect of indoor relative humidity on absenteeism and colds in schools, ASHRAE Trans., Vol. 80, Part. II
5. Gelperin A, Humidification and upper respiratory infection incidence, Heating, Piping and Air Conditioning, 45:3, 1973
Updates in Humidity Research

*With Contributions from Dr. Stephanie Taylor and Dr. Med. Walter Hugentobler*
What is the Microbiome?

- Microbiomes are communities of microbes
  - Bacteria, viruses and fungi—that live in, on and around every living thing
- Microbiome of the gut, the skin, the built environment, the air, etc.

We send our microbes into buildings

Buildings send their microbes into us
Microbiome Research in a New Hospital

• Constructed in 2013 to LEED Silver
  – 1.2 million square feet
  – 12 stories
  – 240 single occupancy rooms
Research Goals: Patient Room vs. Patient Outcome

- Monitor the physical environment (10 rooms, 2 RN stations)
- Measure microbial footprint
- Determine Healthcare Associated Infections (HAIs)

5 minute samples for 1 year = 8 million data points
15% of patients contract HAIs

<table>
<thead>
<tr>
<th>Rate</th>
<th>Symptom</th>
<th>HAI Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unspecified infection</td>
<td>Citrobacter infection</td>
</tr>
<tr>
<td>6</td>
<td>Colitis and Diarrhea</td>
<td>Clostridium difficile</td>
</tr>
<tr>
<td>6</td>
<td>Post-surgical Wound Infection</td>
<td>Organism Unspecified</td>
</tr>
<tr>
<td>2</td>
<td>Pneumonia</td>
<td>Cytomegalovirus, Pseudomonas, Epstein-Barr</td>
</tr>
<tr>
<td>5</td>
<td>Urosepsis</td>
<td>Organism unspecified, E-Coli</td>
</tr>
<tr>
<td>3</td>
<td>Infection with Joint Prosthesis</td>
<td>MRSA</td>
</tr>
<tr>
<td>6</td>
<td>Central Line with Blood Stream Infection</td>
<td>Bacteria Unspecified</td>
</tr>
<tr>
<td>4</td>
<td>Pneumonia</td>
<td>Organism Unspecified</td>
</tr>
<tr>
<td>1</td>
<td>Gastritis, Enteritis</td>
<td>Cytomegalovirus, Salmonella</td>
</tr>
<tr>
<td>4</td>
<td>Bacteremia</td>
<td>Organism Unspecified</td>
</tr>
<tr>
<td>2</td>
<td>Pneumonia</td>
<td>MRSA</td>
</tr>
</tbody>
</table>
Study Results: Indoor Relative Humidity vs. Patient HAIs

Source: Colonization and Succession of Hospital-Associated Microbiota, in Press 2016
Simon Lax, Daniel Smith, Naseer Sangwan, Kim Handley, Peter Larsen, Miles Richardson, Stephanie Taylor, Emily Landon, John Alverdy, Jeffrey Siegel, Brent Stephens, Rob Knight, Jack A Gilbert
Study Results: Indoor RH vs. Bacteria Spread

Spread of skin bacteria from clinical staff

Source: Colonization and Succession of Hospital-Associated Microbiota, in Press 2016
Simon Lax, Daniel Smith, Naseer Sangwan, Kim Handley, Peter Larsen, Miles Richardson, Stephanie Taylor, Emily Landon, John Alverdy, Jeffrey Siegel, Brent Stephens, Rob Knight, Jack A Gilbert
As Relative Humidity goes, the spread of infections and bacterial spread goes up.
## Summary of Total Excess Costs and Hospital Days Due to Hospital Acquired Infections

<table>
<thead>
<tr>
<th></th>
<th>Total Infections</th>
<th>Total Excess Costs</th>
<th>Total Excess Hospital Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary Tract Infections</td>
<td>1,296</td>
<td>$1,435,968</td>
<td>2592.0</td>
</tr>
<tr>
<td>Surgical Wound Infections</td>
<td>365</td>
<td>$7,042,464</td>
<td>4378.0</td>
</tr>
<tr>
<td>CRBSI</td>
<td>148</td>
<td>$4,990,636</td>
<td>2509.0</td>
</tr>
<tr>
<td>VAP</td>
<td>15</td>
<td>$401,369</td>
<td>170.0</td>
</tr>
<tr>
<td>MRSA</td>
<td>120</td>
<td>$927,162</td>
<td>646.0</td>
</tr>
<tr>
<td>CDIFF</td>
<td>122</td>
<td>$500,200</td>
<td>733.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2,066</strong></td>
<td><strong>$15,297,799</strong></td>
<td><strong>11,028.0</strong></td>
</tr>
</tbody>
</table>
Not Just Hospitals! Offices, Schools, Homes

• **Results of study apply more broadly**
  – Infectious organisms found everywhere
  – Controlling humidity is essential

• **Healthy employees pay dividends**
  – Fewer sick days
  – Reduced healthcare costs
  – Increased productivity

• **Costs and incentives**
  – Hospitals penalized monetarily by HAI rates
  – Schools incentives for performance
  – What does illness cost your organization?
Health: Viruses and Seasonal Influenza

• Influenza is more common in the fall and winter months

[Diagram: Peak Month of Flu Activity, 1982-1983 through 2015-2016]

1 [www.cdc.gov/flu/about/season/flu-season.htm](http://www.cdc.gov/flu/about/season/flu-season.htm)
Recent Humidification Research

Influenza Virus

- Studies show that higher humidity reduces infectivity of influenza
- Research indicates that 1 hour after coughing, the influenza virus is ~5 times more infectious at 7-23% than at > 43% RH

1 John Noti, et al, *Humidity Leads to Loss of Infectious Influenza Virus from Simulated Coughs* (February 27, 2013)
Health: Viruses and Seasonal Influenza

• Possible reasons for increased winter influenza include¹:
  – People spend more time indoors in proximity of others
  – Exhaled aerosols can dry out and become smaller in lower humidity and have longer settling times
  – Drying of nasal mucous membrane weakens respiratory system
  – Virus is most stable at lower RH

• Data suggests that humidifiers may be adequate to raise humidity to levels associated with a significant reduction in influenza virus survival²

¹ Anice Lowen, et al, Influenza Virus Transmission Is Dependent on Relative Humidity and Temperature (October 19, 2007)
² J. Metz, et al, Influenza and Humidity – Why a bit more damp may be good for you! (June 2015)
Huge economic cost with an annual influenza epidemic (based on 2003 US population)\(^1\):

- $10.4 billion a year in direct medical expenses
- $16.3 billion in lost earnings annually
- $87 billion a year total economic burden

*Influenza A incidence peaks during winter in temperate regions*

\(^1\) Molinari NA et al. 2007. *Vaccine* 25:5086-5096.
Huge economic cost with an annual influenza epidemic
(based on 2003 US population)\(^1\)

\[\begin{align*}
\text{Direct medical expenses} & \quad $10.4 \\
\text{Lost earnings annually} & \quad $16.3 \\
\text{Total economic burden} & \quad $87
\end{align*}\]


Influenza A incidence peaks during winter in temperate regions
Relationship of outdoor absolute humidity (AH) to hospitalized influenza cases in Minnesota

Predicted flu outbreak onset 10-16 days later

Peak cases

Absoulte humidity trough

Influenza hospitalized cases/week

Flu Season Correlation to Outdoor Humidity
Can altering indoor humidity reduce transmission of respiratory viruses?

Pilot study done January-February 2016
Questions Mayo Researchers sought to answer:

Impact of humidity on:

1. **Viral transmission (presence and quantity)**
   - Air particles
   - Fomites (paper wrapped objects)

2. **Survivability of influenza**
   - Ability of samples to infect cells in culture

3. **Droplet size**
   - Changes in particle size distribution

4. **ILI (influenza like illnesses) and absences of students and staff**
FIGURE 1. METHODOLOGY FLOW CHART

Sample Preparation
(Mayo Clinic)

Wrap
Assemble
Sample Collection
(Aldrich preschool)

Wrap additional classroom objects (if needed)
Calibrate air sampler pumps
Run 150 minutes (during class)

Morning preschool classes (students ages 3-5) in rooms

Unwrap school objects
Collect wrapped objects

Measure air particle sizes
Sample Processing (Mayo Clinic)

Dust paper with fingerprinting powder
Remove fingerprint (+) pieces
Place paper into media

Disassemble air samplers
Add media to tubes
Place filter into media

Vortex, incubate & centrifuge
Isolate viral RNA
RT-PCR
Identify Flu A+
Infectivity assay (electrical impedance)
Humidification Added to School Classrooms

Hypothesis:
Increasing the relative humidity of classrooms to 40-60% will reduce the capacity of influenza to survive on classroom surfaces, or spread between classmates as aerosols.

• Stand-alone electrode humidifiers were installed in some classrooms

• Actual RH levels controlled to +/- 35% in rooms with humidifiers
  – vs +/- 20% for non-humidified rooms
Humidification Resulted in Less Flu-like Illness

• Flu-like illnesses reported:
  – 70% were in control (non-humidified) rooms
  – 30% were in humidified rooms

• Humidified rooms had:
  – A significant decrease in % total air samples containing Influenza A
  – Trend toward decreased % of paper samples containing Influenza A
  – A significant reduction in Influenza A presence for total air and paper samples
Within flu positive samples, a reduced amount within humidified rooms
Humidifying your Facility
## Technologies for Humidification

### Steam Technologies

<table>
<thead>
<tr>
<th>Gas Fired</th>
<th>Electric</th>
<th>Building Steam</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
</tbody>
</table>

- **Gas Fired**
- **Electric**
- **Building Steam**
  - Electrode
  - Resistive
  - Centralized Steam
  - Steam to Steam

1/28/2019
# Technologies for Humidification

**Adiabatic Technologies**

<table>
<thead>
<tr>
<th>Wetted Media</th>
<th>Centrifugal</th>
<th>Ultrasonic</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Wetted Media" /></td>
<td><img src="image2.png" alt="Centrifugal" /></td>
<td><img src="image3.png" alt="Ultrasonic" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medium Pressure</th>
<th>High Pressure</th>
<th>Compressed Air</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4.png" alt="Medium Pressure" /></td>
<td><img src="image5.png" alt="High Pressure" /></td>
<td><img src="image6.png" alt="Compressed Air" /></td>
</tr>
</tbody>
</table>
Unintended Consequences of Optimal Humidity

Improved productivity through well being

• Reduced eye strain
• Reduced vocal strain
• Reduced allergy and asthma impact
• Increased performance
• Mental acuity
• Improved perceived comfort ("humidex")

1 Rief S and Juric M, Air Humidity in the Office Workplace, Fraunhofer IAO, 2014
• When outdoor air is cooler than indoor air you are generally going to see a drying effect in buildings.

• Air that is too dry has negative health effects for occupants. Target 30 – 60% RH for optimal occupant wellness.

• Research shows higher relative humidity with reduced spread of illness and in particular Hospital Acquired Infections (HAI’s).
  o There is a clear payback in hospitals based on reductions in related patient costs.

• Todays humidifiers are available in many types and technologies to match applications and humidification needs.
Standards & Guidelines
Standards & Guidelines

GUIDELINES

- Facility Guidelines Institute (FGI) guidelines (2018) for ventilation
  - Refers to ASHRAE Standard 170 - 2017

STANDARDS

  - Maintain relative humidity (RH) minimums between 20-40% in healthcare facilities
    - 60% maximum
  - With a minimum of 30% RH, a safety factor may be prudent
    - 35% minimum setpoint
### ANSI/ASHRAE/ASHE Standard 170-2017
Ventilation of Health Care Facilities

<table>
<thead>
<tr>
<th>Function of Space</th>
<th>Pressure Relationship to Adjacent Areas (n)</th>
<th>Minimum Outdoor ach</th>
<th>Minimum Total ach</th>
<th>All Room Air Exhausted Directly to Outdoors (j)</th>
<th>Air Recirculated by Means of Room Units (a)</th>
<th>Design Relative Humidity (k), %</th>
<th>Design Temperature (t), °F/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery and Critical Care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical and intensive care</td>
<td>NR</td>
<td>2</td>
<td>6</td>
<td>NR</td>
<td>No</td>
<td>30–60</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Delivery room (Caesarean) (m), (o)</td>
<td>Positive</td>
<td>4</td>
<td>20</td>
<td>NR</td>
<td>No</td>
<td>20–60</td>
<td>68–75/20–24</td>
</tr>
<tr>
<td>Emergency department decontamination</td>
<td>Negative</td>
<td>2</td>
<td>12</td>
<td>Yes</td>
<td>No</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Emergency department exam/treatment room (p)</td>
<td>Negative</td>
<td>2</td>
<td>6</td>
<td>NR</td>
<td>NR</td>
<td>Max 60</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Emergency department public waiting area</td>
<td>Negative</td>
<td>2</td>
<td>12</td>
<td>Yes (q)</td>
<td>NR</td>
<td>Max 65</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Intermediate care (c)</td>
<td>NR</td>
<td>2</td>
<td>6</td>
<td>NR</td>
<td>NR</td>
<td>Max 60</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Laser eye room</td>
<td>Positive</td>
<td>3</td>
<td>15</td>
<td>NR</td>
<td>No</td>
<td>20–60</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Medical anesthesia gas storage (t)</td>
<td>Negative</td>
<td>NR</td>
<td>8</td>
<td>Yes</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Newborn intensive care</td>
<td>Positive</td>
<td>2</td>
<td>6</td>
<td>NR</td>
<td>No</td>
<td>30–60</td>
<td>72–78/22–26</td>
</tr>
<tr>
<td>Operating room (m), (o)</td>
<td>Positive</td>
<td>4</td>
<td>20</td>
<td>NR</td>
<td>No</td>
<td>20–60</td>
<td>68–75/20–24</td>
</tr>
<tr>
<td>Operating/surgical cystoscopic rooms (m), (o)</td>
<td>Positive</td>
<td>4</td>
<td>20</td>
<td>NR</td>
<td>No</td>
<td>20–60</td>
<td>68–75/20–24</td>
</tr>
<tr>
<td>Procedure room (o), (d)</td>
<td>Positive</td>
<td>3</td>
<td>15</td>
<td>NR</td>
<td>No</td>
<td>20–60</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Radiology waiting rooms</td>
<td>Negative</td>
<td>2</td>
<td>12</td>
<td>Yes (q), (w)</td>
<td>NR</td>
<td>Max 60</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Recovery room</td>
<td>NR</td>
<td>2</td>
<td>6</td>
<td>NR</td>
<td>No</td>
<td>20–60</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Substerile service area</td>
<td>NR</td>
<td>2</td>
<td>6</td>
<td>NR</td>
<td>No</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Trauma room (crisis or shock) (c)</td>
<td>Positive</td>
<td>3</td>
<td>15</td>
<td>NR</td>
<td>No</td>
<td>20–60</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Treatment room (p)</td>
<td>NR</td>
<td>2</td>
<td>6</td>
<td>NR</td>
<td>No</td>
<td>20–60</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Triage</td>
<td>Negative</td>
<td>2</td>
<td>12</td>
<td>Yes (q)</td>
<td>NR</td>
<td>Max 60</td>
<td>70–75/21–24</td>
</tr>
<tr>
<td>Wound intensive care (burn unit)</td>
<td>NR</td>
<td>2</td>
<td>6</td>
<td>NR</td>
<td>No</td>
<td>40–60</td>
<td>70–75/21–24</td>
</tr>
</tbody>
</table>

**ASHRAE: 20 or 30% minimum RH typical for health care spaces**
ASHE’s Advocacy Alert – 2015

RH lower than 30% can “pose challenges” for some equipment and sterile supplies:

• Impact the shelf life and product integrity of sterile supplies

• May affect the operation of some electro-medical equipment in the OR, particularly older models

• Humidity regulation is difficult to control when weather changes occur
Conditions for Thermal Comfort

- Does not specify minimum humidity levels but does acknowledge that low humidity can affect comfort factors
- Establishes a range of humidity and temperatures that are considered comfortable by 80% or more of the test objects
- “…ASHRAE Standard 55 recommends that the dew-point temperature of occupied spaces not be less than 36 °F.”
  - 27% RH @ 72 °F

Project Design Recommendation

If humidification is not accepted at the design level or is Value Engineered out, leave adequate space in the AHU for future steam dispersion with the appropriate absorption distance
Humidity Design Resources: More Information

**ASHRAE Handbooks**
- 2016 Systems and Equipment Chapter 22
- 2015 HVAC Applications

**AHRI Humidifiers Section**
- [www.ahrinet.org](http://www.ahrinet.org)
- Click Contractors and Specifiers

**Local Standards and Norms**
- Codes, Federal Standards, etc.
- Euro Standard EN 15251:2007
PDH Questions
Q1: What is the optimal humidification range for human comfort?

Q2: Can humidification reduce HAI’s?

Q3: What is the current ASHRAE Standard for humidification in healthcare?

Q4: Can proper humidification reduce the spread of the ILI’s?
Thank You