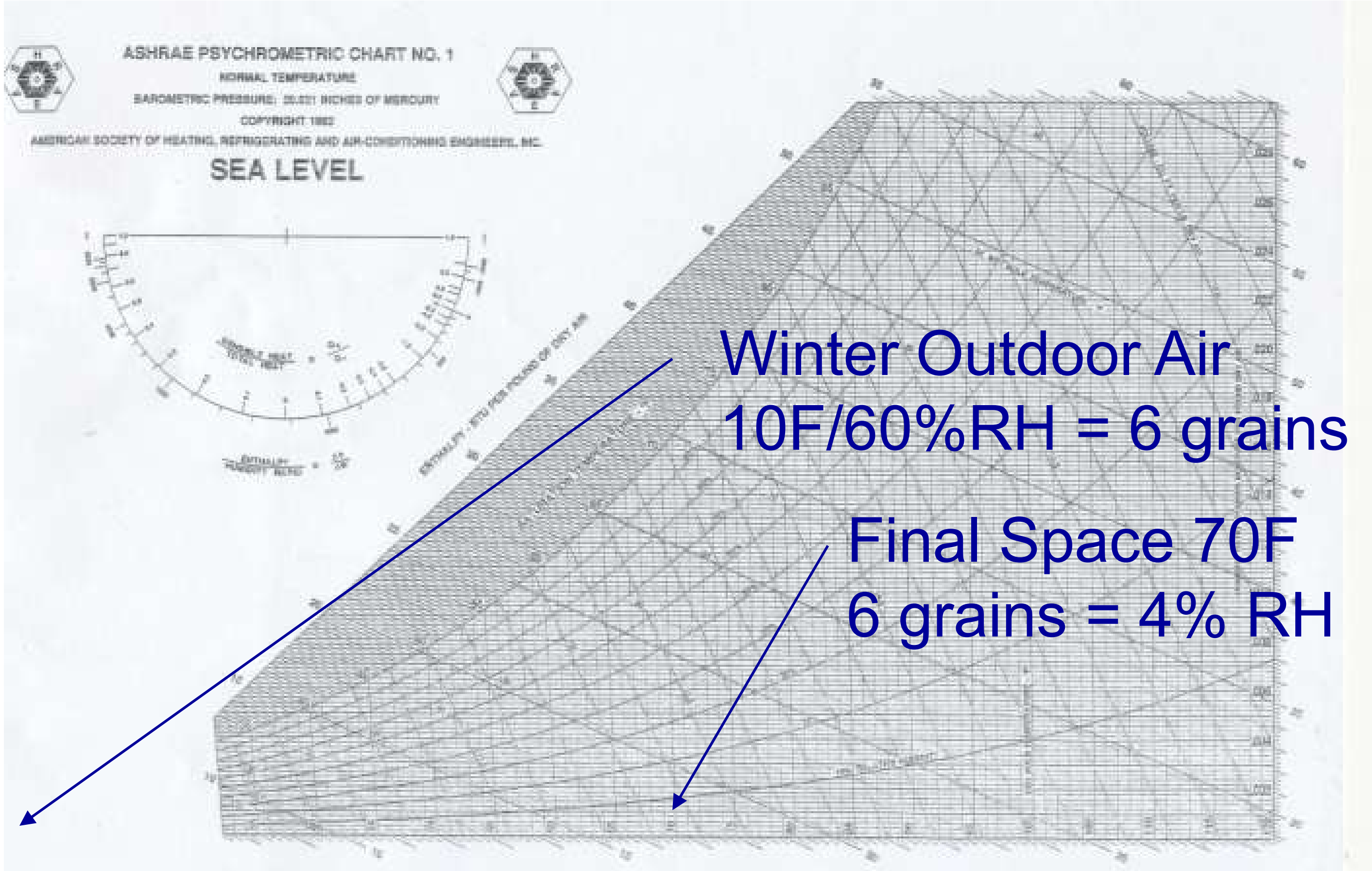
The 10 Steps of Humidification Design

DRISTEEM

Why Humidify?

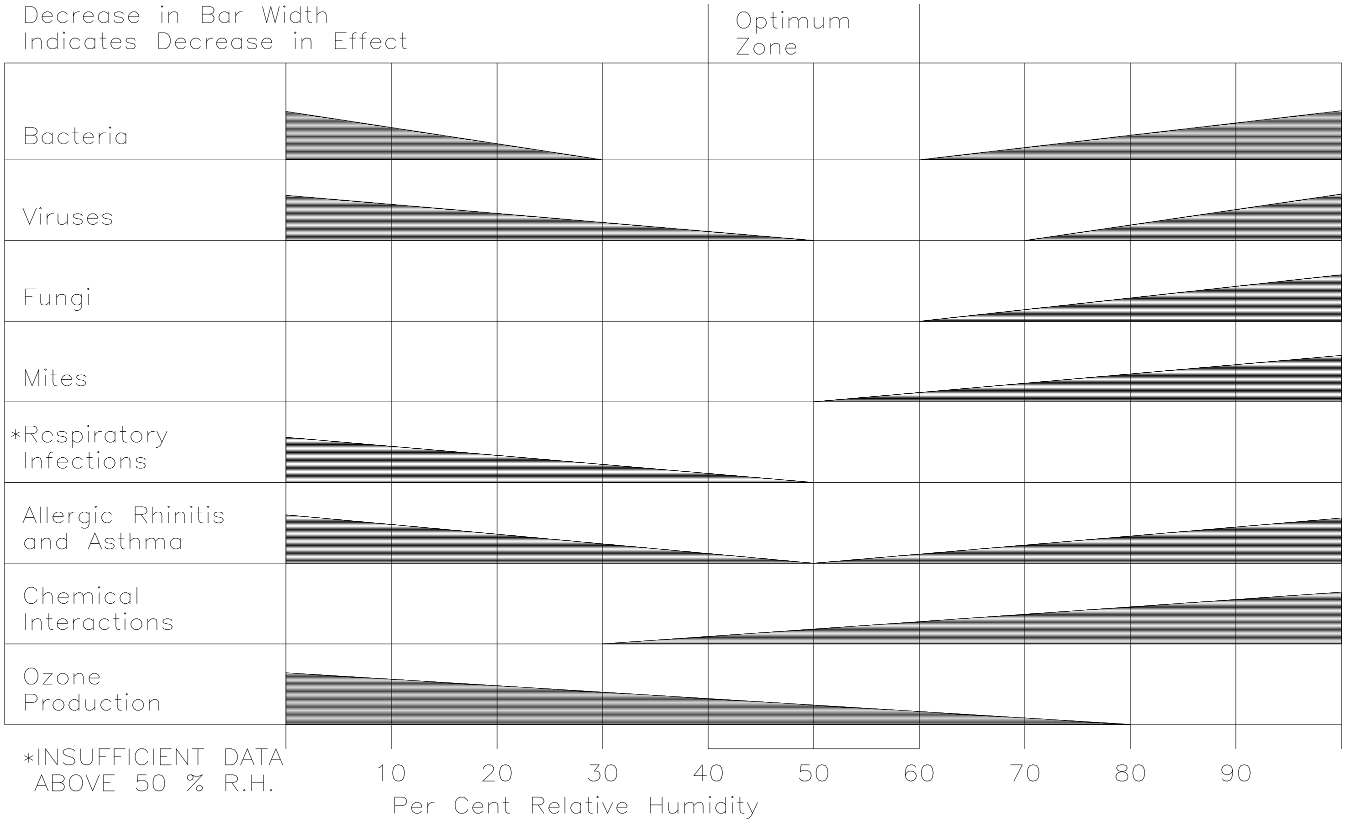


Winter Outdoor Air
10F/60%RH = 6 grains

Final Space 70F
6 grains = 4% RH

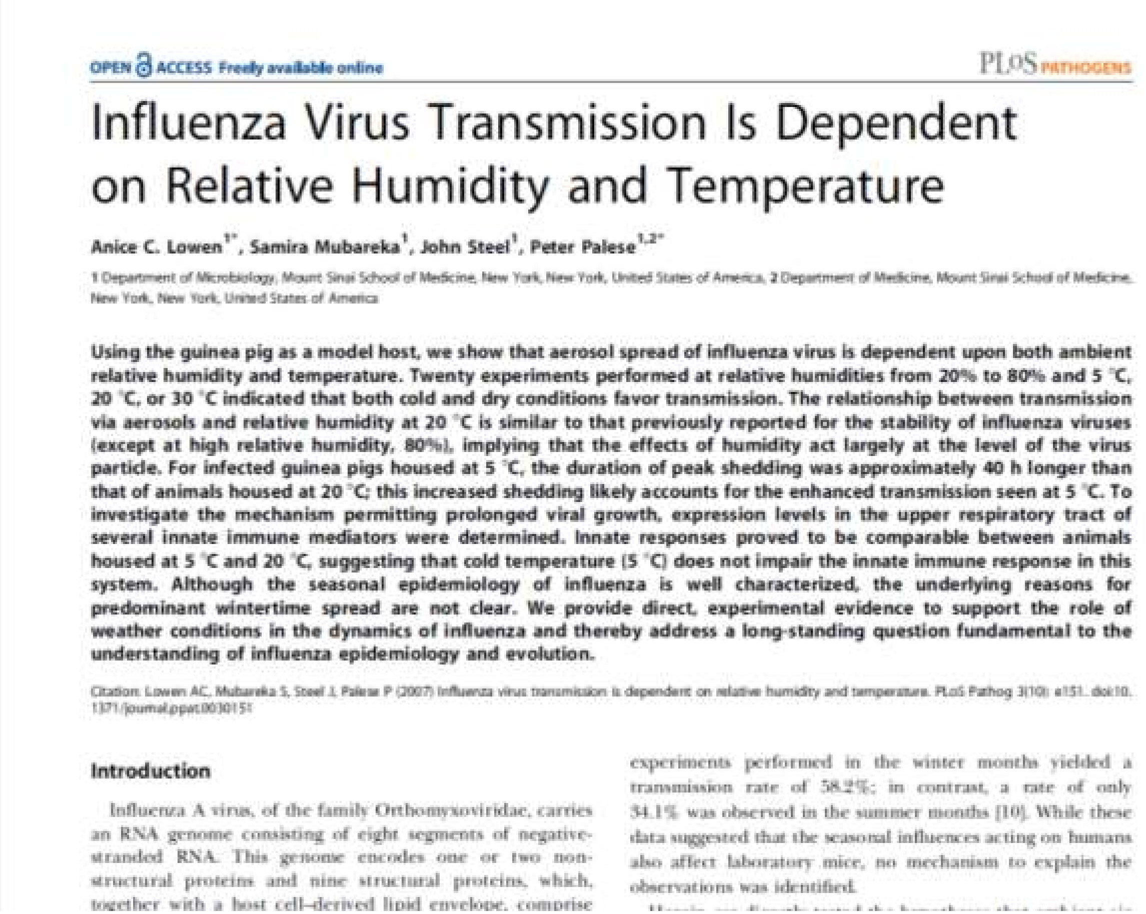
Why Humidify?

ASHRAE 20008 Mechanical Systems



REFERENCE: DR. STERLING

Why Humidify?



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Influenza Virus Transmission Is Dependent on Relative Humidity and Temperature

Anice C. Lowen[1*], **Samira Mubareka**[1], **John Steel**[1], **Peter Palese**[1,2*]

[1] Department of Microbiology, Mount Sinai School of Medicine, New York, New York, United States of America, [2] Department of Medicine, Mount Sinai School of Medicine, New York, New York, United States of America

Using the guinea pig as a model host, we show that aerosol spread of influenza virus is dependent upon both ambient relative humidity and temperature. Twenty experiments performed at relative humidities from 20% to 80% and 5 °C, 20 °C, or 30 °C indicated that both cold and dry conditions favor transmission. The relationship between transmission via aerosols and relative humidity at 20 °C is similar to that previously reported for the stability of influenza viruses (except at high relative humidity, 80%), implying that the effects of humidity act largely at the level of the virus particle. For infected guinea pigs housed at 5 °C, the duration of peak shedding was approximately 40 h longer than that of animals housed at 20 °C; this increased shedding likely accounts for the enhanced transmission seen at 5 °C. To investigate the mechanism permitting prolonged viral growth, expression levels in the upper respiratory tract of several innate immune mediators were determined. Innate responses proved to be comparable between animals housed at 5 °C and 20 °C, suggesting that cold temperature (5 °C) does not impair the innate immune response in this system. Although the seasonal epidemiology of influenza is well characterized, the underlying reasons for predominant wintertime spread are not clear. We provide direct, experimental evidence to support the role of weather conditions in the dynamics of influenza and thereby address a long-standing question fundamental to the understanding of influenza epidemiology and evolution.

Citation: Lowen AC, Mubareka S, Steel J, Palese P (2007) Influenza virus transmission is dependent on relative humidity and temperature. PLoS Pathog 3(10): e151. doi:10.1371/journal.ppat.0030151

Introduction

Influenza A virus, of the family Orthomyxoviridae, carries an RNA genome consisting of eight segments of negative-stranded RNA. This genome encodes one or two non-structural proteins and nine structural proteins, which, together with a host cell–derived lipid envelope, comprise

experiments performed in the winter months yielded a transmission rate of 58.2%; in contrast, a rate of only 34.1% was observed in the summer months [10]. While these data suggested that the seasonal influences acting on humans also affect laboratory mice, no mechanism to explain the observations was identified.

Why Humidify? Potential Change

ASHE

American Hospital Association

FGI
FACILITY GUIDELINES INSTITUTE

Sponsored by

Carolinas HealthCare System

Endorsed by

AORN

APIC

NCHEA

General Information

Registration
On-site conference registration
$375

Live Internet broadcast (per site)
$175

Register Now!

Continuing Education Credits

A HISTORIC CHANGE IN THE OPERATING ROOM ENVIRONMENT

The National Standard for Establishing Relative Humidity in Operating Rooms Has Been Reduced to 20%

Over the years, relative humidity levels have been a source of continued debate in the health care community. In an effort to debunk an age-old requirement, the ANSI/ASHRAE/ASHE Standard 170: Ventilation of Health Care Facilities Standing Committee applied science, a literature search, and research to this subject and recently issued a formal Addendum "d," which becomes effective immediately. ASHRAE 170 has been incorporated into the 2010 FGI *Guidelines for Design and Construction of Health Care Facilities*. The publication of this addendum stresses the aspects of relative humidity in operating rooms in terms of clinical outcomes, comfort, and engineering concepts.

Attend this ASHE/FGI educational event:

The Role of Humidity in Operating Rooms - Demystifying the Myth

June 8, 2010

This program has been designed to provide you with accurate information on the real issues surrounding humidity levels in the operating room environment. Input from AORN, APIC, CDC, NIH, and ASHRAE was instrumental in designing the program content. As a result of participation, you will be able to:

- Explain the rationale behind this significant change to ASHRAE 170 and the Guidelines.
- Prepare health care organizations to implement the lower humidity levels in operating rooms.
- Discuss the effect humidity levels have on surgical site infections, patient outcomes, and comfort.
- Provide health care professionals with well-balanced, pertinent information on the new national standards for humidity in short-stay patient care areas, which includes the operating room.

Step 1:

Select Humidifier Type

DRISTEEM

Two Humidifier Types

- Isothermal – energy for change of state from boiler
- Adiabatic – energy for change of state from air stream

Isothermal

- Steam from low pressure boiler
- Electric Resistant
- Electrode
- Gas Heat Exchanger
- Steam Heat Exchanger

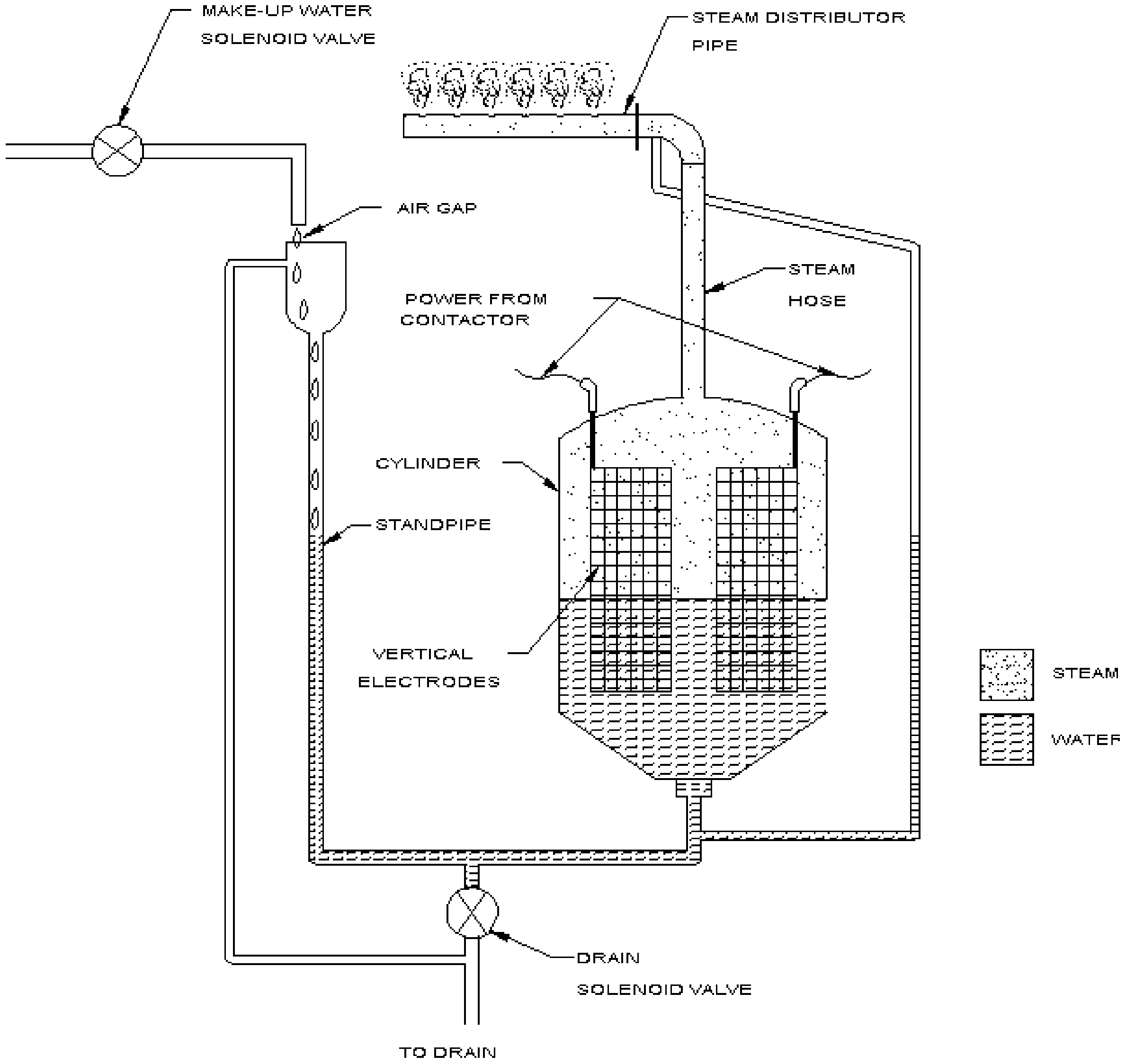
Steam Jacketed Humidifiers

Non-Jacketed Short Absorption

Electric Resistant Heater


CA4
FRAGILE

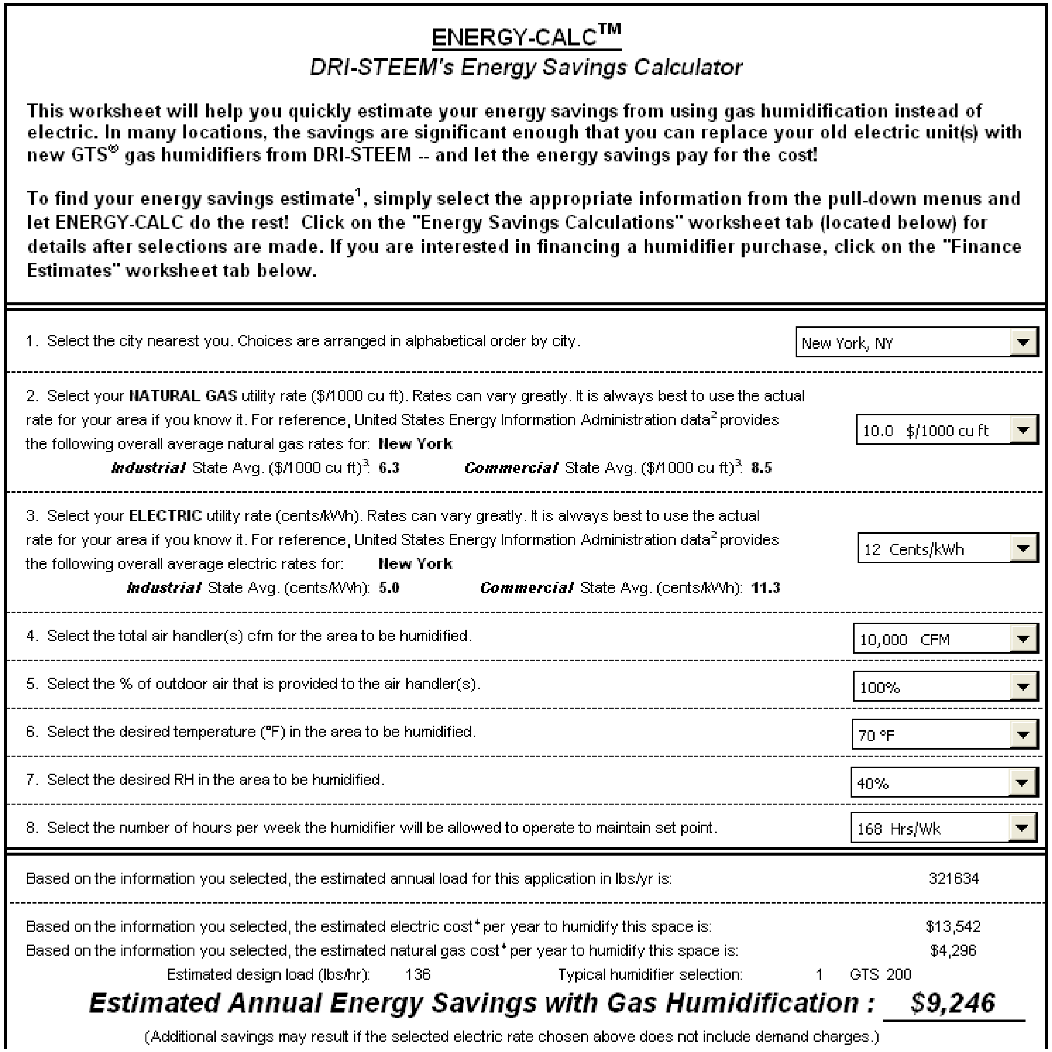
Electrode Type Humidifier


MAKE-UP WATER SOLENOID VALVE
STEAM DISTRIBUTOR PIPE
AIR GAP
STEAM HOSE
POWER FROM CONTACTOR
CYLINDER
STANDPIPE
VERTICAL ELECTRODES
STEAM
WATER
DRAIN SOLENOID VALVE
TO DRAIN

Steam Heat Exchanger

GTS Gas Humidifier

Gas Humidifier Energy Savings
12 Cents per kWhr



ENERGY-CALC™

DRI-STEEM's Energy Savings Calculator

This worksheet will help you quickly estimate your energy savings from using gas humidification instead of electric. In many locations, the savings are significant enough that you can replace your old electric unit(s) with new GTS® gas humidifiers from DRI-STEEM -- and let the energy savings pay for the cost!

To find your energy savings estimate[1], simply select the appropriate information from the pull-down menus and let ENERGY-CALC do the rest! Click on the "Energy Savings Calculations" worksheet tab (located below) for details after selections are made. If you are interested in financing a humidifier purchase, click on the "Finance Estimates" worksheet tab below.

1. Select the city nearest you. Choices are arranged in alphabetical order by city. New York, NY ▼

2. Select your **NATURAL GAS** utility rate ($/1000 cu ft). Rates can vary greatly. It is always best to use the actual rate for your area if you know it. For reference, United States Energy Information Administration data[2] provides the following overall average natural gas rates for: **New York** 10.0 $/1000 cu ft ▼
Industrial State Avg. ($/1000 cu ft)[3]: **6.3** ***Commercial*** State Avg. ($/1000 cu ft)[3]: **8.5**

3. Select your **ELECTRIC** utility rate (cents/kWh). Rates can vary greatly. It is always best to use the actual rate for your area if you know it. For reference, United States Energy Information Administration data[2] provides the following overall average electric rates for: **New York** 12 Cents/kWh ▼
Industrial State Avg. (cents/kWh): **5.0** ***Commercial*** State Avg. (cents/kWh): **11.3**

4. Select the total air handler(s) cfm for the area to be humidified. 10,000 CFM ▼

5. Select the % of outdoor air that is provided to the air handler(s). 100% ▼

6. Select the desired temperature (°F) in the area to be humidified. 70 °F ▼

7. Select the desired RH in the area to be humidified. 40% ▼

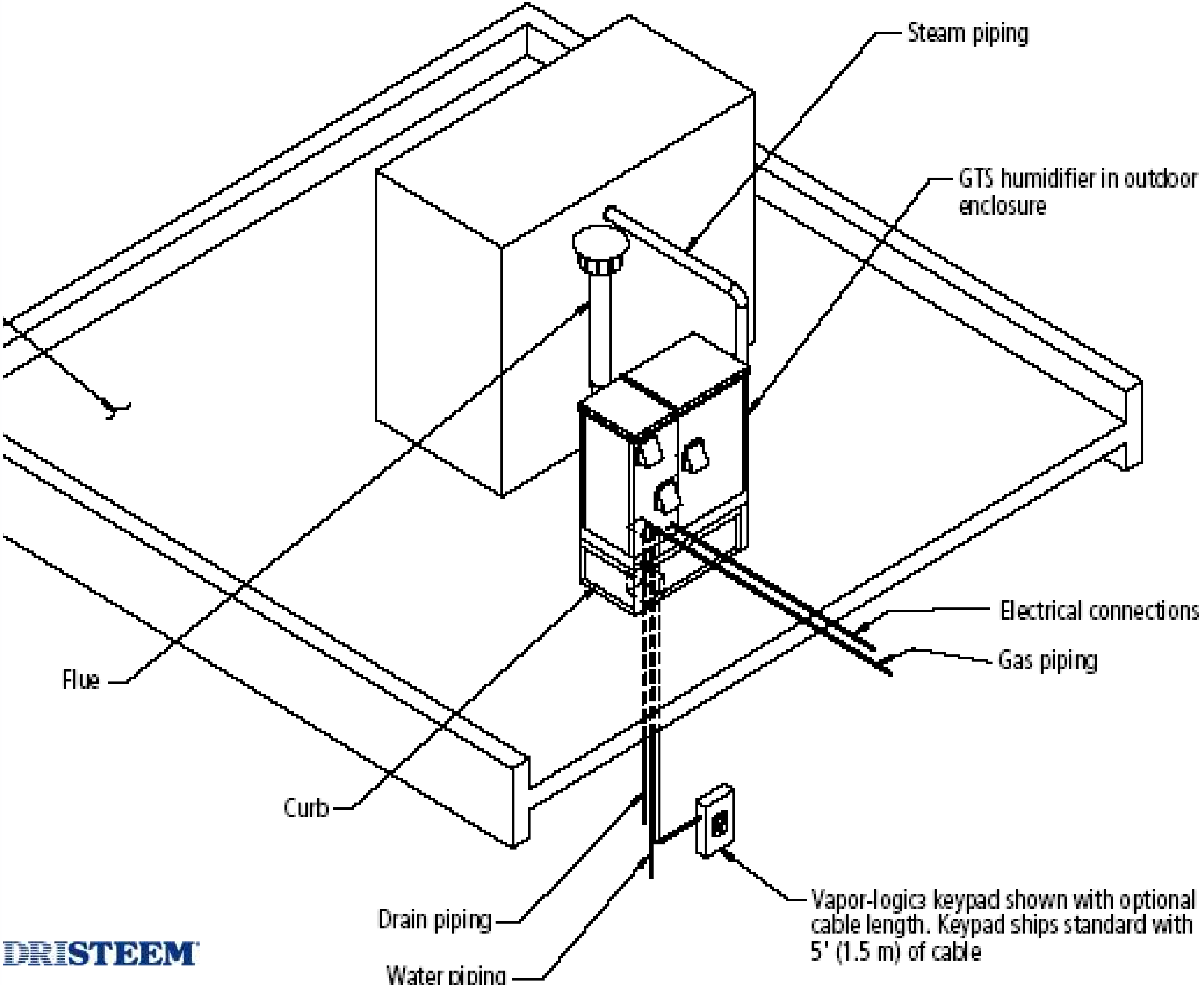
8. Select the number of hours per week the humidifier will be allowed to operate to maintain set point. 168 Hrs/Wk ▼

Based on the information you selected, the estimated annual load for this application in lbs/yr is: 321634

Based on the information you selected, the estimated electric cost[4] per year to humidify this space is: $13,542
Based on the information you selected, the estimated natural gas cost[4] per year to humidify this space is: $4,296
Estimated design load (lbs/hr): 136 Typical humidifier selection: 1 GTS 200

Estimated Annual Energy Savings with Gas Humidification : $9,246

(Additional savings may result if the selected electric rate chosen above does not include demand charges.)


Steam piping
GTS humidifier in outdoor enclosure
Electrical connections
Gas piping
Flue
Curb
Drain piping
Water piping
Vapor-logic3 keypad shown with optional cable length. Keypad ships standard with 5' (1.5 m) of cable

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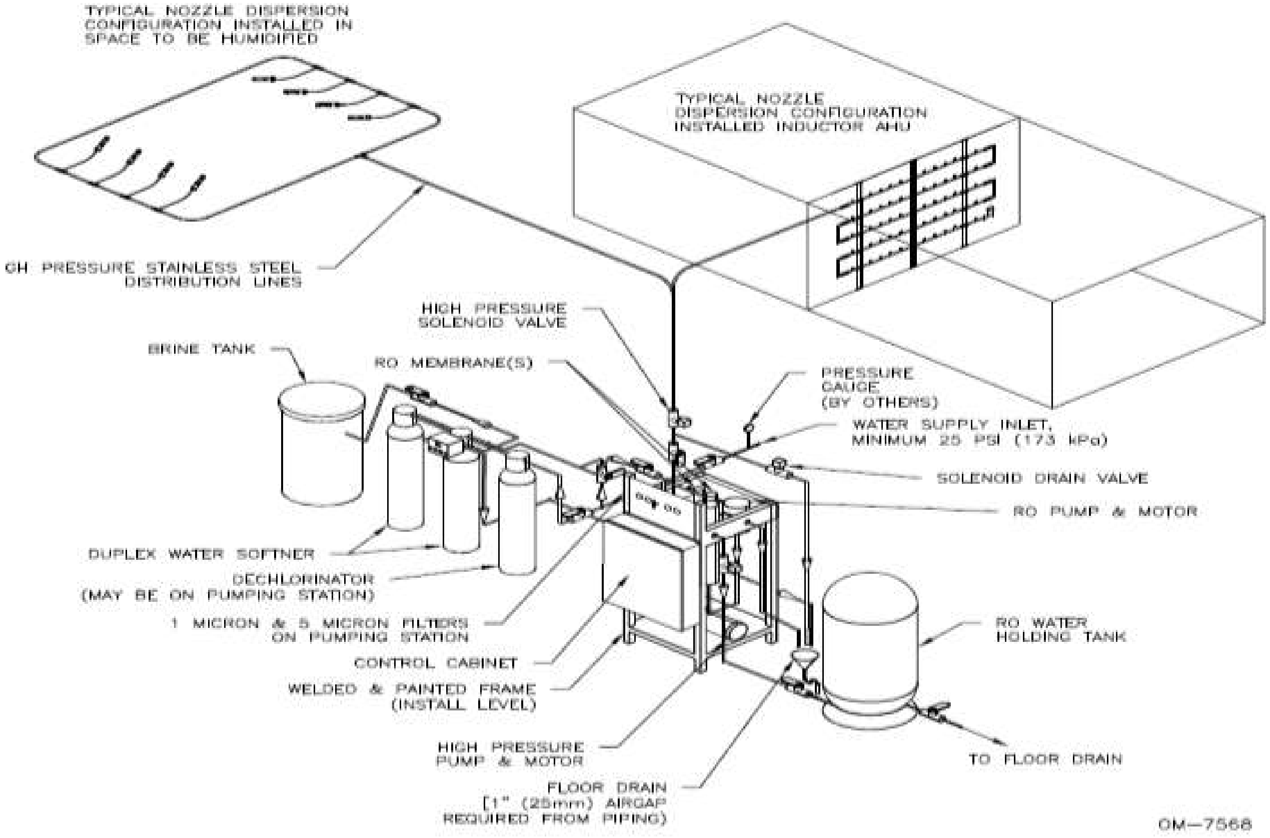
Adiabatic

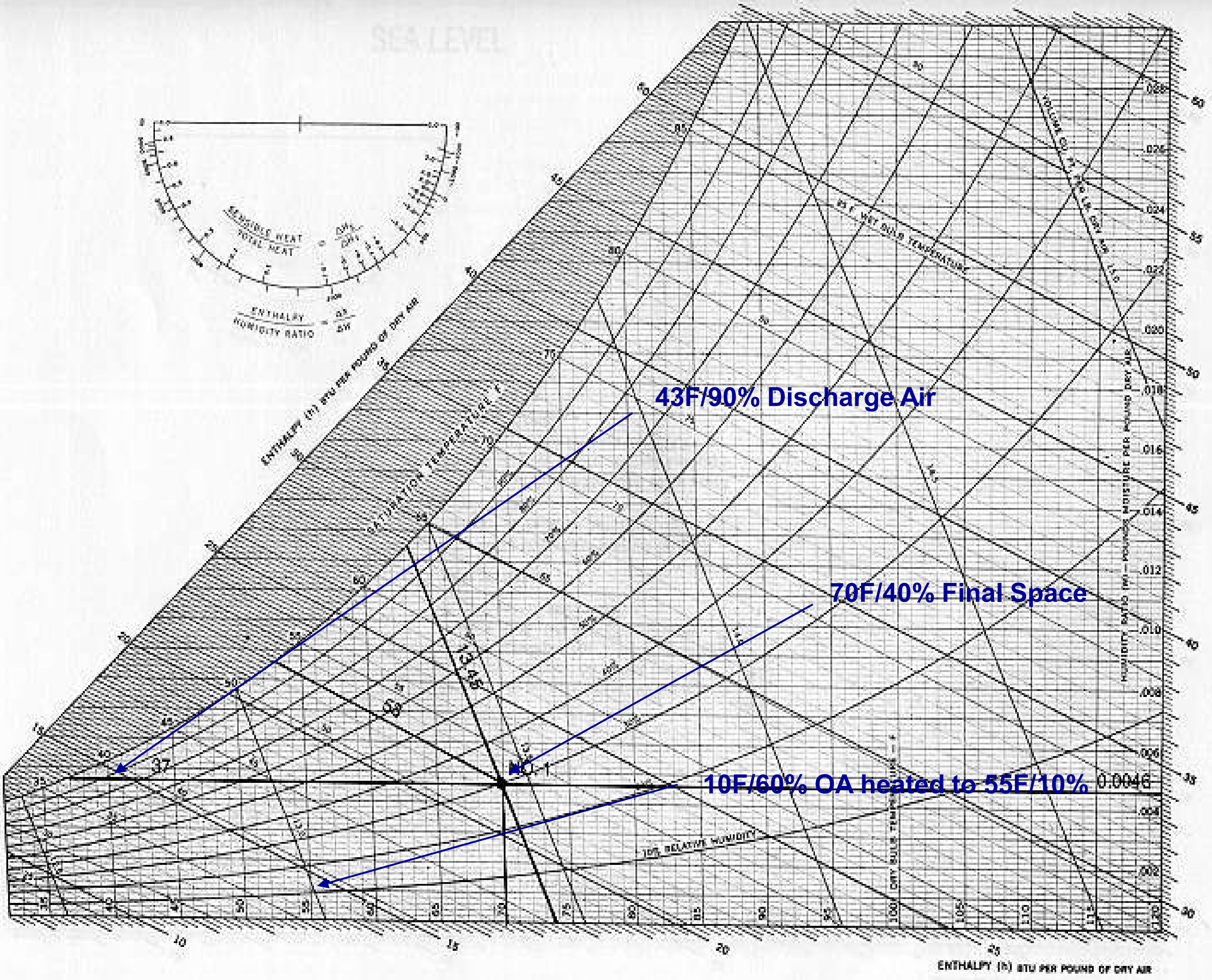
- High Pressure Pump
- Compressed Air + Pump
- Piezo Disk Ultrasonic
- Wetted Media

High Pressure Pump



Adiabatic

- Significant temperature drop
- Longer absorption distance
- RO water required



43F/90% Discharge Air

70F/40% Final Space

10F/60% OA heated to 55F/10%

Step 2:

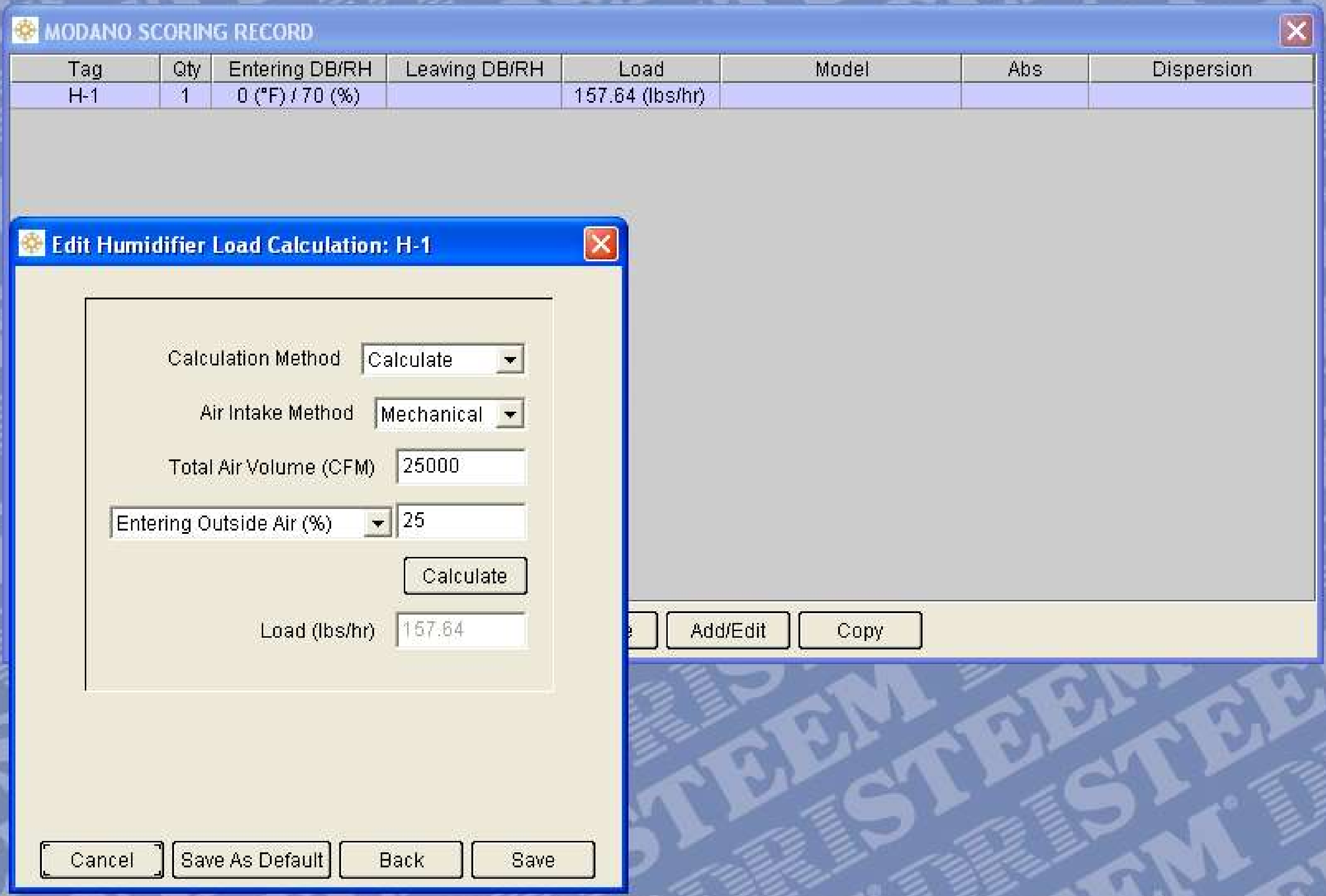
Determine Humidification Load

DRISTEEM

Step 2: Determine Humidification Load

- Mechanical with constant amount of outside air
- Economizer changes amount of outside air to utilize free cooling

Mechanical Calculation



MODANO SCORING RECORD

Tag	Qty	Entering DB/RH	Leaving DB/RH	Load	Model	Abs	Dispersion
H-1	1	0 (°F) / 70 (%)		157.64 (lbs/hr)			

Edit Humidifier Load Calculation: H-1

Calculation Method: Calculate

Air Intake Method: Mechanical

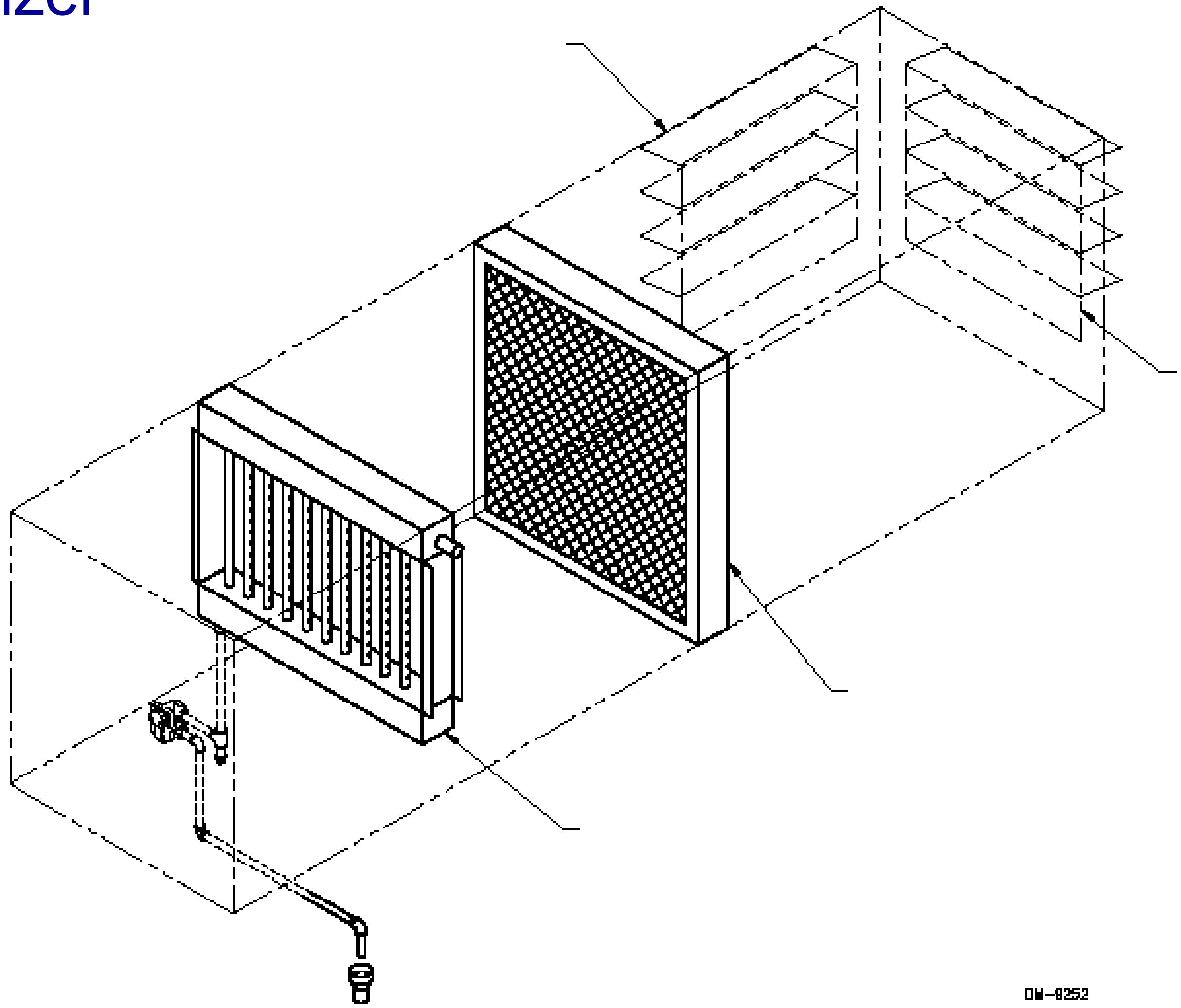
Total Air Volume (CFM): 25000

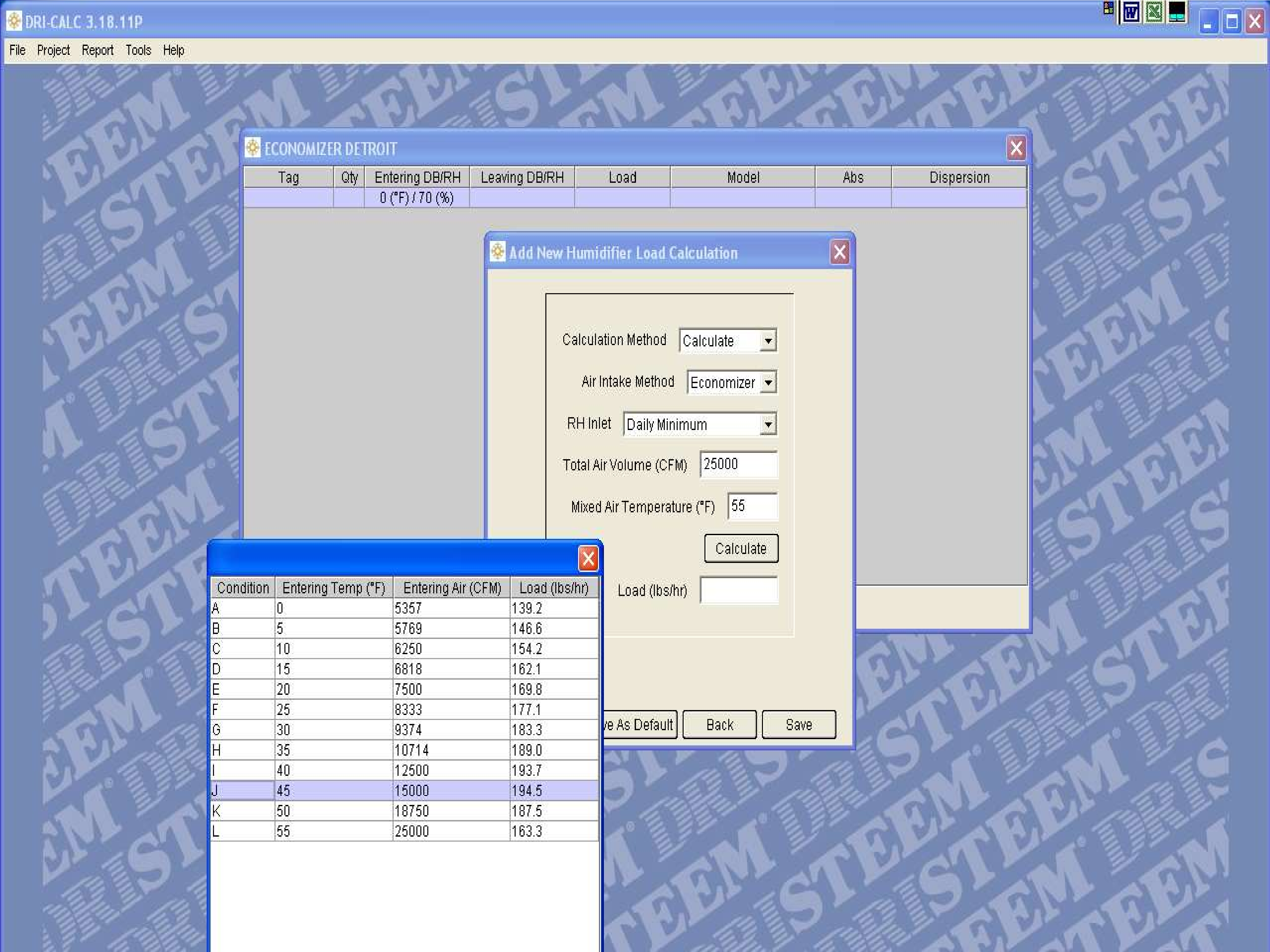
Entering Outside Air (%): 25

Load (lbs/hr): 157.64

Economizer Calculation

Economizer





ECONOMIZER DETROIT

Tag	Qty	Entering DB/RH	Leaving DB/RH	Load	Model	Abs	Dispersion
		0 (°F) / 70 (%)					

Add New Humidifier Load Calculation

Calculation Method: Calculate

Air Intake Method: Economizer

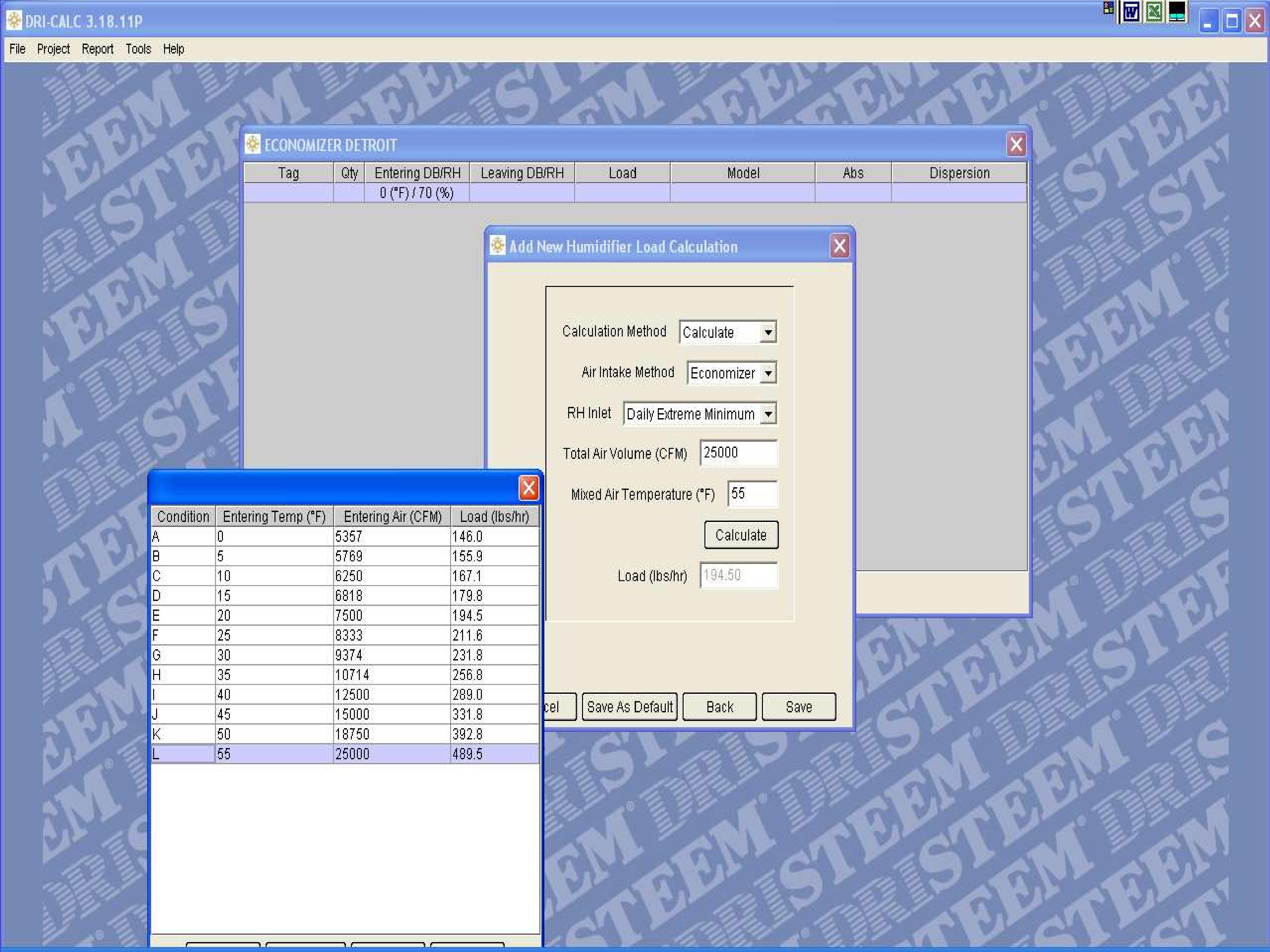
RH Inlet: Daily Minimum

Total Air Volume (CFM): 25000

Mixed Air Temperature (°F): 55

Load (lbs/hr):

Condition	Entering Temp (°F)	Entering Air (CFM)	Load (lbs/hr)
A	0	5357	139.2
B	5	5769	146.6
C	10	6250	154.2
D	15	6818	162.1
E	20	7500	169.8
F	25	8333	177.1
G	30	9374	183.3
H	35	10714	189.0
I	40	12500	193.7
J	45	15000	194.5
K	50	18750	187.5
L	55	25000	163.3



ECONOMIZER DETROIT

Tag	Qty	Entering DB/RH	Leaving DB/RH	Load	Model	Abs	Dispersion
		0 (°F) / 70 (%)					

Add New Humidifier Load Calculation

Calculation Method: Calculate

Air Intake Method: Economizer

RH Inlet: Daily Extreme Minimum

Total Air Volume (CFM): 25000

Mixed Air Temperature (°F): 55

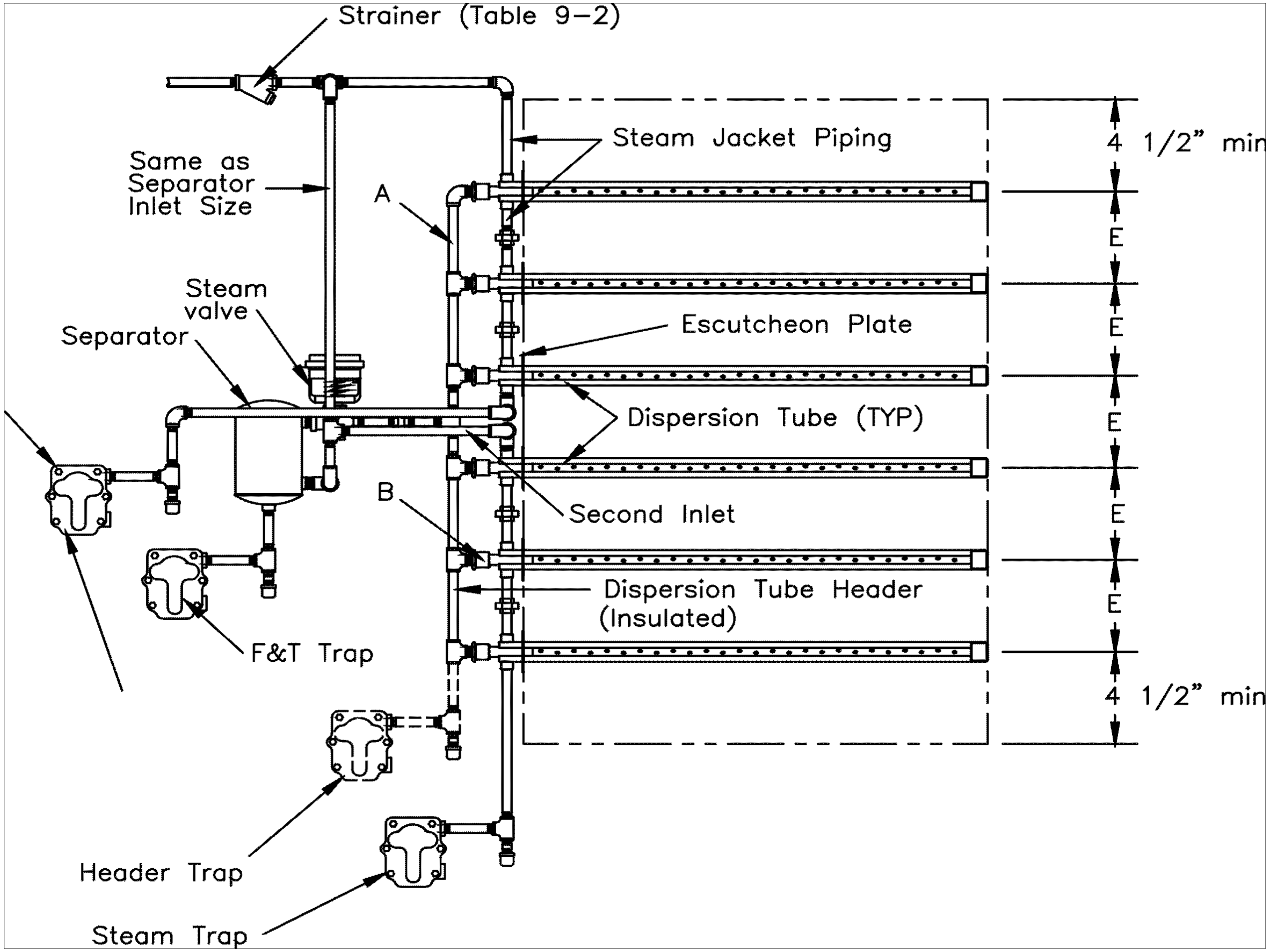
Load (lbs/hr): 194.50

Condition	Entering Temp (°F)	Entering Air (CFM)	Load (lbs/hr)
A	0	5357	146.0
B	5	5769	155.9
C	10	6250	167.1
D	15	6818	179.8
E	20	7500	194.5
F	25	8333	211.6
G	30	9374	231.8
H	35	10714	256.8
I	40	12500	289.0
J	45	15000	331.8
K	50	18750	392.8
L	55	25000	489.5

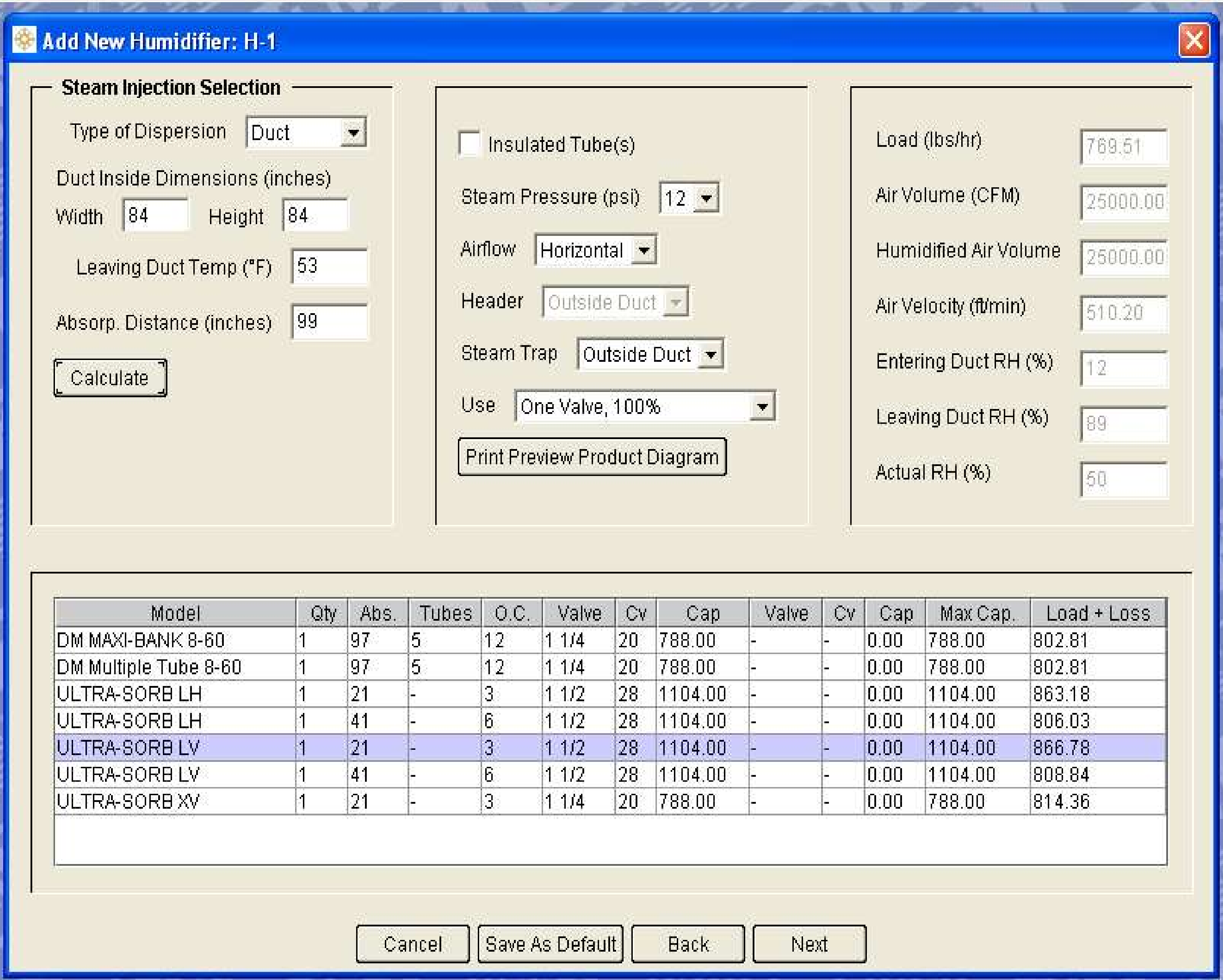
Step 2: Determine Humidification Load

- Accurate humidification load must include condensate loss and steam jacket requirement

Steam Jacket Impact on Load Calculation



Dispersion Panel Condensate Impact on Load Calculation



Steam Injection Selection

Type of Dispersion: Duct

Duct Inside Dimensions (inches)

Width: 84 Height: 84

Leaving Duct Temp (°F): 53

Absorp. Distance (inches): 99

☐ Insulated Tube(s)

Steam Pressure (psi): 12

Airflow: Horizontal

Header: Outside Duct

Steam Trap: Outside Duct

Use: One Valve, 100%

Load (lbs/hr): 769.51

Air Volume (CFM): 25000.00

Humidified Air Volume: 25000.00

Air Velocity (ft/min): 510.20

Entering Duct RH (%): 12

Leaving Duct RH (%): 89

Actual RH (%): 50

Model	Qty	Abs.	Tubes	O.C.	Valve	Cv	Cap	Valve	Cv	Cap	Max Cap.	Load + Loss
DM MAXI-BANK 8-60	1	97	5	12	1 1/4	20	788.00	-	-	0.00	788.00	802.81
DM Multiple Tube 8-60	1	97	5	12	1 1/4	20	788.00	-	-	0.00	788.00	802.81
ULTRA-SORB LH	1	21	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	863.18
ULTRA-SORB LH	1	41	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	806.03
ULTRA-SORB LV	1	21	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	866.78
ULTRA-SORB LV	1	41	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	808.84
ULTRA-SORB XV	1	21	-	3	1 1/4	20	788.00	-	-	0.00	788.00	814.36

Step 3:

Determine Absorption Requirement

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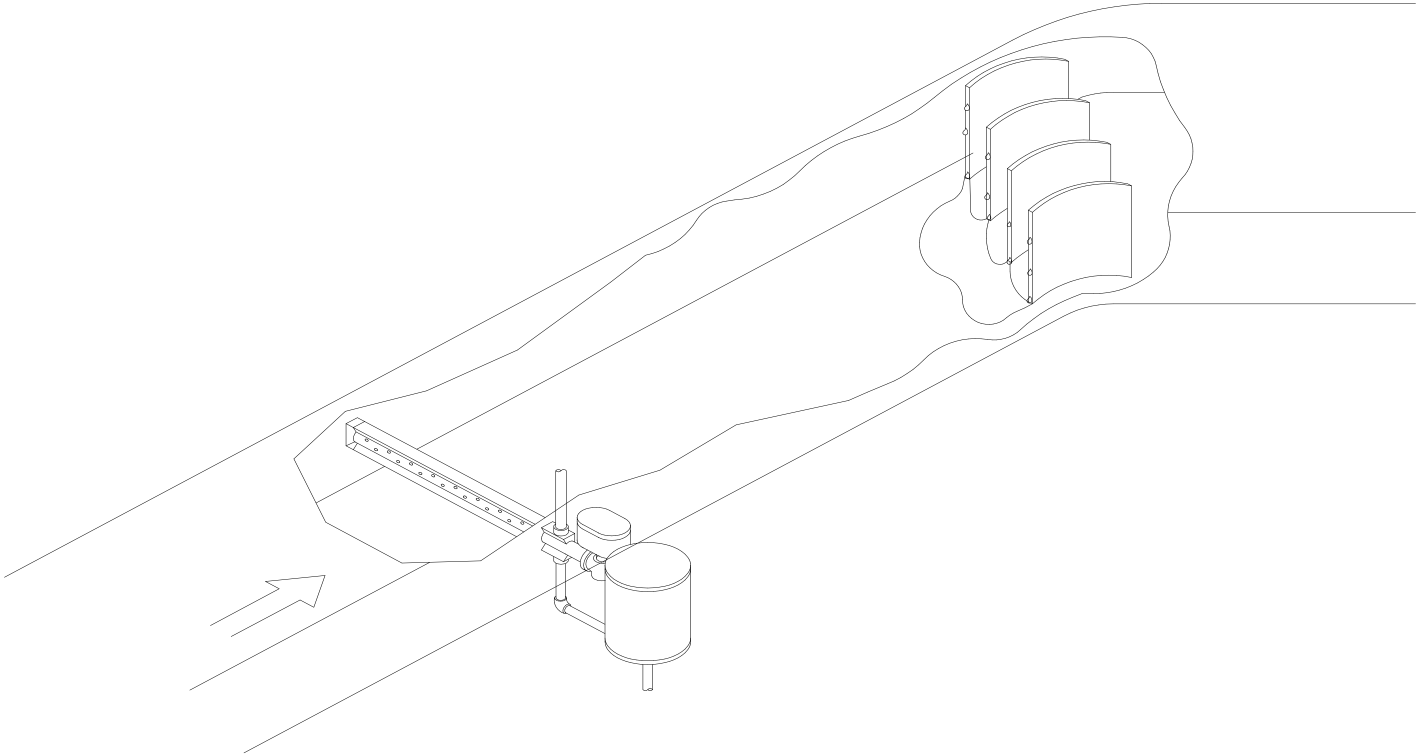
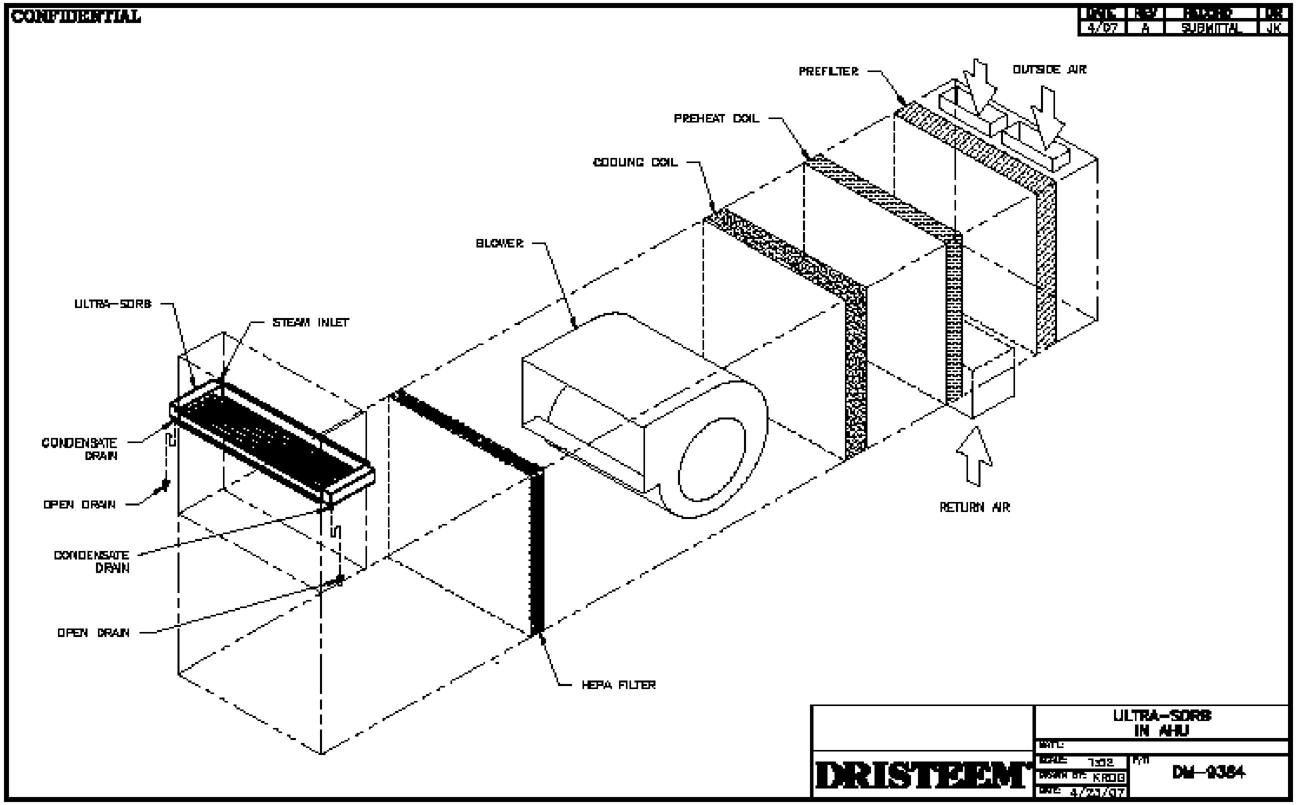
Steam Absorption in Duct



Steam Absorption in AHU

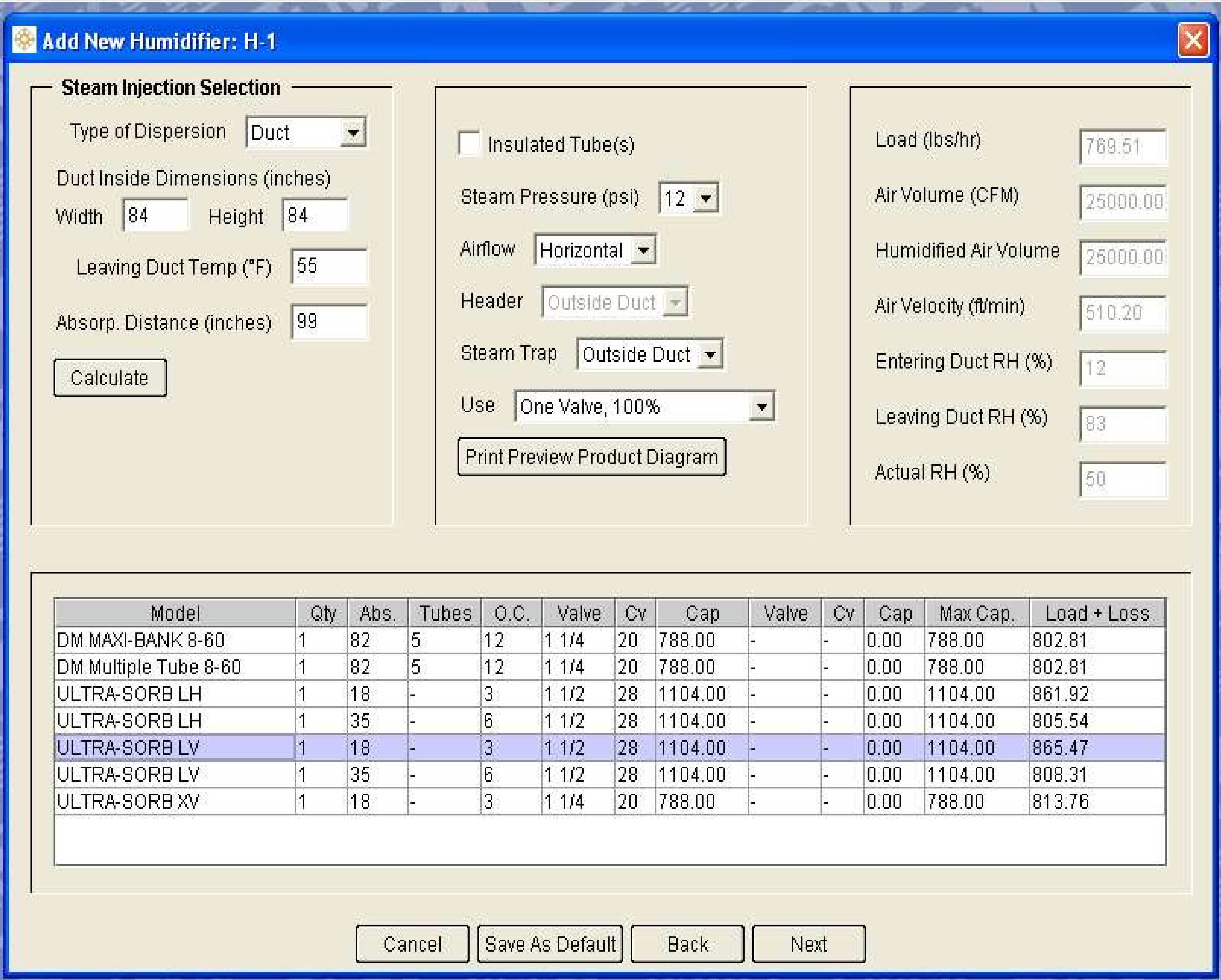


Determine Absorption Requirement

- Temperature
- Velocity
- Fan/Air flow characteristics

Determine Absorption Requirement

- Effect of AHU or duct temperature on steam absorption distance



Steam Injection Selection

Type of Dispersion: Duct

Duct Inside Dimensions (inches)

Width: 84 Height: 84

Leaving Duct Temp (°F): 55

Absorp. Distance (inches): 99

☐ Insulated Tube(s)

Steam Pressure (psi): 12

Airflow: Horizontal

Header: Outside Duct

Steam Trap: Outside Duct

Use: One Valve, 100%

Load (lbs/hr): 769.51

Air Volume (CFM): 25000.00

Humidified Air Volume: 25000.00

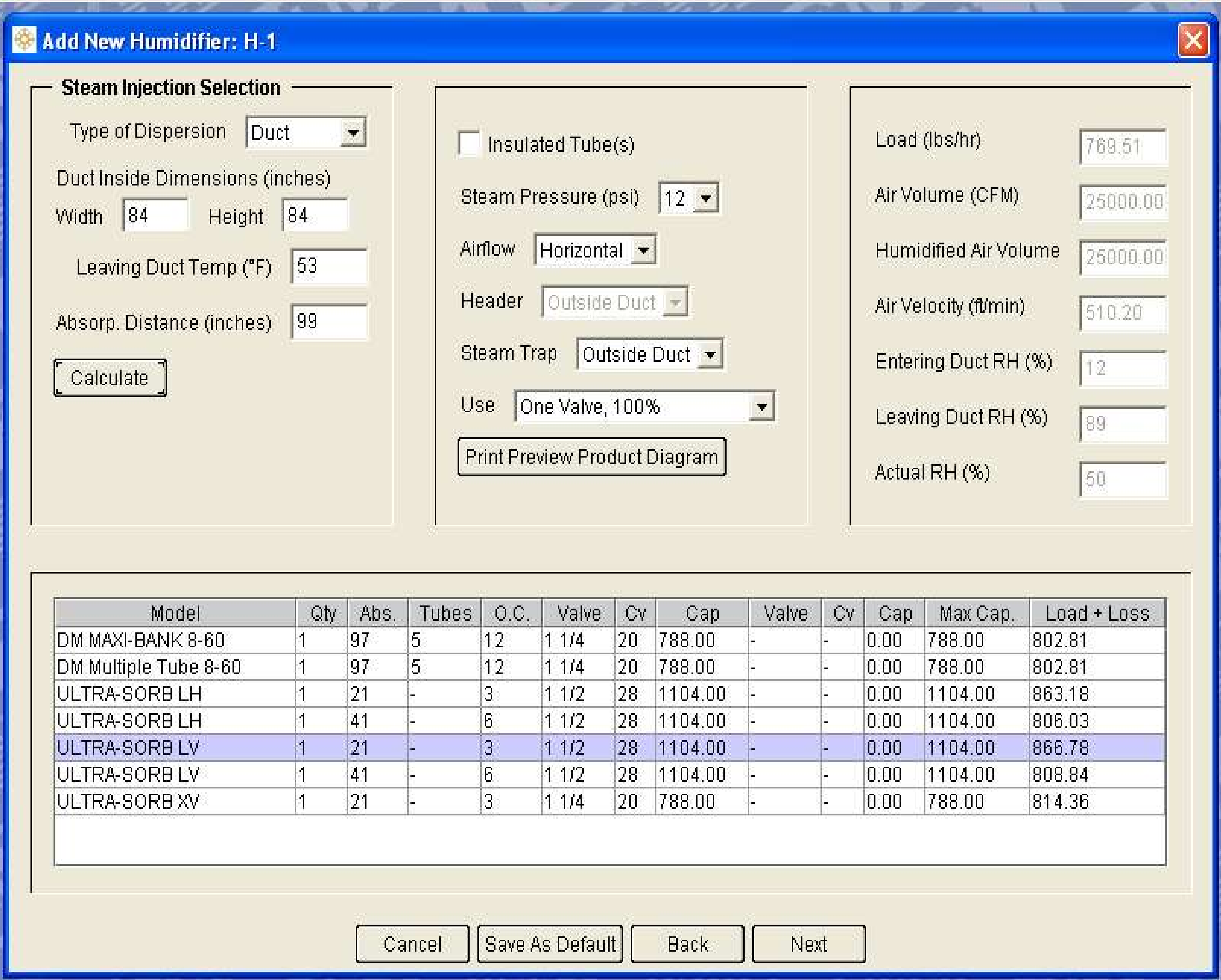
Air Velocity (ft/min): 510.20

Entering Duct RH (%): 12

Leaving Duct RH (%): 83

Actual RH (%): 50

Model	Qty	Abs.	Tubes	O.C.	Valve	Cv	Cap	Valve	Cv	Cap	Max Cap.	Load + Loss
DM MAXI-BANK 8-60	1	82	5	12	1 1/4	20	788.00	-	-	0.00	788.00	802.81
DM Multiple Tube 8-60	1	82	5	12	1 1/4	20	788.00	-	-	0.00	788.00	802.81
ULTRA-SORB LH	1	18	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	861.92
ULTRA-SORB LH	1	35	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	805.54
ULTRA-SORB LV	1	18	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	865.47
ULTRA-SORB LV	1	35	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	808.31
ULTRA-SORB XV	1	18	-	3	1 1/4	20	788.00	-	-	0.00	788.00	813.76



Add New Humidifier: H-1

Steam Injection Selection

Type of Dispersion: Duct

Duct Inside Dimensions (inches)

Width: 84 Height: 84

Leaving Duct Temp (°F): 53

Absorp. Distance (inches): 99

☐ Insulated Tube(s)

Steam Pressure (psi): 12

Airflow: Horizontal

Header: Outside Duct

Steam Trap: Outside Duct

Use: One Valve, 100%

Load (lbs/hr): 769.51

Air Volume (CFM): 25000.00

Humidified Air Volume: 25000.00

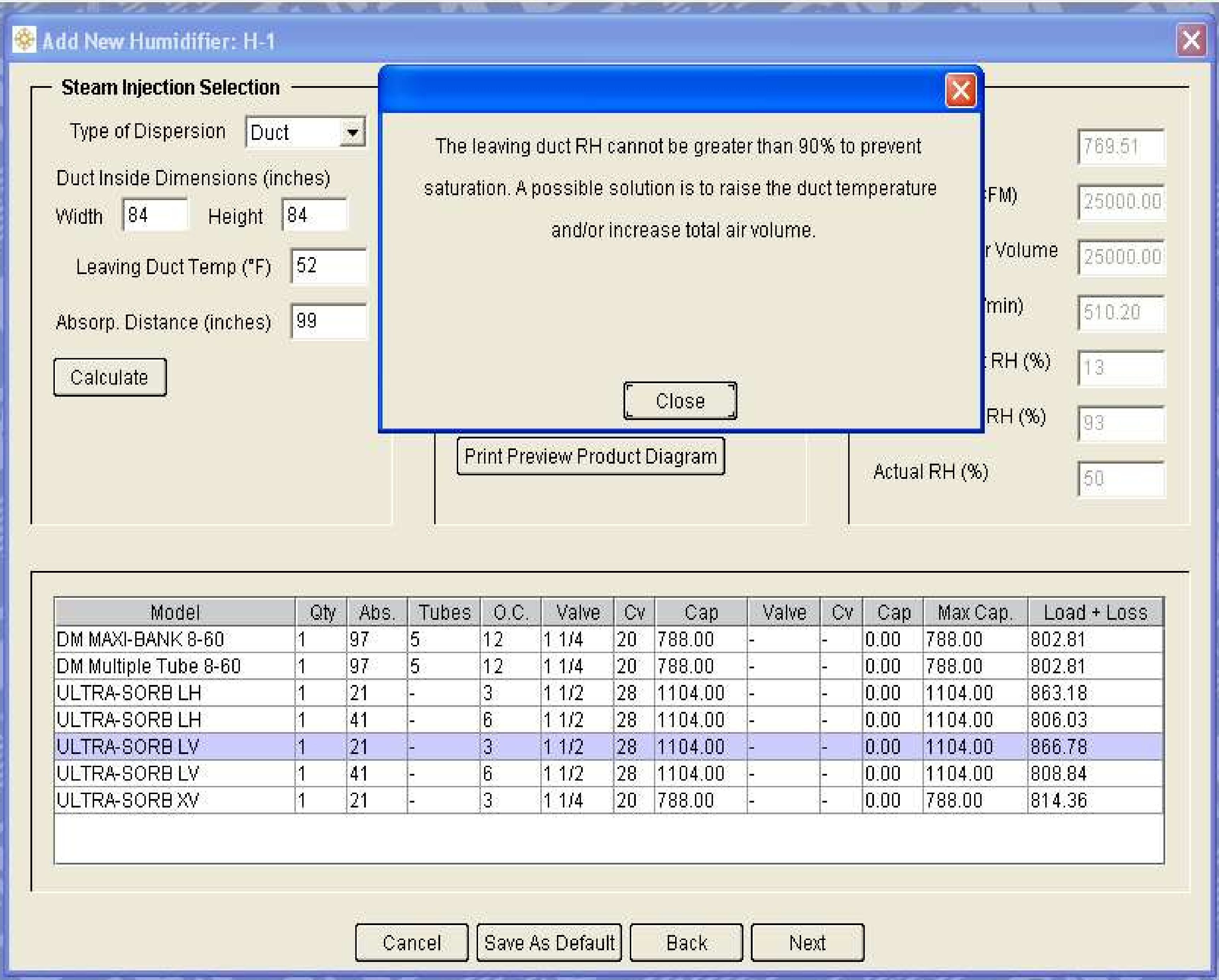
Air Velocity (ft/min): 510.20

Entering Duct RH (%): 12

Leaving Duct RH (%): 89

Actual RH (%): 50

Model	Qty	Abs.	Tubes	O.C.	Valve	Cv	Cap	Valve	Cv	Cap	Max Cap.	Load + Loss
DM MAXI-BANK 8-60	1	97	5	12	1 1/4	20	788.00	-	-	0.00	788.00	802.81
DM Multiple Tube 8-60	1	97	5	12	1 1/4	20	788.00	-	-	0.00	788.00	802.81
ULTRA-SORB LH	1	21	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	863.18
ULTRA-SORB LH	1	41	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	806.03
ULTRA-SORB LV	1	21	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	866.78
ULTRA-SORB LV	1	41	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	808.84
ULTRA-SORB XV	1	21	-	3	1 1/4	20	788.00	-	-	0.00	788.00	814.36



Add New Humidifier: H-1

Steam Injection Selection

Type of Dispersion: Duct

Duct Inside Dimensions (inches)

Width: 84 Height: 84

Leaving Duct Temp (°F): 52

Absorp. Distance (inches): 99

FM): 25000.00

r Volume: 25000.00

min): 510.20

RH (%): 13

RH (%): 93

Actual RH (%): 50

769.51

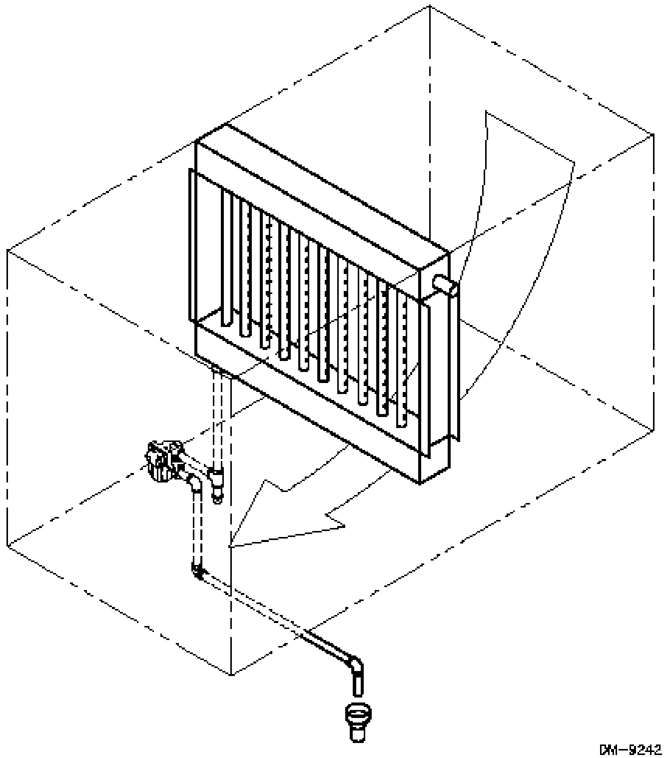
The leaving duct RH cannot be greater than 90% to prevent saturation. A possible solution is to raise the duct temperature and/or increase total air volume.

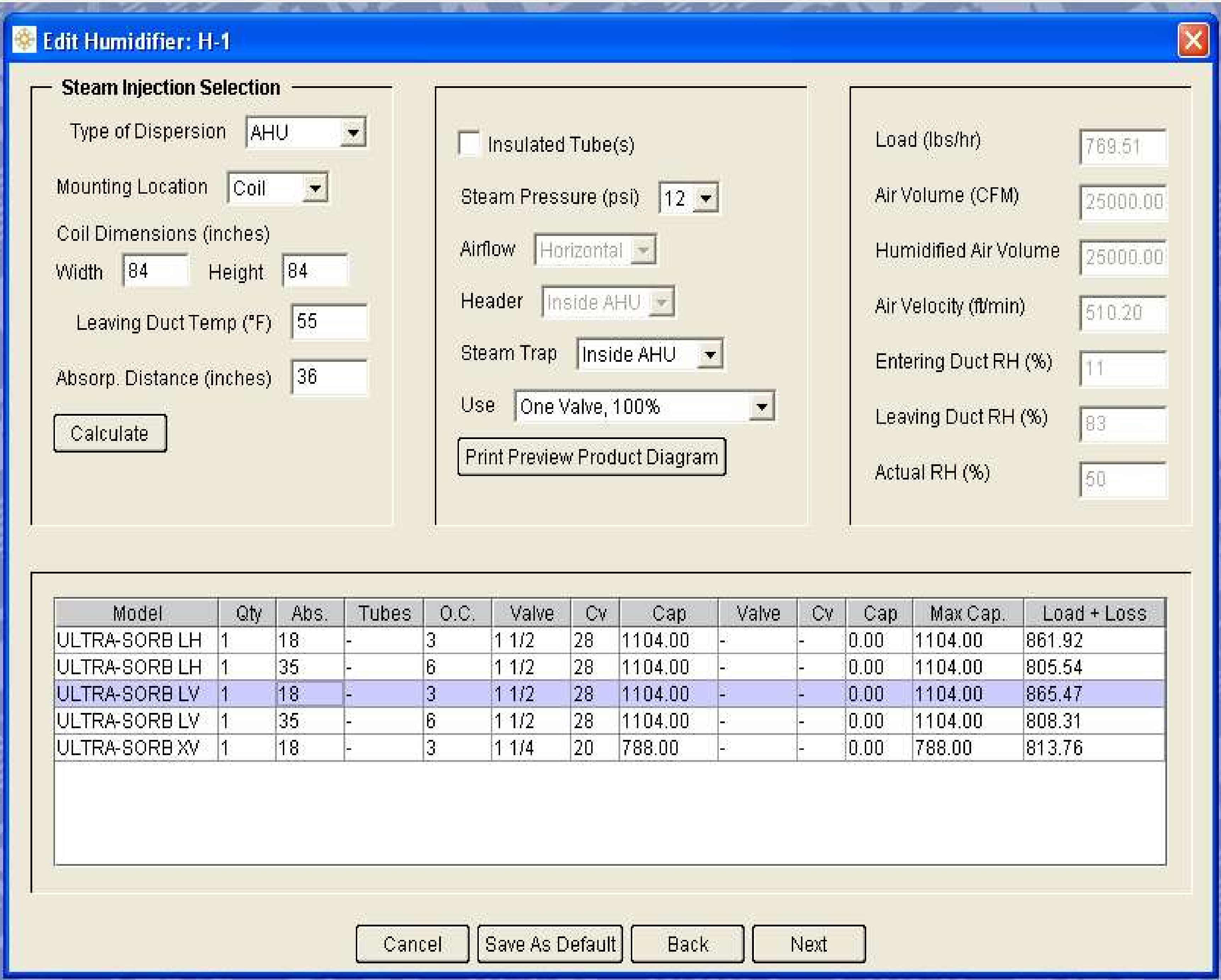
Model	Qty	Abs.	Tubes	O.C.	Valve	Cv	Cap	Valve	Cv	Cap	Max Cap.	Load + Loss
DM MAXI-BANK 8-60	1	97	5	12	1 1/4	20	788.00	-	-	0.00	788.00	802.81
DM Multiple Tube 8-60	1	97	5	12	1 1/4	20	788.00	-	-	0.00	788.00	802.81
ULTRA-SORB LH	1	21	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	863.18
ULTRA-SORB LH	1	41	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	806.03
ULTRA-SORB LV	1	21	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	866.78
ULTRA-SORB LV	1	41	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	808.84
ULTRA-SORB XV	1	21	-	3	1 1/4	20	788.00	-	-	0.00	788.00	814.36

Determine Absorption Requirement

- Isothermal 250-3000 fpm
- Adiabatic 250-750 fpm

Bypass Under Dispersion Panel





Edit Humidifier: H-1

Steam Injection Selection

Type of Dispersion: AHU

Mounting Location: Coil

Coil Dimensions (inches)

Width: 84 Height: 84

Leaving Duct Temp (°F): 55

Absorp. Distance (inches): 36

☐ Insulated Tube(s)

Steam Pressure (psi): 12

Airflow: Horizontal

Header: Inside AHU

Steam Trap: Inside AHU

Use: One Valve, 100%

Load (lbs/hr): 769.51

Air Volume (CFM): 25000.00

Humidified Air Volume: 25000.00

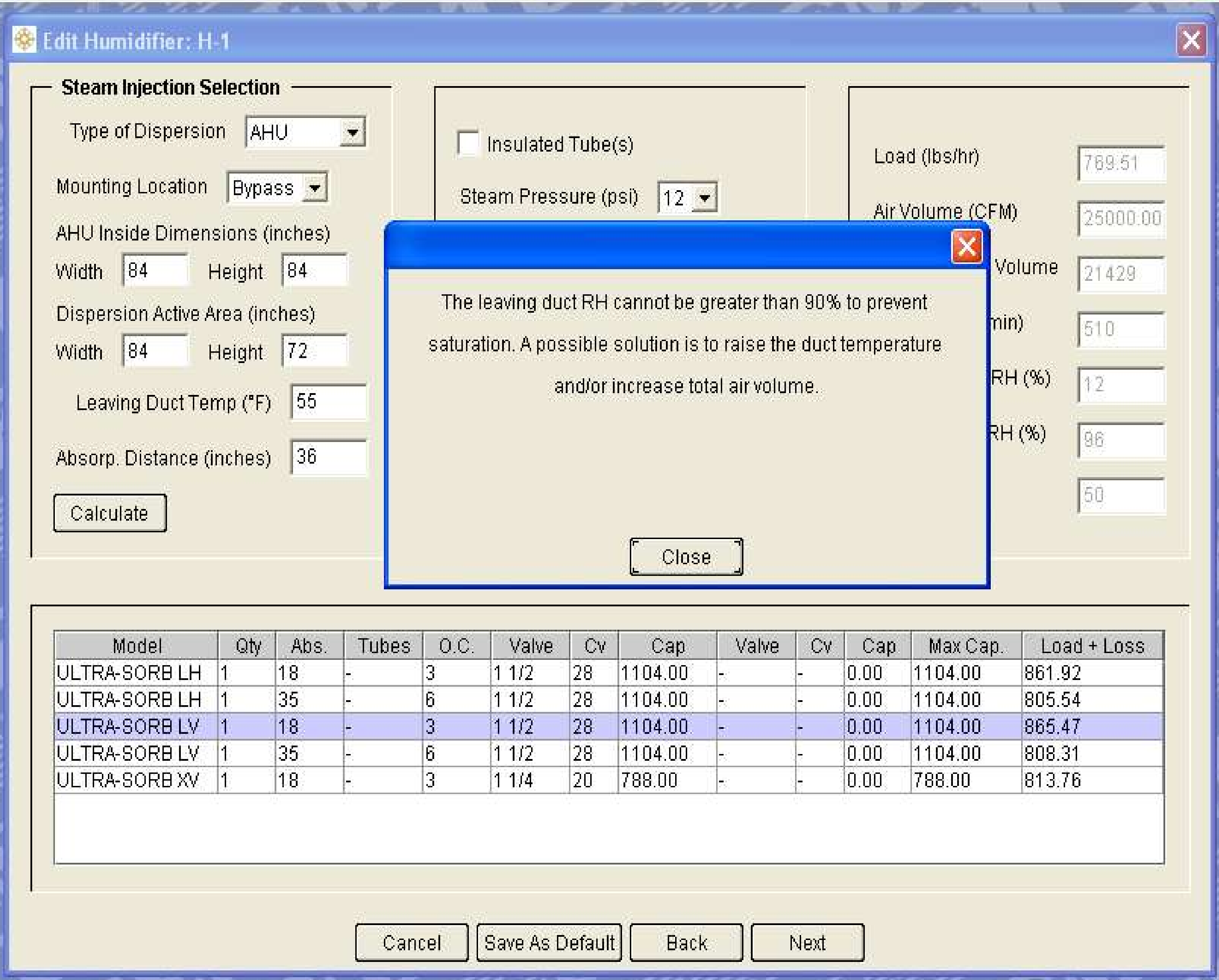
Air Velocity (ft/min): 510.20

Entering Duct RH (%): 11

Leaving Duct RH (%): 83

Actual RH (%): 50

Model	Qty	Abs.	Tubes	O.C.	Valve	Cv	Cap	Valve	Cv	Cap	Max Cap.	Load + Loss
ULTRA-SORB LH	1	18	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	861.92
ULTRA-SORB LH	1	35	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	805.54
ULTRA-SORB LV	1	18	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	865.47
ULTRA-SORB LV	1	35	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	808.31
ULTRA-SORB XV	1	18	-	3	1 1/4	20	788.00	-	-	0.00	788.00	813.76



Steam Injection Selection

Type of Dispersion: AHU

Mounting Location: Bypass

AHU Inside Dimensions (inches)

Width: 84 Height: 84

Dispersion Active Area (inches)

Width: 84 Height: 72

Leaving Duct Temp (°F): 55

Absorp. Distance (inches): 36

☐ Insulated Tube(s)

Steam Pressure (psi): 12

Load (lbs/hr): 769.51

Air Volume (CFM): 25000.00

Volume: 21429

min): 510

RH (%): 12

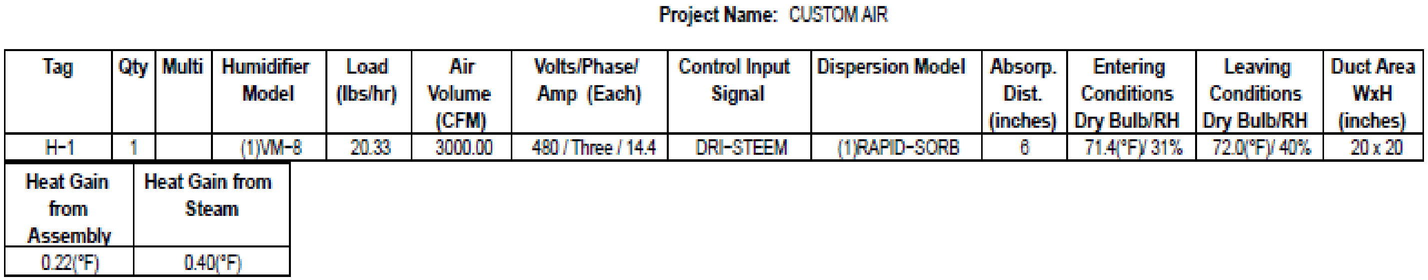
RH (%): 96

50

The leaving duct RH cannot be greater than 90% to prevent saturation. A possible solution is to raise the duct temperature and/or increase total air volume.

Model	Qty	Abs.	Tubes	O.C.	Valve	Cv	Cap	Valve	Cv	Cap	Max Cap.	Load + Loss
ULTRA-SORB LH	1	18	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	861.92
ULTRA-SORB LH	1	35	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	805.54
ULTRA-SORB LV	1	18	-	3	1 1/2	28	1104.00	-	-	0.00	1104.00	865.47
ULTRA-SORB LV	1	35	-	6	1 1/2	28	1104.00	-	-	0.00	1104.00	808.31
ULTRA-SORB XV	1	18	-	3	1 1/4	20	788.00	-	-	0.00	788.00	813.76

Suggested Schedule Format



Project Name: CUSTOM AIR

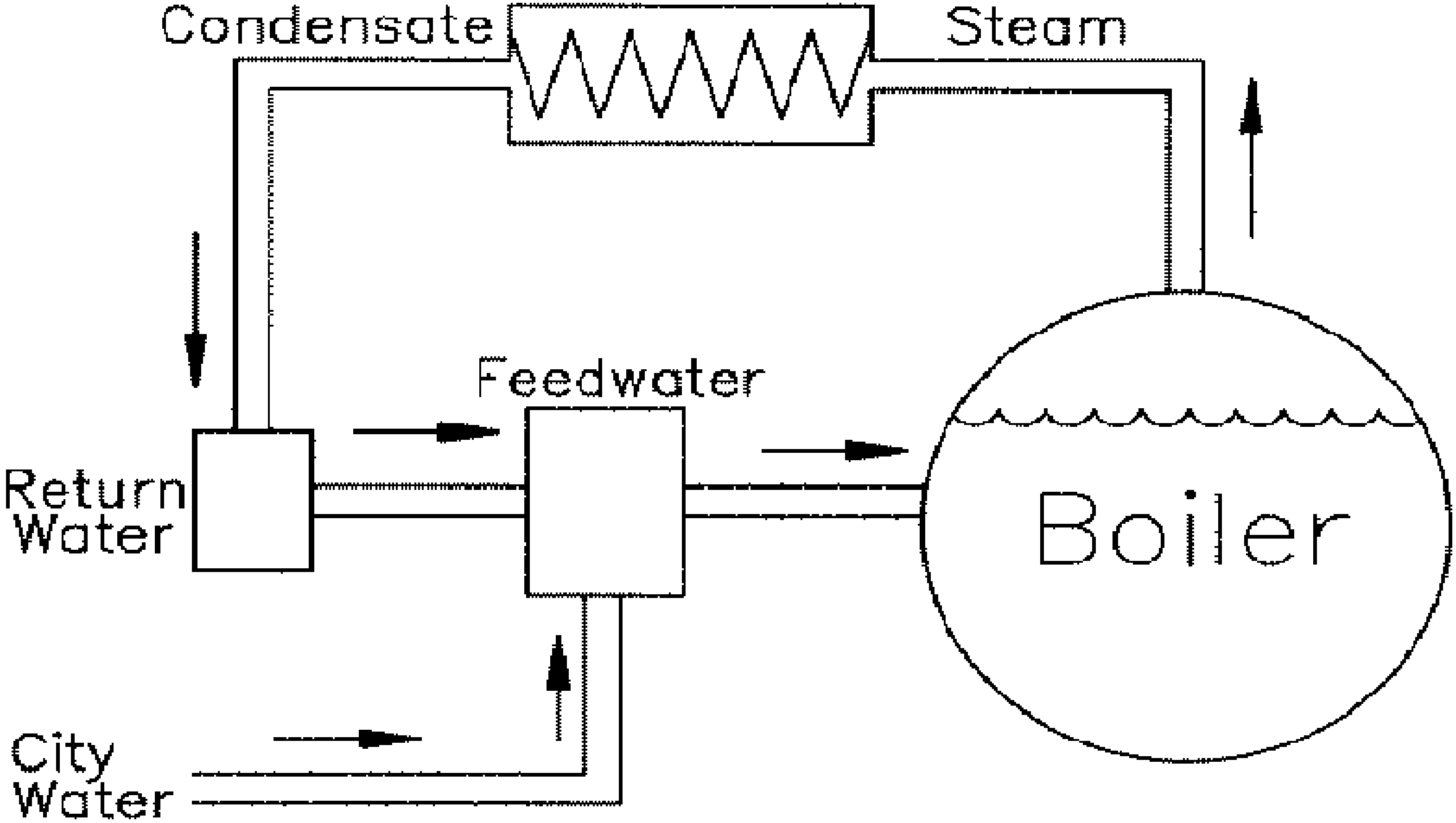
Tag	Qty	Multi	Humidifier Model	Load (lbs/hr)	Air Volume (CFM)	Volts/Phase/ Amp (Each)	Control Input Signal	Dispersion Model	Absorp. Dist. (inches)	Entering Conditions Dry Bulb/RH	Leaving Conditions Dry Bulb/RH	Duct Area WxH (inches)
H-1	1		(1)VM-8	20.33	3000.00	480 / Three / 14.4	DRI-STEEM	(1)RAPID-SORB	6	71.4(°F)/ 31%	72.0(°F)/ 40%	20 x 20

Heat Gain from Assembly	Heat Gain from Steam
0.22(°F)	0.40(°F)

Step 4:

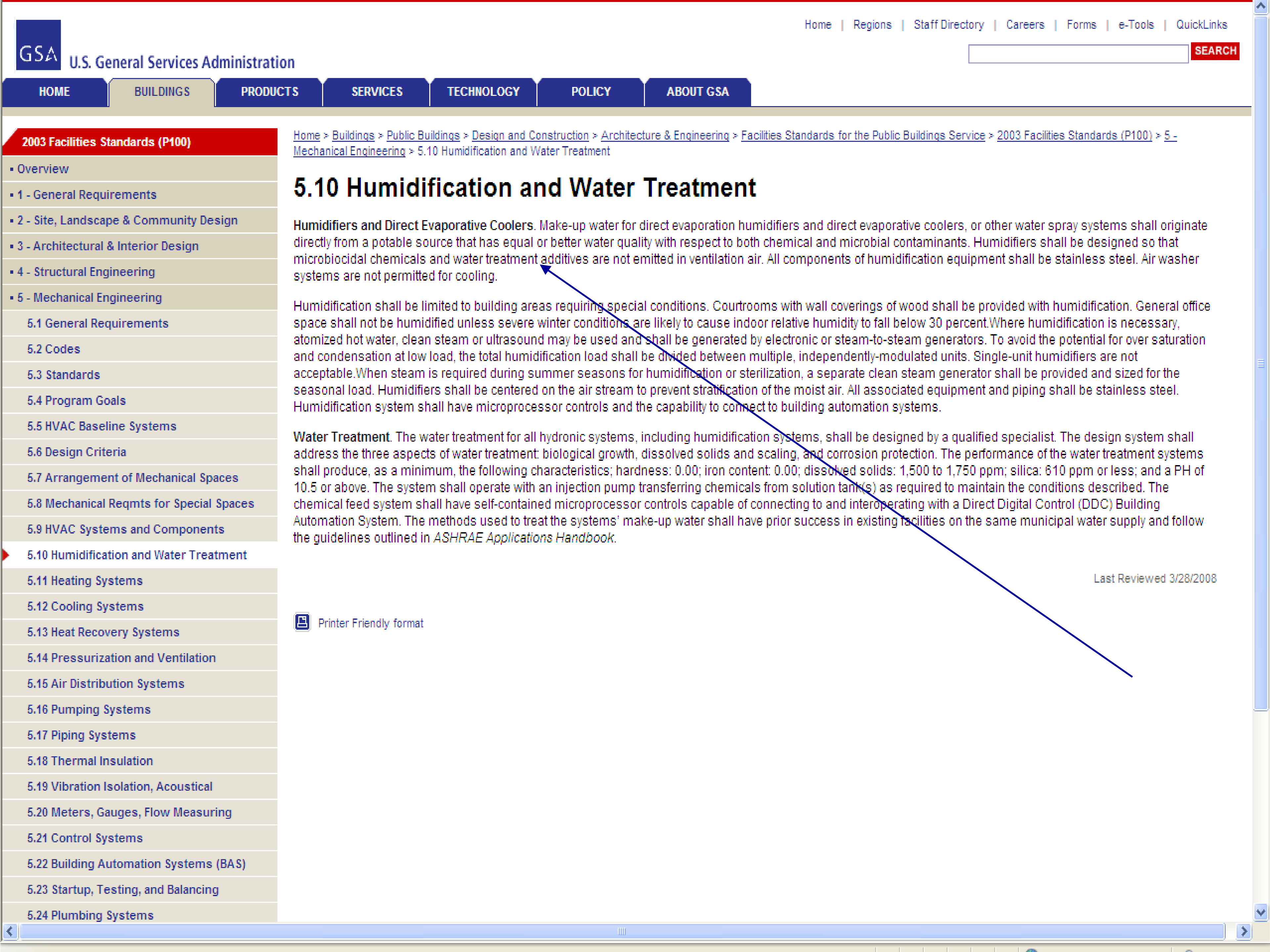
Chemically Treated Steam

DRISTEEM


Condensate
Steam
Feedwater
Return Water
Boiler
City Water

Step 3: Determine if Chemically Treated Steam is Acceptable?

- Steam boilers with condensate return must protect piping with dangerous chemicals Sodium Sulfite, Sodium Hydroxide, Sodium Gluconate
- Chemicals in steam used for humidification will enter AHU air stream
- Scrutinize use in hospitals or museums



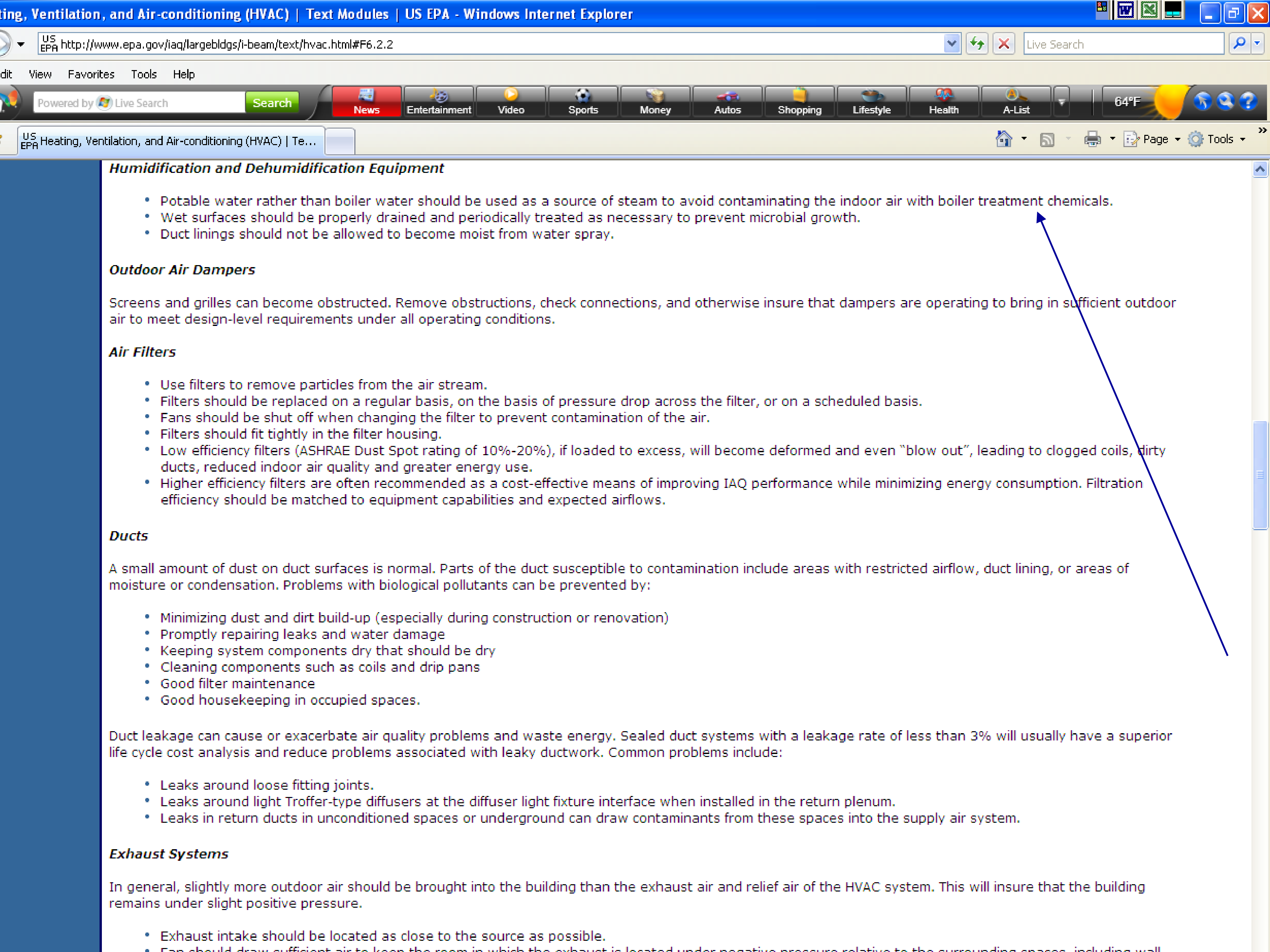
5.10 Humidification and Water Treatment

Humidifiers and Direct Evaporative Coolers. Make-up water for direct evaporation humidifiers and direct evaporative coolers, or other water spray systems shall originate directly from a potable source that has equal or better water quality with respect to both chemical and microbial contaminants. Humidifiers shall be designed so that microbiocidal chemicals and water treatment additives are not emitted in ventilation air. All components of humidification equipment shall be stainless steel. Air washer systems are not permitted for cooling.

Humidification shall be limited to building areas requiring special conditions. Courtrooms with wall coverings of wood shall be provided with humidification. General office space shall not be humidified unless severe winter conditions are likely to cause indoor relative humidity to fall below 30 percent.Where humidification is necessary, atomized hot water, clean steam or ultrasound may be used and shall be generated by electronic or steam-to-steam generators. To avoid the potential for over saturation and condensation at low load, the total humidification load shall be divided between multiple, independently-modulated units. Single-unit humidifiers are not acceptable.When steam is required during summer seasons for humidification or sterilization, a separate clean steam generator shall be provided and sized for the seasonal load. Humidifiers shall be centered on the air stream to prevent stratification of the moist air. All associated equipment and piping shall be stainless steel. Humidification system shall have microprocessor controls and the capability to connect to building automation systems.

Water Treatment. The water treatment for all hydronic systems, including humidification systems, shall be designed by a qualified specialist. The design system shall address the three aspects of water treatment: biological growth, dissolved solids and scaling, and corrosion protection. The performance of the water treatment systems shall produce, as a minimum, the following characteristics; hardness: 0.00; iron content: 0.00; dissolved solids: 1,500 to 1,750 ppm; silica: 610 ppm or less; and a PH of 10.5 or above. The system shall operate with an injection pump transferring chemicals from solution tank(s) as required to maintain the conditions described. The chemical feed system shall have self-contained microprocessor controls capable of connecting to and interoperating with a Direct Digital Control (DDC) Building Automation System. The methods used to treat the systems' make-up water shall have prior success in existing facilities on the same municipal water supply and follow the guidelines outlined in *ASHRAE Applications Handbook*.

Last Reviewed 3/28/2008



Humidification and Dehumidification Equipment

- Potable water rather than boiler water should be used as a source of steam to avoid contaminating the indoor air with boiler treatment chemicals.
- Wet surfaces should be properly drained and periodically treated as necessary to prevent microbial growth.
- Duct linings should not be allowed to become moist from water spray.

Outdoor Air Dampers

Screens and grilles can become obstructed. Remove obstructions, check connections, and otherwise insure that dampers are operating to bring in sufficient outdoor air to meet design-level requirements under all operating conditions.

Air Filters

- Use filters to remove particles from the air stream.
- Filters should be replaced on a regular basis, on the basis of pressure drop across the filter, or on a scheduled basis.
- Fans should be shut off when changing the filter to prevent contamination of the air.
- Filters should fit tightly in the filter housing.
- Low efficiency filters (ASHRAE Dust Spot rating of 10%-20%), if loaded to excess, will become deformed and even "blow out", leading to clogged coils, dirty ducts, reduced indoor air quality and greater energy use.
- Higher efficiency filters are often recommended as a cost-effective means of improving IAQ performance while minimizing energy consumption. Filtration efficiency should be matched to equipment capabilities and expected airflows.

Ducts

A small amount of dust on duct surfaces is normal. Parts of the duct susceptible to contamination include areas with restricted airflow, duct lining, or areas of moisture or condensation. Problems with biological pollutants can be prevented by:

- Minimizing dust and dirt build-up (especially during construction or renovation)
- Promptly repairing leaks and water damage
- Keeping system components dry that should be dry
- Cleaning components such as coils and drip pans
- Good filter maintenance
- Good housekeeping in occupied spaces.

Duct leakage can cause or exacerbate air quality problems and waste energy. Sealed duct systems with a leakage rate of less than 3% will usually have a superior life cycle cost analysis and reduce problems associated with leaky ductwork. Common problems include:

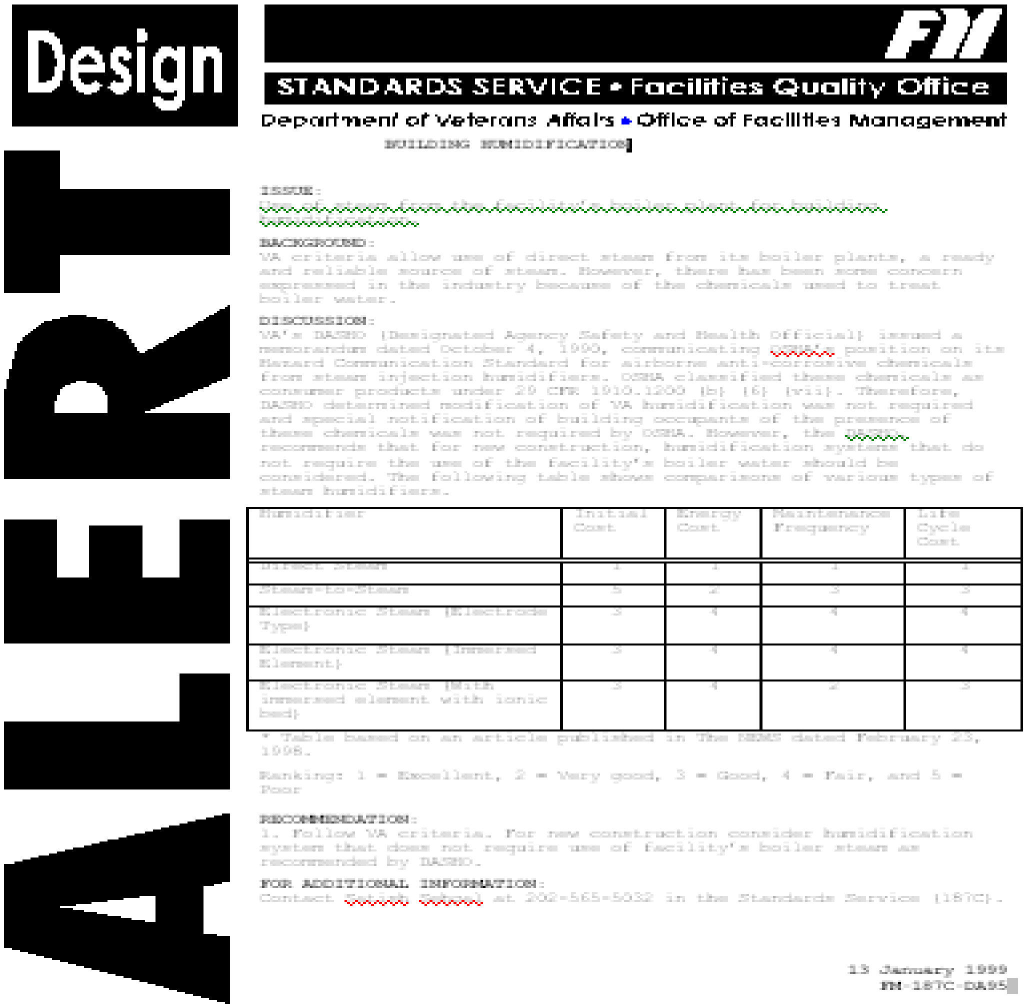
- Leaks around loose fitting joints.
- Leaks around light Troffer-type diffusers at the diffuser light fixture interface when installed in the return plenum.
- Leaks in return ducts in unconditioned spaces or underground can draw contaminants from these spaces into the supply air system.

Exhaust Systems

In general, slightly more outdoor air should be brought into the building than the exhaust air and relief air of the HVAC system. This will insure that the building remains under slight positive pressure.

- Exhaust intake should be located as close to the source as possible.
- Fan should draw sufficient air to keep the room in which the exhaust is located under negative pressure relative to the surrounding spaces, including wall

VA Standard



STANDARDS SERVICE • Facilities Quality Office

Department of Veterans Affairs • Office of Facilities Management

BUILDING HUMIDIFICATION

ISSUE:
Use of steam from the facility's boiler plant for building humidification.

BACKGROUND:
VA criteria allow use of direct steam from its boiler plants, a ready and reliable source of steam. However, there has been some concern expressed in the industry because of the chemicals used to treat boiler water.

DISCUSSION:
VA's DASHO (Designated Agency Safety and Health Official) issued a memorandum dated October 4, 1990, communicating OSHA's position on its Hazard Communication Standard for airborne anti-corrosive chemicals from steam injection humidifiers. OSHA classified these chemicals as consumer products under 29 CFR 1910.1200 (b) (6) (vii). Therefore, DASHO determined modification of VA humidification was not required and special notification of building occupants of the presence of these chemicals was not required by OSHA. However, the DASHO recommends that for new construction, humidification systems that do not require the use of the facility's boiler water should be considered. The following table shows comparisons of various types of steam humidifiers.

Humidifier	Initial Cost	Energy Cost	Maintenance Frequency	Life Cycle Cost
Direct Steam	1	1	1	1
Steam-to-Steam	5	2	3	3
Electronic Steam (Electrode Type)	3	4	4	4
Electronic Steam (Immersed Element)	3	4	4	4
Electronic Steam (With immersed element with ionic bed)	3	4	2	3

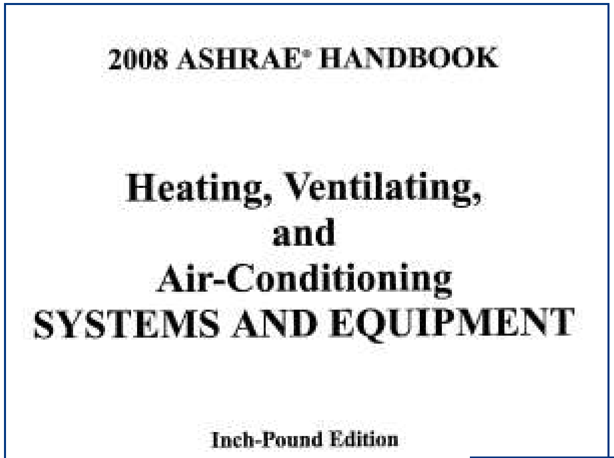
* Table based on an article published in The NEWS dated February 23, 1998.

Ranking: 1 = Excellent, 2 = Very good, 3 = Good, 4 = Fair, and 5 = Poor

RECOMMENDATION:
1. Follow VA criteria. For new construction consider humidification system that does not require use of facility's boiler steam as recommended by DASHO.

FOR ADDITIONAL INFORMATION:
Contact Satish Sehgal at 202-565-5032 in the Standards Service (187C).

13 January 1999
FM-187C-DA95

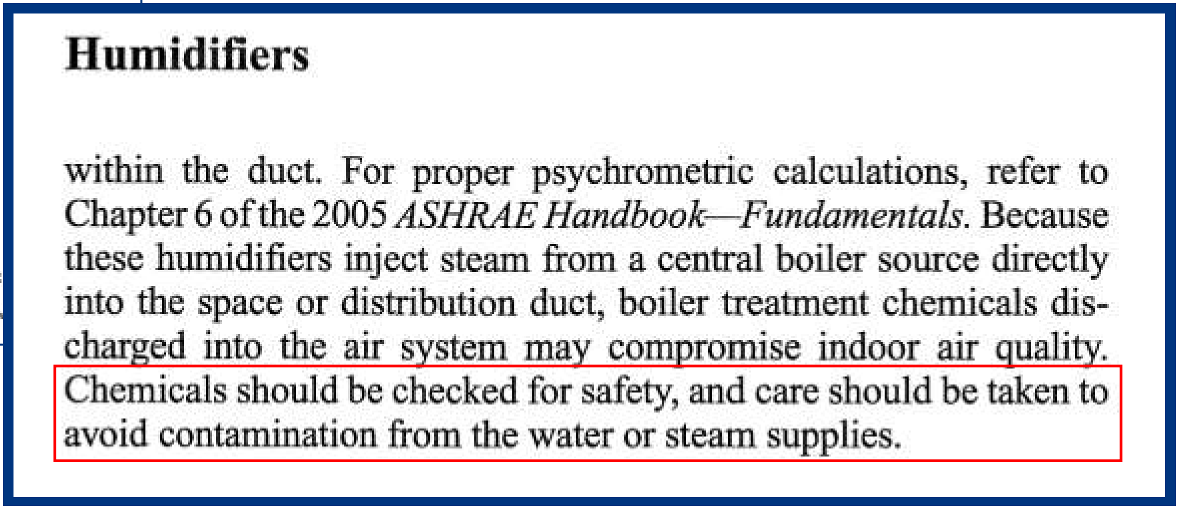


2008 ASHRAE® HANDBOOK

Heating, Ventilating,
and
Air-Conditioning
SYSTEMS AND EQUIPMENT

Inch-Pound Edition

American Society of Heating, Refrigerating and Air-Conditioning
1791 Tullie Circle, N.E., Atlanta, GA 30329
(404) 636-8400 http://ww

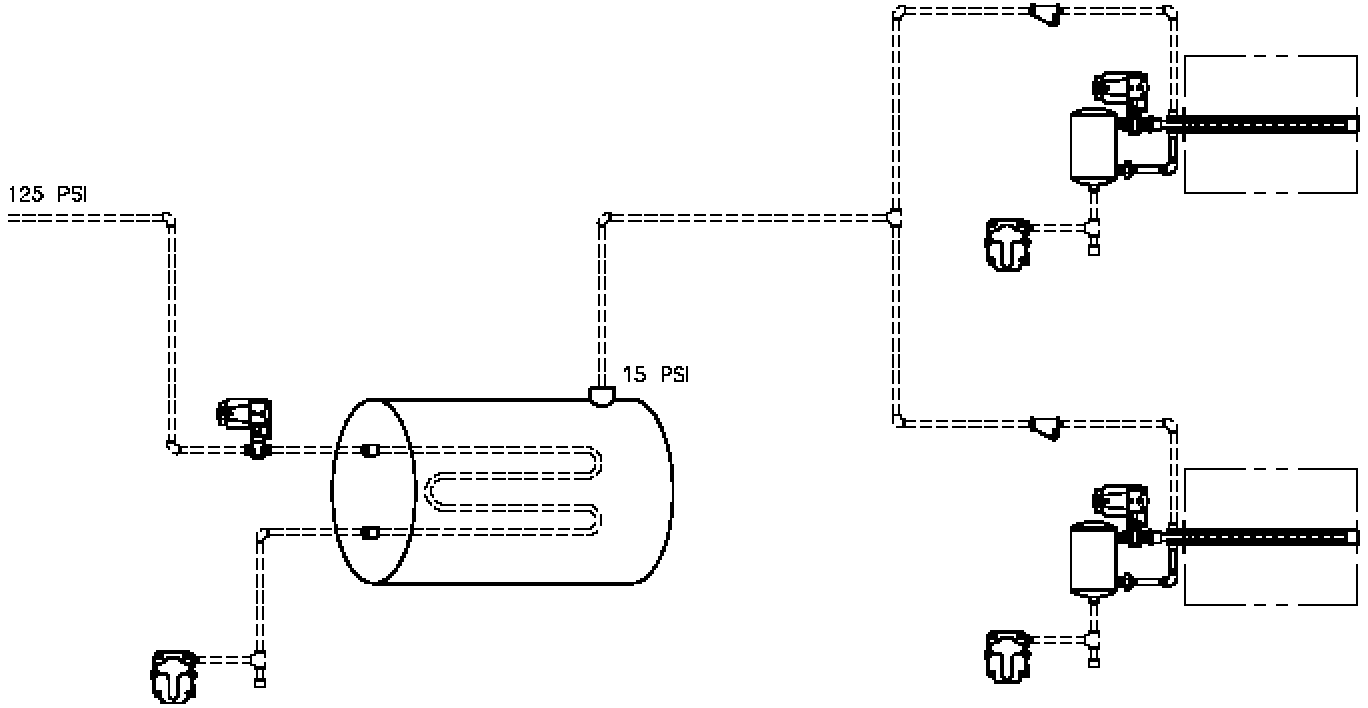


Humidifiers

within the duct. For proper psychrometric calculations, refer to Chapter 6 of the 2005 *ASHRAE Handbook—Fundamentals*. Because these humidifiers inject steam from a central boiler source directly into the space or distribution duct, boiler treatment chemicals discharged into the air system may compromise indoor air quality. Chemicals should be checked for safety, and care should be taken to avoid contamination from the water or steam supplies.

CONFIDENTIAL

DATE	REV	RECORD	DR
4/07	A	SUBMITTAL	CH



STEAM INJECTION SYSTEM

DM-6369

DRISTEEM®

MAT'L:

SCALE: 1:20

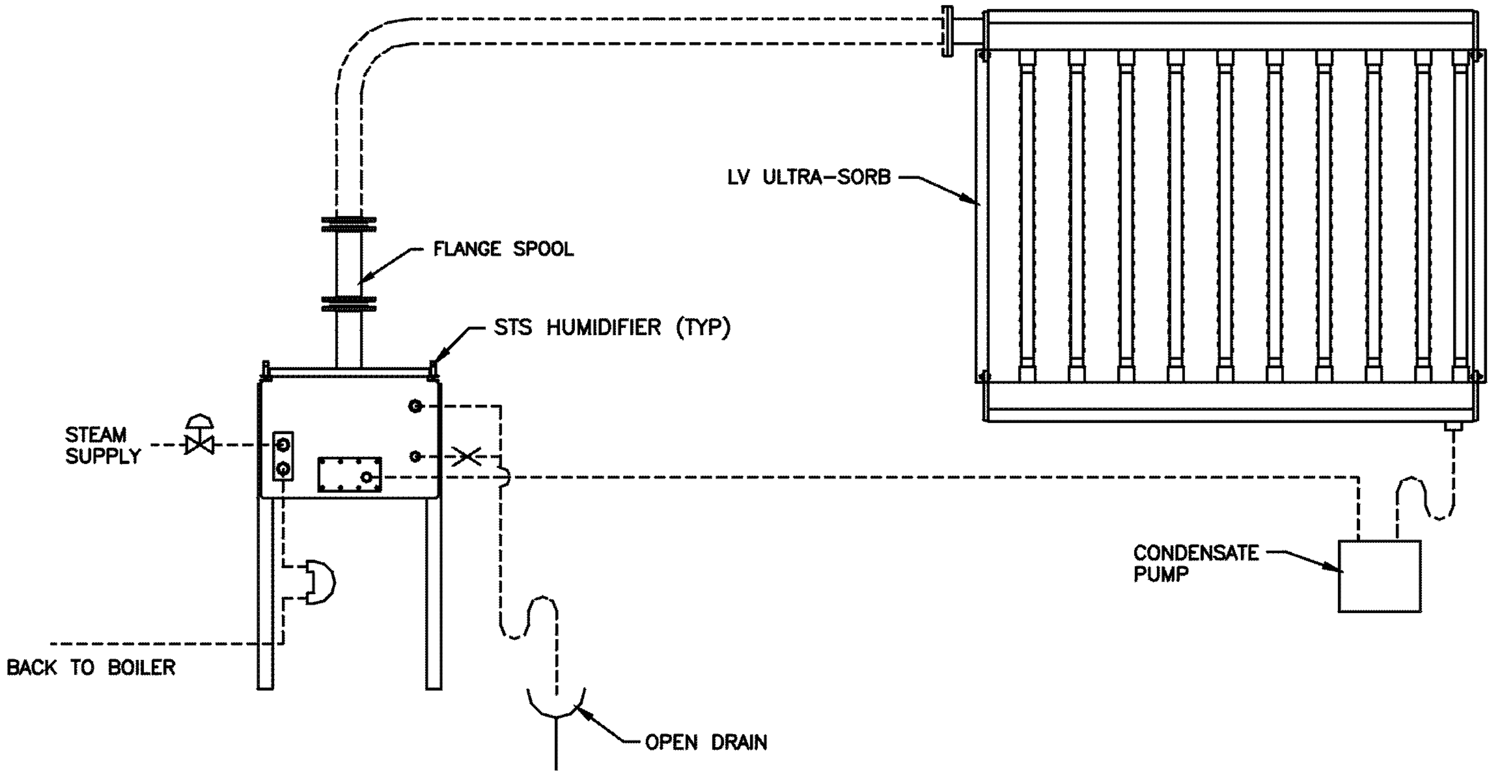
DRAWN BY: CH

DATE: 4/4/07

P/N: DM-6369

Steam Heat Exchanger

Caution: Limit One Per AHU

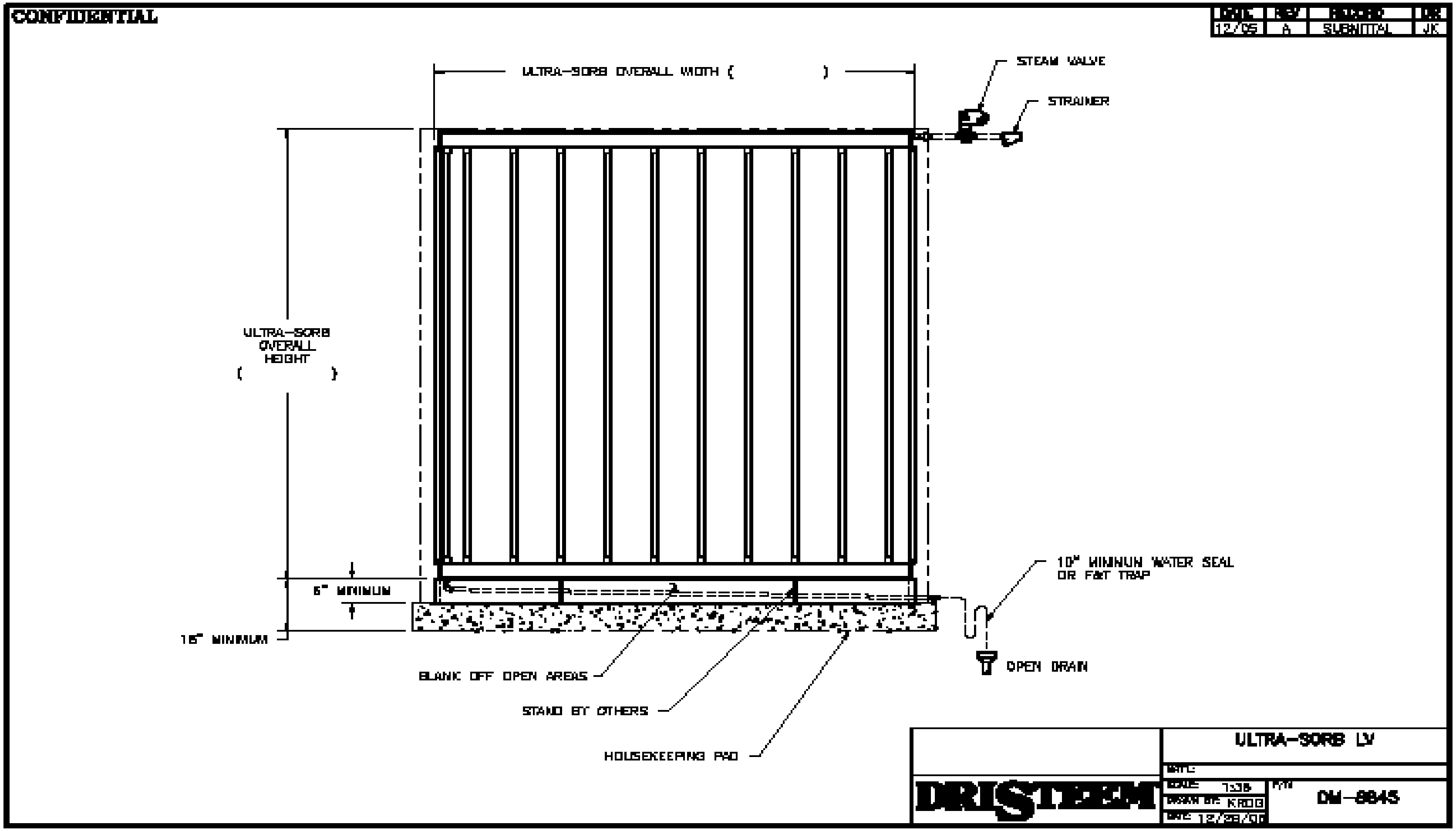


Step 5:

Condensate Management

DRISTEEM

Non-Jacketed Rapid Absorption


CONFIDENTIAL
DATE
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A
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JK
ULTRA-SORB OVERALL WIDTH ( )
STEAM VALVE
STRAINER
ULTRA-SORB
OVERALL
HEIGHT
( )
6" MINIMUM
18" MINIMUM
10" MINIMUN WATER SEAL
OR F&T TRAP
OPEN DRAIN
BLANK OFF OPEN AREAS
STAND BY OTHERS
HOUSEKEEPING PAD
DRISTEEM
ULTRA-SORB LV
TITLE:
SCALE: 1:36
DRAWN BY: KRDG
DATE: 12/28/00
P/N
DM-8845

Step 4: Condensate Management

- Reduce atmospheric condensate

Insulated Tubes

DRISTEEM®

High-efficiency Dispersion Tube Payback Estimator

Rev V1.3.11

City similar to your location New York, NY
Natural gas rate ($/1000Cu Ft=$/therm x 10) 9.5 $/1000 cu ft
Electric rate 10 Cents/kWh
Humidification Water rate $0.0300 Per gallon
Drain water cost $0.0200 Per gallon
District Steam rate $19.500 per 1000 Lb
504 FPM Feet Per Minute Airflow 25,000 CFM
% outdoor air 100%
Airflow temperature at dispersion panel 55 °F
Space temperature 70 °F
Space RH 35%
Drane-kooler™ Drane-kooler™ used
System type Ultra-sorb® (dual header dispersion system)
lanually select tube count 26 Tubes - Manual Entry
Dispersion tube spacing 3 Inches on center
Select tube size 1.5 Inches
Steam generator actual total steam capacity 475 Lbs/Hr ■
ASHRAE min for New York, NY is 484 lbs/hr
Tube length per tube 84 Inches
Enter active duct width 84 Inches
Select "New" or "Retrofit" New: Insulation option only
To manually set humidifier run time, select 3,900 Hrs/Yr

To estimate payback by investing in DRI-STEEM High-efficiency dispersion tubes, enter the appropriate information in the drop-down boxes. Additional parameters located on the "Config" tab

The estimator generates gas & electric paybacks based on TMY2* weather data for the selected region. It estimates modulated control run hours and shows the results in the lower left.

To analyze the investment based on run hours other than estimated from the TMY2 data, manually select run hours in the bottom drop-down box. Manual results are shown on the bottom right.

Notes:

- Accumulates water, cooling and vaporization expenses associated with humidifying ventilation air only
- Minimum modulation rate - fixed 6%
- Colored blocks & text highlight potential issues. Verify entry and disregard highlight if entered correct for your application.
- For proper calculation, verify that steam capacity, number of tubes, airflow, temperatures and dimensions are accurate.

Prepared for: Bellevue Hospital NYU Brain

Unit serial #: 1103290

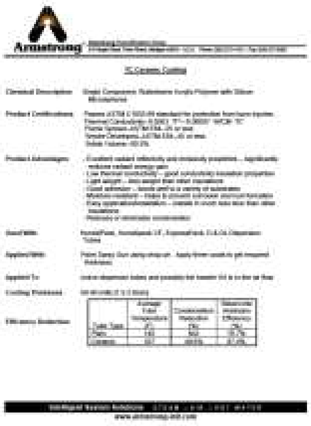
Estimated Insulation Option Payback

Based on TMY2 data using 3885 run hours:			Using manually entered 3900 run hours:	
$9,452 Per Year	0.37 Years	Electric	0.37 Years	$9,488 Per Year
$5,289 Per Year	0.67 Years	Gas	0.67 Years	$5,309 Per Year
$6,370 Per Year	0.56 Years	District Steam	0.56 Years	$6,394 Per Year
50,466 Gallons/yr saved! $2,271 Per Year 54 lbs steam & 53,022 btu/hr saved!		Water	50,662 Gallons/yr saved! $2,280 Per Year 54 lbs steam & 53,228 btu/hr saved!	
Electric = 92,992 lbs CO2/yr Gas = 28,692 lbs CO2/yr		Carbon Dioxide Reductions	Electric = 93,353 lbs CO2/yr Gas = 28,803 lbs CO2/yr	

Tube induced duct heat gain: 1.1 °F Insulated 3.4 °F Uninsulated

Approximate Insulation Option Price (includes optional costs) $3,558

Various Methods To Reduce Condensate and Heat Gain



Performance Differences

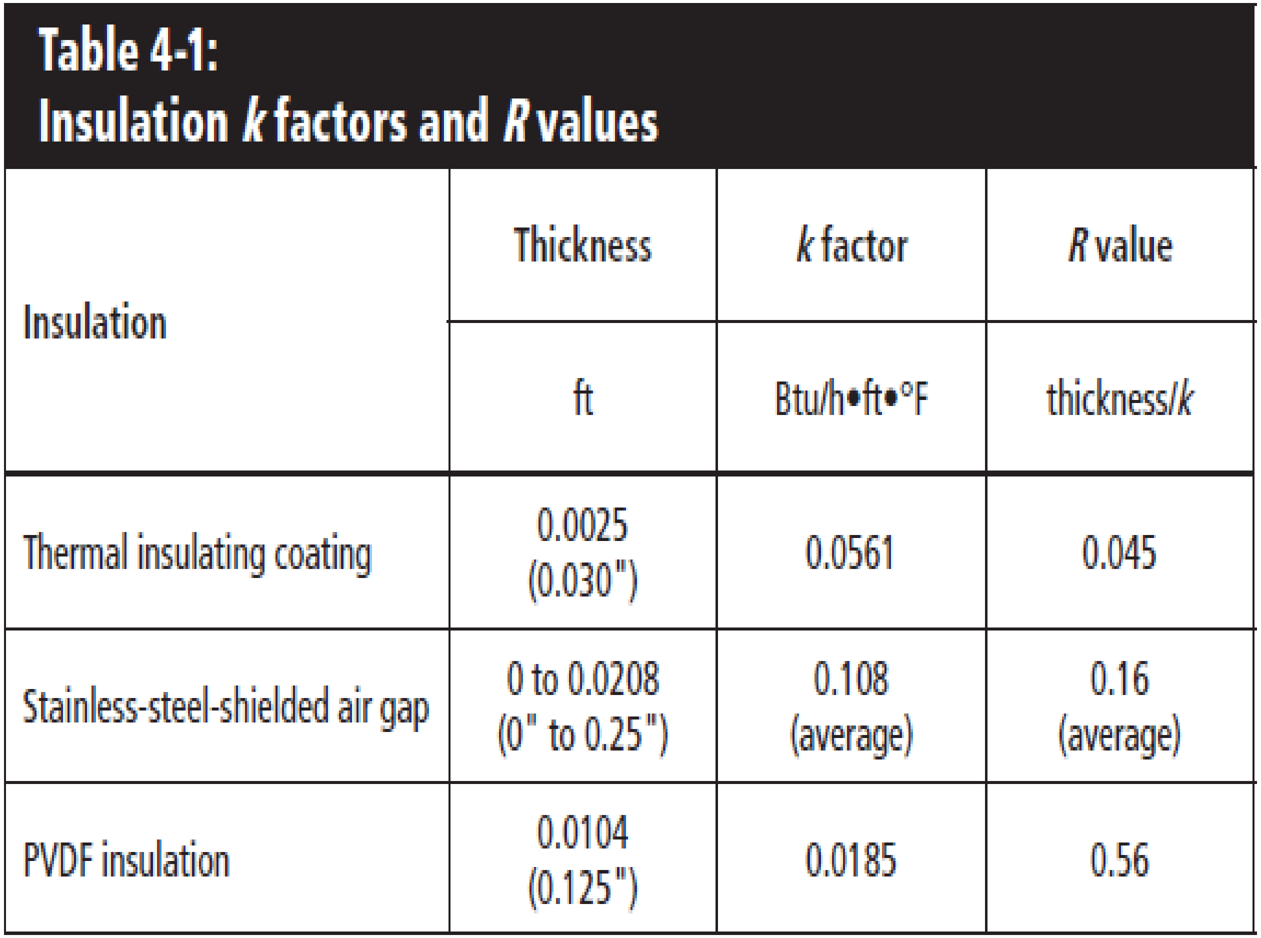


Table 4-1:
Insulation *k* factors and *R* values

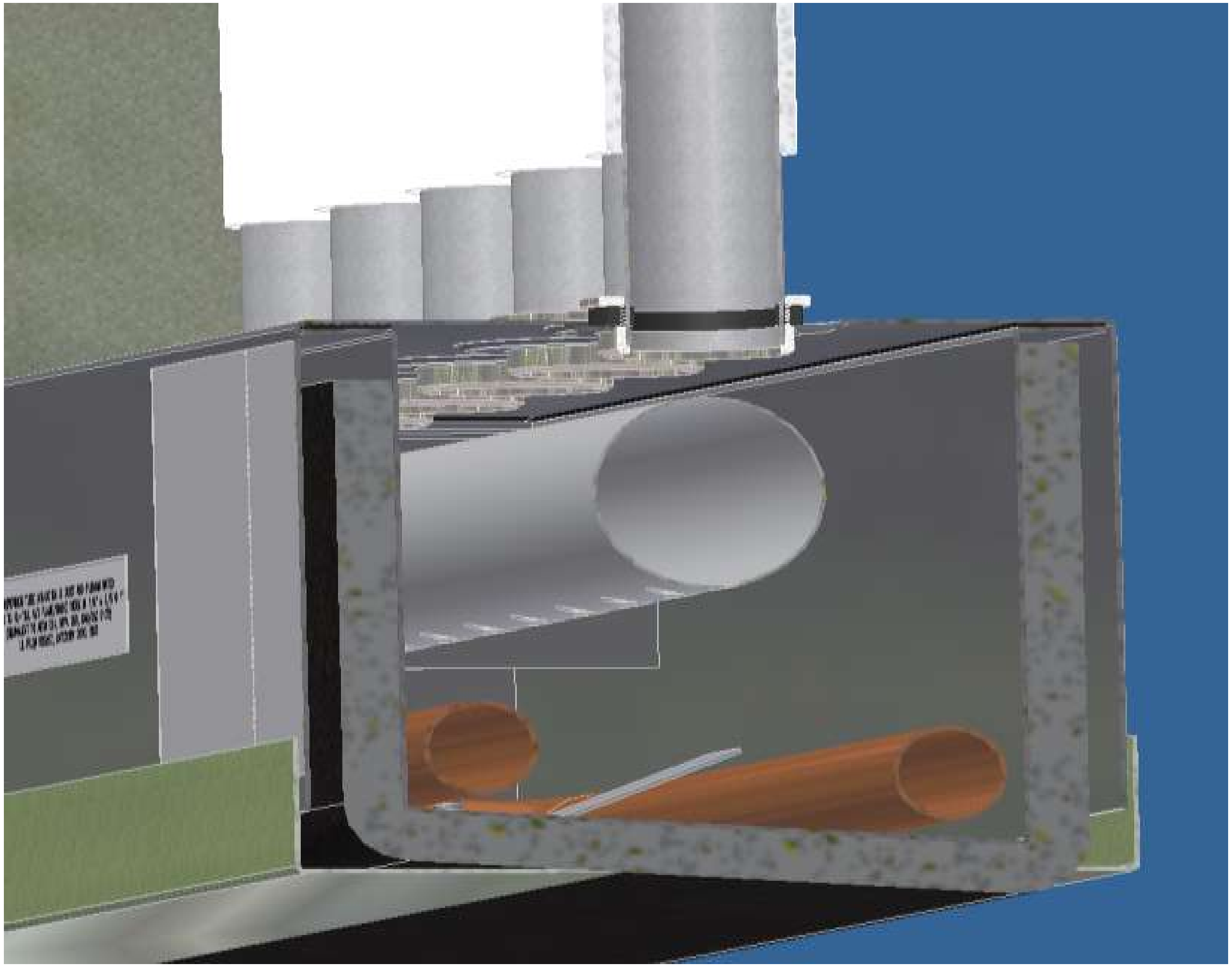
Insulation	Thickness	*k* factor	*R* value
	ft	Btu/h•ft•°F	thickness/*k*
Thermal insulating coating	0.0025 (0.030")	0.0561	0.045
Stainless-steel-shielded air gap	0 to 0.0208 (0" to 0.25")	0.108 (average)	0.16 (average)
PVDF insulation	0.0104 (0.125")	0.0185	0.56

Condensate Management

- No atmospheric condensate-return to LPR

Steam Injection Humidifiers

End View Cut-Away



Step 6:

Define Control Requirement

DRISTEEM

Step 6: Define Humidifier Accuracy

- Based on air changes per hour and RH accuracy requirement
- Standard humidifier will maintain +/- 3% with 2-10 air changes per hour

Humidifier Accuracy

- +/- 1% accuracy with high number of air changes is possible with:
- Pressurized steam controlled by steam valve with adequate turndown
- Resistive electric humidifier with DI/RO water and SSR controller- NOT ELECTRODE TYPE

Define Humidifier Accuracy

- DI/RO makeup water
- Eliminates interruption of boiling due to large amount of cold make up water
- Eliminates unscheduled maintenance or unit failure due to Calcium and Magnesium accumulation

Step 7:

Make Up Water

DRISTEEM

Determine Water Source

- Will there be maintenance

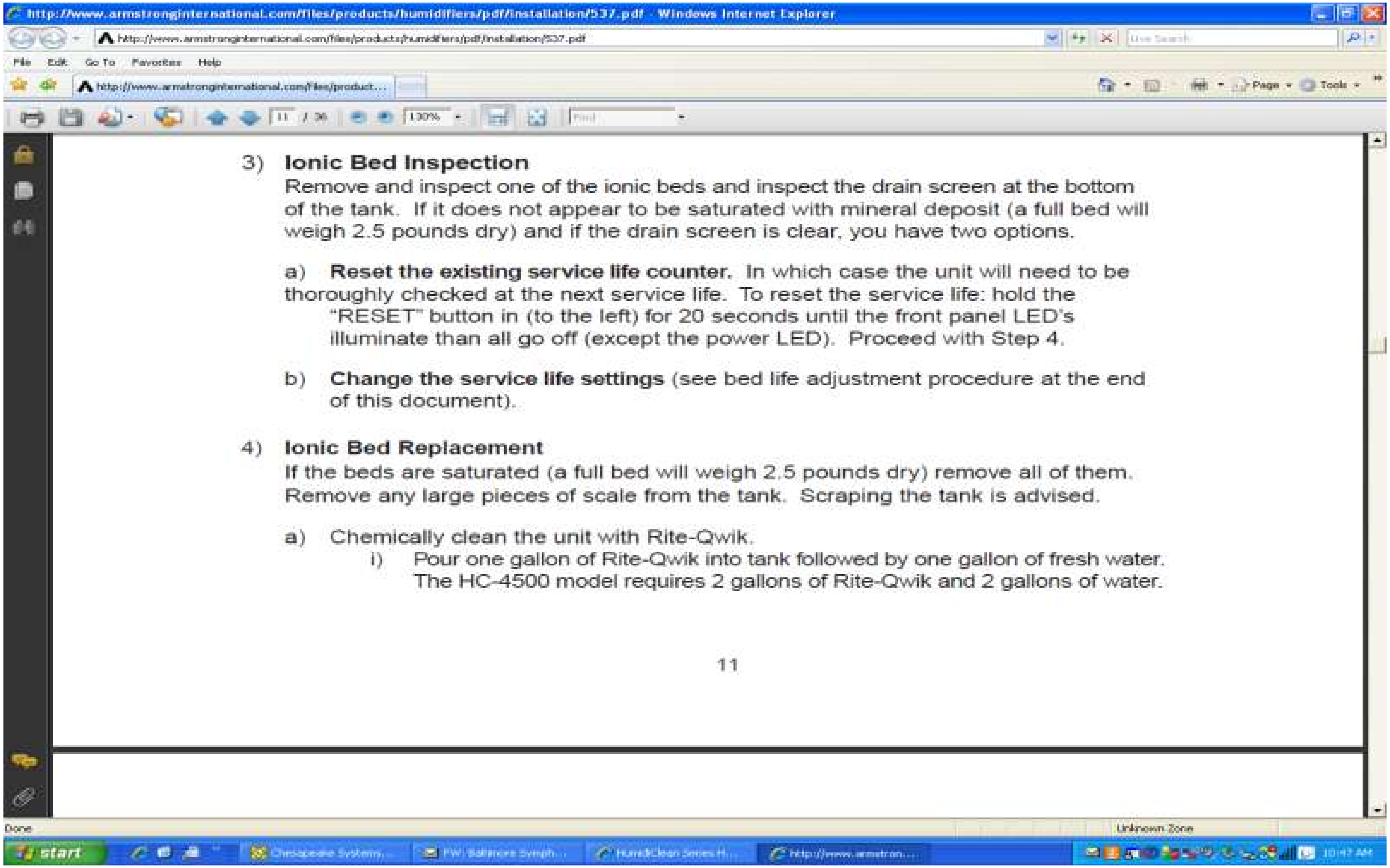
Impact of Make Up Water

Impact of Make Up Water

Determine Water Source

- Anti-Foaming
- Ionic beds
- Softened water
- Skimmer + periodic drain

Ionic Bed Maintenance



3) **Ionic Bed Inspection**
Remove and inspect one of the ionic beds and inspect the drain screen at the bottom of the tank. If it does not appear to be saturated with mineral deposit (a full bed will weigh 2.5 pounds dry) and if the drain screen is clear, you have two options.

a) **Reset the existing service life counter.** In which case the unit will need to be thoroughly checked at the next service life. To reset the service life: hold the "RESET" button in (to the left) for 20 seconds until the front panel LED's illuminate than all go off (except the power LED). Proceed with Step 4.

b) **Change the service life settings** (see bed life adjustment procedure at the end of this document).

4) **Ionic Bed Replacement**
If the beds are saturated (a full bed will weigh 2.5 pounds dry) remove all of them. Remove any large pieces of scale from the tank. Scraping the tank is advised.

a) Chemically clean the unit with Rite-Qwik.
   i) Pour one gallon of Rite-Qwik into tank followed by one gallon of fresh water. The HC-4500 model requires 2 gallons of Rite-Qwik and 2 gallons of water.

11

Determine Water Source

- Softened water for cylinder life

Determine Water Source

- DI makeup water system must be properly maintained by end user or system will generate Chlorides


DRISTEEM
658

Step 8:

Control System Consideration

Step 8: Control System Consideration

- Sensor placement
- VAV
- Primary/secondary
- Heat Gain from Humidifier Dispersion
- PID Loop/Modulating Duct High Limit
- Window dew point control

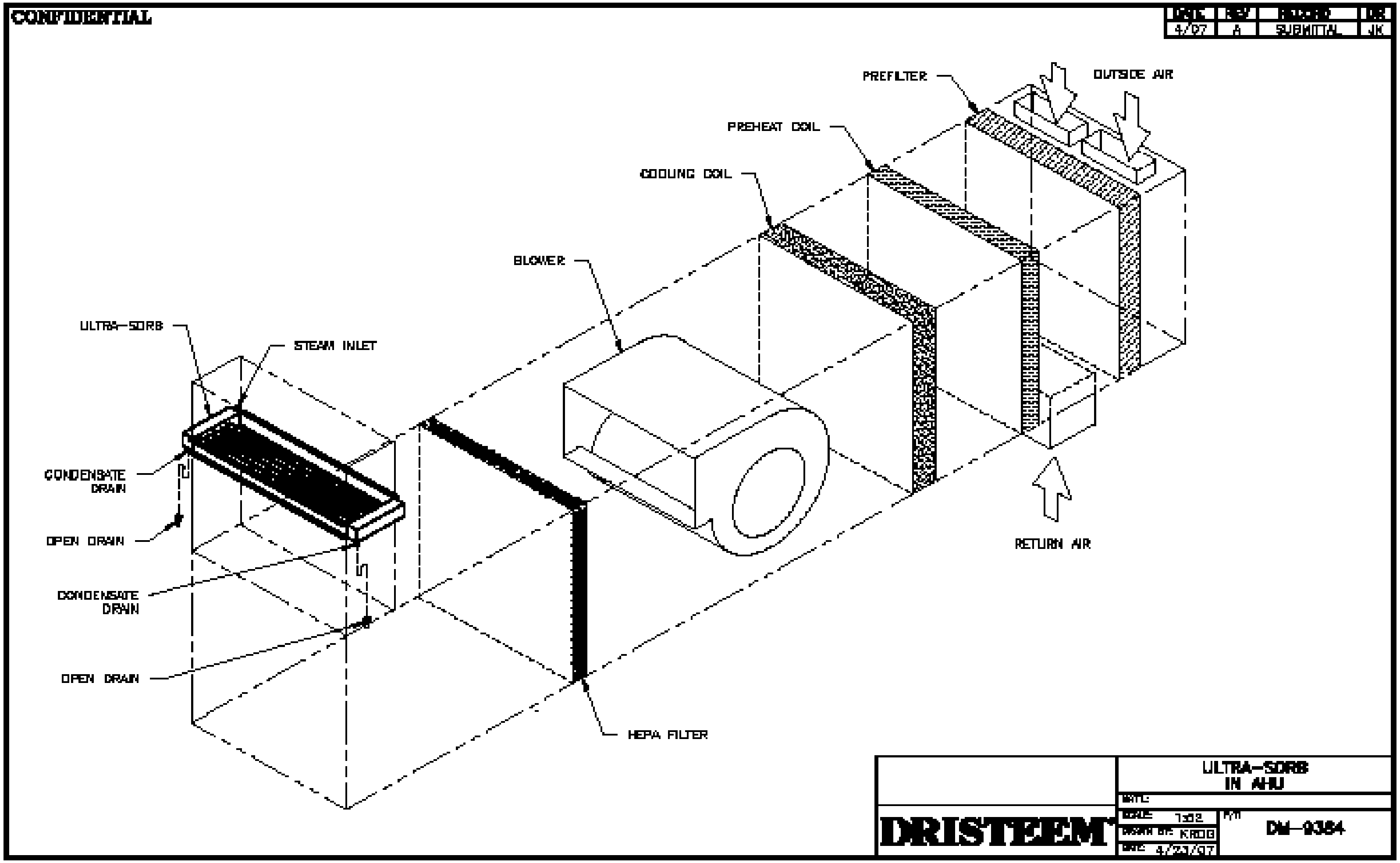
Sensor Placement

- Return Air for space monitoring
- Caution with high temp supply duct

Variable Air Volume

- Impacts ability to deliver humidified air at terminal unit
- Impacts ability to introduce moisture in AHU air stream

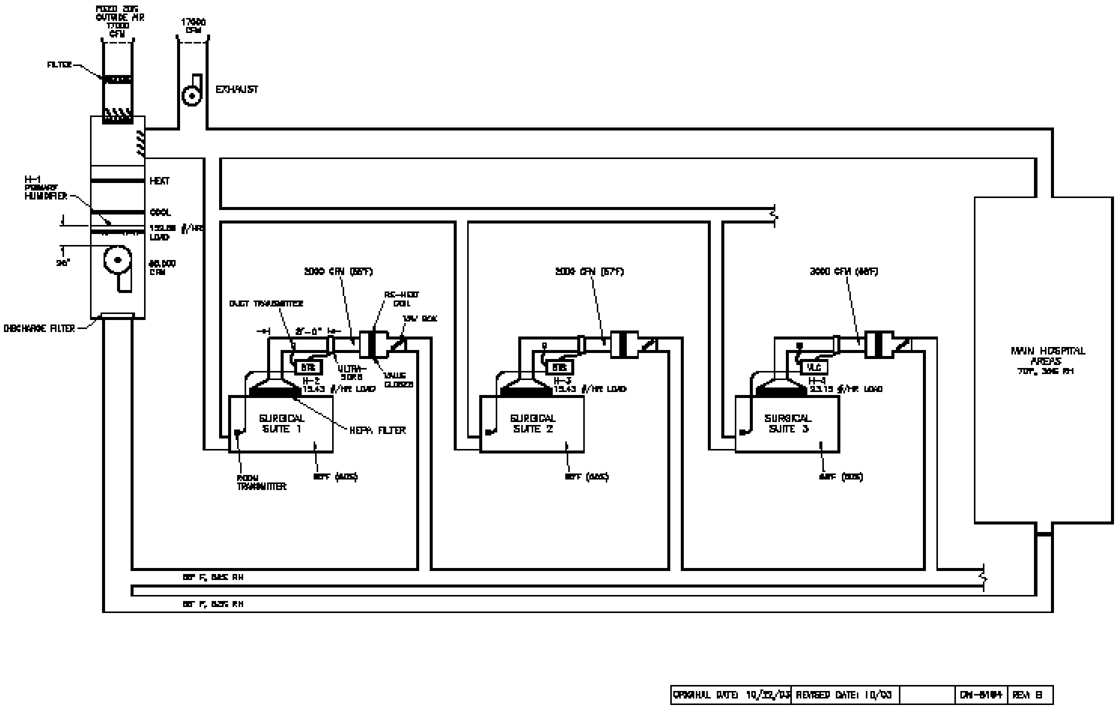
Variable Air Volume



Primary and Secondary/Trim System

- Often hospitals with diverse zones served by single AHU

Primary and Secondary/Trim



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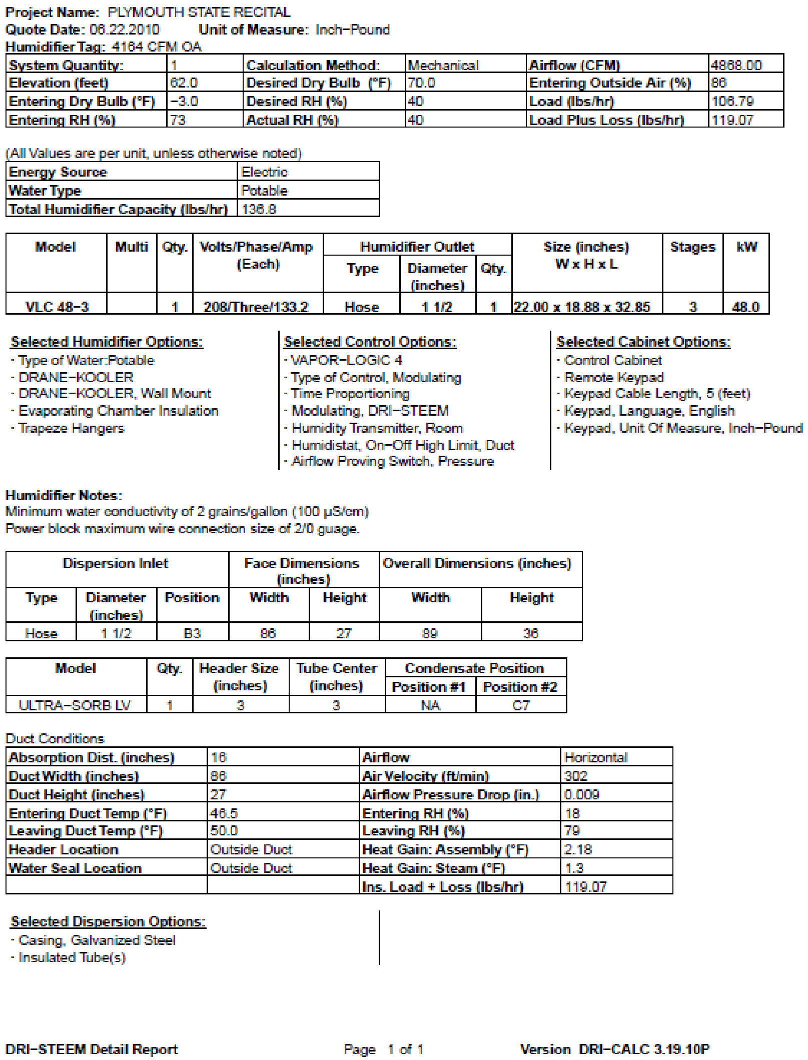
Primary and Secondary/Trim

- Interlock secondary trim humidifiers with reheat coils

Heat Gain from Dispersion



Project Name: PLYMOUTH STATE RECITAL
Quote Date: 06.22.2010 **Unit of Measure:** Inch−Pound
Humidifier Tag: 4164 CFM OA

System Quantity:	1	**Calculation Method:**	Mechanical	**Airflow (CFM)**	4868.00
Elevation (feet)	62.0	**Desired Dry Bulb (°F)**	70.0	**Entering Outside Air (%)**	86
Entering Dry Bulb (°F)	−3.0	**Desired RH (%)**	40	**Load (lbs/hr)**	106.79
Entering RH (%)	73	**Actual RH (%)**	40	**Load Plus Loss (lbs/hr)**	119.07

(All Values are per unit, unless otherwise noted)

Energy Source	Electric
Water Type	Potable
Total Humidifier Capacity (lbs/hr)	136.8

Model	Multi	Qty.	Volts/Phase/Amp (Each)	Humidifier Outlet			Size (inches) W x H x L	Stages	kW
				Type	Diameter (inches)	Qty.			
VLC 48−3		1	208/Three/133.2	Hose	1 1/2	1	22.00 x 18.88 x 32.85	3	48.0

Selected Humidifier Options:

- Type of Water:Potable
- DRANE−KOOLER
- DRANE−KOOLER, Wall Mount
- Evaporating Chamber Insulation
- Trapeze Hangers

Selected Control Options:

- VAPOR−LOGIC 4
- Type of Control, Modulating
- Time Proportioning
- Modulating, DRI−STEEM
- Humidity Transmitter, Room
- Humidistat, On−Off High Limit, Duct
- Airflow Proving Switch, Pressure

Selected Cabinet Options:

- Control Cabinet
- Remote Keypad
- Keypad Cable Length, 5 (feet)
- Keypad, Language, English
- Keypad, Unit Of Measure, Inch−Pound

Humidifier Notes:
Minimum water conductivity of 2 grains/gallon (100 µS/cm)
Power block maximum wire connection size of 2/0 guage.

Dispersion Inlet			Face Dimensions (inches)		Overall Dimensions (inches)	
Type	Diameter (inches)	Position	Width	Height	Width	Height
Hose	1 1/2	B3	86	27	89	36

Model	Qty.	Header Size (inches)	Tube Center (inches)	Condensate Position	
				Position #1	Position #2
ULTRA−SORB LV	1	3	3	NA	C7

Duct Conditions

Absorption Dist. (inches)	16	**Airflow**	Horizontal
Duct Width (inches)	86	**Air Velocity (ft/min)**	302
Duct Height (inches)	27	**Airflow Pressure Drop (in.)**	0.009
Entering Duct Temp (°F)	46.5	**Entering RH (%)**	18
Leaving Duct Temp (°F)	50.0	**Leaving RH (%)**	79
Header Location	Outside Duct	**Heat Gain: Assembly (°F)**	2.18
Water Seal Location	Outside Duct	**Heat Gain: Steam (°F)**	1.3
		Ins. Load + Loss (lbs/hr)	119.07

Selected Dispersion Options:

- Casing, Galvanized Steel
- Insulated Tube(s)

DRI−STEEM Detail Report Page 1 of 1 **Version DRI−CALC 3.19.10P**

Step 9:

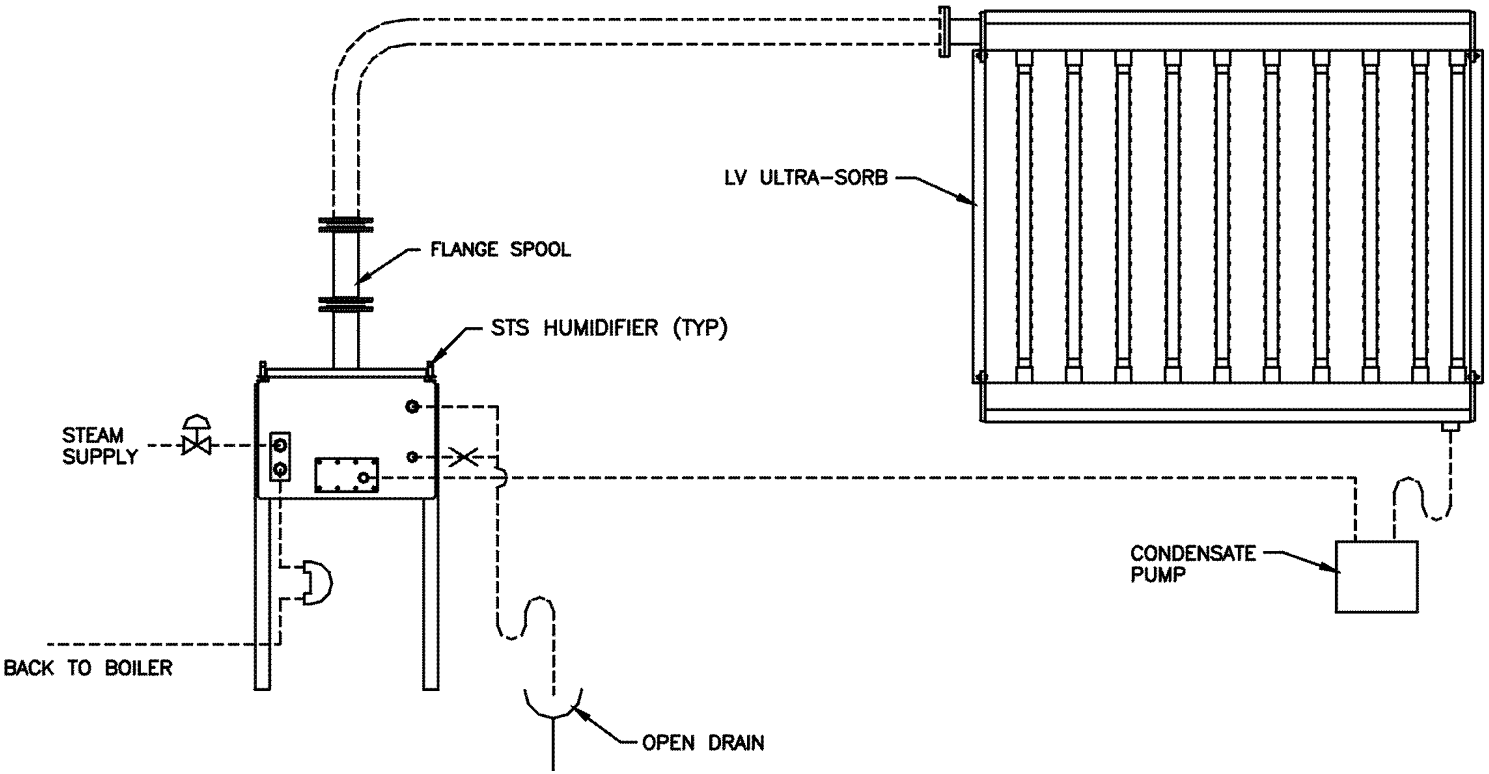
Humidifier Tank Location

DRISTEEM

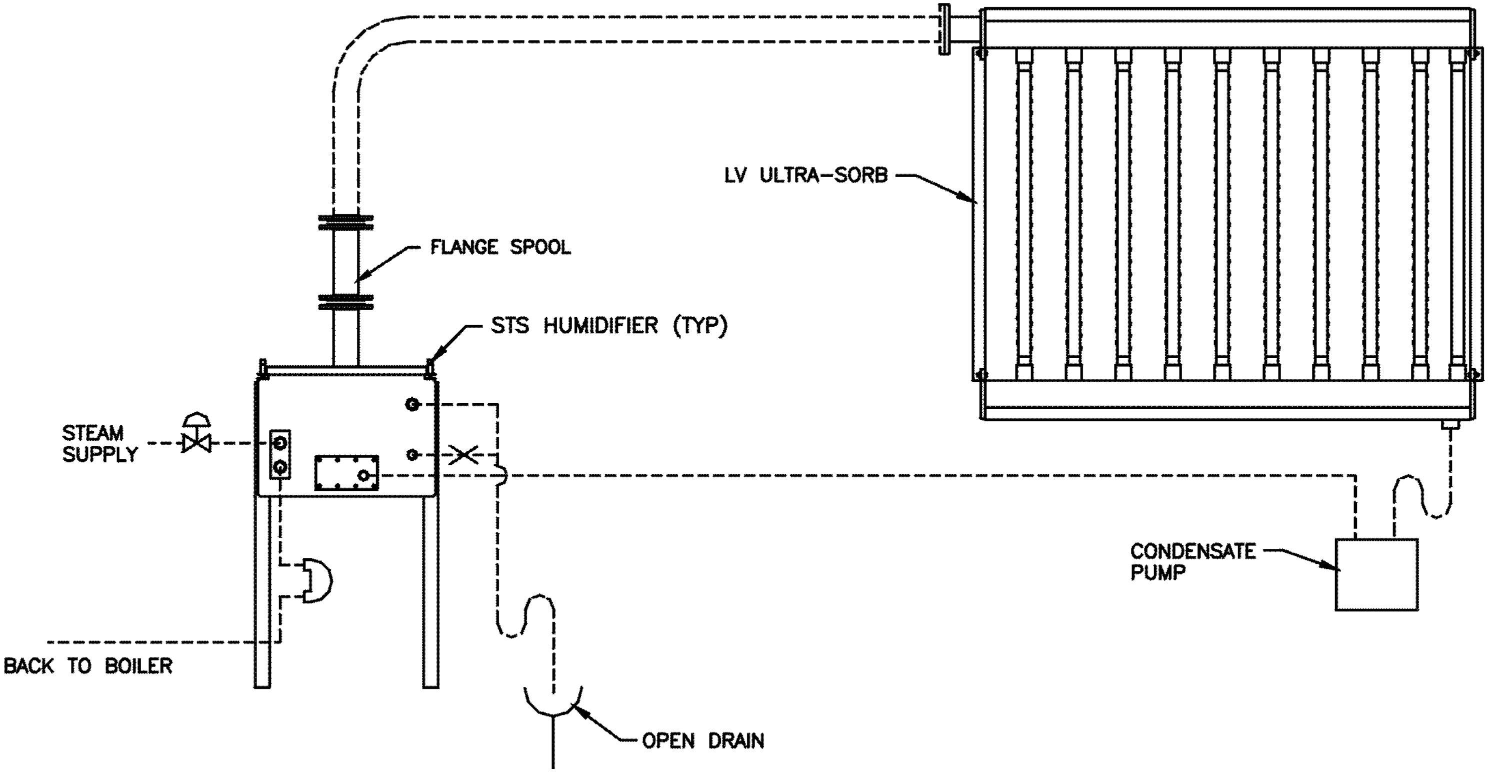
Step 9: Determine Humidifier Placement

- Access for maintenance
- Floor vs. Ceiling

Maximum100 ft. with proper steam supply sizing



Consider condensate from tank & dispersion



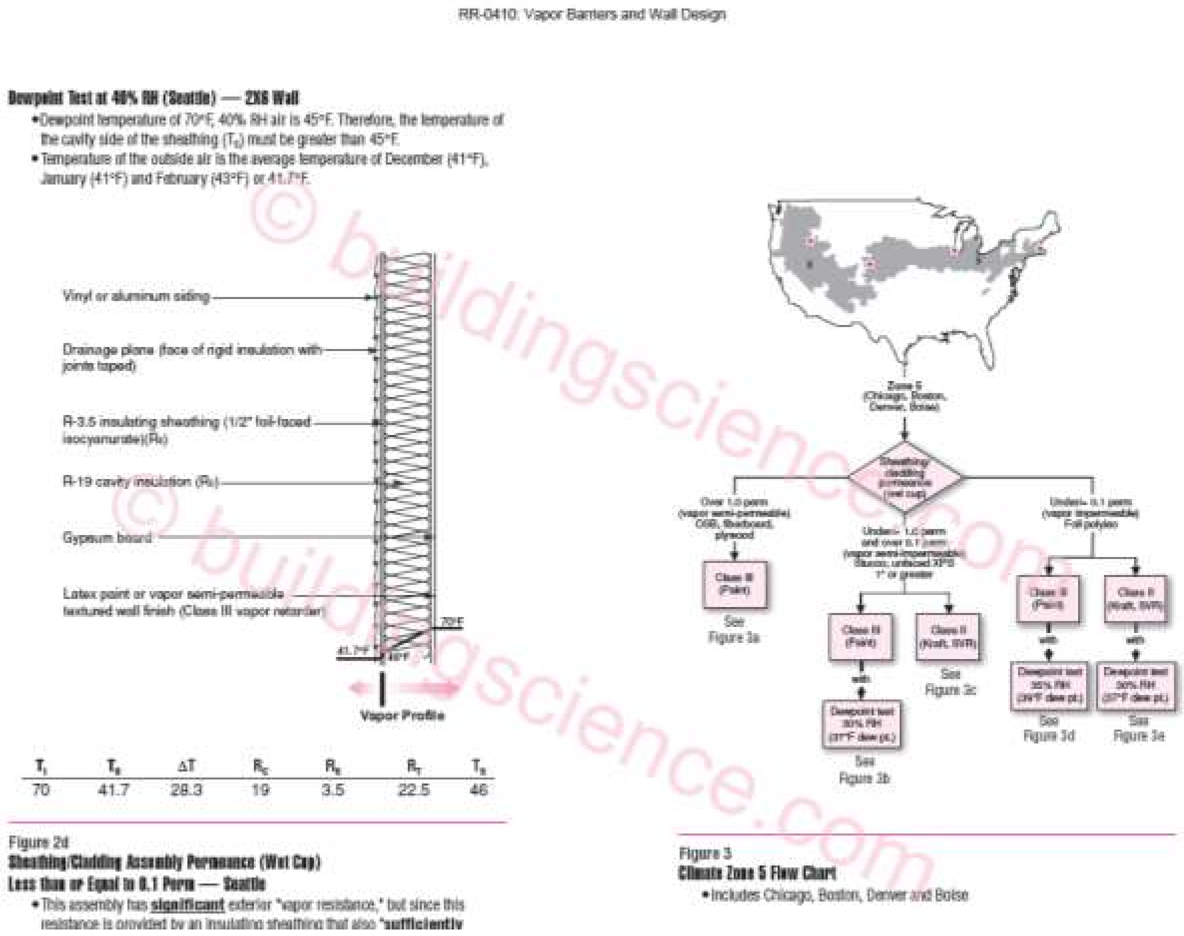
Step 10:

Review Building Construction

Step 10: Review Building Construction

- Vapor barrier
- Windows
- Roof decking
- Dock doors

Vapor Barrier



RR-0410: Vapor Barriers and Wall Design

Dewpoint Test at 40% RH (Seattle) — 2X6 Wall

- Dewpoint temperature of 70°F, 40% RH air is 45°F. Therefore, the temperature of the cavity side of the sheathing (T_s) must be greater than 45°F.
- Temperature of the outside air is the average temperature of December (41°F), January (41°F) and February (43°F) or 41.7°F.

T_1	T_0	ΔT	R_c	R_s	R_T	T_s
70	41.7	28.3	19	3.5	22.5	46

Figure 2d
Sheathing/Cladding Assembly Permeance (Wet Cup)
Less than or Equal to 0.1 Perm — Seattle

- This assembly has **significant** exterior "vapor resistance," but since this resistance is provided by an insulating sheathing that also "**sufficiently**

Figure 3
Climate Zone 5 Flow Chart

- Includes Chicago, Boston, Denver and Boise

Thank You