



THE OFFICIAL HANDBOOK • VERSION W – 1.0

INDUSTRY GUIDE FOR WOODWORKING, CABINETRY & FURNITURE MANUFACTURING

FANMIST LOAD CALCULATOR GUIDE — THE PRACTICAL METHOD

CONTENTS

01 Wood & Relative Humidity	3
02 Core Engineering Principles	4
03 Ventilation vs Infiltration	5
04 Required Building Data	6
05 The Psychrometric Table	7
06 The Practical Method	8
07 Woodworking Plant	9-10
08 Final System Capacity / Equipment	11-13
09 First Principles – Physical Laws	14
10 Quick Load Calculator Card	15
11 Appendix	16-19



1000 psi High-Pressure Misting System with High-Velocity Fans

THE OFFICIAL GUIDE — A NOTE ON SCOPE

This handbook is organized as a step-by-step guide of the general **Practical Method** in calculating for total load (moisture required) to maintain your desired standard for control during winter manufacturing operations (e.g. 40% RH @ 70°F).



THE FOUNDATION • PREFACE

INTRODUCTION

WHERE THE GUIDE BUILDS FROM

Herrmidifier Corporation has served as mentor and guardian of the principles that have guided much of the broader industry of industrial-scale humidity control since its beginnings in 1945, first laid out in its own publication, the *Herrmidifier Load Calculator Guide*. This first edition of the *FanMist Load Calculator Guide* follows and builds on the foundation Herrmidifier set before us.

THE THREE FOUNDATIONAL QUESTIONS

That foundation starts in the same place every humidity control project does: with three simple questions, whose answers determine everything that follows. How much cubic air is actually being humidified? How fast is that air turning over? And what is the desired relative humidity percentage to be maintained? Together, the answers to these three questions define the moisture load — the total moisture that must be added — and that single figure, expressed in pounds per hour, is the foundation everything else is built on.

PHYSICS AS COLLABORATOR

From there, physics coupled with engineering takes over. The natural laws governing water, air, and evaporation are fixed; they set the rules in advance. Humidification becomes less a battle against the air and more a well-tuned collaboration with it. The design principle behind this is not new. It's time-tested: pairing high air velocity with high-pressure water atomization for accelerated evaporation — the natural laws do most of the remaining work automatically.

SCOPE OF THIS GUIDE

At the core of this Guide are the foundational first principles which form “the practical method” which is presented for real-world facility applications — it is the primary path through every calculation in the pages that follow. Where the full Comprehensive Method adds meaningful precision — for example, unusually high product throughput or detailed engineering documentation, this guide references its critical points directly rather than requiring a second, separate document.

HOW THIS GUIDE IS ORGANIZED

This Guide is organized in the same order a real sizing project takes form — from the physical problem, to the numbers behind it, to a finished piece of equipment.

"That which has been is what will be, that which is done is what will be done, and there is nothing new under the sun."

— Ecclesiastes 1:9



CRITICAL CONTROL • SECTION 01

WOOD & RELATIVE HUMIDITY

WHAT IS RELATIVE HUMIDITY (RH)?

RH measures water vapor in the air as a percentage of the maximum amount of water the air can hold at the current temperature and pressure:

- 100% RH = fully saturated (dew or condensation forms).
- 0% RH = theoretically impossible in real atmospheres.
- 50% RH = air holds half its maximum moisture capacity.

WOOD PRODUCTS & THE CRITICAL ROLE OF RELATIVE HUMIDITY

Wood is hygroscopic — it naturally absorbs or releases moisture to reach equilibrium with the surrounding air. Stable RH prevents dimensional instability and boosts product quality, efficiency, and profitability in woodworking facilities.

Heated indoor air (68–72°F) in winter often reduces RH to dangerously low levels, extracting moisture from lumber and causing defects. Adding controlled humidity with a FanMist humidification system maintains 35–45% RH (up to 50% in some cases), stabilizing dimensions during machining, gluing, assembly, sanding, and finishing.

EQUILIBRIUM MOISTURE CONTENT (EMC) & WOOD STABILITY

EMC is the moisture content (% of oven-dry wood weight) at which wood neither gains nor loses moisture. It depends almost entirely on temperature and RH — species differences are less than 1% at 30–60% RH.

**TABLE 1-A
RELATIVE HUMIDITY %
& CORRESPONDING EMC %
(APPLIES TO ALL SPECIES)**

RH	EMC (%)
30%	6.2 – 6.3%
35%	6.9 – 7.1%
40%	7.7 – 7.9%
45%	8.5 – 8.7%
50%	9.2 – 9.5%

WINTER TARGET

35–45% RH @ 69–72°F keeps EMC in the safe 6.9–8.7% range (ideal 6.5–7.5%). This matches kiln-dried lumber and prevents:

- Cracking, checking, splitting
- Warping, cupping, bowing
- Glue-line failures and veneer delamination
- Gaps in doors and drawers
- Finishing defects and static electricity problems

RECOMMENDED PRACTICES FOR WOODWORKING HUMIDITY CONTROL

- Acclimate lumber and components to shop conditions before processing.
- Finish all surfaces to slow future moisture exchange.
- Monitor consistent EMC plant-wide — storage through warehouse — with a hygrometer.



CENTRAL CONCEPTS • SECTION 02

CORE ENGINEERING PRINCIPLES

GOVERNING AIRFLOW

Accurate humidification load calculations are based on understanding air balance within the plant area to be humidified. The single most important value is **the governing airflow** — the greater of:

- **Total process CFM's:** exhaust CFM or total makeup-air CFM (including the HVAC economizer's minimum outdoor-air setting).

– OR –

- **Air Exchanges per Hour (ACH):** when CFM's are not identified, use an estimated air exchange rate based on building construction — tight, well-sealed construction: 1.0 ACH; average construction: 1.5 ACH; loose construction, multiple exposed walls, or frequent shipping-door traffic: 2.0 ACH (see Required Building Data section for detail).

Whichever method is used, the resulting governing airflow becomes the basis for all load calculations.

GRAINS/FT³ DIFFERENCE

Grains/ft³ Difference is the actual moisture deficit the system must supply, after accounting for the moisture already present in the heated incoming outdoor air. Because heating outdoor air lowers its relative humidity without changing its actual water content, some of that moisture is already available to offset the load — the guide credits this conservatively, retaining 50% of the outdoor air's saturation value at design temperature:

Grains/ft³ Difference = the target indoor moisture content (gr/ft³ at the desired relative humidity and indoor temperature) minus the available moisture from heated outdoor air, where available moisture is the saturation value at design winter outdoor temperature multiplied by the conservative 50% retention factor.

LOAD

Load is the central concept of this guide. Load always refers to the total amount of moisture — in pounds of water vapor per hour — that the FanMist system must add to the air to bring it from its incoming moisture content up to the target relative humidity level under design winter conditions.

FINAL SYSTEM CAPACITY

Final System Capacity is Load + 15% safety margin — accounting for colder-than-design temperatures and minor variations in operating conditions.

This progression — Grains/ft³ Difference, Load, Final System Capacity — is the foundation for all load calculations.

Load (lbs/hr) = Grains/ft³ difference × (Governing CFM × 60) ÷ 7,000 grains/lb_w

Final System Capacity (lbs/hr) = Load × 1.15



AIR BALANCE & GOVERNING AIRFLOW • SECTION 03

VENTILATION vs. INFILTRATION

HOW OUTDOOR AIR ENTERS A BUILDING, AND WHY IT ALL BECOMES ONE NUMBER

Every load calculation begins with one question: how much outdoor air is entering the building? That air is cold, holds little moisture, and must be brought up to target humidity — regardless of how it got in. Outdoor air enters through two different paths, and the relationship between them is what makes the governing-airflow calculation meaningful rather than arbitrary.

VENTILATION is the deliberate, engineered exchange of air with the outdoors — process exhaust systems (dust collection, spray booths, fume extraction) pulling air out, and makeup-air units, HVAC economizers, or supply fans bringing tempered air back in. Ventilation is measured and usually preconditioned before it reaches the space.

INFILTRATION is the uncontrolled counterpart: outdoor air leaking in through door gaps, dock doors, wall penetrations, and envelope imperfections. It's what happens automatically whenever a building's air balance falls short.

That's the key connection. Air balance is the relationship between exhaust-air CFM and makeup-air CFM, and it determines how much of a building's air exchange is engineered ventilation versus unmanaged infiltration filling the gap:

- **Balanced (exhaust $\approx$ makeup):** Neutral pressure. Infiltration is minimal, and measured makeup-air CFM is a trustworthy load input.
- **Negative pressure (exhaust $>$ makeup):** The building pulls more air out than it replaces, so the shortfall is drawn in through available gaps. Exhaust CFM effectively stands in for the infiltration it's inducing.
- **Positive pressure (makeup $>$ exhaust):** More air is pushed in than removed, forcing indoor air out through gaps instead. Infiltration is suppressed, sometimes at the cost of excess conditioning capacity.

This is why the governing-airflow rule reads: use the greater of total exhaust CFM or total makeup-air CFM. Whichever side is larger is driving the most outdoor-air exchange, and in an imbalanced building, that figure implicitly captures the infiltration the smaller one leaves out.

Where CFM figures aren't available, the guide falls back to an estimated Air Exchanges per Hour (ACH), tiered by construction — tighter buildings infiltrate less and get a lower ACH; looser buildings or frequent shipping-door traffic get a higher one. See Required Building Data (Section 04) for the specific values.

ONE NUMBER, TWO SOURCES

Ventilation and infiltration are two expressions of the same air balance, not competing sources of outdoor air. A building's exhaust-to-makeup relationship determines how much of its air exchange is deliberate versus incidental — and the governing-airflow figure captures that combined total as one usable load-calculation input.



ESSENTIAL INPUTS • SECTION 04

REQUIRED BUILDING DATA

FIVE MAIN FACTORS FOR LOAD CALCULATIONS

Must-know factors for every area or zone targeted for humidity control:

1 TOTAL CUBIC AIR SPACE (VOLUME)

Measure the dimensions of the area(s) to be humidified: length × width × ceiling height (in feet). This gives the total volume in cubic feet (ft³) — the "air mass" that must be humidified.

2 AIR EXCHANGE RATE PER HOUR (ACH) OR EXHAUST/MAKEUP AIR CFM

This tells you how quickly the air volume in the space is replaced — using one of two measurements: Air Exchanges per Hour (ACH) or exhaust/makeup-air CFM.

- Use Air Exchanges per Hour (ACH) when exhaust/makeup CFM data is unavailable, or for infiltration estimates:
 - Tight, well-sealed construction — 1.0 ACH
 - Average construction — 1.5 ACH
 - Loose construction, multiple exposed walls, or frequent shipping-door traffic — 2.0 ACH
- *(Never use less than 1.0 ACH unless the area is fully sealed with no traffic)*
- Prefer CFM data when available — it is more accurate for controlled systems. Always use the greater of total exhaust CFM or makeup-air CFM. To convert CFM to cubic feet per hour: CFM × 60.

3 DESIRED HUMIDITY STANDARD (TARGET CONDITIONS)

Example: 35% RH at 69°F (saturation = 7.80 gr/ft³ → target moisture content = 2.73 gr/ft³). This defines the target moisture level in the space.

4 OUTDOOR DESIGN TEMPERATURE

Use your local average coldest winter temperature (e.g., 0°F, or a site-specific value) for worst-case dry-air conditions.

5 PSYCHROMETRIC DATA

All calculations rely on a Psychrometric Saturation Table (grains of water vapor per cubic foot of saturated air at 100% RH), or equivalent chart values, for indoor and outdoor conditions.

SPECIAL CONSIDERATION FOR DUST COLLECTION

Most systems are designed to return filtered air indoors during winter, but typically lose 10–20% of the airflow (leaks, pressure relief, etc.). Add the lost portion to total exhaust CFM.

Example:

General Building Exhaust = 27,000 CFM;

Dust Collection = 25,000 CFM (all intended to return air) with ~15% loss → add 3,750 CFM loss

Total Exhaust = 30,750 CFM (always use the greater of exhaust-air or makeup-air CFM).



PSYCHROMETRIC ESSENTIALS • SECTION 05

THE PSYCHROMETRIC TABLE

READING THE TABLE

Load calculations rely on the Psychrometric Saturation Table showing how much moisture — in grains/ft³ — air can hold at 100% saturation for a given temperature. For example, at 69°F, 100% saturated air holds 7.80 grains/ft³.

Table 2-A Grains of Water Per Cubic Foot – Saturated Air (100% RH)														
°C	°F	Grains	°C	°F	Grains	°C	°F	Grains	°C	°F	Grains	°C	°F	Grains
-23	-10	0.29	4	40	2.86		58	5.41		76	9.75		94	16.79
	-5	0.35		41	2.97		59	5.60		77	10.06	35	95	17.28
-18	0	0.48		42	3.08	16	60	5.80		78	10.40		96	17.80
	5	0.61		43	3.20		61	6.00		79	10.80		97	18.31
-12	10	0.70		44	3.32		62	6.20	27	80	11.04		8	18.85
-9	15	0.99	7	45	3.44		63	6.41		81	11.40		99	19.39
-7	20	1.24		46	3.56		64	6.62		82	11.75	38	100	19.95
-4	25	1.56		47	3.69	18	65	6.85		83	12.11		101	20.52
-1	30	1.95		48	3.83		66	7.07		84	12.49		102	21.11
	31	2.04		49	3.97		67	7.31	29	85	12.87		103	21.71
	32	2.13	10	50	4.11		68	7.57		86	13.27		104	22.32
	33	2.21		51	4.26		69	7.80		87	13.67	41	105	22.95
	34	2.29		52	4.41	21	70	8.10		88	14.08		106	23.60
2	35	2.38		53	4.56		71	8.32		89	14.51		107	24.26
	36	2.47		54	4.72		72	8.59	32	90	14.94		108	24.93
	37	2.56	13	55	4.89		73	8.87		91	15.39		109	25.62
	38	2.66		56	5.06		74	9.15		92	15.84	43	110	26.34
	39	2.76		57	5.23	24	75	9.45		93	16.31		111	27.07

KEY CONVERSION: 7,000 GRAINS = 1 POUND OF WATER.

HOW TO CALCULATE GRAINS/FT³ DIFFERENCE

- Look up the grains/ft³ value at your target indoor temperature and multiply by desired RH%.
Example: 35% RH @ 69°F = 0.35 × 7.80 grains/ft³ at 69°F = 2.73 grains/ft³.
- Look up the grains/ft³ value at the outdoor winter design temperature (commonly 0°F = 0.48 grains/ft³) and apply the conservative 50% retention factor (heated incoming air retains only half its original moisture).
Example: 0.50 × 0.48 grains/ft³ = 0.24 grains/ft³.
- Subtract: Grains/ft³ Difference = Indoor target grains – Outdoor grains (50% retention).
Example: 2.73 grains/ft³ – 0.24 grains/ft³ = 2.49 grains/ft³ (This value is used directly in the load calculation formula).



CALCULATIONS • SECTION 06

THE PRACTICAL METHOD

TWO FORMULAS

The practical sizing method accounts for 80–95% of all factors for determining total load, including application of a safety margin. Secondary factors are generally ignored, although factored in as part of the safety margin.

FORMULA #1 **PREFERRED**

Step-by-Step Practical Sizing Method Using Formula #1 – Based on Plant Area(s) CFM to determine the governing CFM the Greater of Either Exhaust – OR – Makeup Air.

- 1 Determine governing CFM = greater of total process exhaust CFM or total makeup-air CFM (including HVAC economizer minimum outdoor-air setting).
- 2 Convert to hourly volume: Governing CFM $\times$ 60 = ft³/hr.
- 3 Obtain Grains/ft³ Difference from the Psychrometric Table.
- 4 Calculate Load:
Load (lbs/hr) = Grains/ft³ Difference $\times$ (Governing CFM $\times$ 60) $\div$ 7,000 grains/lb_w.
- 5 Final System Capacity (in lbs/hr of water): Apply 15% safety margin to the Load (this extra capacity handles occasional colder temperatures and ensures reliable performance without oversizing the system).

FORMULA #2

Step-by-Step Practical Sizing Method Using Formula #2 — Based on Plant Area(s) cubic air space & air exchange rate per hour (ACH). This formula is used when CFM data is not known, with building cubic air space volume used in conjunction with an estimated air-change rate/hour.

- 1 Calculate total volume = Length $\times$ Width $\times$ Ceiling Height = ft³.
- 2 Select appropriate ACH (1.0–2.0).
- 3 Convert to hourly volume: Total ft³ Volume $\times$ ACH = ft³/hr.
- 4 Calculate Load:
Load (lbs/hr) = Grains/ft³ Difference $\times$ (Total Volume in ft³ $\times$ ACH) $\div$ 7,000 grains/lb_w.
- 5 Final System Capacity (in lbs/hr of water): Apply 15% safety margin to the Load (this extra capacity handles occasional colder temperatures and ensures reliable performance without oversizing the system).

FINAL SYSTEM CAPACITY — APPLIES TO BOTH FORMULA #1 AND FORMULA #2

$$\text{Final System Capacity} = \text{Load} \times 1.15$$



ILLUSTRATIVE EXAMPLE • SECTION 07 • PART 1 OF 2

WOODWORKING PLANT

PRACTICAL METHOD FOR SIZING

A medium-sized, 75,000 ft² woodworking facility located in Jasper, IN, manufactures oak, maple, walnut, and birch cabinetry components. This plant serves as the rough mill within a larger complex of adjacent buildings. It is a self-contained, rectangular concrete-block structure, operating with high-volume return-air dust collection and conditioned makeup air to maintain balanced building pressure. This plant will serve as our example throughout this guide.

EXAMPLE BUILDING DATA APPLIED TO FORMULA #1 (CFM BASIS)	
Dimensions of area(s) to be humidified	250' (W) x 300' (L) x 25' Ceiling
Total Cubic air space of area(s) to be humidified	1,875,000 ft ³
Exhaust-air (all dust collection return air / all lost air included in exhaust-air CFM)	30,750 CFM
Makeup-air (MAU, governing)	35,000 CFM
Target indoor conditions (Desired RH to be maintained)	35% RH @ 69°F
Saturation @ 69°F	7.80 gr/ft ³
Target moisture content @ 35%	2.73 gr/ft ³
Outdoor design condition	0°F @ 100% RH
Saturation @ 0°F = .48 gr/ft ³ @ 50% retention	0.24 gr/ft ³
Grains/ft ³ Difference: 2.73 gr/ft ³ (target) – 0.24 gr/ft ³ (available)	2.49 gr/ft ³
Governing CFM × 60 (35,000 CFM × 60 minutes)	2,100,000 ft ³ /hr
Converting lbs/hr to gpm: lbs/hr ÷ 500 (8.34 lbs/gallon × 60 min/hr = 500.4)	—

APPLYING FORMULA #1 TO THE BUILDING DATA

$$\text{Load (lbs/hr)} = 2.49 \text{ gr/ft}^3 \times 2,100,000 \text{ ft}^3/\text{hr} \div 7,000 \text{ grains/lb}_w = 747 \text{ lbs/hr}$$

FINAL SYSTEM CAPACITY

$$\text{Load (lbs/hr)} \times 1.15 \text{ (15\% Safety Margin)} = 859 \text{ lbs/hr (1.72 gpm)}$$

FINAL SYSTEM CAPACITY — JASPER, INDIANA WOODWORKING PLANT
859 lbs/hr (1.72 gpm)



ILLUSTRATIVE EXAMPLE • SECTION 07 • PART 2 OF 2

WOODWORKING PLANT

COMPREHENSIVE METHOD FOR SIZING

The comprehensive method builds on the practical method by accounting for secondary load factors, which allow for more precise load calculations. These factors are typically small relative to the ventilation load and often partially offset one another — but they're still worth quantifying for high-throughput shops or tight tolerance targets

1. PRODUCT REGAIN (*moisture sink — increases load*)

Dry incoming lumber, veneers, or other wood products absorb moisture from the shop air as they move toward equilibrium moisture content (EMC), acting as a moisture sink that increases the required humidifier output. Estimate based on daily or hourly wood throughput (board feet or weight), species, incoming moisture content (often 6–11% for kiln-dried stock), and target EMC (typically 7–9% at 35–55% RH). Hygroscopic regain tables show that wood can absorb several percent of its dry weight in moisture; for high-volume shops this can add several lb/hr to the load, while for low-throughput areas it may be negligible. Use manufacturer data or conservative estimates for initial sizing.

2. PROCESS VAPORS (*moisture gain — decreases load*)

Some operations release water vapor into the air, partially offsetting the need for humidification. Common sources include finishing/spray-booth evaporation, glue curing, and steam-bending or steam-assisted forming. These gains are often modest but should be quantified where present — obtain rates from equipment manufacturers where available.

3. PEOPLE BREATHING AND PERSPIRATION (*moisture gain — decreases load*)

Occupants release moisture through respiration and activity. For light bench or standing shop work, use approximately 0.1–0.2 lb/hr per person (latent moisture only); higher rates — up to roughly 0.9–2 lb/hr per person — apply to more strenuous activity and generally don't reflect typical shop-floor conditions, so use the lower

Comprehensive Method = 747 lbs/hr (ventilation) + Product Regain – Process Vapors – People

FINAL ADJUSTED LOAD WITH SECONDARY FACTORS

Adjusted Load (lb/hr) = 747 lbs/hr Ventilation Load + Product Regain (moisture sink) – Process Vapors (moisture gain) – People (moisture gain)



SIZING • SECTION 08 • PART 1 OF 3

FORMULAS APPLIED TO BUILDING DATA

EXCEL SPREADSHEET CALCULATIONS

An IHC excel spreadsheet using embedded cell values for all calculations from the building data for load calculations according to Formula #1 and Formula #2.

EXAMPLE BUILDING DATA — PSYCHROMETRIC DATA — CALCULATIONS — SIZING																				
	A L	B W	C H	D ft²	E ft³	F ExA	G MuA	H RH	I T°	J Gr	K TMC	L 0°Gr	M %	N GD	O A	P lbs/hr	Q 15	R FSC	S GPM	T 111.16
Formula #1 (CFM)	250	300	25	75,000	1,875,000	30,750	35,000	35%	69°	7.80	2.73	0.48	0.24	2.49	60	747	112	859	1.72	7.73
Formula #2 (ACH)	250	300	25	75,000	1,875,000	—	—	35%	69°	7.80	2.73	0.48	0.24	2.49	1.12	747	112	859	1.72	7.73

Formula #1 (CFM) is always preferred for load calculations. Formula #2 (ACH) based on 1.12 Air Exchanges / hour.

SPREADSHEET CELL DEFINITIONS AND EMBEDDED CELL FORMULAS FOR COLUMNS A-T

Col	Definition	Embedded Cell Formula and/or Raw Data
A-C	L (Length) W (Width) C (Ceiling Height)	Dimensions in feet for area to be humidified
D	Ft² (total square feet)	A x B
E	Ft³ (total cubic feet)	A x B x C
F	ExA (Exhaust-Air)	Entered as CFM with cell coded for number
G	MuA (Makeup-air)	Entered as CFM (Governing) with cell coded for number
H	RH (Desired Relative Humidity Percentage)	Entered as number with cell coded for %
I	T° (Average Indoor Winter Air Temperature)	Entered as temperature with cell coded for number
J	Gr (Grains of I Temperature at Saturation)	Entered gr/ft ³ from the Psychrometric Table corresponding to I
K	TMC (Target Moisture Content gr/ft ³)	J x H
L	0° Gr (gr/ft ³ of Outside Air)	gr/ft ³ from the Psychrometric Table corresponding to the outdoor design temp.
M	% (gr/ft ³ of Outside Air, retained)	L x 50%
N	GD (Grains Difference gr/ft ³)	K - M
O	A (Plant Air Turnover Rate)	Expressed as 60 minutes (formula #1) OR as ACH, e.g. 1.12 (Formula #2)
P	lbs/hr (Load)	N x (G x O) ÷ 7,000 — Note: using 60 minutes for O
Q	15% (safety margin)	15% x P
R	FSC (Final System Capacity in lbs/hr)	P + Q
S	GPM (Gallons per Minute)	R ÷ 500
T	Fans (Total number of fans in the system)	R ÷ 111.16 lbs/hr/fan (fan + mist ring + number & size of nozzles)

FINAL SYSTEM CAPACITY (Formula #1 – CFM)

Final System Capacity (lbs/hr) = [Grains/ft³ difference x (Governing CFM x 60) ÷ 7,000 grains/lb_w] x 1.15



SIZING • SECTION 08 • PART 2 OF 3

SYSTEM EQUIPMENT SIZING

SIZING COMPONENTS

System Components are selected and sized by the Final System Capacity of 859 lbs/hr (1.72 gpm) to maintain 35% RH @ 69°F with 35,000 CFM makeup-air as our governing airflow

PUMP STATION

Required minimum 859 lb/hr (1.72 gpm). Size: 1 each 2.0 gpm station — add excess in intervals of 0.25 gpm, favoring excess up to 0.4 gpm; never allow pump excess capacity to exceed 50% of pump rated total capacity).

Excess Capacity: $2.0 \text{ gpm} - 1.72 \text{ gpm} = .28 \text{ gpm excess (140 lbs/hr)}$

FANS MIST RINGS, NOZZLES, TUBE & SLIP-LOKS

7.7 fans required — sized with 8 fans w/ 27" Mist Rings (14 each 7.94 lb/hr nozzles) @ 111.16 lb/hr/fan = 889.28 lb/hr total output. 1/2" tube line splits into two 3/8" legs, each leg to four fans (maximum five fans per one 3/8" tube line).

LOCATING FANS

Use the natural flow of makeup air moving toward exhaust points in the plant. Locate fans upstream from exhausting points within the mechanical airflow patterns to take full advantage of fan placement, maximizing hang time of humidity in the air while filling all air space to equilibrium as it flows to exhausting locations.

CONTROLS

One wall-mounted humidistat (one per pump) tied to the PLC controller for automatic synchronized fan/pump system ON/OFF operation — ensures 100% evaporation and maintains uniform 35% RH at 69°F throughout the 1,875,000 ft³ space.

WATER TREATMENT

Size water treatment to be 1.5 times the capacity of pump(s) total rated gpm.

EVAPORATION RATE – CFM : LBS/HR LOADING RATIO

The evaporation rate (ER) of 1000-psi atomized water combined with fan airflow is governed by the Loading Ratio (CFM of air per lb/hr of water). This ratio determines how effectively the mist evaporates beyond atomization alone.

- Optimal Evaporation Rate = Loading Ratio greater than 75 CFM per 1 lb/hr_w

36" Fan @ 10,000 CFM — Nozzles @ 7.94 lbs/hr — 27" Mist Ring @ 111.16 lbs/hr_w
Evaporation Rate = 89.96 CFM : 1 lb/hr_w



SIZING • SECTION 08 • PART 3 OF 3

EQUIPMENT & PART NUMBERS

BILL OF MATERIALS — SIZED FOR 8 FANS / 1 PUMP STATION — FANMIST SYSTEM		
Qty	Part #	Description
1	APS200-4	Automated Pump Station 2.0 gpm • 3 ph • EDV • HPS • 24 VAC • Indicator Lights & Hour Meter
1	HRO20	Humidistat (Neptronic) Built in sensor – Signals the on/off pump • 24/7 RH Set Point RH Control
2	93072	3/8" High-Pressure Flexible Nylon Tube, 100' Roll
2	90063	3/8" High-Pressure Flexible Nylon Tube, 500' Roll
50	92714	3/8" Vinyl Coated Steel Wall Clamps
2	90551	1/2" High-Pressure Flexible Nylon Tube, 100' Roll
20	92680	1/2" Vinyl Coated Steel Wall Clamps
8	92702	3/8" SS Slip-Lok Coupling
4	92703	3/8" SS Slip-Lok 90° Elbow
10	92704	3/8" SS Slip-Lok Three Way Tee
3	95702	1/2" SS Slip-Lok Coupling
2	95703	1/2" SS Slip-Lok 90° Elbow
3	95704	1/2" SS Slip-Lok Three Way Tee
3	92709	3/8" Slip-Lok x 3/8" FNPT (transition fitting from 3/8")
3	92854	1/2" Slip-Lok x 3/8" MNPT (transition fitting from 1/2")
8	VBS36CF	36" Fan – High Velocity Cage Fan 1/2HP 3Ph (230/460) 9910 CFM includes bracket
8	93711	27" Diameter Mist Ring (Bare) w/ 14 nozzle ports - 10/24 UNC thread
16	92707	3/8" Slip-Lok x 3/8" MNPT adapter (Ball Valve Assembly: two per Mist Ring)
8	92632	3/8" Stainless Steel Ball Valve with 3/8" FNPT ports (Ball Valve Assembly: one per Mist Ring)
8	93163	3/8" Slip-Lok x 1/8" MNPT adapter (Ball Valve Assembly: one per Mist Ring)
120	7.94N	7.94 lbs/hr (Blue Band) Orifice: 0.2 mm / 0.008" – 0.016 gpm

MAINTENANCE & SPARES PAK

20	7.94N	7.94 lbs/hr (Blue Band) Orifice: 0.2 mm / 0.008" – 0.016 gpm
20	93505	Nozzle Plug 10/24 Male UNC
1	93711	27" Diameter Mist Ring (Bare) w/ 14 nozzle ports - 10/24 UNC thread
2	92707	3/8" Slip-Lok x 3/8" MNPT adapter (Two per Mist Ring)
1	92632	3/8" Stainless Steel Ball Valve with 3/8" FNPT ports
1	93163	3/8" Slip-Lok x 1/8" MNPT adapter
1	95062	Filter wrench for 92609 (10" Filter Housing) - 1 per Pump Station
1	92608	9 3/4" Pre-filter 5 micron cartridge for 92609 - 1 per Pump Station
2	93222	16 oz GP Series Pump Oil – 30 weight (2 per Pump Station)
2	94506	6" Nozzle Extension SS for high-pressure line flushing procedure

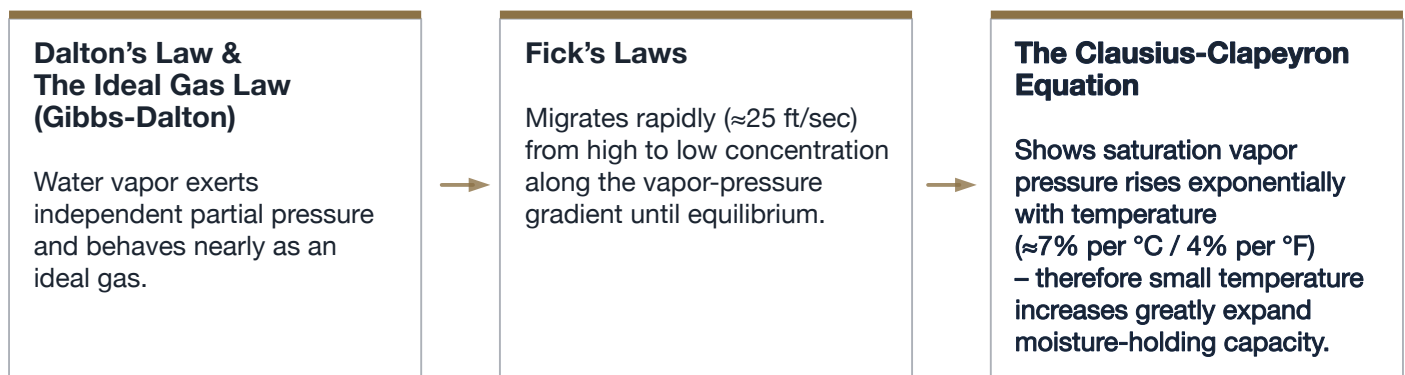


VERITIES • SECTION 09

FIRST PRINCIPLES – PHYSICAL LAWS

HIGH-VELOCITY AIR + 1000-PSI ATOMIZATION = ACCELERATED EVAPORATION

THREE PHYSICAL LAWS WORKING TOGETHER GOVERN HOW HUMIDITY EQUALIZES TO A STATE OF EQUILIBRIUM



Accelerated evaporation is the combination of fan air velocity CFM with high-pressure (1000-psi) water atomization – rapidly converting fine droplets of moisture to vapor within a controlled air plume. The design principle: maintain fan output ratio above **75 CFM : 1 lb of water** – within a 4 ft diameter / 22 ft length plume for complete evaporation.

THIS PERFORMANCE RESTS ON SEVEN INTERDEPENDENT ELEMENTS:

- 1 **Extremely fine droplet size** – with very high surface-area-to-volume ratios, enabling rapid phase change.
- 2 **High air movement and mixing** – Elevated CFM keeps droplets suspended and continuously supplies unsaturated air.
- 3 **Strong vapor-pressure gradient** – Moving air maintains a large difference between actual & saturation vapor pressure, driving fast evaporation.
- 4 **Temperature influence** – Warmer “ceiling” air increases moisture-holding capacity, further accelerating the process.
- 5 **Rapid diffusion and equalization** – Once evaporated, water vapor migrates quickly throughout the connected air space.
- 6 **Precise system design & placement** – Sizing fan, mist-ring, and nozzles positioned to inject moisture into the high-velocity air stream within the defined plume dimensions – positioned and pointed into obstacle-free air spaces.
- 7 **Continuous dilution of near-saturated air** – Sufficient air volume & velocity prevent localized saturation, sustaining high evaporation rates.

Together these factors allow the atomized moisture to be fully evaporated inside the fan's moisture plume without fallout, delivering efficient, uniform humidity distribution.



TEAR OUT REFERENCE • WOODWORKING EDITION • SECTION 10

QUICK LOAD CALCULATOR CARD

A field-ready worksheet using the Recommended Practical Sizing Method — Ventilation Load plus a 15% safety margin — for woodworking, cabinetry & furniture facilities.

TARGET RH% FOR WOODWORKING

Sweet spot: 35–45% RH at 69–72°F (up to 50% RH in some operations) — Maintains wood EMC 6.9–8.7% range.

1 Building Cubic Air Volume

Width _____ × Length _____ × Height _____ ≈ _____ ft³

2 Governing Airflow (CFM)

Use the greater of total exhaust CFM (include dust-collection losses — typically 10–20% of intended return air) or total makeup-air CFM. Governing CFM = _____ — OR — Estimated ACH = _____

3 Target Indoor Conditions

Desired RH: _____% (35–45% typical) @ average winter indoor air temperature: _____°F

Saturation moisture content @ 100% (Table 2-A) ≈ _____ gr/ft³

4 Outdoor Design Conditions

Outdoor winter design temperature: _____°F @ 100% saturation (Table 2-A) = _____ gr/ft³

Available outdoor moisture (50% retention) ≈ _____ gr/ft³

5 Grains Difference

Target indoor moisture _____ gr/ft³ – Available outdoor moisture _____ gr/ft³

= Grains/ft³ difference ≈ _____ gr/ft³

6 Ventilation Load (lb/hr)

Grains/ft³ × Governing CFM × 60 ÷ 7,000 grains ≈ _____ lbs/hr

7 Final FanMist System Capacity

Ventilation Load × 1.15 (15% safety margin) ≈ _____ lbs/hr ≈ _____ gpm at 1,000 psi (lbs/hr ÷ 500)

8 Fan Count Check (Loading Ratio)

1 each fan @ rated _____ CFM ÷ fan lbs/hr capacity _____ lbs/hr ≈ _____ CFM : 1 lb/hr

(Should exceed minimum of 75 CFM : 1 lb/hr)

IMPORTANT NOTES

- When makeup-air includes an HVAC economizer, use its minimum outdoor-air setting (the winter-design operating point) as the makeup-air CFM figure — then compare against exhaust CFM per the governing-airflow rule and use the greater of the two.
- Secondary factors (product regain, people, process vapors) are intentionally omitted — they rarely change the final equipment size.
- Always maintain slight positive building pressure (+0.01 to +0.05 in. w.c.) to minimize infiltration.



ADDENDUM • SECTION 11 • PART 1 OF 4

APPENDIX

This appendix gathers four topics referenced earlier in the guide for deeper reference, without interrupting the main sizing walkthrough in Sections 01–10

APPENDIX A

GOVERNING AIRFLOW — CHOOSING BETWEEN EXHAUST-AIR (ExA) AND MAKEUP-AIR (MuA)

Section 02 and Section 03 establish the core governing-airflow rule: always use the greater of total exhaust CFM (ExA) or total makeup-air CFM (MuA) as the basis for every load calculation. The sizing spreadsheet in Section 08 (Part 1 of 3) enters these as two separate columns — F (ExA) and G (MuA) — but its Load formula (Column P) references Column G directly, rather than automatically selecting whichever of the two is larger.

This is a deliberate simplification, not an oversight in the underlying rule. In the Woodworking Plant worked example (Section 07), makeup-air governs — 35,000 CFM versus 30,750 CFM of exhaust-air including dust-collection exhaust loss— so entering the figures directly into Columns F and G happens to produce the correct result. Nothing in the spreadsheet enforces that outcome, however; it depends entirely on which values are entered where.

Before entering figures into Columns F and G, compare them directly. Whichever is larger is the one that should carry through the Load formula. In practice, that means one of two approaches:

- **If makeup-air is larger** (the typical case, and the one shown throughout this guide): enter it into Column G as usual — the spreadsheet works as built.
- **If exhaust airflow is larger** — a negative-pressure building, per Section 03 — enter the exhaust value into Column G instead, so it drives the Load formula, and note the makeup-air figure in Column F for reference only.

A facility with exhaust CFM meaningfully larger than makeup-air CFM is running under negative pressure, drawing the shortfall in through infiltration — see Section 03 for the full discussion of why this makes exhaust CFM the more representative figure in that scenario. This is worth double-checking in shops with high-volume dust collection systems: if a dust collector's rated CFM (plus its 10–20% return-air loss, per Section 04) exceeds the makeup-air unit's capacity, exhaust — not makeup-air — is the figure that should drive the Load formula. Reversing Columns F and G is the single most common way this spreadsheet under-sizes a system, since the Load formula has no built-in safeguard against it.

SPREADSHEET TIP

If you maintain your own working copy of this spreadsheet, consider adding a helper column — e.g., "Governing = MAX(F,G)" — feeding that into the Load formula instead of Column G directly. This removes the manual comparison step and prevents the sizing error described above.



APPENDIX

APPENDIX B

TARGET RH "SWEET SPOT" — EXTENDED REFERENCE

Section 01 (Wood & Relative Humidity) establishes the guide's core target: 35–45% RH at 69–72°F (up to 50% RH in some operations), keeping wood EMC in the 6.9–8.7% safe range (ideal 6.5–7.5%). This appendix expands on the practical reasoning behind that range for anyone selecting a set point for a specific facility or product line.

WHY THIS RANGE — NOT SIMPLY "HIGHER IS SAFER"

RH above roughly 50% at typical shop temperatures begins to risk mold and fungal growth in stored lumber, over-absorption and warping, and slowed glue-line and finish curing — trading one set of defects for another. RH below 35% re-exposes the shop to the original problem the FanMist system is solving: cracking, checking, splitting, and static electricity buildup.

Species and product-specific adjustment: hygroscopic behavior differs less than 1% across species at 30–60% RH (Section 01), so the target RH itself rarely needs to change species-to-species. What does matter is stock condition and thickness — green or partially kiln-dried lumber and thin veneers respond to humidity swings far faster than thick, fully dried stock, and benefit from staying nearer the upper half of the sweet spot (RH closer to 45%) during acclimation. Facilities running a rough mill alongside a finishing or assembly area may find it worthwhile to set slightly different targets by zone rather than a single plant-wide value — the load calculation in Section 07 can be re-run per zone using that zone's own volume and governing airflow.

Table 1-A (Section 01) remains the reference for translating any RH set point in the 30–50% range into its corresponding EMC — consult it directly whenever evaluating a target outside the 35–45% default used in this guide's worked example.



ADDENDUM • SECTION 11 • PART 3 OF 4

APPENDIX

APPENDIX C

HVAC & THE ECONOMIZER CYCLE — FULL DISCUSSION

HOW ECONOMIZERS AFFECT WINTER MAKEUP-AIR CFM: In most industrial buildings, the HVAC system's economizer is one of the largest sources of controlled makeup air. The economizer modulates outdoor-air dampers year-round: it opens wider during mild weather and shoulder seasons to provide "free cooling" — using cool outdoor air to reduce mechanical refrigeration load and save energy — but during winter it is deliberately set to the minimum outdoor-air position required by ventilation codes (typically 10–20%). This minimum setting satisfies indoor air quality and occupant ventilation requirements while limiting excessive heating energy use.

ESTIMATING THE WINTER MAKEUP-AIR CONTRIBUTION

To estimate the winter makeup-air contribution from the HVAC economizer:

- 1 Multiply total HVAC tonnage by approximately 400 CFM per ton to approximate total supply airflow. This 400 CFM/ton figure is a widely used rule of thumb — actual airflow varies roughly 350–450 CFM/ton depending on equipment design, so treat it as a starting estimate rather than a nameplate value.
- 2 Apply the minimum economizer outdoor-air percentage: Total tons × 400 CFM/ton × economizer setting (example: 20% — $100 \text{ tons} \times 400 \text{ CFM/ton} \times 0.20 = 8,000 \text{ CFM of outside air}$).

This winter minimum value is included when determining the governing makeup-air CFM for humidification load calculations (see Governing Airflow, Section 02, and Required Building Data, Section 04).

HANDLING MULTIPLE HVAC UNITS

Most facilities of any size run several rooftop or air-handling units rather than one central system. Calculate each unit's winter outside-air contribution separately, using that unit's own tonnage and economizer setting, then sum the results — units are rarely sized or set identically. A shop with three 50-ton RTUs at 15%, 20%, and 20% settings, for example, contributes $3,000 + 4,000 + 4,000 = 11,000$ CFM combined, not a single blended calculation across all 150 tons.

WHERE TO FIND ACTUAL VALUES

- **Total tonnage:** equipment nameplates, mechanical schedules on as-built drawings, or the facility's TAB (test-and-balance) report.
- **Economizer minimum-position setting:** the building automation system (BAS/EMS) setpoint or trend log, the controls contractor's sequence of operations, or the mechanical engineer of record's design documents.
- When none of these are available, 20% is a reasonable default per typical ASHRAE 62.1 minimum ventilation rates for light-industrial occupancies — but verify against actual equipment where the load calculation is tight to the equipment's rated capacity.

CAUTION — FREEZE-PROTECTION LOCKOUTS

Many economizers include a low-temperature lockout that closes outdoor-air dampers further (sometimes fully) below a set outdoor temperature — often in the 0–10°F range — to protect coils from freezing. Because this guide's load calculation uses the coldest design-day temperature (Section 04), that is precisely the condition under which a lockout is most likely to be active. If your site's economizer locks out at or above its stated outdoor design temperature, the actual winter makeup-air contribution on the coldest days may be lower than the nameplate-and-setting calculation above suggests. Verify the lockout temperature against your outdoor design temperature, and where the two are close, cross-check using the ACH-basis Formula #2 (Section 06) rather than relying on the economizer figure alone.

See Appendix A (this section, Part 1 of 4) for how this makeup-air figure interacts with the exhaust-air comparison once it feeds into the governing-airflow calculation.



ADDENDUM • SECTION 11 • PART 4 OF 4

APPENDIX

APPENDIX D

ADDITIONAL REFERENCE NOTES

1. UNIT CONVERSION QUICK REFERENCE

CONVERSION	VALUE
Grains to pounds	7,000 grains = 1 lb of water
Water weight	8.34 lbs per gallon
gpm to lbs/hr	1 gpm = 500 lbs/hr at 1000 psi ($8.34 \times 60 = 500.4$)
CFM to ft ³ /hr	CFM x 60
°F to °C	$(^{\circ}\text{F} - 32) \times 5 \div 9$

2. WHERE THE 111.16 LB/HR/FAN RATING COMES FROM

Each 27" mist ring carries 14 nozzle ports; at the standard 7.94 lb/hr Blue Band orifice, $14 \times 7.94 = 111.16$ lb/hr per fan — the figure used throughout Section 08's equipment sizing. This is specific to that nozzle/mist-ring combination. Swapping to a different orifice size or nozzle count changes the per-fan rating accordingly — always re-derive fan output from the actual nozzle specification installed rather than assuming 111.16 lb/hr/fan universally.

3. SAFETY MARGIN PHILOSOPHY

The 15% margin used throughout this guide (Section 02, Section 06) accounts for colder-than-design temperatures and minor operating variation — it is a baseline, not a ceiling. Shops with frequent large door openings (shipping/receiving traffic), mixed operations (a rough mill alongside a finishing or assembly area), or planned future production increases may reasonably size to a larger margin. Where that applies, increase Column Q's multiplier in the sizing spreadsheet (Section 08, Part 1 of 3) deliberately, as a documented decision — rather than defaulting to 15% without considering whether the specific facility warrants more.

4. SECONDARY FACTORS REMINDER

The Practical Method used throughout this guide intentionally omits product regain, process vapors, and people (Section 07's Comprehensive Method covers all three: dry incoming lumber and veneer absorbing moisture as it reaches EMC, water vapor released during finishing/spray-booth evaporation and glue curing, and occupant respiration). These factors are typically small relative to the ventilation load and often partially offset one another — but for high-throughput shops or tight tolerance targets, revisit Section 07 for the fuller calculation before finalizing equipment selection.

5. GLOSSARY OF ABBREVIATIONS

TERM	MEANING
ACH	Air Changes per Hour
CFM	Cubic Feet per Minute
EMC	Equilibrium Moisture Content
RH	Relative Humidity
ExA	Exhaust-Air (CFM)

TERM	MEANING
MuA	Makeup-Air (CFM)
TMC	Target Moisture Content (gr/ft ³)
GD	Grains Difference (gr/ft ³)
FSC	Final System Capacity (lbs/hr)
GPM	Gallons per Minute

INDUSTRY STANDARDS & REFERENCES

The ventilation principles referenced throughout this guide — including minimum outdoor-air requirements and economizer minimum-position settings — are consistent with widely recognized industry guidance, including ASHRAE Standard 62.1 (Ventilation for Acceptable Indoor Air Quality). Building-specific ventilation rates, economizer settings, and code requirements vary by jurisdiction and application; consult your mechanical engineer or local code authority to confirm the specific requirements applicable to your facility.