

Humidification Rules of Thumb

10.01 Window Types and Space Humidity Values

A. Single Pane Windows $\pm 10\%$ RH Maximum

B. Double Pane Windows $\pm 30\%$ RH Maximum

C. Triple Pane Windows $\pm 40\%$ RH Maximum

D. The above numbers are based on the following:

1. 0°F. outside design temperature.
2. 72°F. inside design temperature.
3. $R_{\text{INSIDE AIR FILM}} = 0.680$ $U_{\text{INSIDE AIR FILM}} = 1.471$
4. $R_{\text{SINGLE GLASS}} = 0.909$ $U_{\text{SINGLE GLASS}} = 1.100$
5. $R_{\text{DOUBLE GLASS}} = 1.667$ $U_{\text{DOUBLE GLASS}} = 0.600$
6. $R_{\text{TRIPLE GLASS}} = 2.000$ $U_{\text{TRIPLE GLASS}} = 0.500$
7. Standard air at sea level
8. The relative humidity numbers listed above are rounded for ease of remembrance.
9. The glass R-values and U-values are for average glass construction. Modern glass construction can achieve higher R-values/lower U-values.
10. For additional information on moisture condensation on glass see the tables at the end of this chapter.

10.02 Proper Vapor Barriers

Proper vapor barriers and moisture control must be provided to prevent moisture condensation in walls and to prevent mold, fungi, bacteria, and other plant and micro-organism growth.

10.03 Human Comfort

30–60% RH

10.04 Electrical Equipment, Computers

35–55% RH

10.05 Winter Design Relative Humidities

A. Outdoor Air Below 32°F.:

1. 70–80% RH
2. Design Wet Bulb Temperatures 2 to 4°F. below Design Dry Bulb Temperatures

B. Outdoor Air 32–60°F: 50% RH

10.06 Energy Code Winter Design Relative Humidities

A. CABO Model Energy Code:

1. Winter: 30% RH Maximum
2. Summer: 60% RH Minimum

B. ASHRAE Standard 90A-1980:

1. Winter: 30% RH Maximum
2. Summer: 60% RH Minimum, if Humidistat is used

C. ASHRAE Standard 90A-1987:

1. Winter: 30% RH Maximum
2. Summer: 60% RH Minimum, if Humidistat is used

D. ASHRAE Standard 90.1-1989:

1. Winter: 30% RH Maximum
2. Summer: 60% RH Minimum, if Humidistat is used

10.07 Optimum Relative Humidity Ranges for Health

HEALTH ASPECT	OPTIMUM RELATIVE HUMIDITY RANGE FOR CONTROLLING HEALTH ASPECT
BACTERIA	20 - 70%
VIRUSES	40 - 78%
FUNGI	0 - 70%
MITES	0 - 60%
RESPIRATORY INFECTIONS (1)	40 - 50%
ALLERGIC RHINITIS AND ASTHMA	40 - 60%
CHEMICAL INTERACTIONS	0 - 40%
OZONE PRODUCTION	75 - 100%
COMBINED HEALTH ASPECTS	40 - 60%

Notes:

1. Insufficient data above 50% RH.

10.08 Moisture Condensation on Glass**A. The moisture condensation tables below are based on the following:**

1. $R_{\text{INSIDE AIR FILM}} = 0.680$ $U_{\text{INSIDE AIR FILM}} = 1.471$
2. $R_{\text{SINGLE GLASS}} = 0.909$ $U_{\text{SINGLE GLASS}} = 1.100$
3. $R_{\text{DOUBLE GLASS}} = 1.818$ $U_{\text{DOUBLE GLASS}} = 0.550$
4. $R_{\text{TRIPLE GLASS}} = 2.500$ $U_{\text{TRIPLE GLASS}} = 0.400$
5. Standard air at sea level.

B. The glass surface temperatures, which are also the space dewpoint temperatures, listed in the moisture condensation tables that follow, were developed using the equations in Part 5.

TEMP. ROOM °F.	TEMP. OUTSIDE °F.	SINGLE PANE GLASS		DOUBLE PANE GLASS		TRIPLE PANE GLASS	
		$T_{\text{GLASS}} /$ T_{DEWPOINT}	% R.H.	$T_{\text{GLASS}} /$ T_{DEWPOINT}	% R.H.	$T_{\text{GLASS}} /$ T_{DEWPOINT}	% R.H.
65	-30	-6.1	4.5	29.5	25.9	39.2	38.5
	-25	-2.3	5.6	31.3	27.9	40.5	40.5
	-20	1.4	6.9	33.2	30.2	41.9	42.8
	-15	5.2	8.4	35.1	32.6	43.2	45.0
	-5	12.6	12.1	38.8	37.9	46.0	50.1
	0	16.4	14.5	40.7	40.8	47.3	52.7
	5	20.1	17.2	42.6	44.0	48.7	55.5
	10	23.9	20.3	44.4	47.1	50.0	58.3
	20	31.3	27.9	48.2	54.5	52.8	64.7
	25	35.1	32.6	50.0	58.3	54.1	67.9
	30	38.8	37.9	51.9	62.6	55.5	71.4
	35	42.6	44.0	53.8	67.1	56.8	74.9
	66	-30	-5.8	4.4	30.1	25.6	39.9
-25		-2.1	5.5	32.0	27.7	41.2	40.2
-20		1.7	6.7	33.8	29.9	42.6	42.5
-15		5.4	8.2	35.7	32.3	44.0	44.8
-5		12.9	11.8	39.4	37.4	46.7	49.7
0		16.6	14.1	41.3	40.4	48.0	52.2
5		20.4	16.8	43.2	43.5	49.4	55.1
10		24.1	19.8	45.1	46.8	50.8	58.0
20		31.6	27.3	48.8	53.8	53.5	64.1
25		35.3	31.8	50.7	57.8	54.8	67.2
30		39.1	37.0	52.5	61.8	56.2	70.8
35		42.8	42.8	54.4	66.3	57.6	74.4
67		-30	-5.6	4.3	30.7	25.4	40.6
	-25	-1.8	5.4	32.6	27.5	42.0	40.1
	-20	1.9	6.6	34.5	29.7	43.3	42.2
	-15	5.7	8.0	36.3	32.0	44.7	44.5
	-5	13.1	11.6	40.1	37.2	47.4	49.3
	0	16.9	13.8	41.9	39.9	48.8	52.0
	5	20.6	16.4	43.8	43.0	50.1	54.6
	10	24.4	19.4	45.7	46.2	51.5	57.5
	20	31.8	26.6	49.4	53.2	54.2	63.5
	25	35.6	31.1	51.3	57.1	55.6	66.9
	30	39.3	36.0	53.2	61.3	56.9	70.1
	35	43.1	41.8	55.0	65.4	58.3	73.7

TEMP. ROOM °F.	TEMP. OUTSIDE °F.	SINGLE PANE GLASS		DOUBLE PANE GLASS		TRIPLE PANE GLASS	
		T _{GLASS} / T _{DEWPOINT}	% R.H.	T _{GLASS} / T _{DEWPOINT}	% R.H.	T _{GLASS} / T _{DEWPOINT}	% R.H.
68	-30	-5.3	4.3	31.3	25.1	41.3	37.7
	-25	-1.6	5.3	33.2	27.2	42.7	39.8
	-20	2.2	6.5	35.1	29.4	44.1	42.0
	-15	5.9	7.8	37.0	31.8	45.4	44.2
	-5	13.4	11.3	40.7	36.8	48.1	48.9
	0	17.1	13.5	42.6	39.6	49.5	51.6
	5	20.9	16.0	44.4	42.5	50.9	54.4
	10	24.6	18.9	46.3	45.7	52.2	57.0
	20	32.1	26.0	50.0	52.6	54.9	63.0
	25	35.8	30.3	51.9	56.4	56.3	66.3
	30	39.6	35.2	53.8	60.5	57.7	69.7
	35	43.3	40.7	55.7	64.8	59.0	73.0
69	-30	-5.1	4.2	32.0	25.0	42.1	37.6
	-25	-1.3	5.2	33.8	26.9	43.4	39.5
	-20	2.4	6.3	35.7	29.1	44.8	41.7
	-15	6.2	7.7	37.6	31.4	46.2	44.0
	-5	13.6	11.1	41.3	36.4	48.9	48.7
	0	17.4	13.2	43.2	39.2	50.2	51.2
	5	21.1	15.6	45.1	42.2	51.6	53.9
	10	24.9	18.5	46.9	45.2	53.0	56.8
	20	32.3	25.3	50.7	52.1	55.7	62.7
	25	36.1	29.6	52.5	55.7	57.0	65.7
	30	39.8	34.3	54.4	59.8	58.4	69.1
	35	43.6	39.8	56.3	64.0	59.8	72.6
70	-30	-4.8	4.1	32.6	24.8	42.8	37.3
	-25	-1.1	5.0	34.5	26.8	44.2	39.4
	-20	2.7	6.2	36.3	28.8	45.5	41.4
	-15	6.4	7.5	38.2	31.1	46.9	43.7
	-5	13.9	10.8	41.9	36.0	49.6	48.3
	0	17.6	12.9	43.8	38.8	51.0	51.0
	5	21.4	15.3	45.7	41.7	52.3	53.5
	10	25.1	18.0	47.6	44.8	53.7	56.3
	20	32.6	24.8	51.3	51.5	56.4	62.1
	25	36.3	28.8	53.2	55.3	57.8	65.3
	30	40.1	33.6	55.0	59.0	59.1	68.4
	35	43.8	38.8	56.9	63.2	60.5	71.9

TEMP. ROOM °F.	TEMP. OUTSIDE °F.	SINGLE PANE GLASS		DOUBLE PANE GLASS		TRIPLE PANE GLASS		
		$T_{\text{GLASS}} /$ T_{DEWPOINT}	% R.H.	$T_{\text{GLASS}} /$ T_{DEWPOINT}	% R.H.	$T_{\text{GLASS}} /$ T_{DEWPOINT}	% R.H.	
71	-30	-4.6	4.0	33.2	23.6	43.5	37.0	
	-25	-0.8	5.0	35.1	26.5	44.9	39.1	
	-20	2.9	6.0	37.0	28.7	46.2	41.1	
	-15	6.7	7.4	38.8	30.8	47.6	43.3	
	-5	14.1	10.6	42.6	35.8	50.3	48.0	
	0	17.9	12.6	44.4	38.4	51.7	50.5	
	5	21.6	14.9	46.3	41.3	53.0	53.0	
	10	25.4	17.6	48.2	44.3	54.4	55.8	
	20	32.8	24.1	51.9	50.9	57.1	61.6	
	25	36.6	28.2	53.8	54.6	58.5	64.7	
	30	40.3	32.7	55.7	58.5	59.8	67.8	
	35	44.1	37.9	57.5	62.5	61.2	71.3	
	72	-30	-4.3	4.0	33.8	24.3	44.3	36.9
		-25	-0.6	4.8	35.7	26.3	45.6	38.8
-20		3.2	5.9	37.6	28.4	47.0	41.0	
-15		6.9	7.2	39.5	30.6	48.3	43.0	
-5		14.4	10.4	43.2	35.4	51.1	47.8	
0		18.1	12.3	45.1	38.1	52.4	50.1	
5		21.9	14.6	46.9	40.8	53.8	52.8	
10		25.6	17.2	48.8	43.8	55.1	55.3	
20		33.1	23.6	52.6	50.5	57.9	61.2	
25		36.8	27.5	54.4	54.0	59.2	64.2	
30		40.6	32.0	56.3	57.8	60.6	67.4	
35		44.3	36.9	58.2	61.9	61.9	70.6	
73		-30	-4.1	3.8	34.5	24.2	45.0	36.7
		-25	-0.3	4.8	36.3	26.0	46.3	38.6
	-20	3.4	5.8	38.2	28.1	47.7	40.7	
	-15	7.2	7.1	40.1	30.3	49.1	42.9	
	-5	14.7	10.2	43.8	35.0	51.8	47.4	
	0	18.4	12.1	45.7	37.7	53.1	49.7	
	5	22.1	14.3	47.6	40.5	54.5	52.4	
	10	25.9	16.9	49.4	43.3	55.9	55.1	
	20	33.4	23.1	53.2	49.9	58.6	60.7	
	25	37.1	26.9	55.0	53.3	59.9	63.6	
	30	40.8	31.2	56.9	57.1	61.3	66.8	
	35	44.6	36.1	58.8	61.2	62.7	70.2	

TEMP. ROOM °F.	TEMP. OUTSIDE °F.	SINGLE PANE GLASS		DOUBLE PANE GLASS		TRIPLE PANE GLASS		
		T _{GLASS} / T _{DEWPOINT}	% R.H.	T _{GLASS} / T _{DEWPOINT}	% R.H.	T _{GLASS} / T _{DEWPOINT}	% R.H.	
74	-30	-3.8	3.8	35.1	24.0	45.7	36.4	
	-25	-0.1	4.7	37.0	25.9	47.1	38.4	
	-20	3.7	5.7	38.8	27.8	48.4	40.4	
	-15	7.4	6.9	40.7	30.0	49.8	42.5	
	-5	14.9	9.9	44.5	34.8	52.5	47.0	
	0	18.6	11.8	46.3	37.3	53.9	49.5	
	5	22.4	14.0	48.2	40.1	55.2	51.9	
	10	26.1	16.4	50.1	43.0	56.6	54.6	
	20	33.6	22.6	53.8	49.3	59.3	60.2	
	25	37.3	26.2	55.7	52.9	60.7	63.3	
	30	41.1	30.5	57.5	56.4	62.0	66.2	
	35	44.8	35.2	59.4	60.4	63.4	69.6	
	75	-30	-3.5	3.7	35.7	23.8	46.4	36.2
		-25	0.2	4.6	37.6	25.6	47.8	38.2
-20		3.9	5.6	39.5	27.7	49.2	40.3	
-15		7.7	6.8	41.3	29.7	50.5	42.2	
-5		15.2	9.7	45.1	34.4	53.2	46.7	
0		18.9	11.6	46.9	36.9	54.6	49.1	
5		22.6	13.6	48.8	39.6	56.0	51.7	
10		26.4	16.1	50.7	42.6	57.3	54.2	
20		33.9	22.1	54.4	48.8	60.0	59.7	
25		37.6	25.7	56.3	52.3	61.4	62.7	
30		41.3	29.7	58.2	56.0	62.8	65.9	
35		45.1	34.4	60.0	59.7	64.1	69.0	
76		-30	-3.3	3.6	36.4	23.6	47.2	36.1
		-25	0.4	4.5	38.2	25.4	48.5	37.9
	-20	4.2	5.5	40.1	27.4	49.9	39.9	
	-15	7.9	6.6	42.0	29.5	51.2	41.9	
	-5	15.4	9.5	45.7	34.1	54.0	46.5	
	0	19.1	11.3	47.6	36.6	55.3	48.8	
	5	22.9	13.4	49.4	39.2	56.7	51.3	
	10	26.6	15.7	51.3	42.1	58.0	53.8	
	20	34.1	21.5	55.1	48.4	60.8	59.4	
	25	37.8	25.0	56.9	51.7	62.1	62.2	
	30	41.6	29.1	58.8	55.3	63.5	65.3	
	35	45.3	33.6	60.7	59.2	64.8	68.3	

TEMP. ROOM °F.	TEMP. OUTSIDE °F.	SINGLE PANE GLASS		DOUBLE PANE GLASS		TRIPLE PANE GLASS		
		$T_{\text{GLASS}} /$ T_{DEWPOINT}	% R.H.	$T_{\text{GLASS}} /$ T_{DEWPOINT}	% R.H.	$T_{\text{GLASS}} /$ T_{DEWPOINT}	% R.H.	
77	-30	-3.0	3.6	37.0	24.4	47.9	35.8	
	-25	0.7	4.4	38.8	25.2	49.3	37.8	
	-20	4.4	5.3	40.7	27.2	50.6	39.7	
	-15	8.2	6.5	42.6	29.3	52.0	41.8	
	-5	15.7	9.3	46.3	33.7	54.7	46.1	
	0	19.4	11.1	48.2	36.3	56.1	48.6	
	5	23.1	13.0	50.1	38.9	57.4	50.9	
	10	26.9	15.4	51.9	41.6	58.8	53.5	
	20	34.4	21.1	55.7	47.9	61.5	58.9	
	25	38.1	24.5	57.6	51.3	62.9	61.9	
	30	41.8	28.4	59.4	54.7	64.2	64.7	
	35	45.6	32.8	61.3	58.5	65.6	68.0	
	78	-30	-2.8	3.5	37.6	23.2	48.6	35.6
		-25	0.9	4.3	39.5	25.1	50.0	37.5
-20		4.7	5.3	41.3	26.9	51.3	39.4	
-15		8.4	6.3	43.2	29.0	52.7	41.5	
-5		15.9	9.1	47.0	33.5	55.4	45.8	
0		19.7	10.8	48.8	35.9	56.8	48.2	
5		23.4	12.8	50.7	38.5	58.1	50.5	
10		27.1	15.0	52.6	41.3	59.5	53.1	
20		34.6	20.6	56.3	47.3	62.2	58.4	
25		38.4	24.0	58.2	50.7	63.6	61.3	
30		42.1	27.8	60.0	54.0	64.9	64.2	
35		45.8	32.0	61.9	57.8	66.3	67.4	
79		-30	-2.5	3.5	38.2	23.0	49.4	35.5
		-25	1.2	4.2	40.1	24.8	50.7	37.3
	-20	4.9	5.1	42.0	26.8	52.1	39.3	
	-15	8.7	6.2	43.8	28.7	53.4	41.2	
	-5	16.2	8.9	47.6	33.2	56.2	45.6	
	0	19.9	10.6	49.5	35.6	57.5	47.8	
	5	23.6	12.5	51.3	38.1	58.9	50.3	
	10	27.4	14.7	53.2	40.9	60.2	52.7	
	20	34.9	20.2	56.9	46.8	63.0	58.1	
	25	38.6	23.4	58.8	50.1	64.3	60.8	
	30	42.3	27.1	60.7	53.6	65.7	63.9	
	35	46.1	31.3	62.5	57.1	67.0	66.8	

TEMP. ROOM °F.	TEMP. OUTSIDE °F.	SINGLE PANE GLASS		DOUBLE PANE GLASS		TRIPLE PANE GLASS	
		$T_{GLASS} / T_{DEWPOINT}$	% R.H.	$T_{GLASS} / T_{DEWPOINT}$	% R.H.	$T_{GLASS} / T_{DEWPOINT}$	% R.H.
80	-30	-2.3	3.4	38.9	22.9	50.1	35.3
	-25	1.5	4.2	40.7	24.6	51.4	37.0
	-20	5.2	5.0	42.6	26.5	52.8	39.0
	-15	8.9	6.1	44.5	28.5	54.2	41.0
	-5	16.4	8.7	48.2	32.8	56.9	45.3
	0	20.2	10.4	50.1	35.3	58.2	47.4
	5	23.9	12.2	51.9	37.7	59.6	49.9
	10	27.6	14.4	53.8	40.5	61.0	52.4
	20	35.1	19.7	57.6	46.4	63.7	57.6
	25	38.9	22.9	59.4	49.5	65.0	60.3
	30	42.6	26.5	61.3	53.0	66.4	63.3
	35	46.3	30.6	63.2	56.6	67.8	66.4