Installation and Operation

AM-91A, -92A, 93A; AMAF-91A, -92A, -93A; AMEF-91A, -92A, -93A; FSA-91A, -92A, -93A; VSA-91A, -92A, -93A

Humidifiers for Direct Area Humidification

This bulletin should be used by experienced personnel as a guide to the installation and maintenance of AM-91A, -92A, 93A; AMAF-91A, -92A, -93A; AMEF-91A, -92A, -93A; FSA-91A, -92A, -93A; VSA-91A, -92A, -93A direct area humidifiers. Selection or installation of equipment should always be accompanied by competent technical assistance. We encourage you to contact Armstrong or its local representative if further information is required.

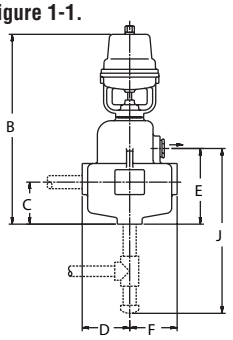
Installation Procedure

Step 1. Check Shipment Against Packing List
All components are listed on the packing slip. Report any shortages immediately. If the humidifier or accessories have been damaged in transit, notify us and file claim with the transportation company.

Step 2. Mount the Humidifier
Support it from the ceiling, Fig. 1-3, or bracket it to a column as shown in Fig. 1-4. There are holes on both sides of the humidifier for mounting purposes.

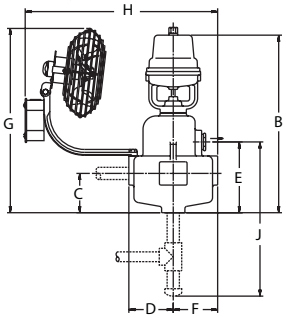
Exception: Where supply and return connections for the 91 & 92 size are short, a pipe hanger to the steam supply line should be sufficient.

Figure 1-1.



AM, VSA Models

Figure 1-2.



AMEF, AMAF, FSA Models

Dimensions, Armstrong Area Humidifiers. Fig. 1-1 VSA, AM models do not have fans. Fig. 1-2 FSA, AMEF models have electrically operated fans. AMAF models utilize air powered fans.

Table 1-1

Model No.	B	C	D	E	F	G	H	J
AM-91A	15-15/16”	3-3/8”	3-13/16”	6-1/16”	3-1/16”	—	—	13-1/4”
AMAF-91A	15-15/16”	3-3/8”	3-13/16”	6-1/16”	3-1/16”	15-5/8”	14-9/16”	13-1/4”
AMEF-91A	15-15/16”	3-3/8”	3-13/16”	6-1/16”	3-1/16”	18-9/16”	15-3/4”	13-1/4”
FSA-91A	10-7/8”	3-3/8”	3-13/16”	6-1/16”	3-1/16”	17-3/8”	15-3/4”	13-1/4”
VSA-91A	10-7/8”	3-3/8”	3-13/16”	6-1/16”	3-1/16”	—	—	13-1/4”
AM-92A	15-15/16”	3-3/8”	3-13/16”	6-1/16”	3-13/16”	—	—	13-1/4”
AMAF-92A	15-15/16”	3-3/8”	3-13/16”	6-1/16”	3-13/16”	15-5/8”	14-9/16”	13-1/4”
AMEF-92A	15-15/16”	3-3/8”	3-13/16”	6-1/16”	3-13/16”	18-9/16”	15-3/4”	13-1/4”
FSA-92A	10-7/8”	3-3/8”	3-13/16”	6-1/16”	3-13/16”	17-3/8”	15-3/4”	13-1/4”
VSA-92A	10-7/8”	3-3/8”	3-13/16”	6-1/16”	3-13/16”	—	—	13-1/4”
AM-93A	25-1/2”	4-5/8”	4-3/4”	9”	4-3/4”	—	—	24”
AMAF-93A	25-1/2”	4-5/8”	4-3/4”	9”	4-3/4”	—	17-3/4”	24”
AMEF-93A	25-1/2”	4-5/8”	4-3/4”	9”	4-3/4”	21”	18-1/4”	24”
FSA-93A	20-3/8”	4-5/8”	4-3/4”	9”	4-3/4”	21”	18-1/4”	24”
VSA-93A	20-3/8”	4-5/8”	4-3/4”	9”	4-3/4”	—	—	24”

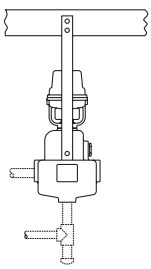
Table 1-2

Note: AM models 91, 92 and 93 shown on this bulletin are furnished with Armstrong C-1801 pneumatic operators. Operator Spring Ranges for pneumatically controlled humidifiers.

Armstrong C-1801	
Operating Range	Adjustable Start Points
5 lbs.	3 psig min. - 6 psig max.
*10 lbs.	3 psig min. - 6 psig max.

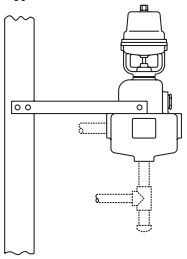
*Standard spring — furnished when no spring range is specified.

Figure 1-3.



Humidifier suspended from ceiling.

Figure 1-4.



Humidifier bracketed to column.

Humidifier Piping

Step 3. Run the steam supply line from the steam header to the humidifier as indicated in Fig. 2-1. Observe the following:

A. Take steam supply line from the top of the supply main – never from the side or bottom. If several humidifiers take steam from a single supply line, be sure to trap the end of the run-out with an Armstrong Trap of suitable size. If the steam supply is very wet, install a drip pocket or separator ahead of the humidifier.

B. Size supply line in accordance with Table 2-1. If the steam supply is 5 psi or less, it is advisable to use one pipe size larger and reduce the pipe size just ahead of the strainer and humidifier.

C. Pitch the supply line in the direction of flow.

D. Expansion and Contraction. With average length of supply line, the dimension change from hot to cold should not exceed 2". Provide piping with 3 elbows to get swing to take care of expansion and contraction (See Fig. 2-2).

E. Clean piping. After running the supply line, blow down at full steam pressure to eliminate dirt and pipe cuttings.

F. A Pipe Strainer is furnished with each humidifier. Install (after blowing down supply line) as indicated on drawing.

G. Swivel connections may be desirable – see Fig. 2-2 and explanatory captions.

H. Pressure Reducing Valve. If required refer to Fig. 3-1 and explanatory captions.

Table 2-1 Recommended Pipe Sizes

Humidifier Size	Supply Header to Strainer	Steam Inlet & Strainer	Drip Leg	Trap Piping
91	3/4"	3/4"	1"	3/4"
92	3/4"	3/4"	1"	3/4"
93	1-1/4"	1-1/4"	1-1/4"	3/4"

Steam Pipe Capacities

For computing ability of piping to deliver an adequate supply of steam to humidifier. Capacities shown are in pounds per hour.

Table 2-2 Steam Pipe Capacity at 5 psi

Pipe Size in.	Pressure drop, psi per 100 ft. of pipe length				
	1/8	1/4	1/2	3/4	1
1	24	31	44	54	62
1-1/4	52	68	97	120	140
1-1/2	81	100	150	180	210
2	160	210	300	370	430
2-1/2	270	350	500	610	710

Table 2-3 Steam Pipe Capacity at 15 psi

Pipe Size in.	Pressure drop, psi per 100 ft. of pipe length					
	1/8	1/4	1/2	3/4	1	2
1	27	38	53	65	76	110
1-1/4	59	83	120	140	160	230
1-1/2	91	130	180	220	260	360
2	180	260	370	450	520	740
2-1/2	300	430	600	740	860	1210

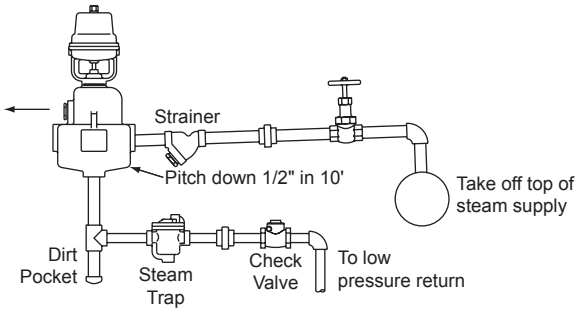
Table 2-4 Steam Pipe Capacity at 25 psi

Pipe Size in.	Pressure drop, psi per 100 ft. of pipe length					
	1/8	1/4	1/2	3/4	1	2
3/4	15	21	30	37	43	60
1	30	43	61	75	86	122
1-1/4	67	95	130	160	190	260
1-1/2	100	140	210	250	290	410
2	210	300	420	510	590	840
2-1/2	340	490	690	850	980	1380

Table 2-5 Steam Pipe Capacity at 50 psi

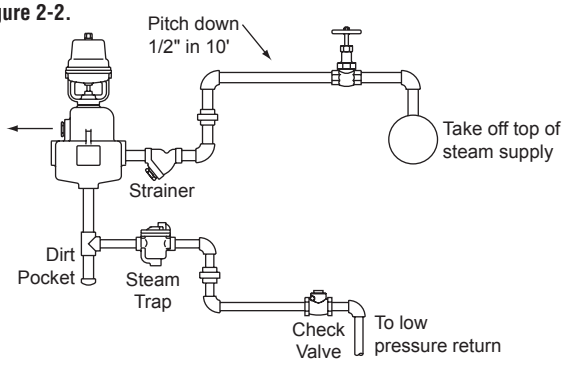
Pipe Size in.	Pressure drop, psi per 100 ft. of pipe length					
	1/4	1/2	3/4	1	2	5
3/4	27	38	47	54	76	120
1	54	77	94	110	150	240
1-1/4	120	170	210	240	340	530
1-1/2	180	260	320	370	520	830
2	370	530	650	750	1060	1680
2-1/2	620	870	1070	1240	1750	2760

Figure 2-1.



Typically pneumatically controlled humidifier installation.

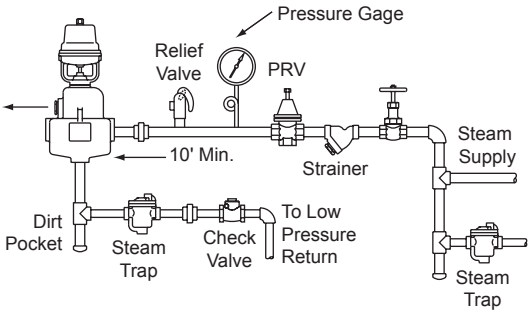
Figure 2-2.



Swivel connections shown above permit direction of discharge to be altered easily. Loosen both unions, adjust direction, then retighten unions.

Air and Electrical Connections

Figure 3-1.



P.R.V. Installation. Reducing Valves. Where the steam pressure available for humidifiers is too high, a reducing valve of the single-seated or dead-end type should be used. The reducing valve should be at least 10 ft. from the humidifier. If the supply line is more than 20 ft. long, provide a drip pocket and extra trap just ahead of the pressure reducing valve.

Relief Valve. A pressure relief valve between the humidifier and pressure reducing valve is a good insurance. Humidifier bodies are only rated for 60 psig steam service.

Pressure Gage. A pressure gage or connection for installing a gage between reducing valve and the humidifier may save its cost many times over.

Step 4. Install the Armstrong Steam Trap and connect the trap to the return header. It is important:

A. To provide a dirt pocket ahead of the trap as shown in the drawings.

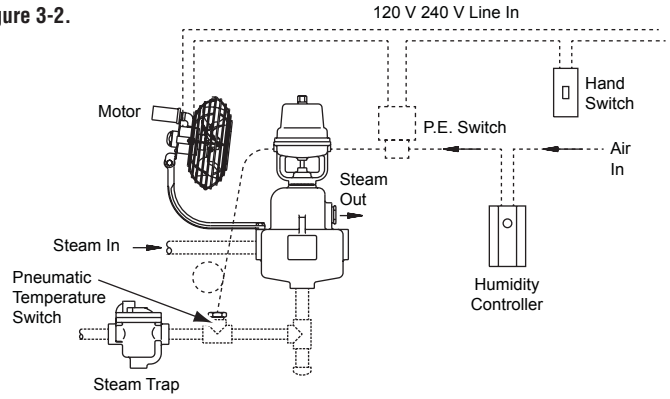
B. To make sure the return header pressure is well below the steam supply pressure. **Never connect a humidifier trap to a line carrying returns from high pressure traps.**

Step 5. Install Fan and Motor of AMAF, AMEF, and FSA units. The bracket is located on the side opposite the steam discharge outlet in the humidifier cap. Cap screws are provided.

Step 6. Make Electric Connections for AMEF model fan motors. Electrical connections are shown in double dash lines in Fig. 3-2.

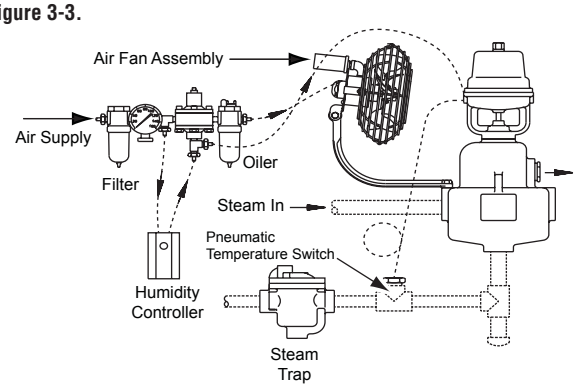
A. If automatic control of the fan motor is desired, install a pneumatic-electric relay. The relay should be set to start fan with a 2 psi air signal. See Fig. 3-2.

Figure 3-2.



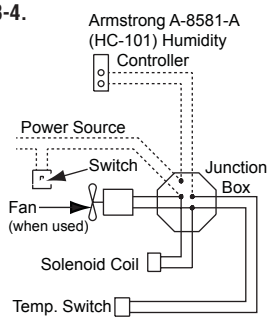
Compressed air hookup. Electrical connections for AMEF units are shown. For AMAF model omit electric.

Figure 3-3.



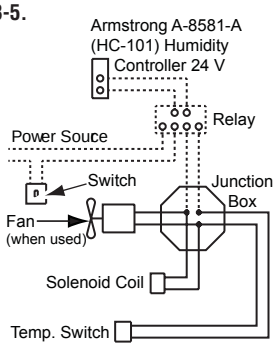
Compressed air hookup showing air powered fan and air line accessories for AMAF units.

Figure 3-4.



Wiring diagram for standard 120V or 240V FSA or VSA Humidifiers.

Figure 3-5.



Wiring diagram for 120V or 240V VSA Humidifier with 24V line to humidistat.

Air and Electrical Connections

B. If automatic control is not used, the use of a hand switch to control the fan motor has definite advantages. The fan operates continuously during the heating season. The motors are oil less in all positions. Current consumption is low – 6 watts for all AMEF models.

For FSA, VSA Models (See Figs. 3-4 & 3-5)

A. Beware of Voltage Drop. If the wire supplying current to the humidifier is too small or too long, there may be a voltage drop that will reduce the life of your equipment. When the voltage is too low, the solenoid valve will not open but current will continue to flow and will burn up the coil.

B. 24 Volt Wiring. (VSA Only) Where codes permit 24 volt wiring without conduit, the use of a 120-24 volt transformer relay, as shown in Fig. 3-5 will lower the installation cost.

Step 7: Install Pneumatic Piping. (AM)

A. Air Supply. Air supply for Armstrong Humidifiers should be 15 to 20 psi. This air must be clean and dry instrument air. Make air connections to fan of AMAF models.

B. Compressed Air Piping. Plastic tubing or equivalent is used for all air connections.

Step 8: Install Humidity Controller.

Location. The humidistat should be installed anywhere from 20 ft. to 30 ft. from the humidifier – at one side of the air stream from the humidifier. The hygrostat should be able to "see" the unit controlled. It must not be hidden behind piles of goods or in channels of columns where air movements cannot reach it. It may be necessary to experiment with the location in order to get the best control.

Setting and Adjusting should be done in accordance with the manufacturer's instructions furnished with the humidistat.

Recommended Option.

A pneumatic or an electric temperature switch is recommended in any system where the steam supply to the manifold jacket and humidifier body may be interrupted or turned off.

Sizing and Selection

A survey of your requirements should be taken to determine the amount of steam needed for humidification, the number, size and type of units required, and the location of both humidifier and humidity controllers.

Sizing and location with natural ventilation.

These are the average industrial humidification applications with:

Room temperatures – 65° to 80°.

Relative humidities – 35% to 80%.

Natural ventilation – i.e., infiltration around windows and doors.

Selection Data Required.

- Minimum Outdoor Temperature: for most jobs, figure 10°F above the lowest recorded temperature for your locality. The lowest temperatures are seldom encountered for more than a few hours.
- Indoor Temperature
- RH Desired
- Pressure of Steam Available for Humidification
- Number of Cubic Feet in Room
- Air Changes Per Hour: air changes taking place under average conditions exclusive of air provided for ventilation or regain of hygroscopic materials.

Rooms, 1 side exposed 1
Rooms, 2 sides exposed ..... 1 ½
Room, 3 or 4 sides exposed 2
Rooms with no windows or
outside doors ..... ½ - ¾

Typical Problem:
Design outdoor temperature ..... 0°F
Indoor temperature ..... 70°F
RH required 40%
Air changes per hour 2
Steam pressure available ..... 5 psi
Room size 400' x 160' with 10' ceiling.
Natural ventilation
Heated by:
Unit heaters – fan on-off control.

Step 1: Steam required for humidification. Our room contains (400' x 160' x 10') or 640,000 cu. Ft.

From the 70°F Table 5-1, read across from 0°F outside temperature to the 40% RH column where you find the figure .409 lbs. of steam per hour per 1000 cu. ft. of space for each air change. Then, 640 x .409 x 2 equals 524 lbs. of steam per hour installed humidification capacity required.

Step 2: Electric or air controlled units. The large floor area calls for multiple humidifiers. No explosion hazard has been specified so use of air controlled units is not required. Electric units are recommended.

Step 3: Number of humidifiers for job. Divide steam required by capacity of humidifiers at steam pressure available.

Step 4: What size humidifier to use. For this example, a large number of smaller capacity units is recommended. Larger capacity units could cause condensation on the low ceiling. Also, because of the large floor area, the humidistats for fewer units would be widely spaced, which could result in less accurate control than desirable.

Sizing and Selection

Step 5: What type of humidifier to use. In this example, integral fan units are preferable to steam jet units installed in conjunction with unit heaters. Since the unit heater fans are on or off to control temperature, it follows that the humidistat may call for steam when the nearest unit heater is nor running. With the low ceiling, the discharge from a steam jet humidifier might rise to the ceiling and produce condensation. Therefore, the integral fan type should be used.

Step 6: Location of humidifiers. Several patterns are possible, and actual location can usually conform with the existing steam supply and return lines to make an economical installation with a minimum of new piping.

In our problem of a 400' x 160' x 10' room, there would likely be steam lines along both sides of the room, and humidifiers can be located as shown in Fig. 5-1. If the supply lines run down the center of the room, the center line pattern would be practical. Runouts to integral fan units in a 160' wide room would be about 20' long. If the room were only 60 or 80 ft. wide, runouts need be no longer than required for actual hook-up.

Step 7: Location of humidistat. This should be form 20 to 30 feet away from the humidifier and slightly to one side of the air stream from the unit. The humidistat should "see" its humidifier. Do not hide it behind a post or in the channel of an H-beam. It must get a good sample of the air, to control the humidity.

Sizing and location with forced ventilation.

Typical jobs: Mill and sanding rooms in furniture factories. Here, the problem of selecting and installing humidifiers is much the same as previously described except for:

A. Determining the number of air changes.

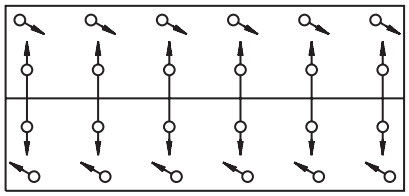
B. Location of humidifiers and humidistat.

Air Changes: These can be determined from exhaust fan capacity where known. The cu. ft. per hour capacity of the fans divided by the cubic feet of space to be humidified will give the number of air changes.

Where the capacity of fan or fans is not known, air changes can be measured with velometer readings at all open doors, elevator shafts, etc., leading to the room and with fans operating at full capacity. Your Armstrong Representative can determine air changes for you.

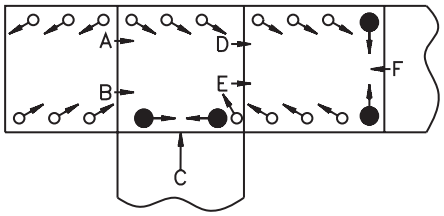
Humidifier Location: Bear in mind that humidifiers will have to control the humidity 24 hours a day, seven days a week during the heating season. Exhaust fans may operate only 40 hours or 80 hours per week. Thus the humidifiers and humidistats must be located for good distribution of humidity during the fan-off periods as well as when the fans are operating. Figure 5-2 outlines a typical requirement.

Figure 5-1.



Where practical, locate humidifiers to minimize piping. Locations shown where steam supply lines are along outer walls; and where supply is in center of room.

Figure 5-2.



Schematic layout of humidifiers in woodworking plant where exhaust fans are used. Arrows indicate air flow induced by fans. Humidifiers are sized for load conditions imposed by fan. Humidifiers are located to give uniform distribution of humidity when fans are off or when fans are running.

Table 5-1

70°F. Humidification. Pounds of Steam Per Hour, Per Air Chcange for Each 1000 cu. FT. of Space to Secure Desired Indoor Relative Humidity at 70°F. with Various Outdoor Temperature (Outside Air 75% Saturated).

Outdoor Temp.	70°F. - RELATIVE HUMIDITY DESIRED INDOORS-70°F										
	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
30	.079	.136	.194	.251	.309	.367	.424	.482	.539	.597	.654
20	.154	.212	.269	.327	.385	.441	.499	.557	.615	.672	.730
10	.204	.262	.319	.377	.434	.492	.549	.607	.665	.722	.780
0	.237	.294	.352	.409	.467	.524	.582	.639	.697	.754	.812
-10	.257	.314	.372	.430	.487	.545	.602	.660	.717	.775	.832
-20	.270	.327	.385	.442	.500	.557	.615	.672	.730	.787	.844

Table 6-1

75°F. Humidification. Pounds of Steam Required Per Hour, Per Air Chcange for Each 1000 cu. FT. of Space to Secure Desired Indoor Relative Humidity at 75°F. with Various Outdoor Temperature (Outside Air 75% Saturated).

Outdoor Temp.	70°F. - RELATIVE HUMIDITY DESIRED INDOORS-70°F										
	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
30	.129	.196	.264	.331	.399	.466	.533	.601	.668	.736	.803
20	.204	.271	.339	.406	.474	.541	.609	.676	.744	.811	.879
10	.254	.321	.389	.456	.524	.591	.659	.726	.794	.861	.929
0	.286	.354	.421	.489	.556	.624	.691	.759	.826	.894	.961
-10	.307	.374	.442	.509	.577	.644	.711	.779	.846	.914	.981
-20	.319	.387	.454	.522	.589	.657	.724	.792	.859	.927	.994

Operation

How electrically operated units work.
After passing through the Armstrong inline strainer, steam enters the cast iron steam-separating chamber. The use of cast iron as a separator is probably the single most important feature in the Armstrong humidifier design.

The preferred material of strength and durability, case iron gives Series 9000 humidifiers flexibility in design without fabrication. In addition, castings mean better heat retention because of thicker walls. Which in turn means a lower rate of condensation.

Entering the main separating chamber, steam encounters a cupped baffle which reverses its flow and turns it back on itself. The outer walls of the casting form another cup, and the same thing happens again. These two 180° turns help condition the steam, reducing its volume and separating the condensate from the vapor. Condensate from supply and radiation and most of the particulates in the steam not removed by the strainer collect in the large drain leg and are discharged through the inverted bucket drain trap.

Steam from the separating chamber flows around and through the solenoid valve which is actuated by a demand signal from the humidistat. (Solenoid can be exchanged for electric or pneumatic control if desired by choosing an operator and bonnet assembly).

Next the steam flows into the drying chamber which is jacketed by the separating chamber. The drying chamber is filled with a stainless steel silencing material which almost completely absorbs the noise of escaping steam. Dispersion is through a jet nozzle or by a fan.

How air-operated units work.
Air-operated units operate in the same manner as electric units except that they utilize a pneumatic humidistat as humidity controller in the space and an air operator to open and close the steam valve.

Explosion hazard humidification.
Sizing air-operated humidifiers for areas where an explosion hazard exists is done exactly as for other requirements except that they should be sized for the **most severe** conditions of makeup air, RH required and minimum steam pressure.

Figure 6-1.

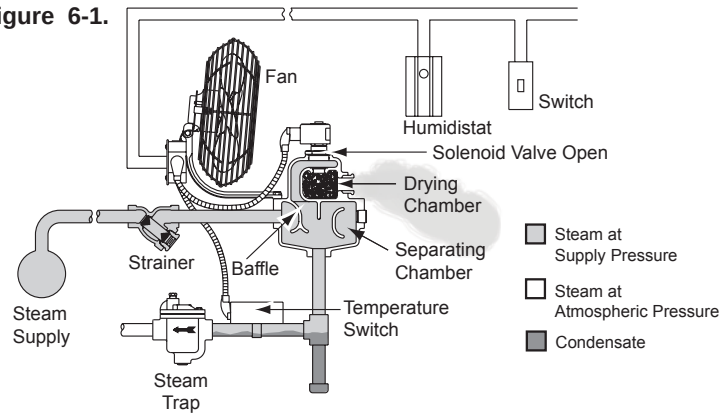


Table 6-2 Location of Unit Humidifiers for Direct Discharge into Atmosphere.

Method of Steam Dispersion	Maximum Discharge Capacities in lbs. of Steam per hour	Minimum Ceiling	Ceiling Clearance
Electric Fan FSA, AMEF Models	30	8’	2’
	80	10’	3’
	200	14’	6’
	300	16’	8’
Air Fan AMAF Models	30	10’	3’
	80	12’	4’
	200	16’	8’
	300	20’	8’
Jet VSA, AM Models	30	10’	4’
	80	12’	6’
	200	20’	10’
	300	20’	10’

Operation and Servicing

Putting the Humidifier Into Operation

When Temperature Switch is Employed simply set humidity controller at desired level, and turn on the steam.

When Temperature Switch Is Not Employed deactivate operator control so that humidifier control valve will remain closed. Then:

A. Open steam supply valve, to bring humidifier up to temperature.

B. When drain line from humidifier is at steam temperature, activate the operator control.

C. Set desired relative humidity.

After the Humidifier Is In Operation

Clean Strainer. The screen in the strainer installed in the steam supply line should be cleaned a few days after the humidifier is placed in operation, and thereafter at least once each season – more often if you find much dirt in the screen.

Check Trap. The steam trap is used to drain the humidifier should be inspected at the same time the strainer is cleaned.

Trouble Shooting FSA, VSA
Humidifier Will Not Discharge Steam

A. –Solenoid Fails to Open
1. Burned out coil.
2. Humidistat at fault.
3. Hand switch open.
4. Dirt in plunger tube or bent tube.
5. Steam pressure too high for unit as furnished.
6. *Damaged piston ring.
7. *Plugged or restricted pilot orifice.

B. -Steam System Malfunction:
1. Silencing chamber plugged with dirt. Remove and replace silencing material and retainer.
2. Strainer screen plugged.
3. Dirt in steam line.
4. Steam valve closed in line to humidifier.
5. Pressure reducing valve out of order.

*FSA-92 and FSA-93, VSA-92 and VSA-93 only.

Humidifier Discharge Water

A. –Faulty Installation:
1. Long, untrapped supply line.
2. Humidifier supply from bottom or side of steam header.
3. Untrapped valve in vertical, downfeed supply line.

B. –Faulty Drainage
1. Steam trap filled with dirt.
2. Return line pressure above humidifier pressure.
3. Too much vertical lift.
4. Wrong type of trap used.
5. Second trap short circuiting the humidifier trap.

Humidifier Discharges Continuously, Even though Humidity Has Reached Desired Level:

A. –Mechanical Trouble:
1. Humidistat fails to open (points frozen).
2. Dirt holds solenoid plunger in open position.
3. Bent solenoid tube holds plunger in open position.
4. Dirt between valve and seat.
5. Coil not de-energized.
6. Damaged spring.
7. Plugged bleed hole.

B. –Insufficient Capacity:
1. Not enough units to give desired relative humidity.

Trouble Shooting AM, AMAF, AMEF
Humidifier Will Not Discharge Steam

A. –Control System At Fault:
1. Faulty control valve operator.
2. Faulty humidity controller.
3. Faulty connections between humidity controller and control valve operator.
4. Air valve closed.

B. –Steam System Malfunction:
1. Silencing chamber plugged with dirt. Remove and replace silencing material and retainer.
2. Strainer screen plugged.
3. Dirt in steam line.
4. Steam valve closed in line to humidifier.
5. Pressure reducing valve out of order.

Humidifier Discharges Water

A. –Faulty Steam Supply:
1. Long, untrapped supply line.
2. Humidifier supply from bottom or side of steam header.
3. Untrapped valve in vertical, down feed supply line.
4. Boiler carryover.

B. –Faulty Operation:
1. Faulty temperature switch.
2. Humidity controller set up before humidifier has reached steam temperature.

C. –Faulty Operation:
1. Faulty temperature switch.
2. Humidity controller set up before humidifier has reached steam temperature.

Humidifier Discharges Continuously Even Though Humidity Has Reached Desired Level.

A. –Humidity Controller Out of Calibration.

B. –Trouble in Humidifier:
1. Valve stem “frozen” to stem seal due to unusual chemical or corrosive conditions in steam system.
2. Operator spring broken.
3. Dirt or scale between valve and seat.

Armstrong International, Inc.
Limited Warranty and Remedy

Armstrong International, Inc. ("Armstrong") warrants to the original user of those products supplied by it and used in the service and in the manner for which they are intended, that such products shall be free from defects in material and workmanship for a period of one (1) year from the date of installation, but not longer than 15 months from the date of shipment from the factory, [unless a Special Warranty Period applies, as listed below]. This warranty does not extend to any product that has been subject to misuse, neglect or alteration after shipment from the Armstrong factory. Except as may be expressly provided in a written agreement between Armstrong and the user, which is signed by both parties, Armstrong **DOES NOT MAKE ANY OTHER REPRESENTATIONS OR WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.**

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Special Warranty Periods are as follows:

Series EHU-700 Electric Steam Humidifier, Series HC-4000 HumidiClean Humidifier and GFH Gas Fired Humidifier with Ionic Beds:
Two (2) years after installation, but not longer than 27 months after shipment from Armstrong's factory.

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