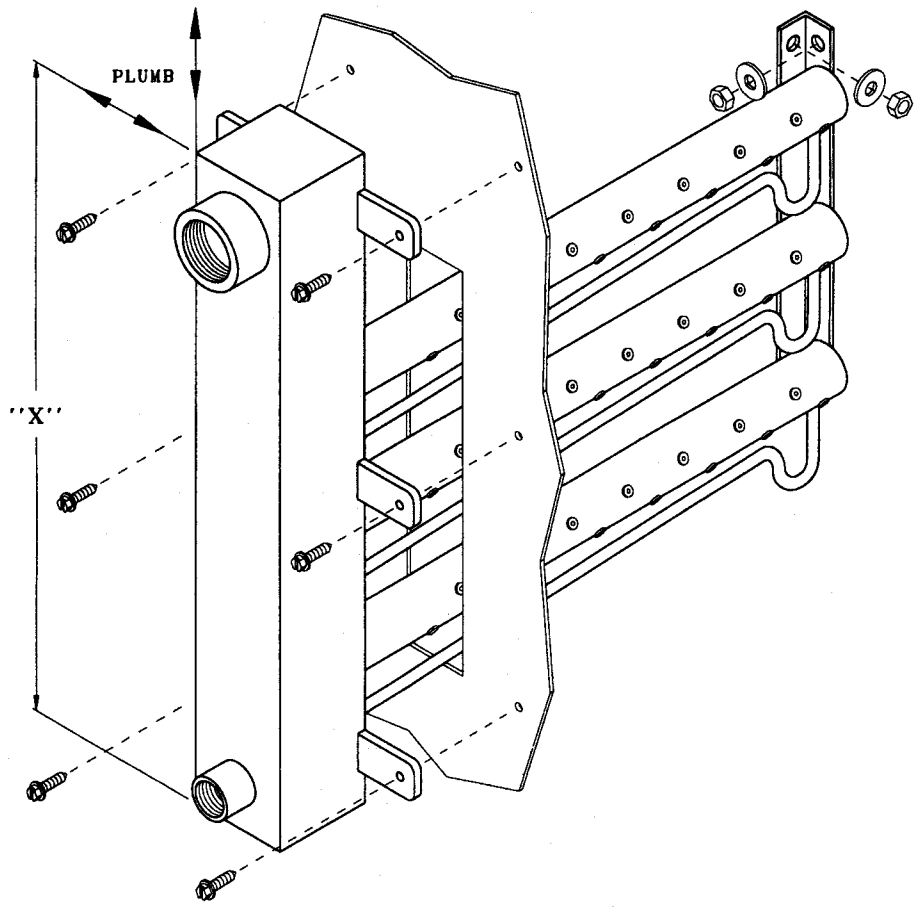
HERRMIDIFIER
A TRION Company

Application Guide
Herricane CS Series Humidifiers



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Warranty

1. The HERRMIDIFIER COMPANY, INC. warrants to the buyer or any user during the duration of the Warranty that the steam distribution system, manufactured by Herrmidifier, is free from defects of material and workmanship for a period of three (3) years from the date of installation. Accessories, such as steam valves, actuators, traps and strainers, are warranted for a period of (1) one year.
2. For this Warranty to be effective, this humidifier must be installed, operated and maintained in accordance with the instructions provided in the Owner's Manual.
3. Guaranteed Evaporative Distance or G.E.D., as defined in the Herricane CS Owner's Manual, is based on various psychrometric and air handler design criteria. Herrmidifier offers a Guaranteed Evaporative Distance or G.E.D. warranty separate from all other warranties. This warranty is available only for applications in which the necessary data to determine evaporation distance has been provided to Herrmidifier. Any changes in this data without prior written approval of Herrmidifier or any variations in the actual operating conditions from the data submitted, terminate the G.E.D. warranty. The accessories (i.e. traps, valves, actuators, etc.) must be supplied or specified by Herrmidifier for the G.E.D. warranty to be valid.
4. In the event of a defect or malfunction in this product during the Warranty Period, user may contact the Customer Service Department for a Return Material Authorization number. Items tagged with this part number may be returned to the Herrmidifier Factory Repair Department for complete reconditioning without charge to the user for parts or labor or credit consideration. Incidental expenses such as cost of transporting the humidifier to Herrmidifier shall be borne by the user. Upon completion of the reconditioning, the humidifier will be returned at no cost to the user. Item returned without an RMA number will not be accepted!
5. This Warranty does not cover field labor for repairs to this humidifier or any special, indirect or consequential damages. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.
6. If, after a reasonable number of attempts to do so, Herrmidifier is unable to remedy any defects or malfunction in this humidifier, then the user may elect either a replacement of such a product or part which may be defective without charge or a refund at Herrmidifier's selling price.
7. This Warranty gives you specific legal rights, and you may have other rights which vary from state to state.

Evaporative distance can be measured in two ways. "Bulk" evaporative distance is the distance beyond which condensation will not occur on objects at duct temperature. "Last Wisp" evaporation is the point beyond which there is no visible steam and it is safe to install high-efficiency filters. Herrmidifier has published evaporative distance tables for standard conditions (55 degrees F, 70% relative humidity). Steam intensity and air velocity are evaluated at these conditions. A second table is published which allows correction to non-standard (other than 55 degree F and 70% relative humidity downstream of the humidifier) conditions. **The tables are only useful with Herricane CS Series humidifiers.** Application to other brands of humidifiers is not recommended. Differences in distribution patterns will cause problems!

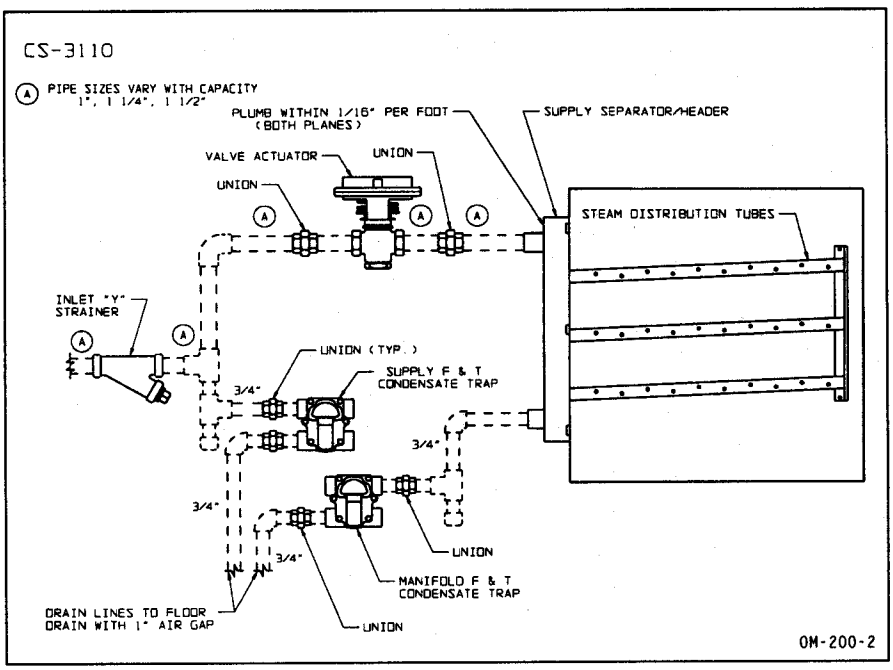
If you desire, you may forward your design criteria to Herrmidifier for a written analysis of your evaporative distances. We will be able to define the "bulk" and "last wisp" evaporative distance based on this criteria only. If any changes are made to the design, a follow-up analysis must be made to assure fail-safe operation.

Why Choose the CS Series?

The CS-Series offers a family of four different products custom sized to handle all of your steam distribution needs. The distribution system design has the following features that customers and engineers have told us they desire:

- Zero Maintenance
- Quality Construction - All Stainless Steel, ASME Certified Welds
- Quality Control - Your unit has been operated prior to shipment
- Flexible Design - Works with pressurized boiler, atmospheric boiler, or unfired boiler
- Capacity to 2000 lbs/hr.
- Stainless Steel Precision Nozzles
- Available "Guaranteed Evaporative Distance" Performance Guarantee
- Quiet Operation
- Superb Energy Efficiency
- NO FIELD ASSEMBLY of distribution system
- Total system design assures that YOU GET THE CAPACITY YOU PAID FOR!

The system is as ingenious as it is simple. In a system with steam supplied by a central boiler, steam flow from the source first passes the inlet strainer. From here the steam travels to a condensate trap, and on to the steam valve. Depending on the application, this valve could have a solenoid operator, a pneumatic operator, or an electric operator. Once the steam has passed through the steam valve, it enters the steam distribution system. The steam distribution system utilizes the same nozzle design as the original CS-1. This design is extremely quiet, up to 7.3 times quieter than the competition, and efficient, 3-23% more efficient than jacketed designs, depending on the duty cycle. Any condensate that forms in the distribution system will be disposed of through the manifold trap.
With a self-generating steam unit, the modulation of steam would occur in the boiler itself, therefore, the strainer, steam valve and supply trap would be eliminated (See page 24)



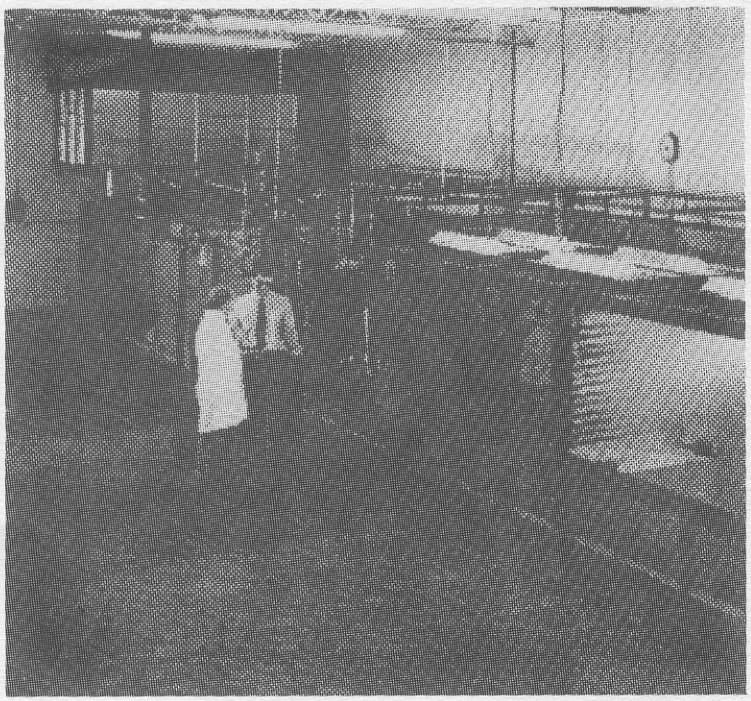
Redefining Guaranteed Performance with the H.A.R.E.

Using the proprietary H.A.R.E. (Humidified Air Research Environment) facility, Herrmidifier engineers were able to accurately evaluate all potential humidification system variables - temperature, velocity, downstream relative humidity, and steam intensity. From data gathered at the 32,000 cfm facility, two sets of information have been generated enabling a humidification system to combine the best possible mix of economy and performance.

While temperature and velocity are common well defined terms, downstream relative humidity and steam intensity need further review. Downstream relative humidity is the humidity level that must be achieved after the moisture from the humidifier is introduced into the airstream in order to meet the desired room conditions. Steam intensity is defined as the amount of moisture (steam) introduced per lineal foot of distribution manifold ($lb_m/hr/ft$).

The first tool is a comparison of evaporative distance under changing conditions of air velocity and steam intensity at standard condition of 55 degrees F and 70% downstream relative humidity. The second tool, developed from thermodynamic and psychrometric relationships and verified with the H.A.R.E., determines the correction factor needed to compensate for psychrometric conditions (upstream temperature and downstream relative humidity) which differ from the selected standard conditions (55 degrees F and 70% downstream relative humidity). See Section C for these two charts.

The H.A.R.E. research facility was designed and constructed in 1994. System building blocks are:



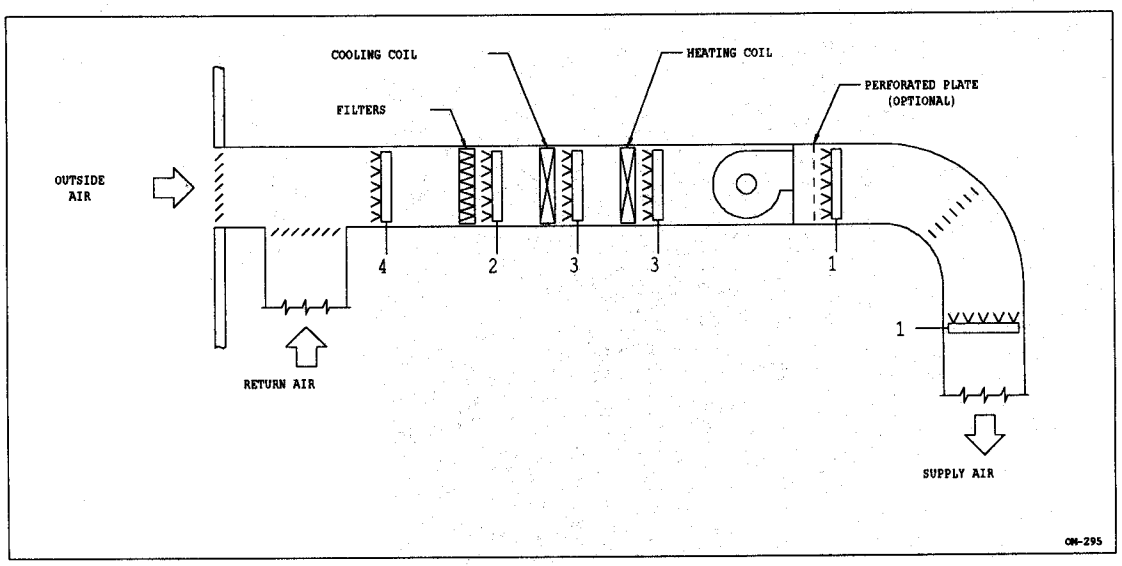
- Burnham Series EL-60-0-GP, 2.1 million Btu/hour Boiler
- York International Model AP-400 Air Handler (up to 32,000 cfm)
- Steam Flow Meter, featuring Meriam Instrument Orifice Plates
- Custom designed and fabricated Test Tunnel with variable cross-section up to 6.5'H x 8'W. Test section length equals 32' of laminar flow.

Installation Guidelines

Steam absorption distance for a system is defined in terms of "bulk" and "last wisp." "Bulk" evaporation is the point beyond which no condensation will occur on objects at the duct temperature. "Last wisp" evaporation is the point beyond which there is no visible steam and it is safe to install high efficiency filters.

Installation

1. The first choice for an installation location would be a point where there is sufficient straight run to allow for "last wisp" evaporation.
2. The second choice would be to locate the system in front of the cooling coil when there is sufficient "bulk" evaporation distance in front of the cooling coil. Since the cooling coil typically has a drain pan, the coil can act as a moisture eliminator in case something should go awry with the total system control.
3. The area prior to the fan or heating coil would be the next choice if sufficient "bulk" evaporation distance is present. If the heating coil is "on" during periods of humidification, the extra heat would help minimize evaporation distance.
4. Locating the system in the mixed air box would be a poor choice due to the potential for cold temperature and turbulent airflow, which could lead to creation of wetted areas.
5. Safing is not required for the most installation. Safing is best avoided since it adds uncontrollable turbulance to the airflow, which can cause surfaces to become wet and, or extend the evaporative distance.

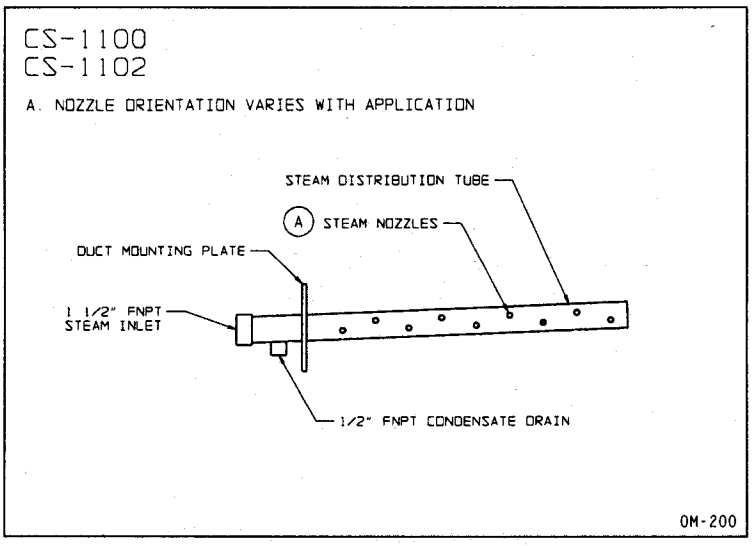


Parts Supplied with the Humidifier

The Herrmidifier CS Series steam distribution system is available in four basic configurations – the CS-1000, the CS-2000, the CS-3000, and the CS-4000. As shown below, each of these systems include at a minimum a method of distributing steam, mounting provisions, a steam inlet connection, and a condensate drain connection(s).

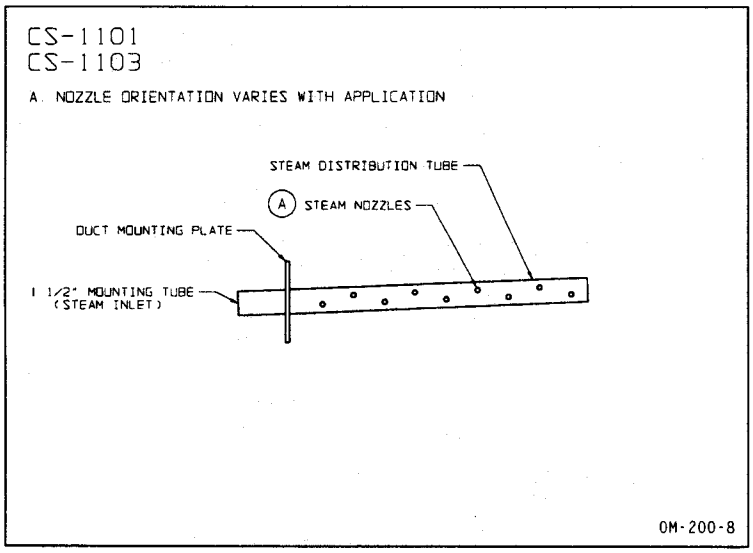
CS-1100, CS-1102 Steam Distribution Systems

(CS-1100 designed for horizontal airflow, CS-1102 designed for vertical airflow)



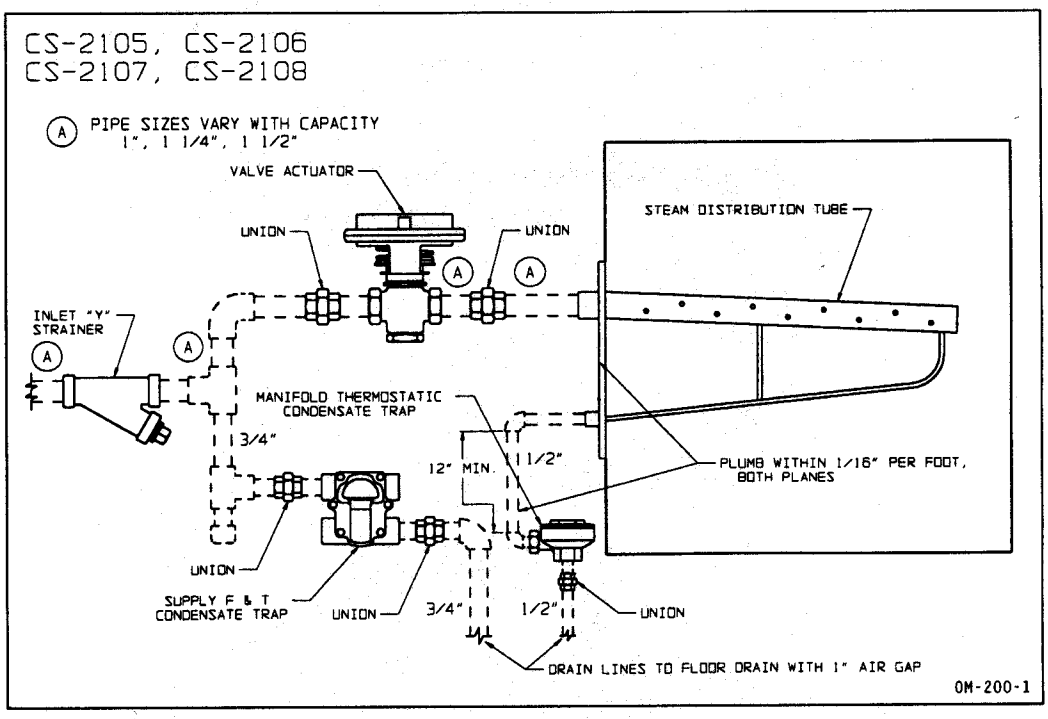
CS-1101, CS-1103 Steam Distribution Systems

(CS-1101 and CS-1103 designed for horizontal airflow)



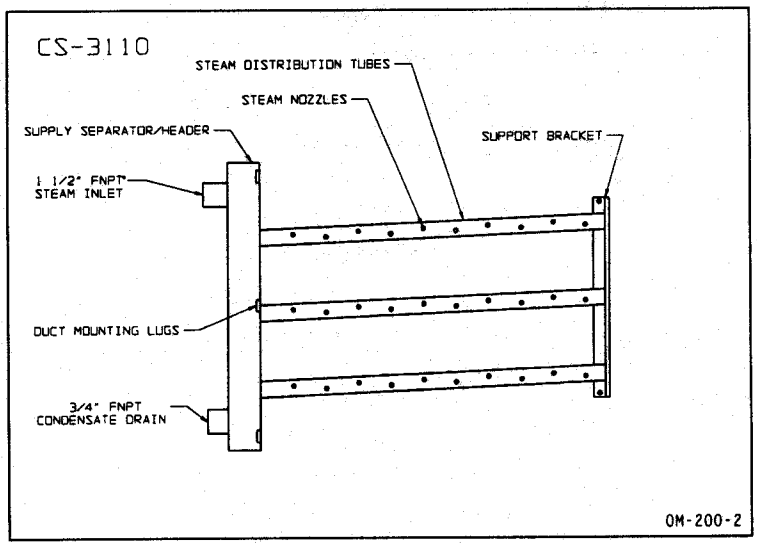
CS-2105, CS-2106, CS-2107, CS-2108 Steam Distribution Systems

(CS-2105, CS-2106 designed for horizontal airflow; CS-2107, CS-2108 designed for vertical airflow)



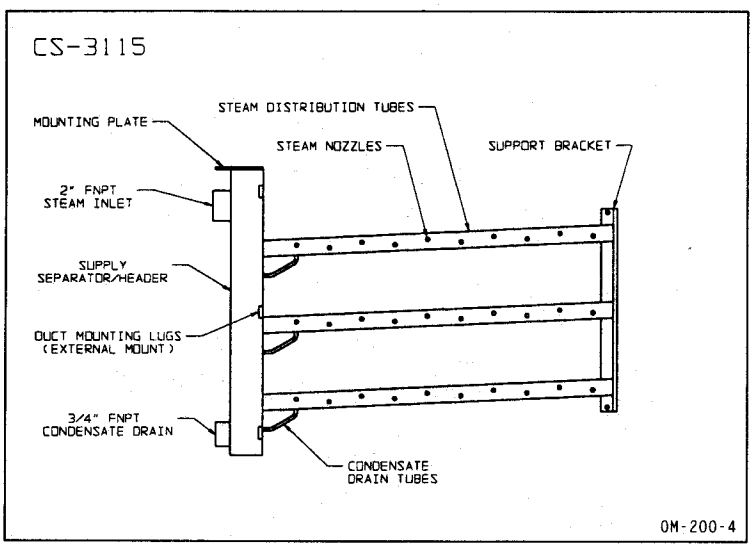
CS-3110 Steam Distribution System

(CS-3110 designed for horizontal airflow)



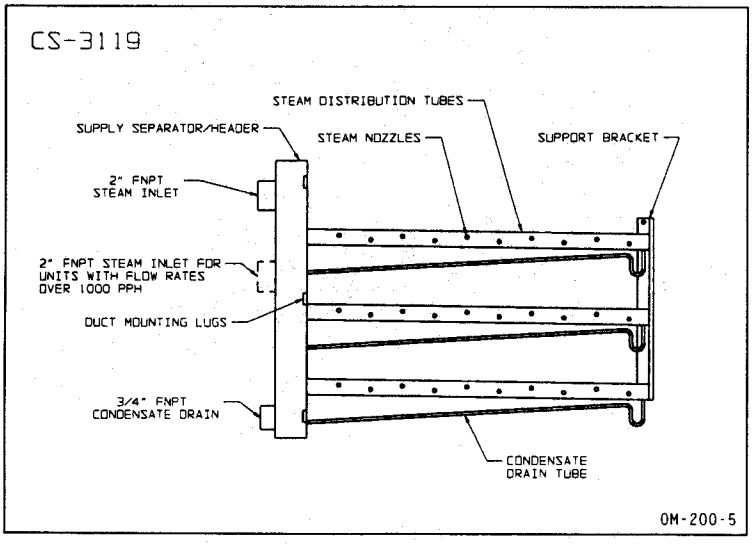
CS-3115 Steam Distribution System

(CS-3115 designed for horizontal airflow, rapid absorption)



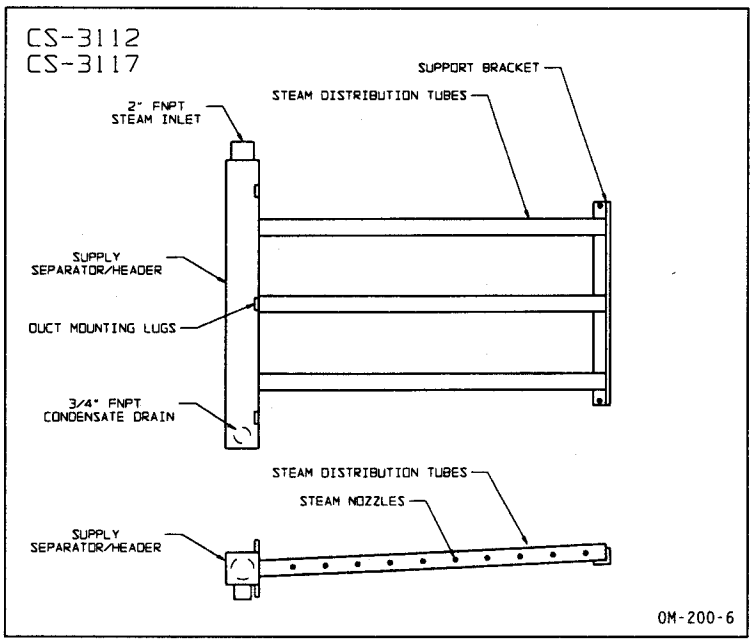
CS-3119 Steam Distribution System

(CS-3119 designed for horizontal airflow, maximum capacity)



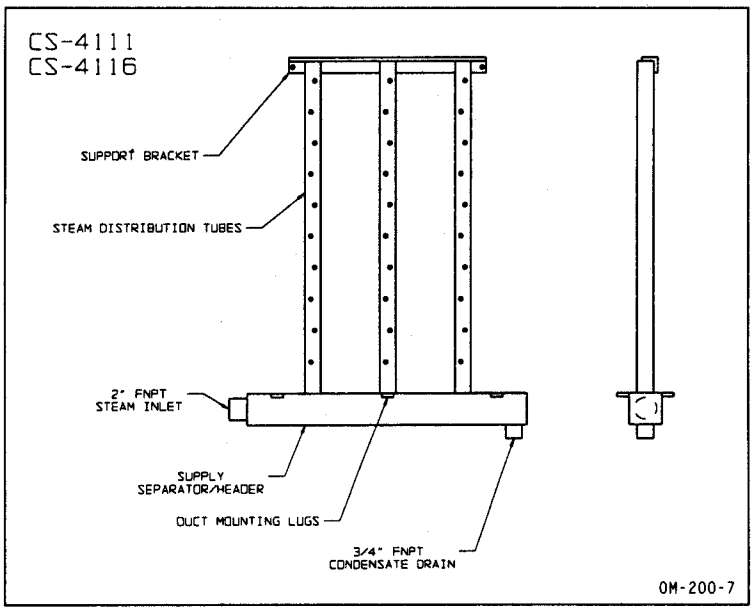
CS-3112, CS-3117 Steam Distribution Systems

(CS-3112, CS-3317 designed for vertical airflow)



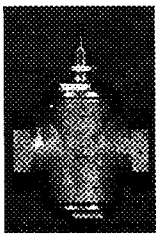
CS-4111, CS-4116 Steam Distribution Systems

(CS-4111, CS-4116 designed for vertical installation in horizontal airflow)

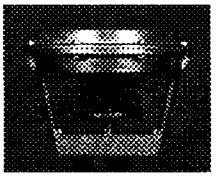


Optional Parts Supplied with Humidifier or Supplied by Others

Steam Valve

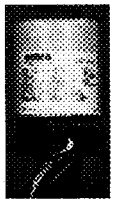


Valve Actuactor



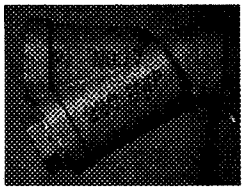
Pneumatic

OR

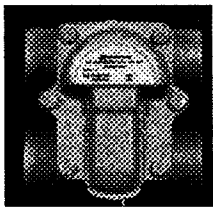


On/Off or Electric Actuators

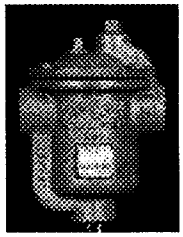
Inlet Strainer



Supply Trap



F & T Trap

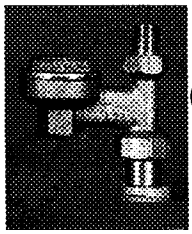


Inverted Bucket Trap

Manifold Trap(s)

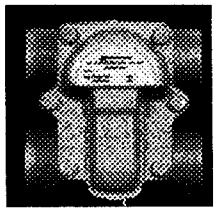
Angle Thermostatic Trap

OR



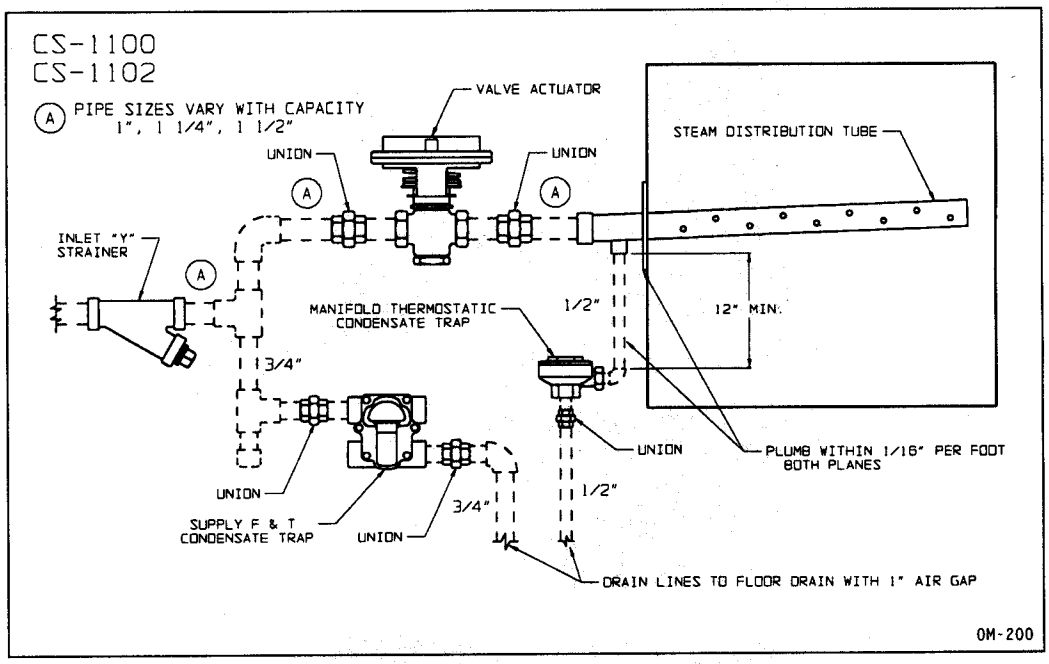
Vertical Thermostatic Trap

OR

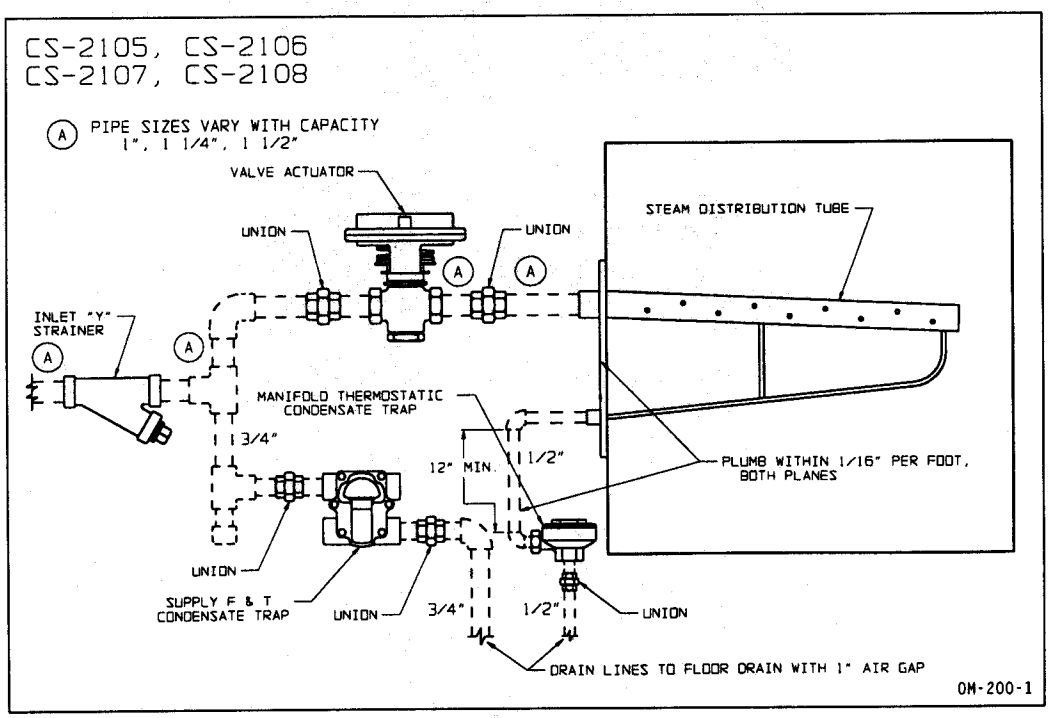


F & T Trap

Parts Supplied by Others
(Unions and items shown in dashed lines)
CS-1100, CS-1102 Steam Distribution Systems

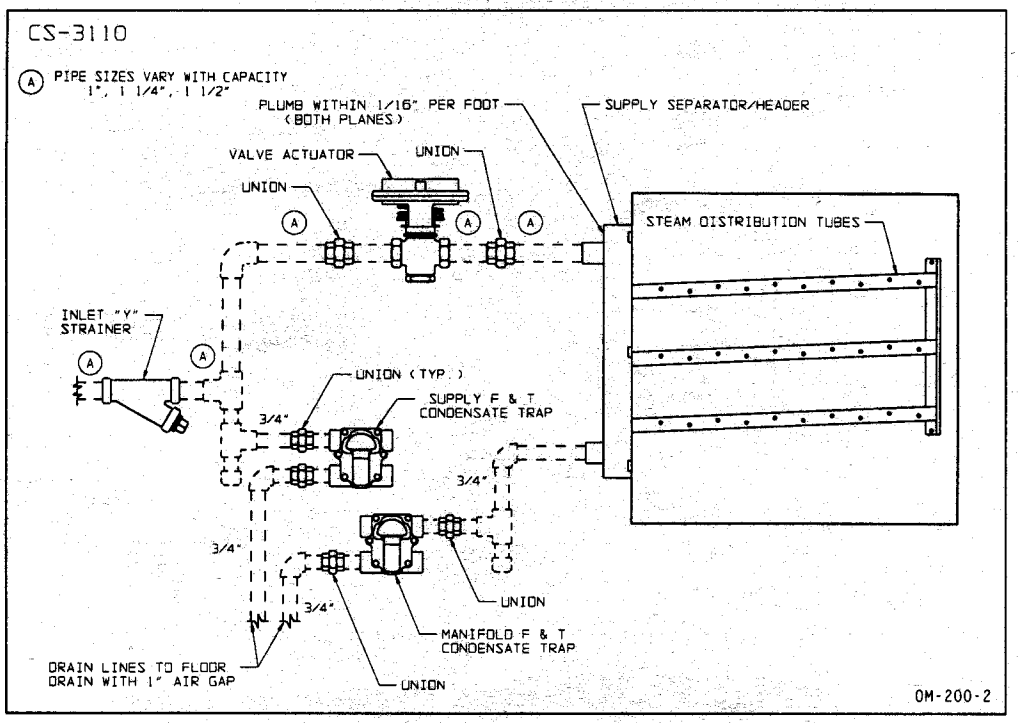


CS-2105, CS-2106, CS-2107, CS-2108 Steam Distribution Systems

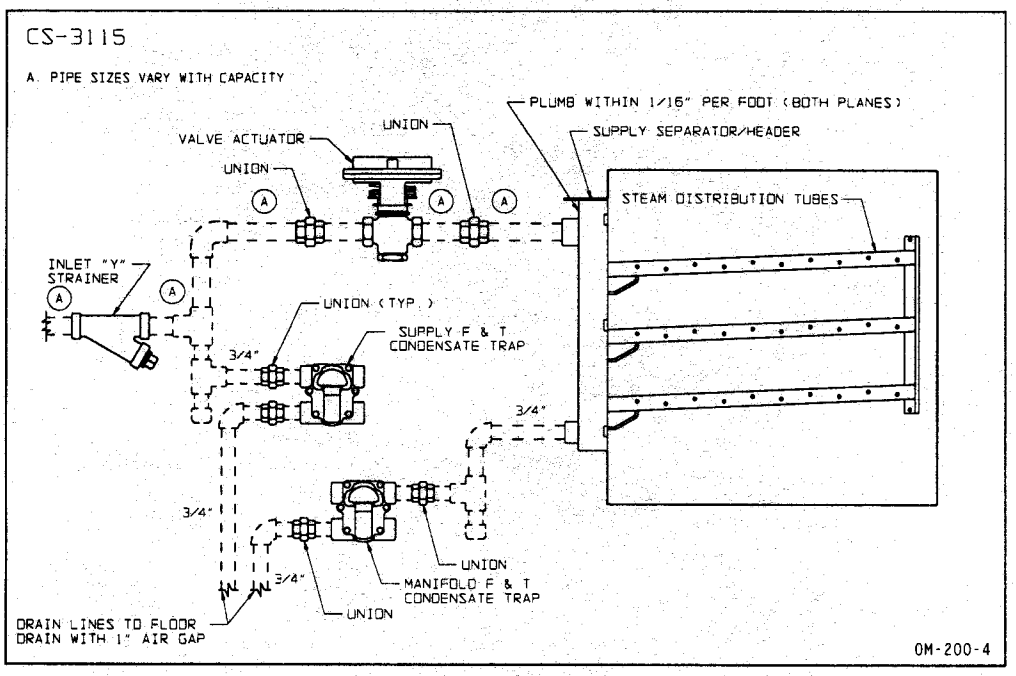


Parts Supplied by Others
(Unions and items shown in dashed lines)

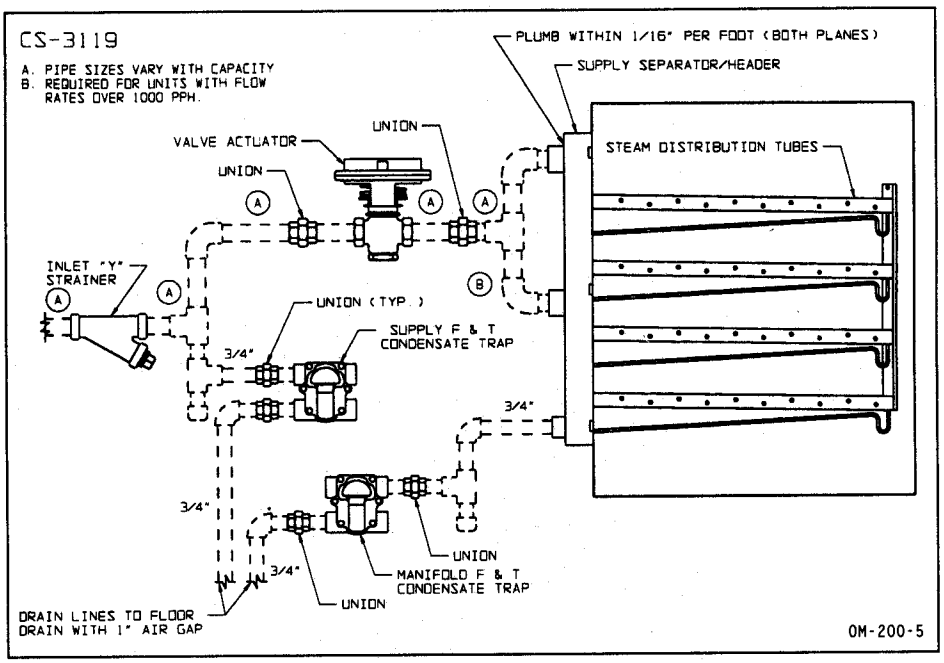
CS-3110 Steam Distribution System



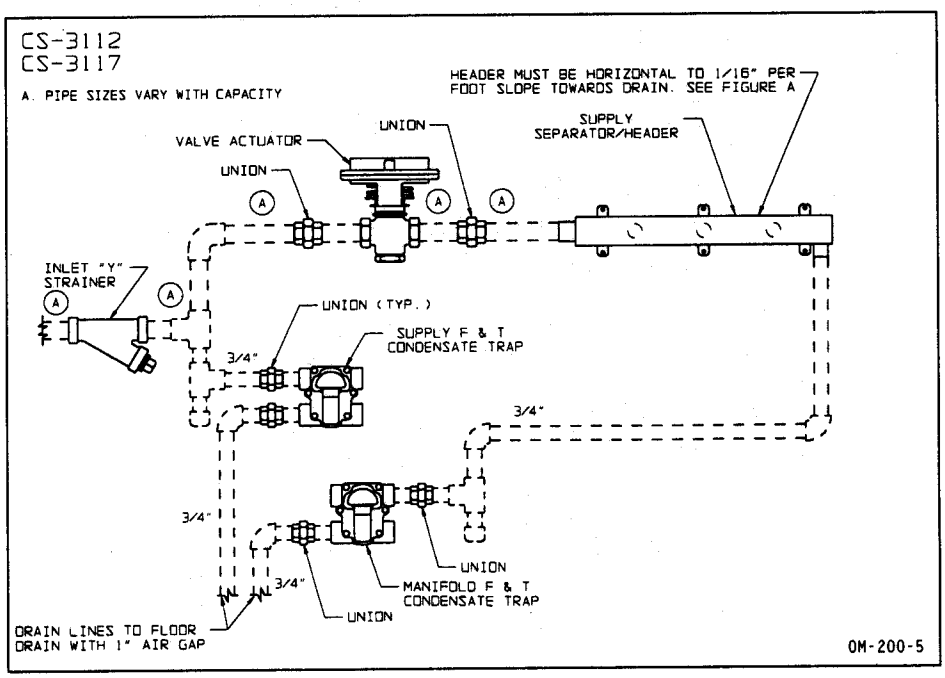
CS-3115 Steam Distribution System



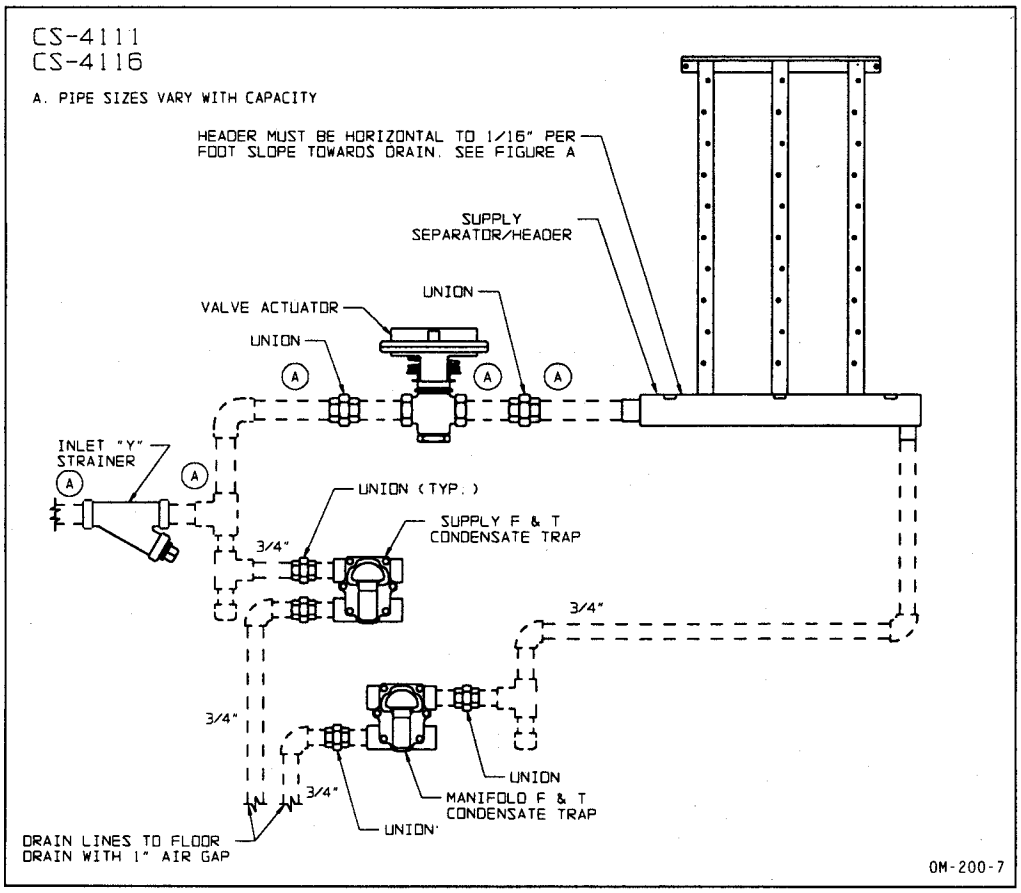
Parts Supplied by Others
(Unions and items shown in dashed lines)
CS-3119 Steam Distribution System



CS-3112, CS-3117 Steam Distribution Systems
(Vertical Airflow)



Parts Supplied by Others
(Unions and items shown in dashed lines)
CS-4111, CS-4116 Steam Distribution Systems
(Vertical Tubes for Horizontal Airflow)



I. Determine the Downstream Duct Relative Humidity

To properly select your new steam distribution system, some information is required initially. You will need to know the duct or air handler dimensions where the unit is to be installed, the capacity requirement, and what type of control and accessories will be used. If you already know the duct relative humidity downstream of the humidifier, you may skip to step #2.

Duct Relative Humidity

Room Temp.	Duct Temperature °F	°C	Room Relative Humidity - %R.H. 25	30	35	40	45	50	55	60	65	70	75	80
68° F	50	10	46	57	65	75	83	93						
19° C	55	12.8	39	48	54	62	70	79	85	94				
	60	15.6	31	40	46	51	59	66	71	79	87	91	98	
	65	18.3	28	33	39	44	50	55	60	66	73	79	82	89
	70	21.1	22	29	31	38	41	48	51	56	61	65	70	75
70° F	50	10	50	61	72	81	92							
21° C	55	12.8	40	51	60	68	77	84	94					
	60	15.6	36	42	50	56	63	70	77	85	92			
	65	18.3	30	36	41	50	53	60	66	71	78	82	89	96
	70	21.1	25	30	35	40	45	50	56	60	65	70	75	80
72° F	50	10	50	65	75	85	96							
22° C	55	12.8	42	54	62	70	80	90	97					
	60	15.6	37	46	52	60	68	74	81	90	98			
	65	18.3	30	39	44	50	56	61	70	76	81	88	94	
	70	21.1	27	31	38	41	48	52	59	54	70	73	80	85
74° F	50	10	59	69	80	92								
23° C	55	12.8	49	58	67	78	87	97						
	60	15.6	40	48	56	65	71	80	89	98				
	65	18.3	33	39	48	54	60	69	73	81	89	95		
	70	21.1	29	34	40	47	51	58	62	69	73	80	86	91

II. Upstream Clearance Requirements

Some upstream clearance is required for the nozzle discharge into the airstream. This varies depending on temperature,the obstruction, velocity and nozzle sizing. The chart below is for duct temperature above 50 degrees F. Distances shown are from the center of the steam distributor tube in inches.

Air	Steam Intensity, lbm/hr/ft							
Velocity, fpm	**5.0**	**7.5**	**10**	**15**	**20**	**25**	**30**	**50**
400	**2.5**	**2.5**	**3.0**	**3.0**	**3.0**	**4.0**	**4.0**	**6.0**
500	**2.0**	**2.0**	**3.5**	**2.5**	**2.5**	**3.5**	**3.5**	**5.0**
750	**1.75**	**1.75**	**2.25**	**2.25**	**.25**	**3.0**	**3.0**	**4.0**
1000	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.5**	**2.5**	**3.0**
>1000	**<1.5**	**<1.5**	**<2.0**	**<2.0**	**<2.0**	**<2.5**	**<2.5**	**<3.0**

We recommend a minimum of 6" downstream of an object for service and installation concerns. The only time 6" is insufficient would be on a VAV system which combines manifolds in the air handler and a very high steam intensity - which is a rare condition. The upstream clearance chart is shown for confirmation that the 6" number is adequate.
For example: We have a total of 30" to evaporate the steam at 60 degrees F, 80% RH and 1500 fpm. The chart shows we only need between <1.5" and <3.0" at the velocities over 1000 fpm. The 6" recommended clearance is more than sufficient. Therefore, our **net** available evaporation distance is 24"

III. "Correction Factor" for Duct Temperature and Duct Relative Humidity.

Duct temperature and *downstream duct relative humidity* have a profound effect on the evaporative distance of any humidifier. Together with *air velocity,* which will be addressed in step #4, these are the factors that can make or break an otherwise good application. All three must be addressed for a good application.

The correction factor will take the conditions present in the subject duct/air handler and translate those conditions to the standard conditions of 55 degrees F @ 70% RH. The evaporation distances at standard conditions are detailed on the Steam Intensity Chart on the next page. The correction factor will make the specific conditions in the duct/air handler equal to the standard conditions of 55 degrees F @ 70% RH. For example, if the conditions in the duct are less conducive to evaporation, say 60 degrees F @ 80% RH, we must use the "Correction Factor" Chart to determine the shorter evaporation distance than required at standard conditions.

Correction Factor For Bulk and Last Wisp Evaporation Distances

DUCT TEMP, °F	RELATIVE HUMIDITY						
	30%	40%	50%	60%	70%	80%	90%
40	0.75	0.88	1.06	1.32	1.76	2.64	5.28
45	0.62	0.73	0.87	1.09	1.45	2.18	4.35
50	0.52	0.60	0.72	0.90	1.20	1.80	3.61
55	0.43	0.50	0.60	0.75	1.00	1.50	3.00
60	0.36	0.42	0.50	0.63	0.84	1.25	2.51
65	0.30	0.35	0.42	0.53	0.70	1.05	2.10
70	0.25	0.30	0.35	0.44	0.59	0.88	1.77
75	0.21	0.25	0.30	0.37	0.50	0.75	1.49
80	0.18	0.21	0.25	0.32	0.42	0.63	1.27
85	0.15	0.18	0.22	0.27	0.36	0.54	1.08
90	0.13	0.15	0.18	0.23	0.31	0.46	0.92
95	0.11	0.13	0.16	0.20	0.26	0.39	0.79
100	0.10	0.11	0.14	0.17	0.23	0.34	0.68

Notice that the correction factor is 1.25 and we want the bulk of the steam evaporated in 24". The corrected bulk evaporation distance is:

E_c = 24" / 1.25 = 19.2" or 1.6'

IV. Determine Steam Intensity

The steam intensity is defined as the amount of steam in lbm/hr. to be distributed by a foot of evaporative tube. The lower the steam intensity, the quicker the evaporation. Using the velocity of the duct or air handler to be humidified, together with the corrected evaporative distance in feet, E_c, the necessary steam intensity can be determined. The steam intensity must be selected so that the evaporation distances are less than the corrected evaporation distances.

	Steam Intensity, #/hr/ft							
Air Velocity,fpm	5 Bulk	5 Last Wisp	7.5 Bulk	7.5 Last Wisp	10 Bulk	10 Last Wisp	15 Bulk	15 Last Wisp
500	0.6	7.8	0.9	9.8	1.4	12.4	2.0	15.7
750	0.6	6.9	0.9	8.8	1.3	11.1	2.0	14.1
1000	0.5	6.5	0.8	8.1	1.2	10.1	1.9	12.6
1250	0.5	5.6	0.7	7.0	1.2	8.7	1.9	10.9
1500	0.4	4.8	0.7	6.0	1.1	7.6	1.9	9.4

Air Velocity, fpm	20 Bulk	20 Last Wisp	30 Bulk	30 Last Wisp	50 Bulk	50 Last Wisp
500	2.9	19.8	4.3	25.1	6.3	31.8
750	3.0	17.8	4.5	22.6	6.9	28.6
1000	3.0	15.8	4.8	19.8	7.5	24.8
1250	3.1	13.7	5.1	17.1	8.1	21.4
1500	3.2	11.8	5.3	14.8	8.7	18.5

"Steam Intensity" is the amount of steam discharged from a steam manifold in lbm/hr of steam/ft of manifold
"Bulk" evaporation is the point beyond which no condensation will occur on objects at the duct temperature
"Last Wisp" evaporation is the point beyond which there is no visible steam.

From our example in step #3, the corrected bulk evaporative distance, E_c, was equal to 19.2" or 1.6'. Our duct velocity was 1500 fpm. Therefore, the required steam intensity would be 10 lbm/hr./ft. The highlighted spot shows an evaporation distance of 1.1' at 1500 fpm velocity. Steam which would evaporate in 1.1' at 55 degrees F @ 70% would evaporate in 1.1' x 1.25 correction factor or 1.38' at 60 degrees F, 80% RH.

WARNING: Utilizing the three charts above will allow you to accurately predict the evaporative distance based on the design parameters you select. Any deviation from the parameters you've selected (temperature, downstream RH, velocity, steam intensity) or turbulent airflow will dramatically effect the evaporative distance. Consult the factory prior to running a system that has been modified from the design parameters to insure a troublefree installation.

V. Choosing the proper *Herricane CS Series Humidifier* for your Application

- You should now have almost all the information needed to select the components necessary to build your humidifier. To summarize, the following information is needed:
- Capacity
- Duct or Air Handler Dimensions
- Steam Intensity

The CS Series has the following design limitations:

Model Number	Manifold Limitations	Maximum Capacity
CS-1000	Single Manifold, 6' Length	100 lbs/hr (45.5 kg/hr)
CS-2000	Single Manifold, 10' Length	600 lbs/hr (273 kg/hr)
CS-3000	Horizontal Pipe Multi-Tube Humidifier	2000 lbs/hr (910 kg/hr)
CS-4000	Vertical Pipe Multi-Tube Humidifier	1600 lbs/hr (727 kg/hr)

NOTE: The CS Series units are designed to be mounted to the duct or air handler wall. The standard systems are designed for a maximum 1" thick wall. If the duct wall is thicker, additional spacing will have to be provided on either end of the distributor tube to prevent any condensation from forming on the duct walls.

You will also have to calculate the maximum capacity per tube as follows
Maximum Capacity per Tube = (Duct Width - 6") x Steam Intensity = **Tc**

1) If **Tc** can be achieved with one tube with less than 60 lbs/hr capability, the CS-1100 is your choice.
2) If **Tc** can be achieved with one tube with less than 500 lbs/hr capability, the CS-2105 is your choice.
3) The CS-3110 has a minimum tube spacing of 3". Therefore, the maximum number of tubes is 25 tubes. If your total system capacity divided by **Tc** is less than 25, the CS-3110 may be a possibility. It may be possible that the CS-3110 is more expensive that the CS-3115 or CS-3119 to achieve the same evaporative performance. Consult your Herrmidifier representative for a comparative analysis.
4) The CS-3115 and CS-3119 is has the greatest system capacity, upwards of 2000 lbs/hr. Due to the various design factors including the various header sizes, it is necessary to contact your Herrmidifier representative for exact system design.

Steam Valve - Valves are available for all capacity requirements. At this time all valves are selected by the factory. To make the selection, we need to know capacity requirements, inlet steam pressure, and any special features required such as stainless steel construction.

Actuator - Pneumatic, electric and solenoid operators are available. These actuators are matched to the steam valves.

Inlet Strainer - Strainer sizes are selected based on valve sizing. Special construction such as stainless steel are available upon request.

Supply Traps - Float and Thermostatic or Inverted Bucket supply traps are available. Trap sizes are based on inlet pressure and capacity requirements.

Manifold Traps - Float and Thermostatic as well as Thermostatic (both angle and vertical) are available. These are selected based on capacity requirements.

Control Options - A variety of control options are available from Herrmidifier to meet your exact requirements. It is recommended that control, high limit and air proving devices are utilized for each humidifier. If several humidifiers are used to humidify a common area, a common control humidistat may be used but individual high limit and air proving devices are still recommended.

Central Steam Comparative Noise Levels

Background: A standard Herrmidifier single tube manifold (CS-1105) was compared to competitive units (one jacketed with steam nozzle, the other jacketed with silencing media and holes for steam discharge). All units were mounted 8' downstream of flow straighteners in 4' x 4' duct section. All measurements were taken 1 meter downstream of the manifolds with a Type 1 (+/- 1.0 dB accuracy) SPL meter. Air velocity was 500 fpm.

Results:

Herrmidifier CS-2105	78.5 dB
Jacketed with Nozzles	94.5 dB
Jacketed with Holes	96.0 dB

Conclusion: The Herrmidifier design, including the precision nozzles and matched manifold results in a unit that is up to 7.6 times quieter than the competition.

1. Typical Size and Weight

Model	Weight Calculation	Examples		
		1' Wide	3' Wide	6' Wide
CS-1100, 1101, 1102, 1103	0.87 x distribution tube length (in feet) + 1.65	2.52 lb.	4.26 lb.	6.87 lb.
CS-2105, 2106,	Distribution tube length (in feet) + 2.50.	3.50 lb.	5.50 lb.	8.50 lb.
CS-2107, 2108,	1.74 x Distribution tube length (in feet) + 2.50.	4.24 lb.	7.72 lb.	12.94 lb.

Model	Weight Calculation
CS-3110. 3112, 4111	4.64 x length of header (in feet) + (0.93 x length of distribution tube (in feet) x number of distribution tubes)
CS-3115, 3117, 4116	6.28 x length of header (in feet) + (1.70 x length of distribution tube (in feet) x number of distribution tubes)
CS-3119	6.28 x length of header (in feet) + (1.83 x length of distribution tube (in feet) x number of distribution tubes)

Note:

- **CS-1000 and CS-2000 series allow 2" clearance between end of tube and wall.**
- **CS-3000 and 4000 series allow 1/4" clearance between end of tubes and wall.**
- **If more than 1" insulation is used, notify the factory for nozzle repositioning. ONLY EXTERNAL INSULATION SHOULD BE USED IN BULK EVAPORATION AREA!**

2. Air Static Pressure Loss, in. W.C.

Air	Tube-Spacing, in.		
Velocity	3.0	4.5	6.0
500	0.01	<0.01	<0.01
750	0.03	0.01	0.01
1000	0.05	0.02	0.02
1250	0.07	0.04	0.03
1500	0.10	0.05	0.04
1750	0.13	0.07	0.06
2000	0.16	0.09	0.08

3. HEAT GAIN AND TEMPERATURE RISE OF AIR FLOW

Heat gain, and the resulting temperature rise, of the air flow is caused by two sources:

1) Heat transfer from the steam distribution manifolds - considered Efficiency.
   This heat transfer is manifest in two forms:
   a) Convection from distribution manifold(s) to the air.
   b) Radiation from distribution manifold(s) to the air and duct walls with consequential convection to the air.

2) Sensible heat transfer from the water vapor to the air.

To calculate the total heat gain to the air, humidifier efficiency, and air temperature rise, use the following two charts and formulas.

NOMENCLATURE

m(IN) = mass flow rate of steam entering humidifier
m(OUT) = mass flow rate of steam discharging from humidifier
m(LIQ) = mass flow rate of condensate from humidifier
f = heat gain from humidifier per unit length of manifold
u = heat gain due to sensible heat transfer from steam per unit rate of flow
h = total heat gain n = efficiency of humidifier l = total length of manifold(s)
x = heat gain from humidifier
s = heat gain due to sensible heat transfer from discharged steam
Q = air flow rate ΔT = air temperature rise V = air velocity
v = air specific volume A = duct cross sectional area

HEAT GAIN FROM HUMIDIFIER PER FOOT OF MANIFOLD

Btu/hr-ft *(f)*

UPSTREAM				VELOCITY, fpm					
DUCT TEMP, F	300	400	500	750	1000	1250	1500	1750	2000
40	606.3	643.7	677.4	751.6	816.3	874.7	928.7	979.2	1026.8
45	594.2	630.8	663.9	736.6	800.0	857.3	910.2	959.6	1006.3
50	582.2	618.0	650.5	721.6	783.8	839.9	891.7	940.2	985.9
55	569.9	604.9	636.7	706.4	767.2	822.1	872.8	920.3	965.1
60	558.0	592.3	623.4	691.6	751.2	805.0	854.6	901.1	944.9
65	545.9	579.5	609.9	676.6	734.9	787.5	836.1	881.5	924.4
70	533.8	566.6	596.4	661.6	718.6	770.1	817.6	862.0	903.9
75	521.7	553.8	582.9	646.7	702.4	752.7	799.1	842.5	883.5
80	509.6	541.0	569.4	631.7	686.1	735.2	780.6	823.0	863.0
85	497.5	528.1	555.9	616.7	669.8	717.8	762.0	803.4	842.5
90	485.4	515.3	542.3	601.7	653.5	700.3	743.5	783.9	822.0
95	473.3	502.4	528.8	586.7	637.2	682.8	724.9	764.3	801.5
100	461.3	489.7	515.4	571.8	621.0	665.5	706.5	744.9	781.2
105	449.2	476.8	501.8	556.7	604.7	648.0	688.0	725.3	760.7

HEAT GAIN DUE TO SENSIBLE HEAT TRANSFER FROM STEAM FLOW, PER 1.0 LBM/HR

Btu/hr (*u*)

UPSTREAM		UPSTREAM	
DUCT TEMP, F	Btu/hr	DUCT TEMP, F	Btu,hr
40	74.0	75	58.7
45	71.8	80	56.5
50	69.8	85	54.3
55	67.4	90	52.2
60	65.2	95	50.0
65	63.0	100	47.9
70	60.9	105	45.8

BASIC FORMULAS

$x = (f)(l)$ $s = [m(\text{OUT})](u)$ $h = x + s$

$n = [m(\text{OUT})]/[m(\text{IN})]$ $m(\text{OUT}) = m(\text{IN}) - m(\text{LIQ})$

$m(\text{LIQ}) = x/(966.2\text{Btu/lbm}H_2O)$ $\Delta T = [(h)(v)]/[(Q)(C_p)]$

EXAMPLE:

Model CS-3115, 3 tubes, 5 ft long distribution tubes, 3 ft high header, 400 #/hr 50°F upstream duct temperature, 750 ft/min, 6 ft duct width, 5 ft duct height, unit mounted completely inside duct.

$x = (f)(l) = (721.6\text{Btu/hr-ft})[(3\text{ tubes})(5\text{ ft/tube}) + (3\text{ ft/header})]$
$x = 12{,}990$ Btu/hr

$m(\text{LIQ}) = x/(966.2\text{ Btu/lbm}H_2O) = (12{,}990\text{ Btu/hr})/(966.2\text{ Btu/lbm}H_2O)$
$m(\text{LIQ}) = 13.44\text{ lbm}H_2O\text{/hr}$

$m(\text{OUT}) = m(\text{IN}) - m(\text{LIQ}) = 400\text{ lbm}H_2O\text{/hr} - 13.44\text{ lbm}H_2O\text{/hr}$
$m = 387\text{ lbm}H_2O\text{/hr}$

$n = m(\text{OUT})/m(\text{IN}) = (387\text{ lbm}H_2O\text{/hr})/(400\text{ lbm}H_2O\text{/hr})$
$n = 96.8\%$

$s = [m(\text{OUT})](u) = (387\text{ lbm}H_2O\text{/hr})(69.8\text{ Btu/hr})$
$s = 27{,}010$ Btu/hr

$h = x + s = 12{,}990\text{ Btu/hr} + 27{,}010\text{ Btu/hr}$
$h = 40{,}000$ Btu/hr

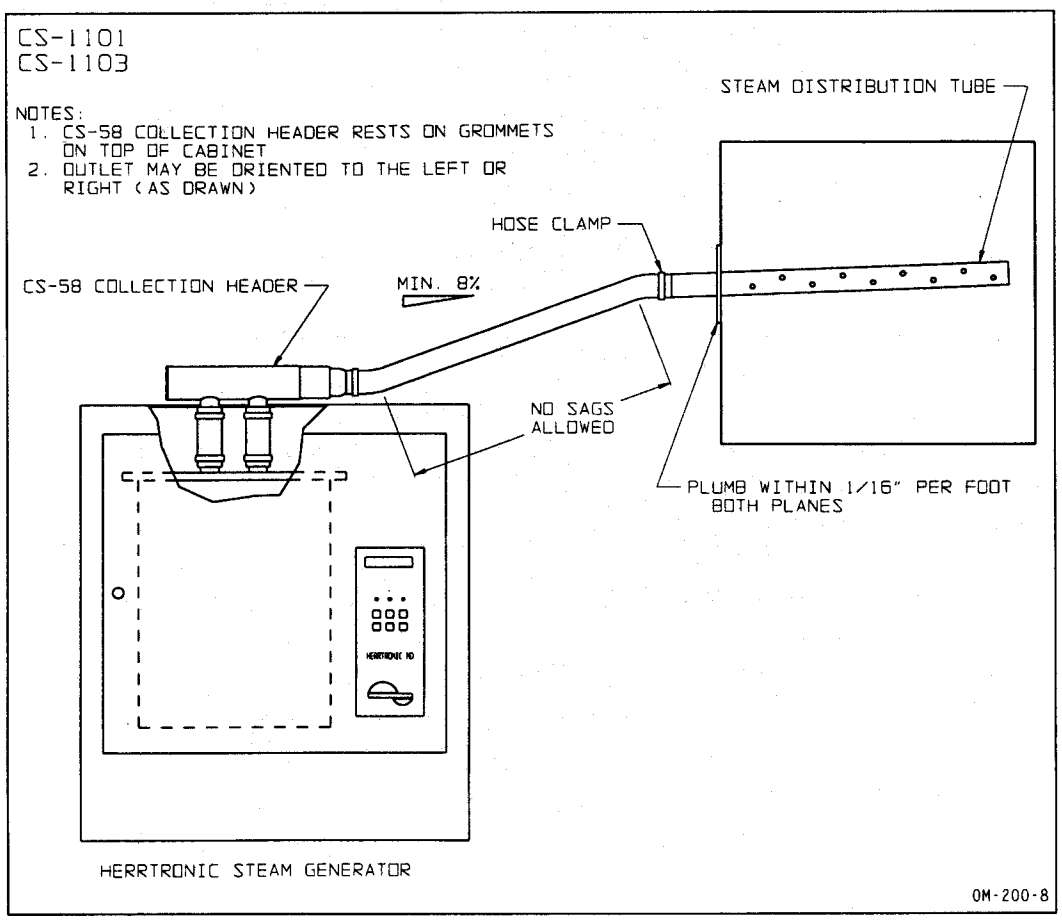
AIR TEMPERATURE RISE

$Q = (V)(A) = (750\text{ ft/min})(6\text{ ft})(5\text{ ft})$
$Q = 22{,}500\text{ ft}^3\text{/min}$

$\Delta T = [(h)(v)]/[(Q)(C_p)]$
$\Delta T = [(40{,}000\text{ Btu/hr})(12.95\text{ ft}^3\text{/lbm})]/[(22{,}500\text{ ft}^3\text{/min})(60\text{ min/hr})(0.24\text{ Btu/lb}_m\text{-°F})]\Delta T = 1.6$°F

The use of a low pressure source of steam, such as a self-contained electrode boiler requires some special installation considerations with regard to duct air velocity, duct static pressure and interconnecting plumbing between the steam generating unit and the steam distribution system. Following the instructions below will insure a trouble-free installation.

1. Manifolds, header, and nozzles are all stainless steel material.
2. Manifold trap required on CS-2000, CS-3000 and CS-4000 series units. Trap not required on CS-1000 series units.
3. CS-58 collection header may be used to connect a dual outlet steam tank to a single 2" hose or tube for connection to a distribution system.
4. MDD units require a separate distribution system for each cylinder.
5. Exact number of steam distributor tubes may vary.
6. Exact number of steam nozzles per distributor tube may vary.
7. Duct static pressure: <5" H_2O
8. Air Velocity: < 2000 fpm
9. Steam outlets on steam cylinder are 1 1/2" O.D. Recommended supply lines are 1 1/2" Insulated Type L Copper Pipe with 1 1/2" Hose cuffs for single steam outlet (units to 50 lbs/hr) and 2" I.D. insulated copper pipe for two outlet units (units with capacity from 51-100 lbs/hr)
10. Unit shown with CS-1101. Other CS Series may also be used.
11. Plumbing from unit to steam distribution system provided by others.



Suggested Specifications for Herrmidifier Herricane CS Series Central Steam Distribution System

15781 Humidifiers
Part 1 General

A. Scope

1. Furnish a system of humidification indicated on the drawings complete with:
   - Steam Distribution System
   - Inlet Strainer (optional)
   - Supply Trap (optional)
   - Steam Valve and Actuator (optional)
   - Manifold Traps (optional)
   - Controls - Control Humidistat, Limit Humidistat, Air Proving Device (all recommended) (optional)
2. Operation of the system shall be controlled automatically to maintain_____%RH at ____degrees F with a tolerance of +/-_____% RH.
3. Warranty system for a period of one (1) year from date of beneficial use of the owner. Distribution system shall be warranted for a period of three (3) years.
4. Provide owners manual to cover installation, start-up, operating and maintenance.
5. The manufacture shall guarantee the performance of the system in writing based on design air volume, temperature, downstream RH, and capacity. Performance is defined as "bulk" and "last wisp" evaporation and laminar airflow.

Part 2 Product

A. Distribution System

1. Provide steam distribution system constructed entirely of stainless steel. Dissimilar materials are not acceptable.
2. All welding to be done in accordance with ASME Section IX.
3. Steam distribution system shall be pressure tested with steam at operating pressure or greater, at the factory prior to shipment.
4. Entering steam will be forced to take two 90 degree turns before reaching the distribution system (pressure systems only).
5. The manifold shall be equipped with stainless steel nozzles, press fitted into the stainless steel manifold. The output of the nozzle is limited to a maximum of 5 lbs/hr. Exact capacity of nozzles to be determined based on required evaporative distance and design psychrometric conditions. Nozzles extend into the center of the manifold to allow only the driest, hottest steam to be allowed to enter the airstream. Nozzles must be identical output for entire distriibution manifold. Manifolds with holes or orifices only are not acceptable.

6. Multiple manifold system shall have header and distribution tubes constructed as a system: all joints shall be welded - slip joints and "o" rings are not acceptable.
7. Distribution manifold shall be unjacketed and allowed to cool to surrounding temperature when there is no requirement for humidity. Jacketed manifolds with insulation (extra airflow resistance) or isolation valve (cracking welds) are not acceptable.
8. Distribution manifold design feature provisions for manifold trap(s). This trap, which can be either a thermostatic or float and thermostatic trap (a "P-Trap" will work with self-generating systems), allows any condensate formed to exit without entering the airstream.
9. Steam valve, actuator, traps and strainer to be based on parameters of the application.
10. Temperature interlock switch is not required. Any condensate formed within the manifold will be drained out of the manifold trap.

Part 3 Execution

A. General

1. Install system(s) as detailed on the drawings and/or as recommended by the manufacturer. Shop drawings shall be provided by the manufacturer. Manufacturer's representative shall provide analysis, design, and startup support of the custom engineered humidification system(s).
2. It shall be the responsibility of the installing contractor to furnish necessary control provisions, wiring, and plumbing as indicated in the manufacturer's specifications and the appropriate schedules. All wiring shall be in accordance with applicable sections of electrical specifications and local codes.
3. Manufacturer:

Herrmidifier Company, Inc.
1812 Colonial Village Lane
Lancaster, PA 17605-1148

www.herrmidifier.net • e-mail: herrsales@trioninc.com
P.O Box 760 • 101 McNeill Road • Sanford, North Carolina 27331-0760 • Customer Service: (800) 884-0002 • Fax: (800) 458-2379
Trion Limited • Reith Way, West Portway Industrial Estate • Andover, Hampshire SP10 3TY • Tel: (01264) 364622 • Fax: (01264) 350983
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