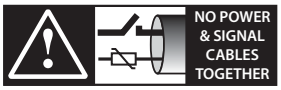
ultimateSAM

CAREL

Direct Steam Humidification System
Sistema di umidificazione ultimateSAM

ENG Design manual
ITA Guida alla progettazione



Integrated Control Solutions & Energy Savings

WARNINGS

The CAREL Industries humidifiers are advanced products, whose operation is specified in the technical documentation supplied with the product or can be downloaded, even prior to purchase, from the website www.carel.com. Each CAREL Industries product, in relation to its advanced level of technology, requires setup/configuration/programming/commissioning to be able to operate in the best possible way for the specific application. The failure to complete such operations, which are required/indicated in the user manual, may cause the final product to malfunction; CAREL Industries accepts no liability in such cases.
The customer (manufacturer, developer or installer of the final equipment) accepts all liability and risk relating to the configuration of the product in order to reach the expected results in relation to the specific final installation and/or equipment. CAREL Industries may, based on specific agreements, acts as a consultant for the installation/commissioning/use of the unit, however in no case does it accept liability for the correct operation of the humidifier and the final installation if the warnings or suggestions provided in this manual or in other product technical documents are not heeded. In addition to observing the above warnings and suggestions, the following warnings must be followed for the correct use of the product:

- **DANGER OF ELECTRIC SHOCK**

The humidifier contains live electrical components. Disconnect the power supply before accessing inside parts or during maintenance and installation.

- **DANGER OF WATER LEAKS**

The humidifier automatically and constantly fills/drains certain quantities of water. Malfunctions in the connections or in the humidifier may cause leaks.

- **DANGER OF BURNS**

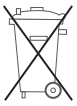
The humidifier contains high temperature components and delivers steam at 100°C/ 212°F.

Warning:

- The installation of the product must include an earth connection, using the special yellow-green terminal available in the humidifier.
- The environmental and power supply conditions must conform to the values specified on the product rating labels.
- The product is designed exclusively to humidify rooms either directly or through distribution systems (ducts).
- Only qualified personnel who are aware of the necessary precautions and able to perform the required operations correctly may install, operate or carry out technical service on the product.
- Only water with the characteristics indicated in this manual must be used for steam production.
- All operations on the product must be carried out according to the instructions provided in this manual and on the labels applied to the product. Any uses or modifications that are not authorized by the manufacturer are considered improper. CAREL Industries declines all liability for any such unauthorized use.
- Do not attempt to open the humidifier in ways other than those specified in the manual.
- Observe the standards in force in the place where the humidifier is installed.
- Keep the humidifier out of the reach of children and animals.
- Do not install and use the product near objects that may be damaged when in contact with water (or condensate). CAREL Industries declines all liability for direct or indirect damage following water leaks from the humidifier.
- Do not use corrosive chemicals, solvents or aggressive detergents to clean the inside and outside parts of the humidifier, unless specifically indicated in the user manual.
- Do not drop, hit or shake the humidifier, as the inside parts and the linings may be irreparably damaged.

CAREL Industries adopts a policy of continual development. Consequently, CAREL reserves the right to make changes and improvements to any product described in this document without prior warning. The technical specifications shown in the manual may be changed without prior warning.
The liability of CAREL Industries in relation to its products is specified in the CAREL Industries general contract conditions, available on the website www.carel.com and/or by specific agreements with customers; specifically, to the extent where allowed by applicable legislation, in no case will CAREL Industries, its employees or subsidiaries be liable for any lost earnings or sales, losses of data and information, costs of replacement goods or services, damage to things or people, downtime or any direct, indirect, incidental, actual, punitive, exemplary, special or consequential damage of any kind whatsoever, whether contractual, extra-contractual or due to negligence, or any other liabilities deriving from the installation, use or impossibility to use the product, even if CAREL Industries or its subsidiaries are warned of the possibility of such damage.

DISPOSAL



The humidifier is made up of metal parts and plastic parts. In reference to European Union directive 2002/96/EC issued on 27 January 2003 and the related national legislation, please note that:

1. WEEE cannot be disposed of as municipal waste and such waste must be collected and disposed of separately;
2. the public or private waste collection systems defined by local legislation must be used. In addition, the equipment can be returned to the distributor at the end of its working life when buying new equipment;
3. the equipment may contain hazardous substances: the improper use or incorrect disposal of such may have negative effects on human health and on the environment;
4. the symbol (crossed-out wheeled bin) shown on the product or on the packaging and on the instruction sheet indicates that the equipment has been introduced onto the market after 13 August 2005 and that it must be disposed of separately;
5. in the event of illegal disposal of electrical and electronic waste, the penalties are specified by local waste disposal legislation.

Warranty on the materials: 2 years (from the date of production, excluding consumables).

Approval: the quality and safety of CAREL products are guaranteed by the ISO 9001 certified design and production system, as well as by the mark.

Content

1. HOW THE ULTIMATESAM WORKS 7

2. MODEL NOMENCLATURE AND DIMENSIONS 8

3. FEATURES 9

4. SELECTION OF HUMIDIFIER DISTRIBUTOR 9

4.1 Steam capacities ... 11
4.2 Location of distributor ... 12
4.3 Absorption distance ... 13
4.4 Backpressure effects on atmospheric humidifiers ... 13
4.5 Air Flow Resistance ... 16
4.6 Steam Losses ... 16
4.7 Assembly options ... 17
4.8 Uninsulated option without nozzles ... 17

5. SELECTION OF INLET ADAPTER KITS 18

5.1 Inlet adapter kits (SAKI******) ... 18
5.2 List of available inlet adapters ... 18

6. SELECTION OF VALVE AND ACTUATOR KITS 19

6.1 Valve sizing and flow coefficient ... 20
6.2 List of available valves and features ... 21
6.3 Actuators and fitting kits ... 21

7. SELECTION OF TRAP, STRAINER, AND SEPARATOR KITS 22

7.1 Listing of available inlet trap, strainer and separator kits ... 22
7.2 Selecting trap and strainer kits ... 23
7.3 Drain traps for distributor headers ... 23

8. OPTIONS 24

8.1 Mounting stand (SAKS010000) ... 24
8.2 Steam-to-steam heat exchanger (North American market only; SAE2S200U0) ... 24

9. SPECIFICATIONS /SPECIFICHE 25

9.1 Distributor details - TD_SA_1000 /
Dettagli distributore - TD_SA_1000 25
9.2 Distributor details - TD_SA_1001 /
Dettagli distributore - TD_SA_1001 26
9.3 Distributor weight tables TD_SA_1004 /
Tabella pesi TD_SA_1004 27
9.4 Distributor weight tables TD_SA_1005 /
Tabella pesi TD_SA_1005 28
9.5 Distributor weight tables TD_SA_1006 /
Tabella pesi TD_SA_1006 29
9.6 Inlet adapters - TD_SA_1010 /
Adattatori ingresso vapore - TD_SA_1010 30
9.7 Inlet adapters - TD_SA_1011 /
Adattatori ingresso vapore - TD_SA_1011 31
9.8 Inlet adapters - TD_SA_1012 /
Adattatori ingresso vapore - TD_SA_1012 32
9.9 Valves and valve fitting kits - TD_SA_1020 /
Kit valvole e connessioni - TD_SA_1020 32
9.10 Valves and valve fitting kits - TD_SA_1021 /
Kit valvole e connessioni - TD_SA_1021 33
9.11 Valves and valve fitting kits - TD_SA_1022 /
Kit valvole e connessioni - TD_SA_1022 33
9.12 Valves and valve fitting kits - TD_SA_1023 /
Kit valvole e connessioni - TD_SA_1023 34
9.13 Valves and valve fitting kits - TD_SA_1024 /
Kit valvole e connessioni - TD_SA_1024 34
9.14 Electrical actuators - TD_SA_1030 /
Attuatori elettrici - TD_SA_1030 35
9.15 Electrical actuators - TD_SA_1031 /
Attuatori elettrici - TD_SA_1031 35
9.16 Electrical actuators - TD_SA_1032 /
Attuatori elettrici - TD_SA_1032 36
9.17 Electrical actuators - TD_SA_1033 /
Attuatori elettrici - TD_SA_1033 37
9.18 Pneumatic actuators - TD_SA_1040 /
Attuatori pneumatici - TD_SA_1040 38
9.19 Pneumatic actuators - TD_SA_1041 /
Attuatori pneumatici - TD_SA_1041 38
9.20 Pneumatic actuators - TD_SA_1042 /
Attuatori pneumatici - TD_SA_1042 39
9.21 Trap, strainer and saparator kits - TD_SA_1050 /
Kit filtro separatore e scaricatore di condensa - TD_SA_1050 40
9.22 Trap, strainer and saparator kits - TD_SA_1051 /
Kit filtro separatore e scaricatore di condensa - TD_SA_1051 41
9.23 Trap, strainer and saparator kits - TD_SA_1052 /
Kit filtro separatore e scaricatore di condensa - TD_SA_1052 42

1. HOW THE ULTIMATESAM WORKS

The ultimateSAM Direct Steam Humidification System is designed to distribute a uniform blanket of dry steam into a duct or air handling unit. When properly configured, the ultimateSAM system can accommodate steam from either an atmospheric or pressurized steam supply system. Its wide range of steam capacities and abundant options make it ideally suited for use in a variety of applications, including:

- Hospitals;
- Libraries;
- Museums;
- Offices.

For pressurized supply systems, steam enters the ultimateSAM distributor from a control valve and immediately drops to nearly atmospheric pressure. In this way, there is no further steam expansion and, consequently, less opportunity for additional condensate to form. Additionally, the internal stainless-steel surfaces of the distributor are thermally insulated to minimize condensate formation. Finally, the steam injection tubes are designed with baffling and nozzle inserts to insure that only a very high quality dry steam is discharged into the duct.

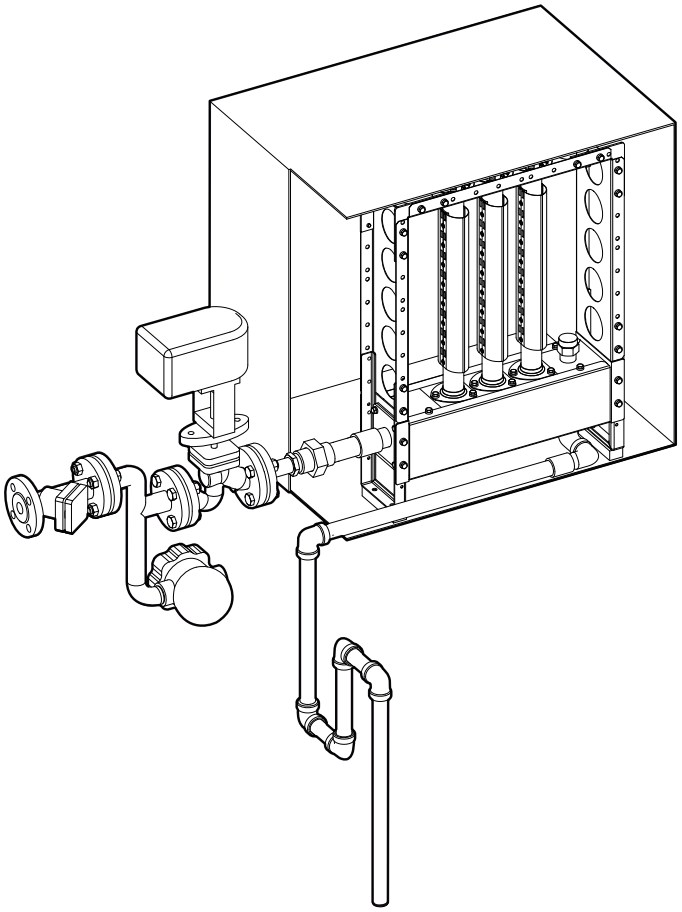


Fig. 1.a

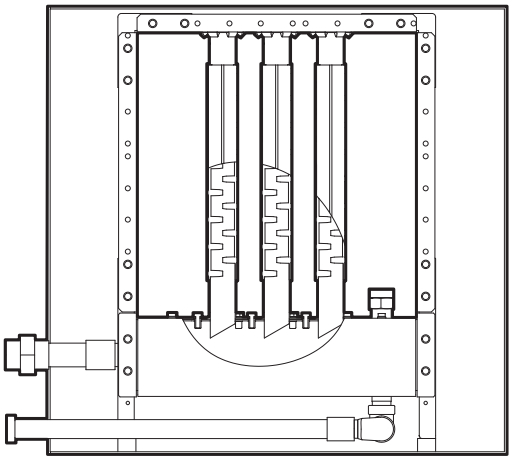


Fig. 1.b

NOTE: The inlet adapter, control valve, actuator, trap, and strainer shown above are available as options.
The "P" drains are not provided as part of the ultimateSAM system.

2. MODEL NOMENCLATURE AND DIMENSIONS

An ultimateSAM Direct Steam Humidification System (Fig.1) consists of the following:
- A humidifier distributor sized for the duct/AHU and the humidification load
- Steam trap(s) and strainer(s) (sold separately)
- A controlling humidistat and/or sensor (sold separately)
- A steam control valve & actuator for use with pressurized steam sources (sold separately)
- Other optional equipment that may be required (sold separately)

The system for identifying the humidifier distributor is shown in Table 2. See other sections of this manual for details on other ultimateSAM items, such as valves and traps.

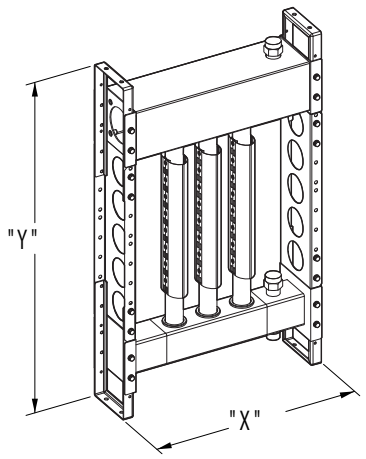


Fig. 2.c

Example: an SABFESI300 model is an ultimateSAM that has the following features:
- Bottom feed;
- Width of 1207 mm (47 ¾");
- Height of 1206 mm (47 ½");
- Uprights that are 35 mm OD (1.5" OD) spaced on 152 mm (6") centers;
- Uprights that are insulated with nozzle inserts;
- Framing included;
- Distributor shipped fully-assembled;
- ¾" Male Gas threaded drain.

Example 2: a SATNMLI2U0 model is an ultimateSAM that has the following features:
- Top feed;
- Width of 2423 mm (95 ½");
- Height of 2422 mm (95 ½");
- Uprights that are 45 mm OD (1.75" OD) spaced on 152 mm (6") centers;
- Uprights that are insulated with nozzle inserts;
- Framing included;
- Distributor shipped unassembled;
- ¾" Male NPT threaded drain.

SA	x	x	x	x	x	x	x	0
①	②	③	④	⑤	⑥	⑦	⑧	⑨

①	ID prefix				
②	Feed type:	B= Bottom feed T=Top feed			
③	Width:			No. of uprights	
		Code	Dimension "X" mm (in)	152mm (6") spacing	76mm (3") spacing
		A=	447 (17.75)	2	3
		B=	599 (23.75)	3	5
		C=	751 (29.75)	4	7
		D=	903 (35.75)	5	9
		E=	1055 (41.75)	6	11
		F=	1207 (47.75)	7	13
		G=	1359 (53.75)	8	15
		H=	1511 (59.50)	9	17
		I=	1663 (65.50)	10	19
		J=	1815 (71.50)	11	21
		K=	1967 (77.50)	12	23
		L=	2119 (83.50)	13	25
		M=	2271 (89.50)	14	27
		N=	2423 (95.50)	15	29
		O=	2575 (101.50)	16	31
		P=	2727 (107.50)	17	33
		Q=	2879 (113.50)	18	35
		R=	3031 (119.50)	19	37

④	Height:		Dimension "Y" mm (in)	
		Code	Botom feed	Top feed
		A=	598 (23.75)	749 (29.50)
		B=	750 (29.75)	901 (35.50)
		C=	902 (35.75)	1053 (41.50)
		D=	1054 (41.50)	1205 (47.50)
		E=	1206 (47.50)	1357 (53.50)
		F=	1358 (53.50)	1509 (59.50)
		G=	1510 (59.50)	1661 (65.50)
		H=	1662 (65.50)	1813 (71.50)
		I=	1814 (71.50)	1965 (77.50)
		J=	1966 (77.50)	2117 (83.50)
		K=	2118 (83.50)	2269 (89.50)
		L=	2270 (89.50)	2421 (95.50)
		M=	2422 (95.50)	2573 (101.50)
		N=	2574 (101.50)	2725 (107.50)
		O=	2726 (107.50)	2877 (113.50)
		P=	2878 (113.50)	3029 (119.50)
		Q=	3030 (119.50)	3181 (125.25)

⑤	Uprights:	Code	Spacing mm (in)"	OD mm (in)
		S=	152 (6.00)	35 (1.50)
		L=	152 (6.00)	45 (1.75)
		H=	76 (3.00)	35 (1.50)

⑥	Insulation:	I= insulated uprights w/ nozzles N= uninsulated uprights w/o nozzles
⑦	Frame:	0= no frame, unassembled 1= no frame, assembled 2= w/ frame, unassembled 3= w/ frame, assemble
⑧	Drain:	U= ¾" Male NPT 0= ¾" Male Gas
⑨	---	---

Tab. 2.a

Note: The height dimension assumes that the bottom pedestals are in the factory-assembled position. See section 8.1 for other pedestal positions.
The front-to-back depth of all distributors is the same, 133mm (5¼"). For distributor weights and physical dimensions of other features, like inlets and drains, see section 9, "Specifications."

3. FEATURES

It becomes evident, after reviewing the list of features, that the ultimateSAM Direct Steam Humidification System can meet the needs of all stakeholders, including designers, engineers, installers, and maintenance personnel. Among its many features are the following:

- Standardized sizes in 152mm (6") increments for optimal fit in the duct
- Wide range of sizes to fit rectangular ducts as small as 500mm wide x 600mm high (18" x 24") as well as ducts larger than 3000mm x 3000 mm (120" x 120").
- Wide range of capacities from 20 kg/hr (44 lb/hr) to more than 1000 kg/hr (2200 lb/hr) to meet any humidification need.
- Short absorption distance that prevents wetting of downstream components.
- Low heat gain to humidified air to keep temperature increases under 2°C (4°F).
- AISI304 Stainless steel construction to maximize life and minimize downtime.
- Simplified assembly of frame and steam distributor tubes.
- Complete line of options and accessories for either atmospheric or pressurized steam sources.

4. SELECTION OF HUMIDIFIER DISTRIBUTOR

Many variables must be considered to select a distributor that provides optimal performance, including:

- Duct size
- Humidification load
- Layout of duct/AHU components
- Absorption distance
- Type of steam source (atmospheric or pressurized)

A flowchart illustrating a typical process for selecting the proper distributor is shown in Figure 4.a.

- In general, it is best to select the largest possible distributor to fit into the duct. The overall dimensions of the distributor system are shown in Table 2.

NOTES:

1. Allow no less than 25mm (~1") clearance between the sides and top of the duct/AHU and the distributor.
2. If a tilted distributor is desired to facilitate condensate drainage, ensure that adequate clearances are provided. A 1% grade (~1 cm per meter, ~1/8" per foot) should suffice.
3. If additional components are to be mounted inside the duct or AHU, additional clearance may be needed.

- Once a size is selected, the distributor must be configured so that its steam capacity exceeds the humidification load of the application. (An online humidification load calculator is available at either http://ksa.carel.com/carelksa/web/eng/enterHumitools.jsp or http://www.carelusa.com/humidcalc.xls.) Steam capacities are shown on Table 4.a.

- After selecting a distributor that can meet the humidification load, other factors may need to be considered. For example:

  - Absorption distance: Use the information in section 4.3 to find the absorption distance for the selected distributor. Determine the clearance between the distributor and any downstream components in the AHU. (See section 4.2 for information on selecting the optimal location of the distributor in the AHU.) If the absorption distance does not meet requirements, choose configuration "H," and recheck the absorption distance of the new selection.

  - Backpressure on drains and atmospheric humidifiers: Use the information in section 4.4 to determine how much backpressure the selected distributor will generate. If the backpressure exceeds either the specifications of the distributor drain or the humidifier, choose a distributor with a higher steam capacity. Recheck the backpressure for this new selection which will be operating below its maximum capacity.

  - Air flow resistance: Use the information in section 4.5 to determine how much pressure drop will result from the distributor in the air flow of the duct or AHU. If the pressure drop significantly affects the performance of the circulating fan, contact Carel for possible remedies.

  - Condensate loss: Use the information in section 4.6 to determine how much steam is lost due to condensate formation. A higher capacity distributor may be needed to compensate for condensate loss.

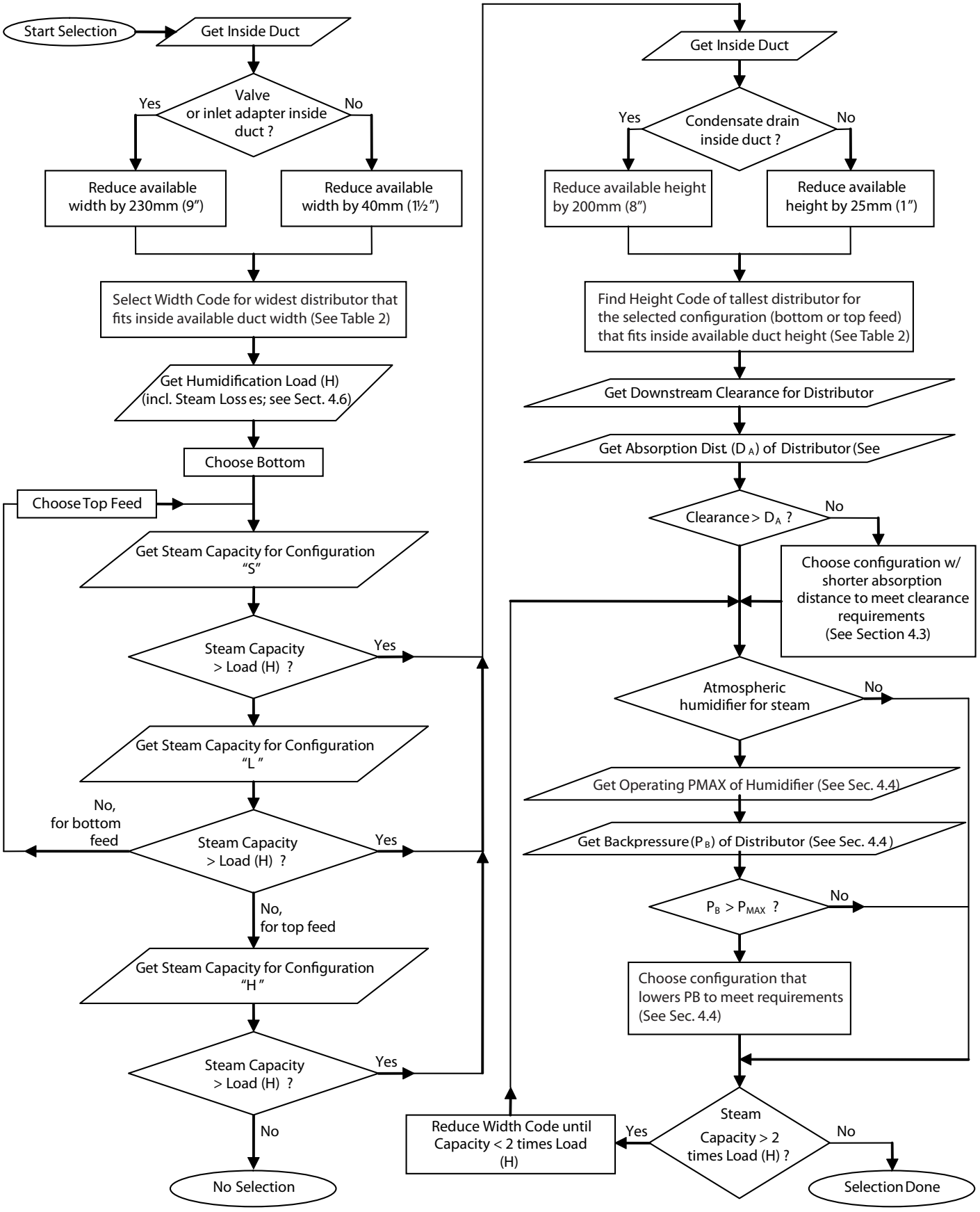

Start Selection
Get Inside Duct
Valve or inlet adapter inside duct ?
Yes
No
Reduce available width by 230mm (9")
Reduce available width by 40mm (1½")
Select Width Code for widest distributor that fits inside available duct width (See Table 2)
Get Humidification Load (H) (incl. Steam Losses; see Sect. 4.6)
Choose Bottom
Choose Top Feed
Get Steam Capacity for Configuration "S"
Steam Capacity > Load (H) ?
Yes
Get Steam Capacity for Configuration "L"
No, for bottom feed
Steam Capacity > Load (H) ?
Yes
No, for top feed
Get Steam Capacity for Configuration "H"
Steam Capacity > Load (H) ?
Yes
No
No Selection
Get Inside Duct
Condensate drain inside duct ?
Yes
No
Reduce available height by 200mm (8")
Reduce available height by 25mm (1")
Find Height Code of tallest distributor for the selected configuration (bottom or top feed) that fits inside available duct height (See Table 2)
Get Downstream Clearance for Distributor
Get Absorption Dist. (D_A) of Distributor (See
Clearance > D_A ?
No
Choose configuration w/ shorter absorption distance to meet clearance requirements (See Section 4.3)
Atmospheric humidifier for steam
No
Get Operating PMAX of Humidifier (See Sec. 4.4)
Get Backpressure (P_B) of Distributor (See Sec. 4.4)
P_B > P_{MAX} ?
No
Choose configuration that lowers PB to meet requirements (See Sec. 4.4)
Steam Capacity > 2 times Load (H) ?
Yes
No
Reduce Width Code until Capacity < 2 times Load (H)
Selection Done

Fig. 4.a

4.1 Steam capacities

After selecting a distributor width that most closely fits the duct size, the steam capacity of the distributor must be compared to the humidification load needed for the application. For a given distributor width, the steam capacity depends upon the configuration of the following elements of the system:

- the type of system feed, that is, bottom feed or top feed
- the diameter of the uprights
- the number and type of uprights, that is,
  - insulated, w/ nozzle inserts
  - uninsulated, w/o nozzle inserts

The steam capacities of insulated uprights for each configuration are shown in Table 4.a. (For uninsulated uprights, see section 4.8.)

NOTE: These capacities are based on using the distributor with a pressurized steam supply. If the steam source is an atmospheric humidifier, the steam capacities may need to be de-rated. The de-rating is associated with limiting the maximum backpressure generated by the distributor. This backpressure can affect the performance of an atmospheric humidifier. See section 4.4.

For the desired width, use Table 4.a to locate the most efficient configuration (one that uses the fewest uprights and supply connections) that meets or exceeds the calculated humidification load. Other criteria (e.g., absorption distance, backpressure, air flow resistance) may require the selection of a different configuration.

NOTE: If the capacity of the selected distributor is more than twice the desired humidification load, the width of the distributor should be reduced so that the distributor capacity is no more than twice the humidification load.

Steam Capacity for Insulated Uprights kg/hr (lb/hr)

Type of Feed		Bottom Feed			Top Feed			"Overall Widthmm (in)"	# of Uprights	
Type of Configuration		"S" 35mm (1.5") OD 152mm (6") c.d."	"L" 45mm (1.75") OD 152mm (6") c.d."	"H" 35mm (1.5") OD 76mm (3") c.d."	"S" 35mm (1.5") OD 152mm (6") c.d."	"L" 45mm (1.75") OD 152mm (6") c.d."	"H" 35mm (1.5") OD 76mm (3") c.d."		"S" "L"	"H"
Width Code	A	20 (44)	33 (73)	30 (66)	60 (132)	100 (220)	90 (198)	447 (18)	2	3
	B	30 (66)	50 (110)	50 (110)	90 (198)	150 (330)	150 (330)	599 (24)	3	5
	C	40 (88)	67 (147)	70 (154)	120 (264)	200 (440)	210 (462)	751 (30)	4	7
	D	50 (110)	83 (183)	90 (198)	150 (330)	250 (550)	270 (594)	903 (36)	5	9
	E	60 (132)	100 (220)	110 (242)	180 (396)	300 (660)	330 (726)	1055 (42)	6	11
	F	70 (154)	117 (257)	130 (286)	210 (462)	350 (770)	390 (858)	1207 (48)	7	13
	G	80 (176)	133 (293)	150 (330)	240 (528)	400 (880)	450 (990)	1359 (54)	8	15
	H	90 (198)	150 (330)	170 (374)	270 (594)	450 (990)	510 (1122)	1511 (60)	9	17
	I	100 (220)	167 (367)	190 (418)	300 (660)	500 (1100)	570 (1254)	1663 (66)	10	19
	J	110 (242)	183 (403)	210 (462)	330 (726)	550 (1210)	630 (1386)	1815 (72)	11	21
	K	120 (264)	200 (440)	230 (506)	360 (792)	600 (1320)	690 (1518)	1967 (78)	12	23
	L	130 (286)	217 (477)	250 (550)	390 (858)	650 (1430)	750 (1650)	2119 (84)	13	25
	M	140 (308)	233 (513)	270 (594)	420 (924)	700 (1540)	810 (1782)	2271 (90)	14	27
	N	150 (330)	250 (550)	290 (638)	450 (990)	750 (1650)	870 (1914)	2423 (96)	15	29
	O	160 (352)	267 (587)	310 (682)	480 (1056)	800 (1760)	930 (2046)	2575 (102)	16	31
	P	170 (374)	283 (623)	330 (726)	510 (1122)	850 (1870)	990 (2178)	2727 (108)	17	33
	Q	180 (396)	300 (660)	350 (770)	540 (1188)	900 (1980)	1050 (2310)	2879 (114)	18	35
	R	190 (418)	317 (697)	370 (814)	570 (1254)	950 (2090)	1110 (2442)	3031 (120)	19	37

Tab. 4.a

Two examples are provided to demonstrate the selection process for the distributor. These examples follow the process diagrammed in the flow chart on Fig. 4.a.

Example 1: Assume that a site has the following conditions:

- Inside duct dimensions:
  - 1200 mm wide (47 ¼");
  - 800 mm high (31 ½");
- Insulated uprights w/ nozzle inserts;
- No downstream impediments;
- Humidification load: 90 kg/hr (200 lb/hr);
- Atmospheric steam source (UE090X****);
- Distributor drain located outside of duct, as shown in Fig.1.

1. Based on the inside duct width of 1200 mm (47 ¼") and data from Table 2, an "E" width distributor [1055 mm (42")] would be the best choice. (This allows enough clearance to tilt the distributor for drainage, if desired.).
2. For a humidification load of 90 kg/hr (200 lb/hr), Table 4.a shows that the following configuration could be used:
   - Bottom feed, "L" configuration – for up to 100 kg/hr (220 lb/hr) [This configuration uses fewer uprights than the "H" configuration.]
3. Based on the inside duct height of 800 mm (31 ½") and the data from Table 2, a "B" height distributor [750 mm (29 ¾")] would be the best choice. This allows adequate clearance above the distributor.
4. Because there are no downstream obstructions, like fans, cooling coils, or elbows, the absorption distance of this distributor is not a design factor.
5. Because steam is being supplied by an atmospheric source, the backpressure of the distributor should be checked.

   NOTE: Also, check (1) the backpressure of the distributor inlet adapter and (2) the backpressure of the connecting hose or pipe between the humidifier and the distributor. Be sure that the complete system does not exceed the maximum backpressure specification of the humidifier. Refer to section 4.4 for more information.

   Given that the humidification load is 90 kg/hr (200 lb/hr), the backpressure will be 880 Pa (3.6" H2O), including the back pressure of the inlet adapter and tubing. (See section 4.4 for explanation of calculation.) Provided that the static pressure of the duct is less than 1000Pa (4" H2O), the total backpressure is less than the maximum pressure permitted at the outlet of the atmospheric steam source [PMAX=2000 Pa (8" H2O)].

   - Part number for this example: SABEBLI300 (assuming insulated distributor with frame, shipped assembled)

Example 2: Assume that a site has the following conditions:
- Inside duct dimensions:
- 3000 mm wide (118");
- 3000 mm high (118");
- Insulated uprights w/ nozzle inserts;
- Fan downstream of distributor limits downstream clearance to 700 mm (27½");
- Relative humidity after distributor (RHa): 82%;
- Relative humidity before distributor (RHb): 10% @ 15ºC (59ºF);
- Humidification load: 750 kg/hr (1650 lb/hr);
- Pressurized steam source;
- Control valve located outside of duct, as shown in Fig. 1;
- Distributor drain located outside of duct, as shown in Fig.1;

1. Based on the duct width of 3000 mm (118") and the data from Table 2, a "Q" width [2879mm (113 ½"")] distributor would be the best choice. This allows ~60 mm (~2 ½") clearance on both sides to tilt the distributor for drainage.
2. For a humidification load of 750 kg/hr (1650 lb/hr), Table 4.a shows that the following configuration could be used:
   - Top feed, "L" configuration – for up to 900 kg/hr (1980 lb/hr) [This configuration uses fewer uprights than the "H" configuration]
3. Based on the duct height of 3000 mm (118") and the need for a top feed system, an "O" height [2877 mm (113 ½")] distributor would be the best choice.
4. Given the 700 mm (27½") downstream clearance, the configuration must change to the "H" configuration to get an acceptable absorption distance. (The absorption distance for the "L" configuration is too long for this application. See example in section 4.3.)
   - Part number for this example: SATQOHI200 (assuming insulated distributor with frame, shipped unassembled)

4.2 Location of distributor

Properly locating the ultimateSAM Direct Steam Humidification System and its controls in your air handler or duct is very important - most steam absorption problems are the result of improper installation. Possible locations (A-G) for the distributor are shown in Figure 4.b. For additional assistance, contact Carel.

Locations:

A. BEST: locate distributor far enough from fan to avoid turbulence. Maintain adequate evaporation distance.
B. GOOD: provided there is enough distance from the distributor to the fan inlet for proper evaporation.
C. OK: provided there is enough distance from the distributor to the heating coil for proper evaporation (particularly if the heating coil is electric).
D. POOR: workable only if the cooling coil is inactive during humidifier operation. An active cooling coil will remove the moisture the humidifier is trying to put in.
E. POOR: same problems as C&D plus the air may be very cold, increasing evaporation distance or causing condensation.
F. POOR: same problems as C, D, & E plus the filters may get wet producing an unsafe condition with growth of biologicals.
G. POOR: only workable if the system is 100% recirculated air with no exhaust.

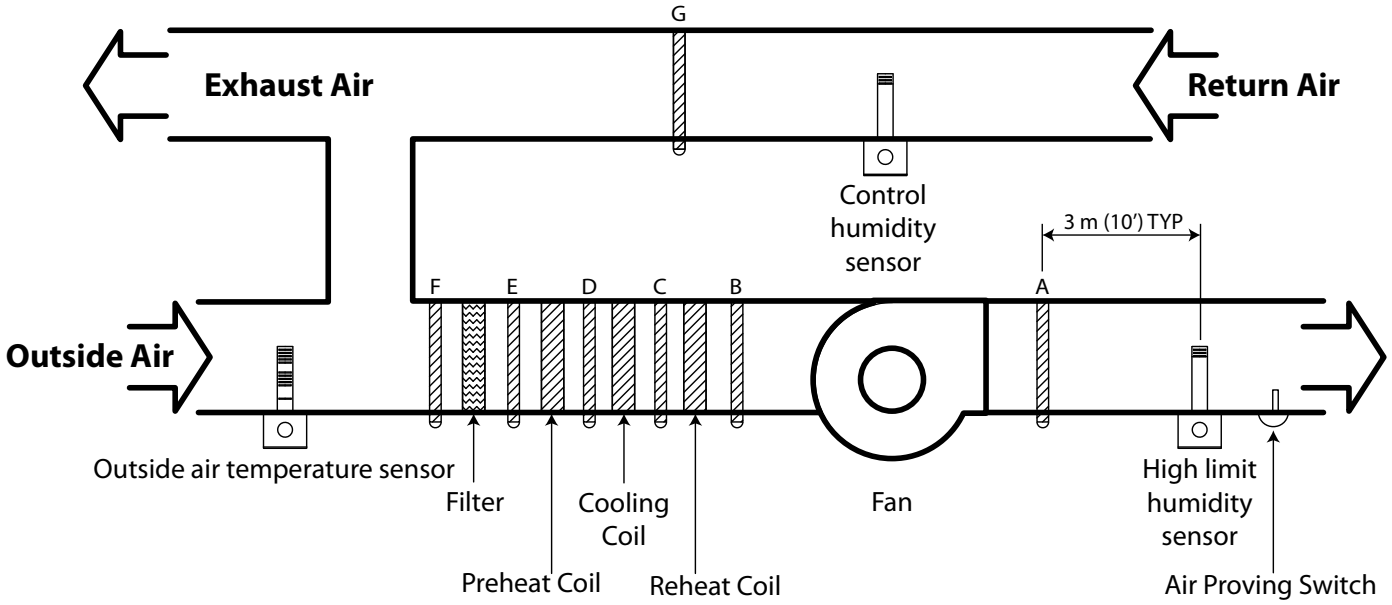


Fig. 4.b

4.3 Absorption distance

Absorption distance (Da) is the distance downstream of the steam distributor beyond which surface-wetting will not occur. A short absorption distance allows the layout of the HVAC system to be more compact. Many factors affecting absorption distance (Da) depend on the specific application, including:

- the supply air conditions (temperature & R.H.) Low temperatures, below 10 C (50 F), increase Da.;
- the desired space conditions (temperature & R.H.) Space RH greater than 90% increases Da.

To address these factors and to allow flexibility in designing the HVAC system, the ultimateSAM Direct Steam Humidification System can be configured for different absorption distances. To determine the absorption distance of an ultimateSAM distributor:

1. Calculate the saturation-ratio (SR)

$$SR = \frac{(RH_a - RH_b)}{(100 - RH_b)}$$

RH_a: relative humidity after distributor
RH_b: relative humidity before distributor

2. Use the SR-ratio on Figures 4.c and 4.d to determine the absorption distance (Da).
3. Choose the configuration with an absorption distance (Da) that is less than the requirements of the specific application.

Example: Assume that a site has the following conditions:

- Distributor, SATQOLI200, top-feed, "L" configuration (See example 2 in section 4.1)
- RH upstream of distributor: RHb=10% @ 15°C (59°F)
- RH downstream of distributor: RHa=82%

1. Calculate the SR-ratio

$$SR = \frac{(82-10)}{(100 - 10)} = 0.8$$

2. Using Fig.4.c for 152mm (6") o.c., the absorption distance (Da) is 750 mm (30") for this distributor.

NOTE: If this absorption distance is too large, the "H" configuration with an absorption distance of only 600 mm (23½") can be used.

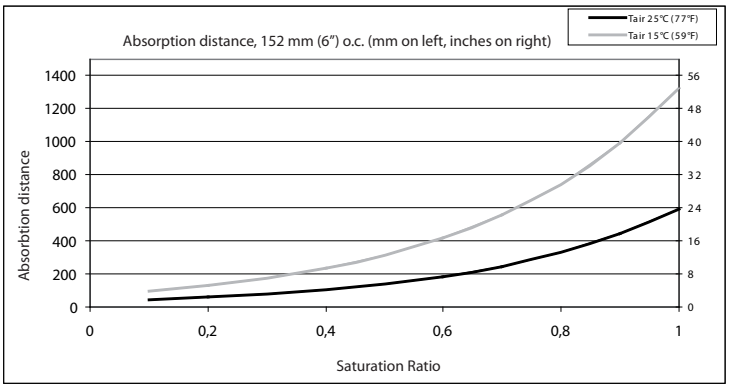


Fig. 4.c

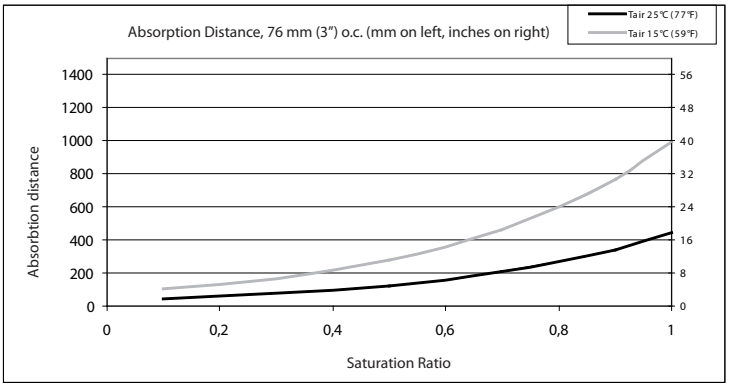


Fig. 4.d

4.4 Backpressure effects on atmospheric humidifiers

The backpressure (PB) of the ultimateSAM distributor may affect the operation of atmospheric humidifiers. For example, the maximum backpressure acting on the outlet of Carel atmospheric humidifiers is:

- UEX: 1300-2000 Pa (5-8 in H2O), varies with model size
- UG: 2000 Pa (8 in H2O)
- UR: 1500-2000 Pa (6-8 in H2O), varies with model size

NOTE: Condensate drains can also be affected by the pressure within the distributor. See section 7.3 for additional information.

These considerations can influence the choice of distributor (see Fig.4.a). If the backpressure of the selected distributor exceeds the operational limits of the steam supply, a different configuration can be chosen to reduce the backpressure.

The total backpressure of an ultimateSAM distributor system comes from 3 sources.

- PB1: The backpressure of the distributor itself (see tables 4.b.c.d).
- PB2: The backpressure of the inlet adapter installed on the distributor (see tables 4.e)
- PB3: The backpressure of the connecting hose(s) or pipe(s) between the atmospheric humidifier and the ultimateSAM distributor (see tables 4.f)

The backpressure created by the distributor itself (PB1) depends on four factors:

- Height of uprights (that is, the number of nozzles)
- Width of header (that is, the number of uprights)
- Distributor configuration
- Humidification load (H)

To calculate the backpressure of the distributor, use the equation:

$$P_{B1} = A\left(\frac{H}{100}\right)^2$$

P_{B1}: backpressure in kPa (in H2O)
A: constant in kPa (in H2O)
H: humidification load in kg/hr (lb/hr)

Tables 4.b.c.d give the value of the constant "A" for each distributor configuration. The calculated value may vary ±10% or ±0.1 kPa (½ in H2O), whichever is greater.

Manifold Backpressure Constant (A) Configuration "S" kPa (in H_2O)

Height Code	Width Code A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
A	10.01 (8.3)	4.47 (3.7)	2.53 (2.1)	1.63 (1.4)	1.14 (0.95)	0.846 (0.70)	0.655 (0.54)	0.524 (0.44)	0.431 (0.36)	0.362 (0.30)	0.309 (0.26)	0.268 (0.22)	0.236 (0.20)	0.210 (0.17)	0.188 (0.16)	0.171 (0.14)	0.156 (0.13)	0.144 (0.12)
B	4.75 (3.9)	2.13 (1.8)	1.21 (1.00)	0.786 (0.65)	0.556 (0.46)	0.416 (0.35)	0.326 (0.27)	0.264 (0.22)	0.220 (0.18)	0.188 (0.16)	0.163 (0.14)	0.144 (0.12)	0.129 (0.11)	0.116 (0.10)	0.106 (0.09)	0.098 (0.08)	0.091 (0.08)	0.085 (0.07)
C	2.94 (2.4)	1.32 (1.1)	0.758 (0.63)	0.496 (0.41)	0.354 (0.29)	0.268 (0.22)	0.213 (0.18)	0.175 (0.15)	0.148 (0.12)	0.128 (0.11)	0.113 (0.09)	0.101 (0.08)	0.092 (0.08)	0.084 (0.07)	0.078 (0.06)	0.073 (0.06)	0.069 (0.06)	0.065 (0.05)
D	2.12 (1.8)	0.961 (0.80)	0.554 (0.46)	0.366 (0.30)	0.263 (0.22)	0.202 (0.17)	0.162 (0.13)	0.135 (0.11)	0.115 (0.10)	0.101 (0.08)	0.090 (0.07)	0.082 (0.07)	0.075 (0.06)	0.070 (0.06)	0.065 (0.05)	0.062 (0.05)	0.059 (0.05)	0.056 (0.05)
E	1.70 (1.4)	0.772 (0.64)	0.447 (0.37)	0.297 (0.25)	0.216 (0.18)	0.167 (0.14)	0.135 (0.11)	0.114 (0.09)	0.098 (0.08)	0.087 (0.07)	0.078 (0.06)	0.071 (0.06)	0.066 (0.05)	0.062 (0.05)	0.059 (0.05)	0.056 (0.05)	0.053 (0.04)	0.051 (0.04)
F	1.46 (1.2)	0.664 (0.55)	0.387 (0.32)	0.259 (0.22)	0.189 (0.16)	0.147 (0.12)	0.120 (0.10)	0.102 (0.08)	0.088 (0.07)	0.079 (0.07)	0.071 (0.06)	0.066 (0.05)	0.061 (0.05)	0.058 (0.05)	0.055 (0.05)	0.052 (0.04)	0.050 (0.04)	0.049 (0.04)
G	1.31 (1.1)	0.599 (0.50)	0.350 (0.29)	0.235 (0.20)	0.173 (0.14)	0.135 (0.11)	0.111 (0.09)	0.094 (0.08)	0.083 (0.07)	0.074 (0.06)	0.067 (0.06)	0.062 (0.05)	0.058 (0.05)	0.055 (0.05)	0.052 (0.04)	0.050 (0.04)	0.049 (0.04)	0.047 (0.04)
H	1.22 (1.00)	0.559 (0.46)	0.328 (0.27)	0.221 (0.18)	0.163 (0.14)	0.128 (0.11)	0.105 (0.09)	0.090 (0.07)	0.079 (0.07)	0.071 (0.06)	0.065 (0.05)	0.060 (0.05)	0.056 (0.05)	0.053 (0.04)	0.051 (0.04)	0.049 (0.04)	0.048 (0.04)	0.046 (0.04)
I	1.16 (0.96)	0.533 (0.44)	0.313 (0.26)	0.212 (0.18)	0.156 (0.13)	0.123 (0.10)	0.102 (0.08)	0.087 (0.07)	0.077 (0.06)	0.069 (0.06)	0.063 (0.05)	0.059 (0.05)	0.055 (0.05)	0.052 (0.04)	0.050 (0.04)	0.048 (0.04)	0.047 (0.04)	0.046 (0.04)
J	1.12 (0.93)	0.517 (0.43)	0.304 (0.25)	0.206 (0.17)	0.152 (0.13)	0.120 (0.10)	0.099 (0.08)	0.085 (0.07)	0.075 (0.06)	0.068 (0.06)	0.062 (0.05)	0.058 (0.05)	0.054 (0.04)	0.052 (0.04)	0.050 (0.04)	0.048 (0.04)	0.046 (0.04)	0.045 (0.04)
K	1.10 (0.91)	0.506 (0.42)	0.298 (0.25)	0.202 (0.17)	0.150 (0.12)	0.118 (0.10)	0.098 (0.08)	0.084 (0.07)	0.074 (0.06)	0.067 (0.06)	0.062 (0.05)	0.057 (0.05)	0.054 (0.04)	0.051 (0.04)	0.049 (0.04)	0.047 (0.04)	0.046 (0.04)	0.045 (0.04)
L	1.09 (0.90)	0.499 (0.41)	0.294 (0.24)	0.199 (0.17)	0.148 (0.12)	0.117 (0.10)	0.097 (0.08)	0.083 (0.07)	0.074 (0.06)	0.066 (0.05)	0.061 (0.05)	0.057 (0.05)	0.054 (0.04)	0.051 (0.04)	0.049 (0.04)	0.047 (0.04)	0.046 (0.04)	0.045 (0.04)
M	1.07 (0.89)	0.494 (0.41)	0.291 (0.24)	0.198 (0.16)	0.147 (0.12)	0.116 (0.10)	0.096 (0.08)	0.083 (0.07)	0.073 (0.06)	0.066 (0.05)	0.061 (0.05)	0.057 (0.05)	0.053 (0.04)	0.051 (0.04)	0.049 (0.04)	0.047 (0.04)	0.046 (0.04)	0.045 (0.04)
N	1.07 (0.89)	0.491 (0.41)	0.290 (0.24)	0.197 (0.16)	0.146 (0.12)	0.116 (0.10)	0.096 (0.08)	0.082 (0.07)	0.073 (0.06)	0.066 (0.05)	0.061 (0.05)	0.057 (0.05)	0.053 (0.04)	0.051 (0.04)	0.049 (0.04)	0.047 (0.04)	0.046 (0.04)	0.044 (0.04)
O	1.06 (0.88)	0.490 (0.41)	0.289 (0.24)	0.196 (0.16)	0.146 (0.12)	0.115 (0.10)	0.096 (0.08)	0.082 (0.07)	0.073 (0.06)	0.066 (0.05)	0.060 (0.05)	0.056 (0.05)	0.053 (0.04)	0.051 (0.04)	0.049 (0.04)	0.047 (0.04)	0.046 (0.04)	0.044 (0.04)
P	1.06 (0.88)	0.488 (0.41)	0.288 (0.24)	0.195 (0.16)	0.145 (0.12)	0.115 (0.10)	0.095 (0.08)	0.082 (0.07)	0.073 (0.06)	0.066 (0.05)	0.060 (0.05)	0.056 (0.05)	0.053 (0.04)	0.051 (0.04)	0.049 (0.04)	0.047 (0.04)	0.046 (0.04)	0.044 (0.04)
Q	1.06 (0.88)	0.488 (0.41)	0.288 (0.24)	0.195 (0.16)	0.145 (0.12)	0.115 (0.10)	0.095 (0.08)	0.082 (0.07)	0.073 (0.06)	0.066 (0.05)	0.060 (0.05)	0.056 (0.05)	0.053 (0.04)	0.051 (0.04)	0.049 (0.04)	0.047 (0.04)	0.046 (0.04)	0.044 (0.04)

Tab. 4.b

Manifold Backpressure Constant (A) Configuration "L" kPa (in H_2O)

Height Code	Width Code A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
A	11.58 (9.6)	5.16 (4.3)	2.92 (2.4)	1.88 (1.6)	1.31 (1.1)	0.974 (0.81)	0.753 (0.63)	0.602 (0.50)	0.493 (0.41)	0.413 (0.34)	0.353 (0.29)	0.305 (0.25)	0.268 (0.22)	0.238 (0.20)	0.213 (0.18)	0.193 (0.16)	0.175 (0.15)	0.161 (0.13)
B	5.24 (4.4)	2.35 (2.0)	1.33 (1.1)	0.865 (0.72)	0.610 (0.51)	0.457 (0.38)	0.357 (0.30)	0.289 (0.24)	0.240 (0.20)	0.204 (0.17)	0.177 (0.15)	0.155 (0.13)	0.139 (0.12)	0.125 (0.10)	0.114 (0.09)	0.105 (0.09)	0.097 (0.08)	0.091 (0.08)
C	3.03 (2.5)	1.37 (1.1)	0.782 (0.65)	0.512 (0.43)	0.365 (0.30)	0.276 (0.23)	0.219 (0.18)	0.180 (0.15)	0.152 (0.13)	0.131 (0.11)	0.115 (0.10)	0.103 (0.09)	0.094 (0.08)	0.086 (0.07)	0.080 (0.07)	0.074 (0.06)	0.070 (0.06)	0.066 (0.05)
D	2.02 (1.7)	0.914 (0.76)	0.528 (0.44)	0.349 (0.29)	0.252 (0.21)	0.193 (0.16)	0.156 (0.13)	0.130 (0.11)	0.111 (0.09)	0.097 (0.08)	0.087 (0.07)	0.079 (0.07)	0.073 (0.06)	0.068 (0.06)	0.064 (0.05)	0.060 (0.05)	0.057 (0.05)	0.055 (0.05)
E	1.47 (1.2)	0.671 (0.56)	0.391 (0.32)	0.261 (0.22)	0.191 (0.16)	0.149 (0.12)	0.121 (0.10)	0.103 (0.09)	0.089 (0.07)	0.079 (0.07)	0.072 (0.06)	0.066 (0.05)	0.062 (0.05)	0.058 (0.05)	0.055 (0.05)	0.053 (0.04)	0.051 (0.04)	0.049 (0.04)
F	1.15 (0.95)	0.526 (0.44)	0.309 (0.26)	0.209 (0.17)	0.155 (0.13)	0.122 (0.10)	0.101 (0.08)	0.087 (0.07)	0.076 (0.06)	0.069 (0.06)	0.063 (0.05)	0.059 (0.05)	0.055 (0.05)	0.052 (0.04)	0.050 (0.04)	0.048 (0.04)	0.047 (0.04)	0.045 (0.04)
G	0.937 (0.78)	0.434 (0.36)	0.257 (0.21)	0.176 (0.15)	0.132 (0.11)	0.105 (0.09)	0.088 (0.07)	0.076 (0.06)	0.068 (0.06)	0.062 (0.05)	0.057 (0.05)	0.054 (0.04)	0.051 (0.04)	0.049 (0.04)	0.047 (0.04)	0.045 (0.04)	0.044 (0.04)	0.043 (0.04)
H	0.798 (0.66)	0.372 (0.31)	0.223 (0.19)	0.154 (0.13)	0.116 (0.10)	0.094 (0.08)	0.079 (0.07)	0.069 (0.06)	0.062 (0.05)	0.057 (0.05)	0.053 (0.04)	0.050 (0.04)	0.048 (0.04)	0.046 (0.04)	0.045 (0.04)	0.043 (0.04)	0.042 (0.04)	0.042 (0.03)
I	0.701 (0.58)	0.329 (0.27)	0.198 (0.16)	0.138 (0.11)	0.106 (0.09)	0.086 (0.07)	0.073 (0.06)	0.065 (0.05)	0.058 (0.05)	0.054 (0.04)	0.051 (0.04)	0.048 (0.04)	0.046 (0.04)	0.044 (0.04)	0.043 (0.04)	0.042 (0.03)	0.041 (0.03)	0.041 (0.03)
J	0.632 (0.52)	0.298 (0.25)	0.181 (0.15)	0.127 (0.11)	0.098 (0.08)	0.080 (0.07)	0.069 (0.06)	0.061 (0.05)	0.056 (0.05)	0.052 (0.04)	0.049 (0.04)	0.046 (0.04)	0.045 (0.04)	0.043 (0.04)	0.042 (0.04)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)
K	0.582 (0.48)	0.276 (0.23)	0.169 (0.14)	0.119 (0.10)	0.092 (0.08)	0.076 (0.06)	0.066 (0.05)	0.059 (0.05)	0.054 (0.04)	0.050 (0.04)	0.047 (0.04)	0.045 (0.04)	0.044 (0.04)	0.042 (0.03)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)
L	0.544 (0.45)	0.259 (0.22)	0.159 (0.13)	0.113 (0.09)	0.088 (0.07)	0.073 (0.06)	0.063 (0.05)	0.057 (0.05)	0.052 (0.04)	0.049 (0.04)	0.046 (0.04)	0.044 (0.04)	0.043 (0.04)	0.042 (0.03)	0.041 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)
M	0.516 (0.43)	0.247 (0.21)	0.152 (0.13)	0.109 (0.09)	0.085 (0.07)	0.071 (0.06)	0.062 (0.05)	0.056 (0.05)	0.051 (0.04)	0.048 (0.04)	0.046 (0.04)	0.044 (0.04)	0.042 (0.03)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)	0.038 (0.03)
N	0.495 (0.41)	0.237 (0.20)	0.147 (0.12)	0.105 (0.09)	0.083 (0.07)	0.069 (0.06)	0.060 (0.05)	0.054 (0.04)	0.050 (0.04)	0.047 (0.04)	0.045 (0.04)	0.043 (0.04)	0.042 (0.03)	0.041 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)
O	0.479 (0.40)	0.230 (0.19)	0.143 (0.12)	0.103 (0.09)	0.081 (0.07)	0.068 (0.06)	0.059 (0.05)	0.054 (0.04)	0.050 (0.04)	0.047 (0.04)	0.044 (0.04)	0.043 (0.04)	0.042 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)
P	0.467 (0.39)	0.224 (0.19)	0.140 (0.12)	0.101 (0.08)	0.079 (0.07)	0.067 (0.06)	0.059 (0.05)	0.053 (0.04)	0.049 (0.04)	0.046 (0.04)	0.044 (0.04)	0.043 (0.04)	0.041 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)	0.038 (0.03)
Q	0.457 (0.38)	0.220 (0.18)	0.137 (0.11)	0.099 (0.08)	0.078 (0.06)	0.066 (0.05)	0.058 (0.05)	0.053 (0.04)	0.049 (0.04)	0.046 (0.04)	0.044 (0.04)	0.042 (0.03)	0.041 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)	0.038 (0.03)

Tab. 4.c

Manifold Backpressure Constant (A) Configuration "H" kPa (in H_2O)

Height Code	Width Code A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
A	4.47 (3.7)	1.63 (1.4)	0.846 (0.70)	0.524 (0.44)	0.362 (0.30)	0.268 (0.22)	0.210 (0.17)	0.171 (0.14)	0.144 (0.12)	0.124 (0.10)	0.109 (0.09)	0.098 (0.08)	0.089 (0.07)	0.082 (0.07)	0.076 (0.06)	0.072 (0.06)	0.068 (0.06)	0.065 (0.05)
B	2.13 (1.8)	0.786 (0.65)	0.416 (0.35)	0.264 (0.22)	0.188 (0.16)	0.144 (0.12)	0.116 (0.10)	0.098 (0.08)	0.085 (0.07)	0.076 (0.06)	0.069 (0.06)	0.064 (0.05)	0.060 (0.05)	0.057 (0.05)	0.055 (0.05)	0.052 (0.04)	0.051 (0.04)	0.049 (0.04)
C	1.32 (1.1)	0.496 (0.41)	0.268 (0.22)	0.175 (0.15)	0.128 (0.11)	0.101 (0.08)	0.084 (0.07)	0.073 (0.06)	0.065 (0.05)	0.060 (0.05)	0.056 (0.05)	0.053 (0.04)	0.050 (0.04)	0.048 (0.04)	0.047 (0.04)	0.046 (0.04)	0.045 (0.04)	0.044 (0.04)
D	0.961 (0.80)	0.366 (0.30)	0.202 (0.17)	0.135 (0.11)	0.101 (0.08)	0.082 (0.07)	0.070 (0.06)	0.062 (0.05)	0.056 (0.05)	0.052 (0.04)	0.049 (0.04)	0.047 (0.04)	0.046 (0.04)	0.044 (0.04)	0.043 (0.04)	0.043 (0.04)	0.042 (0.03)	0.042 (0.03)
E	0.772 (0.64)	0.297 (0.25)	0.167 (0.14)	0.114 (0.09)	0.087 (0.07)	0.071 (0.06)	0.062 (0.05)	0.056 (0.05)	0.051 (0.04)	0.048 (0.04)	0.046 (0.04)	0.045 (0.04)	0.043 (0.04)	0.042 (0.03)	0.042 (0.03)	0.041 (0.03)	0.041 (0.03)	0.040 (0.03)
F	0.664 (0.55)	0.259 (0.22)	0.147 (0.12)	0.102 (0.08)	0.079 (0.07)	0.066 (0.05)	0.058 (0.05)	0.052 (0.04)	0.049 (0.04)	0.046 (0.04)	0.044 (0.04)	0.043 (0.04)	0.042 (0.03)	0.041 (0.03)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)
G	0.599 (0.50)	0.235 (0.20)	0.135 (0.11)	0.094 (0.08)	0.074 (0.06)	0.062 (0.05)	0.055 (0.05)	0.050 (0.04)	0.047 (0.04)	0.045 (0.04)	0.043 (0.04)	0.042 (0.03)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.039 (0.03)
H	0.559 (0.46)	0.221 (0.18)	0.128 (0.11)	0.090 (0.07)	0.071 (0.06)	0.060 (0.05)	0.053 (0.04)	0.049 (0.04)	0.046 (0.04)	0.044 (0.04)	0.043 (0.04)	0.041 (0.03)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.039 (0.03)
I	0.533 (0.44)	0.212 (0.18)	0.123 (0.10)	0.087 (0.07)	0.069 (0.06)	0.059 (0.05)	0.052 (0.04)	0.048 (0.04)	0.046 (0.04)	0.044 (0.04)	0.042 (0.03)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)
J	0.517 (0.43)	0.206 (0.17)	0.120 (0.10)	0.085 (0.07)	0.068 (0.06)	0.058 (0.05)	0.052 (0.04)	0.048 (0.04)	0.045 (0.04)	0.043 (0.04)	0.042 (0.03)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)	0.038 (0.03)
K	0.506 (0.42)	0.202 (0.17)	0.118 (0.10)	0.084 (0.07)	0.067 (0.06)	0.057 (0.05)	0.051 (0.04)	0.047 (0.04)	0.045 (0.04)	0.043 (0.04)	0.042 (0.03)	0.041 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)	0.038 (0.03)
L	0.499 (0.41)	0.199 (0.17)	0.117 (0.10)	0.083 (0.07)	0.066 (0.05)	0.057 (0.05)	0.051 (0.04)	0.047 (0.04)	0.045 (0.04)	0.043 (0.04)	0.042 (0.03)	0.041 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)	0.038 (0.03)
M	0.494 (0.41)	0.198 (0.16)	0.116 (0.10)	0.083 (0.07)	0.066 (0.05)	0.057 (0.05)	0.051 (0.04)	0.047 (0.04)	0.045 (0.04)	0.043 (0.04)	0.041 (0.03)	0.041 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)	0.038 (0.03)
N	0.491 (0.41)	0.197 (0.16)	0.116 (0.10)	0.082 (0.07)	0.066 (0.05)	0.057 (0.05)	0.051 (0.04)	0.047 (0.04)	0.044 (0.04)	0.043 (0.04)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)	0.038 (0.03)
O	0.490 (0.41)	0.196 (0.16)	0.115 (0.10)	0.082 (0.07)	0.066 (0.05)	0.056 (0.05)	0.051 (0.04)	0.047 (0.04)	0.044 (0.04)	0.043 (0.04)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)	0.038 (0.03)	0.038 (0.03)
P	0.488 (0.41)	0.195 (0.16)	0.115 (0.10)	0.082 (0.07)	0.066 (0.05)	0.056 (0.05)	0.051 (0.04)	0.047 (0.04)	0.044 (0.04)	0.043 (0.04)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)	0.038 (0.03)	0.038 (0.03)
Q	0.488 (0.41)	0.195 (0.16)	0.115 (0.10)	0.082 (0.07)	0.066 (0.05)	0.056 (0.05)	0.051 (0.04)	0.047 (0.04)	0.044 (0.04)	0.043 (0.04)	0.041 (0.03)	0.040 (0.03)	0.040 (0.03)	0.039 (0.03)	0.039 (0.03)	0.038 (0.03)	0.038 (0.03)	0.038 (0.03)

Tab. 4.d

Because each inlet adapter for the ultimateSAM distributor has a unique flow characteristic, its back pressure (PB2) will depend upon the humidification load (H), as shown in the equation below.

$$P_{B2} = B\left(\frac{H}{100}\right)^2$$

P_{B2}: backpressure in kPa (in H2O)
B : constant in kPa (in H2O)
H : humidification load in kg/hr (lb/hr)

Table 4.e gives the value of the constant "B" for each inlet adapter. The calculated value may vary ±10% or ±0.1 kPa (½ in H2O), whichever is greater.

Table 4.e also shows the maximum humidification load for each inlet adapter. NOTE: While threaded adapters are included on the table, the tubing adapters (SAKIT*****) would be used for most atmospheric humidifier applications.

Inlet	Max. load kg/hr (lb/hr)	Constant "B" kPa (in H_2O)
SAKIE441*0	150 (330)	2.6 (2.2)
SAKIE641*0	350 (770)	0.44 (0.37)
SAKIE841*0	600 (1320)	0.13 (0.11)
SAKIE941*0	1200 (2640)	0.018 (0.01)
SAKIP441*0	150 (330)	1.7 (1.4)
SAKIP641*0	350 (770)	0.29 (0.24)
SAKIP841*0	600 (1320)	0.090 (0.07)
SAKIP941*0	1200 (2640)	0.012 (0.01)
SAKIT40100	250 (550)	0.55 (0.46)
SAKIT40200	500 (1100)	0.21 (0.17)
SAKIT40400	1000 (2200)	0.054 (0.04)
SAKIT80100	1200 (2640)	0.000 (0.00)
SAKIX80100	1200 (2640)	0.001 (0.00)

Tab. 4.e

The connecting hoses and/or pipes between the ultimateSAM distributor and the atmospheric humidifier will generate additional backpressure (PB3) that must be considered. This effect can be calculated using the equation below.

$$P_{B3} = C*L\left(\frac{H}{100}\right)^2$$

P_{B3}: backpressure in kPa (in H2O)
C: constant in kPa/m (in H2O/ft)
L: hose length in m (ft)
H: humidification load in kg/hr (lb/hr)

Table 4.f shows the constant "C" for some types of tubing and pipes. The backpressure depends upon the length (L) of the hose or pipe and the humidification load (H). The calculated value may vary ±10% or ±0.1 kPa (½ in H2O), whichever is greater.

Inlet	Max. load kg/hr (lb/hr)	Max. length m (ft)	Constant "C" kPa/m (in H_2O/ft)
40mm hose[1]	45 (99)	4 (13.1)	0.36 (0.091)
80mm hose[1]	320 (704)	4 (13.1)	0.0074 (0.0019)
2" Sch 40 pipe	140 (308)	5 (16.4)	0.077 (0.019)
3" Sch 40 pipe	300 (660)	10 (32.8)	0.0085 (0.0022)
3" Cu tubing "K"	270 (594)	10 (32.8)	0.012 (0.0030)

Tab. 4.f

[1]Carel-brand steam hose is recommended for use with the ultimateSAM.

For atmospheric humidifiers, the total backpressure acting on the device is the total backpressure from each part of the steam delivery system (distributor, inlet adapter, and connecting pipe) as well as the static pressure in the duct or AHU. NOTE: Depending on the location of the distributor, the static pressure n the duct could be negative.

PTOTAL = PB1 + PB2 + PB3 + PAHU

If the total backpressure exceeds the maximum pressure allowed at the outlet of the atmospheric humidifier, then steps must be taken to reduce the pressure (e.g., increase the pipe and inlet diameters, or maximize the height and width of the distributor).

Sample calculation using Example 1 in Sec.4.1: assume that a site has the following conditions:
- Humidification load: 90 kg/hr (200 lb/hr)
- Distributor: SABEBLI300
- Inlet adapter: SAKIT40200
- 40mm steam hose: 2 pieces, 3m (10') long, 45 kg/hr (100 lb/hr) per hose.

1. Use Table 4.c to determine constant "A."
   For width code "E" and height code "B," A=0.610 kPa (0.51 in H2O).

2. Calculate PB1.

$$P_{B1} = (0.610)\left(\frac{90}{100}\right)^2 = 0.49kPA$$

$$P_{B1} = (0.51)\left(\frac{200}{100}\right)^2 = 2.0 \text{ in } H_2O$$

3. Use Table 4.e to determine constant "B." For SAKIT40200, B=0.21 kPa (0.17 in H2O).

4. Calculate PB2.

$$P_{B2} = (0.21)\left(\frac{90}{100}\right)^2 = 0.17kPA$$

$$P_{B2} = (0.17)\left(\frac{200}{100}\right)^2 = 0.68 \text{ in } H_2O$$

5. Use Table 4.f to determine constant "C." For 40mm steam hose, C=0.36 kPa/m (0.091 inH2O per ft).

6. Calculate PB3.

$$P_{B3} = (0.36)\ (3)\left(\frac{45}{100}\right)^2 = 0.22kPA$$

$$P_{B3} = (0.091)(10)\left(\frac{100}{100}\right)^2 = 0...91 \text{ in } H_2O$$

7. PTOTAL = 0.49 + 0.17 + 0.22 = 0.88kPa (PTOTAL=2.0 + 0.68 + 0.91 = 3.6 in H2O)
   NOTE: The static pressure of the duct must be less than 1.12kPa (4.4 in H2O) to keep the outlet pressure acting on the UE090X**** under 2kPa (8" H2O).

4.5 Air Flow Resistance

The static pressure drop created due to the ultimateSAM distributor in the duct or AHU is shown in Table 4.g. A distributor that is properly sized to the duct or AHU will minimize the pressure drop. The data table can only be used to determine the flow resistance of air passing through the effective area of the distributor. It does not include pressure losses due to facing off areas of the duct for valves, drains, or other connections.

Pressure Loss, Pa (in H_2O)

Air Velocity, m/s (fpm)	Uprights configuration		
	S	L	H
3 (600)	0 (0.002)	1 (0.006)	5 (0.022)
6 (1200)	2 (0.008)	6 (0.024)	22 (0.088)
10 (2000)	5 (0.022)	17 (0.067)	61 (0.245)

Tab. 4.g

4.6 Steam Losses

When designing an ultimateSAM Direct Steam Humidification System, allowance must be made for steam that condenses within the system before the steam mixes with the air in the duct. There are two areas in which steam losses occur:
- Within the ultimateSAM distributor itself;
- Within the piping between the humidifier and the ultimateSAM distributor.

To achieve maximum operating efficiency, the ultimateSAM distributor is insulated to minimize steam loss due to condensation. The design includes a header wrapped with stainless-steel-clad insulating foam and uprights with stainless-steel insulating shields.
Table 4.h provides information on the estimated steam loss, expressed as a percentage of steam capacity. Values can be used to compare the effect of different configurations on steam loss, given the same distributor size (width code: "J", height code: "J"). It is important to allow for this loss when selecting a distributor configuration.

Nominal Steam Loss @ 15C (59F) (% of max. capacity)

	Air velocity m/s (fpm)		
Configuration	3 (600)	6 (1200)	10 (2000)
SATJJSI***	5	6	6
SABJJSI***	9	12	14
SATJJLI***	3	4	4
SABJJLI***	6	8	9
SATJJHI***	3	4	5
SABJJHI***	8	10	11
SATJJSN***	7	8	9
SABJJSN***	13	15	18
SATJJLN***	4	5	6
SABJJLN***	8	10	12
SATJJHN***	5	6	7
SABJJHN***	11	13	15

Tab. 4.h

NOTES:
1. Compared to a top-feed distributor with comparable configuration, width and height, a bottom-feed distributor has 2 times the steam loss as a percentage of capacity because the bottom-feed has 1/3 of the maximum capacity of the top-feed.
2. Compared to insulated distributors, uninsulated distributors have 40% more steam loss. For example, at 3 m/s (600 fpm) an SABJJSI*** has a steam loss of 9% of 110 kg/hr (240 lb/hr), that is 10 kg/hr (22 lb/hr). The uninsulated version, SABJJSN***, has 40% greater steam loss, that is 14 kg/hr (31 lb/hr), or 13% of capacity. (Note: Besides increased steam loss, uninsulated distributors are likely to inject condensate into the airway because the distributors do not have nozzle inserts. See section 4.8.)

To calculate estimated steam loss for specific width and height codes, tables 4.i and 4.j provide steam loss per length of upright and header. NOTE: As shown, steam loss increases as ambient temperature deceases. To calculate estimated steam loss at other ambient temperatures (Ta), adjust the values by the ratio (Ta-100)/85 or (Ta-100)/75 for tables 4.i and 4.j, respectively.

To calculate the total steam loss,
1. Calculate the steam loss for the uprights
2. Calculate the steam loss of the header(s)

Steam Loss @ 15C (59F) kg/hr/m (lb/hr/ft)

		Air velocity m/s (fpm)		
Configuration		3 (600)	6 (1200)	10 (2000)
Uprights	"SA***SI*** SA***HI***"	0.34 (0.23)	0.42 (0.28)	0.48 (0.32)
	"SA***SN*** SA***HN***"	0.48 (0.32)	0.59 (0.39)	0.67 (0.45)
	SA***LI***	0.39 (0.26)	0.49 (0.33)	0.56 (0.38)
	SA***LN***	0.55 (0.37)	0.69 (0.46)	0.78 (0.53)
Headers	SAB***I***	2.0 (1.4)	2.5 (1.7)	2.9 (1.9)
	SAB***N***	2.5 (1.7)	3.1 (2.1)	3.5 (2.4)
	SAT***I***	4.5 (3.0)	5.6 (3.8)	6.4 (4.3)
	SAT***N***	7.0 (4.7)	8.7 (5.8)	9.9 (6.7)

Tab. 4.i

Steam Loss @ 25C (77F) kg/hr/m (lb/hr/ft)

Configuration		Air velocity m/s (fpm)		
		3 (600)	6 (1200)	10 (2000)
Uprights	"SA***SI*** SA***HI***"	0.30 (0.20)	0.37 (0.25)	0.42 (0.28)
	"SA***SN*** SA***HN***"	0.42 (0.28)	0.52 (0.35)	0.59 (0.39)
	SA***LI***	0.34 (0.23)	0.43 (0.29)	0.50 (0.34)
	SA***LN***	0.48 (0.32)	0.60 (0.40)	0.70 (0.47)
Headers	SAB***I***	1.8 (1.2)	2.2 (1.5)	2.5 (1.7)
	SAB***N***	2.2 (1.5)	2.7 (1.8)	3.1 (2.1)
	SAT***I***	4.0 (2.7)	4.9 (3.3)	5.6 (3.8)
	SAT***N***	6.2 (4.2)	7.6 (5.1)	8.7 (5.8)

Tab. 4.j

Example: calculate the steam loss for an SATRQHI*** operating in a duct of air velocity 6 m/s (1200 fpm). (See section 9, "Specifications," for the dimensional data of distributors having other sizes and configurations)

1. From the dimensional data of the distributor, calculate the upright length:
   Overall height (3181 mm) -
   Inlet header height (167.5mm) –
   Condensate header (152.5mm) =
   Upright length (2861mm)
   Then:

$$(2861\text{mm})\left(\frac{0.42\ ^{\text{kg}}/_{\text{hr}}}{1000\,\text{mm}}\right)(37\text{uprights}) = 44\ \frac{\text{kg}}{\text{hr}}$$

$$(125.25"-6.25"-5")\left(\frac{0.28\ ^{\text{lb}}/_{\text{hr}}}{12\text{in}}\right)(37\text{uprights}) = 98\ \frac{\text{lb}}{\text{hr}}$$

2. Given a header length of 3031 mm,

$$(3031\text{mm})\left(\frac{5.6\ ^{\text{kg}}/_{\text{hr}}}{1000\text{mm}}\right) = 17\ \frac{\text{kg}}{\text{hr}}$$

$$(119.5")\left(\frac{3.8\ ^{\text{lb}}/_{\text{hr}}}{12"}\right) = 38\ \frac{\text{lb}}{\text{hr}}$$

3. Total steam loss= 62 kg/hr (136lb/hr), that is, 5.5% of the 1110 kg/hr (2442lb/hr) capacity.

For atmospheric humidifiers, every effort should be made to reduce condensate production in the pipes connecting the humidifier to the ultimateSAM distributor. For example, when connecting a high capacity humidifier, such as a Carel UE130X****, to an ultimateSAM distributor, the multiple steam outlets on the humidifier should be merged into a single insulated pipe having the same cross-sectional area as the combined areas of the multiple outlets. (See section 5 for adapters.) Table 4.k provides information on steam loss in connecting pipes.

Steam Loss @ 25°C (77°F)
kg/hr/m (lb/hr/ft)

Size	Insulation mm (in)	Max. length m (ft)	Steam loss kg/hr/m (lb/hr/ft)
40mm hose	n/a	4 (13.1)	0.15 (0.10)
80mm hose	n/a	4 (13.1)	0.24 (0.16)
2" Sch 40	0	5 (16.4)	0.24 (0.16)
cast iron pipe	50 (2)	5 (16.4)	0.029 (0.019)
3" Sch 40	0	10 (32.8)	0.32 (0.21)
cast iron pipe	63 (2.5)	10 (32.8)	0.032 (0.021)
3" Cu	0	10 (32.8)	0.29 (0.19)
"K" tubing	63 (2.5)	10 (32.8)	0.030 (0.020)

Tab. 4.k

4.7 Assembly options

The distribution system comes with a frame designed to support the uprights and distributors while providing flexibility during installation. Although the distribution system with frame can be shipped fully-assembled from the factory (product code SA*****3**), the system is designed for fast, simple field-assembly with ordinary metric tools (product code SA*****2**). For applications in which the frame for securing the uprights and distributor headers will be provided by a third party at the site, the distribution system can be provided without the frame (product code SA*****1** if assembled, SA*****0** if not assembled).

4.8 Uninsulated option without nozzles

The ultimateSAM Direct Steam Humidification System is available with several options. To achieve optimal performance, most applications will require the use of fully insulated uprights with nozzle inserts (product code SA****I***). The insulation minimizes the formation of condensate inside the upright. However, even with the insulation, some condensate will form on the inner surface of the upright tube. To prevent this condensate from being blown into the duct, nozzles are inserted into the uprights to keep the steam entering the duct condensate-free.
There are some unique circumstances in which condensate droplets entering the air stream might not pose a problem. For these situations, the uprights are available without insulation and nozzle inserts (product code SA****N***). Before using this type of upright, be sure to evaluate all downstream surfaces in the AHU with respect to chemical compatibility, corrosion resistance, and biological growth. This option should only be used in applications that can tolerate pure liquid water.

5. SELECTION OF INLET ADAPTER KITS

The ultimateSAM Direct Steam Humidification System has a variety of inlet adapters, allowing maximum flexibility to meet the particular needs of the installation. All of the adapters are made of stainless steel and are sized to connect easily to all of other ultimateSAM equipment, like valves.

5.1 Inlet adapter kits (SAKI******)

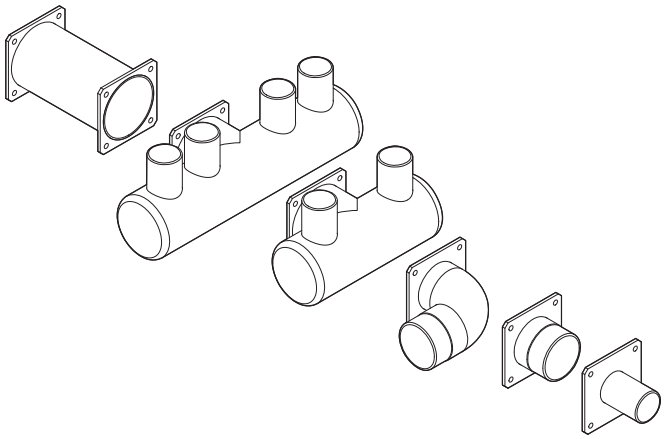


Fig. 5.a

The choice of adapters for a bottom feed system is shown in Figure 5.a. The choices include:

- 150mm (6") extension
- Quad and dual elbows for 40mm tubing
- Threaded pipe adapters
  - Elbows and straight
  - 1", 1½", 2", and 2½" sizes
- Straight adapters for 40mm and 80mm tubing

The system for identifying inlet adapters is described in Table 5.a. NOTE: Not all of the possible combinations shown on the table are available. A complete list of available inlet adapters is provided in Section 5.2.

SAKI x xx x x 0

① ② ③ ④ ⑤ ⑥

①	ID prefix	
②	Style:	E = Threaded Elbow P = Threaded Male Pipe T = Straight Tube X = Extension
③	Size:	40 = 40mm 44 = 1" 64 = 1 ½" 80 = 80mm 84 = 2" 94 = 2½"
④	Inlets:	1 = Single 2 = Double 4 = Quad
⑤	Region:	U = North America 0 = Other
⑥	---	---

Tab. 5.a

Each adapter is shipped in a kit that includes a gasket and fasteners for attaching the adapter to the distributor. For weights and dimensions of the adapters, see Section 9, "Specifications."

Example: a SAKIT40200 is an ultimateSAM inlet adapter that has the following features:

- 2 inlets (suitable for dual outlet atmospheric humidifiers; see Fig.4.b)
- Elbow for 40mm ID tube

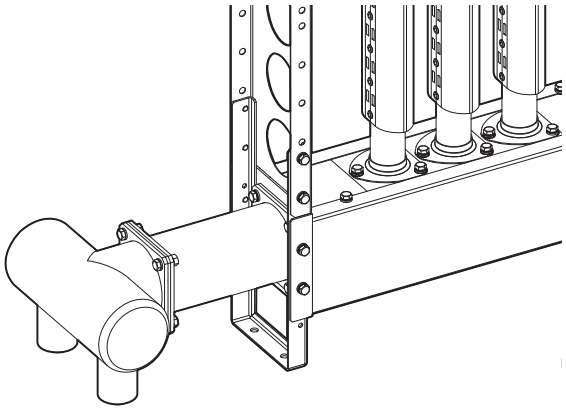


Fig. 5.b

NOTE: Figure 5.b also shows the SAKIX801000 inlet extension.

5.2 List of available inlet adapters

Table 5.b provides a listing of all of the available inlet adapters for making pipe or hose connections. In addition, the table provides information on the type of inlet connection for each adapter.

For installations requiring an extended inlet for the distributor, a 150 mm (6") extension adapter (SAKIX80100) is also available. The extension adapter has the same mounting flange on both ends. (See Figure 4.b)

	Inlet connections			
	Style, Region Codes			
Inlet Size	"****E***0* ****P***0*"	****T***0*	****P***U*	****E***U*
"SAKI*401*0 SAKI*402*0 SAKI*404*0"	n/a	for 40 mm ID hose	n/a	n/a
SAKI*441*0	G male	n/a	NPT male	NPT female[1]
SAKI*641*0	G male	n/a	n/a	n/a
SAKI*801*0	n/a	for 80 mm ID hose[2]	n/a	n/a
SAKI*841*0	G male	n/a	NPT male	NPT female[1]
SAKI*941*0	G male	n/a	n/a	n/a

Tab. 5.b

[1] The SAKIE***U* consists of an SAKIP***U* with a female pipe elbow attached.

[2] Use this adapter to connect the ultimateSAM distributor to 3" copper tubing since 80mm ID steam hose can slide over the OD of 3" copper tubing.

6. SELECTION OF VALVE AND ACTUATOR KITS

For pressurized steam systems, control valves are needed to regulate the flow of steam to the ultimateSAM distributor. Flow regulation is achieved by 3 actions.

1. A humidity sensor/controller creates either an electrical or pneumatic demand signal that modulates in proportion to the humidity deficit.
2. The demand signal produces a corresponding change in the position of the valve's actuator.
3. The actuator's position causes a linear change of flow rate, thereby tracking the humidity deficit.

For most applications, the control valve and actuator, such as the one shown in Fig. 6.a, should have the following general characteristics:

- Normally-closed
- Stainless steel trim
- Linear (or nearly linear) signal-to-output modulation
- Spring-return to closed position during failure

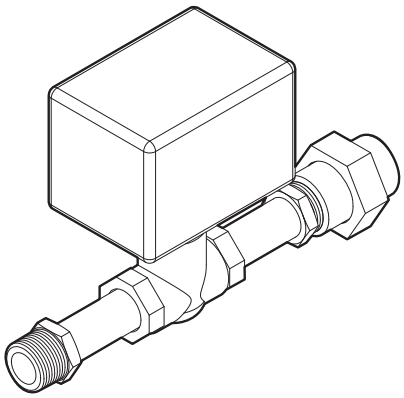


Fig. 6.a

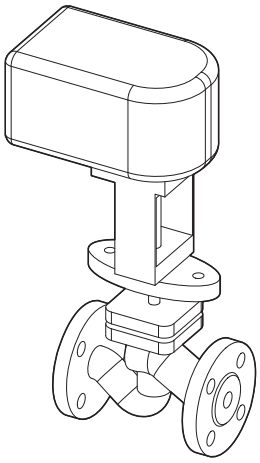


Fig. 6.b

In addition, several other factors must be considered when selecting the proper control valve, including,

- Humidification load (H)
- Bottom or top feed distributor
- Steam delivery pressure
- Pressure drop across the valve
- Steam quality requirements

The system for identifying control valve accessories is shown in Table 6.a.

NOTE: Not all of the possible combinations shown on the table are available. A complete list of available valves, as well as information on other features, is provided in Section 6.2.

SAKV 0 x x x x 0

① ② ③ ④ ⑤ ⑥ ⑦

①	ID prefix	
②	---	---
③	Material:	0 = Brass F = Iron
④	Operating pressure:	0 = Up to 1bar (15psi) H = 1-4bar (15-50psi)
⑤	Nominal Size: Kv (EU) Cv (US)	A= 0,4 B= 0,63 C= 1 D= 1,6 E= 2,5 F= 4 G= 6,3 H= 10 I= 16 J= 25 K= 40 L= 58
⑥	Region:	U = North America 0 = Other
⑦	---	---

Tab. 6.a

Example 1: an SAKV0F0D00 valve includes the following:

- Cast iron valve body with SS trim
- Market outside of North America
- Operating pressure up to 1 bar (15 psig)
- Kv rating of 1.6
- Flange PN 16 connections

Example 2: an SAKV00HIU0 valve includes the following:

- Brass valve body with SS trim
- North American market
- Operating pressure up to 4 bar (50 psig)
- Cv rating of 16
- NPT connections for North American market

A flowchart illustrating a typical process for selecting the proper control valve is shown in Figure 6.b.

- In general, it is best to select the smallest valve that still has a maximum flow rate greater than the humidification load (H). Valve flow capacity is given in terms of the flow coefficient, Kv or Cv. Additional information on valve sizing and flow coefficient is provided in Section 6.1.
- Once the Kv or Cv of the valve is determined, the choice of material is influenced by the operating pressure for the valve. For some applications, regulations may require the use of valves having all stainless steel construction.

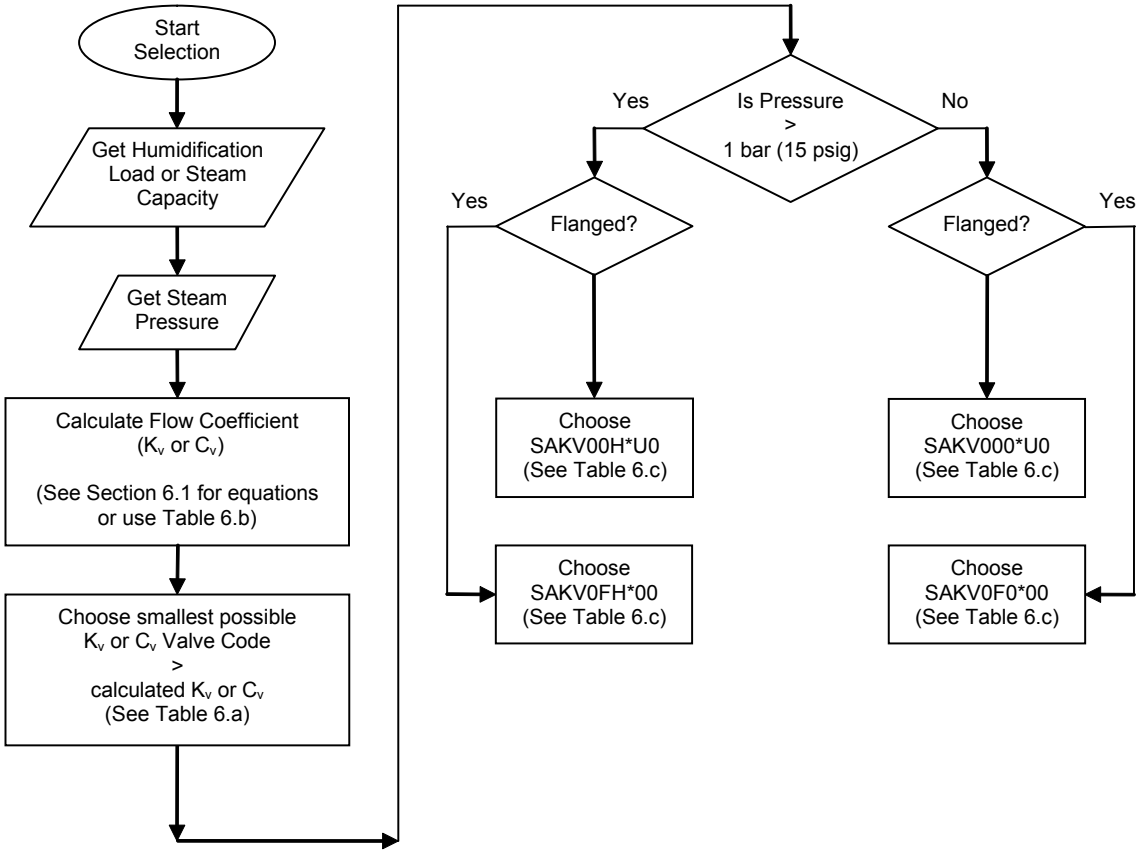


Fig. 6.c

6.1 Valve sizing and flow coefficient

Valve size is generally described by its flow coefficient, Kv for metric systems and Cv for imperial systems. The Kv for a valve represents that number of cubic meters of water per hour through the valve for each 1 bar pressure drop across the valve. Likewise, the Cv for a valve represents that number of gallons of water per minute through the valve for each 1 psi pressure drop across the valve. The relationship between Kv and Cv is shown below.

$$C_V = 1.16K_v$$

As described, the selection of valve size depends on the pressure drop and the flow rate. Because the ultimateSAM distributor creates a minimal amount of back pressure (see Section 4.4), the pressure drop across the control valve equals the inlet steam pressure. For steam systems in which the supply pressure is less than 0.7 bar (10 psig), valves can be sized using the following formula (shown in both metric and imperial form),

$$K_v = \frac{\dot{m}}{16.1\sqrt{P_1^2 - P_2^2}}$$

m : maximum steam flow rate (kg/hr)
P_1: inlet pressure (bar a)
P_1: bar a
P_2: outlet pressure (bar a)
P_2^3: @ standard conditions

$$C_v = \frac{\dot{m}}{2.1\sqrt{P_1^2 - P_2^2}}$$

m : maximum steam flow rate (lb/hr)
P_1: inlet pressure (psia)
P_1: psia
P_2: outlet pressure (psia)
P_2^3: @ standard conditions

When the inlet pressure exceeds 0.7 bar (10 psig), the critical pressure drop for the valve is reached. The critical pressure drop for dry saturated steam is reached whenever the absolute pressure at the valve outlet is 58% of the absolute pressure at the valve inlet. This point is called the critical pressure drop because, once the critical pressure drop is reached, reductions in downstream pressures will not result in additional flow through the valve. For steam systems in which the supply pressure is greater than 0.7 bar (10 psig) --- that is, systems operating at or above the critical pressure drop ---, valves can be sized using the following formula (shown in both metric and U.S. imperial form),

$$K_v = \frac{\dot{m}}{12.5P_1}$$

m : maximum steam flow rate (kg/hr)
P_1: inlet pressure (bar a)
P_1: 1.7 bar a

$$C_v = \frac{\dot{m}}{1.63P_1}$$

m : maximum steam flow rate (kg/hr)
P_1: inlet pressure (bar a)
P_1: 25 psia

When a system is operating at greater than the critical pressure drop, excessive noise may be generated due to near sonic velocity. The noise and coincident vibration can shorten valve life.
To facilitate valve selection, Table 6.b shows the flow capacity of each valve size at different inlet pressures. Capacities given in "kg/hr" are calculated using the Kv equations, while capacities given in "lb/hr" are calculated using the Cv equations. (The "lb/hr" values are not calculated as unit conversions of the "kg/hr" values.)
NOTE: When the steam capacity of the selected valve is significantly higher than the humidification load, the controls should be configured to limit the stroke of the valve.

"Steam Valve Capacity kg/hr (lb/hr)"

	Inlet Pressure bar (psig)									
Kv (EU)	0.15	0.35	0.70	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Cv (US)	(2)	(5)	(10)	(15)	(22)	(29)	(36)	(44)	(51)	(58)
A = 0.40	3.7	5.9	8.9	10	13	15	18	20	23	25
	(6.7)	(11)	(17)	(19)	(24)	(28)	(33)	(38)	(43)	(-)
B = 0.63	5.8	9.2	14	16	20	24	28	32	36	39
	(10)	(17)	(26)	(30)	(38)	(45)	(52)	(60)	(67)	(-)
C = 1.0	9.2	15	22	25	31	38	44	50	56	63
	(17)	(28)	(42)	(48)	(60)	(71)	(83)	(96)	(110)	(-)
D = 1.6	15	23	36	40	50	60	70	80	90	100
	(27)	(44)	(67)	(77)	(96)	(110)	(130)	(150)	(170)	(-)
E = 2.5	23	37	56	63	78	94	110	130	140	160
	(42)	(69)	(100)	(120)	(150)	(180)	(210)	(240)	(270)	(-)
F = 4.0	37	59	89	100	130	150	180	200	230	250
	(67)	(110)	(170)	(190)	(240)	(280)	(330)	(380)	(430)	(-)
G = 6.3	58	92	140	160	200	240	280	320	360	390
	(100)	(170)	(260)	(300)	(380)	(450)	(520)	(600)	(670)	(-)
H = 10	92	150	220	250	310	380	440	500	560	630
	(170)	(280)	(420)	(480)	(600)	(710)	(830)	(960)	(1100)	(-)
I = 16	150	230	360	400	500	600	700	800	900	1000
	(270)	(440)	(670)	(770)	(960)	(1100)	(1300)	(1500)	(1700)	(-)
J = 25	230	370	560	630	780	940	1100	1300	1400	1600
	(420)	(690)	(1000)	(1200)	(1500)	(1800)	(2100)	(2400)	(2700)	(-)
K = 40	370	590	890	1000	1300	1500	1800	2000	2300	2500
	(670)	(1100)	(1700)	(1900)	(2400)	(2800)	(3300)	(3800)	(4300)	(-)
L = 58	530	850	1290	1500	1800	2200	2500	2900	3300	3600
	(970)	(1600)	(2400)	(2800)	(3500)	(4100)	(4800)	(5500)	(6200)	(-)

Tab. 6.b

6.2 List of available valves and features

Table 6.c provides a complete listing of all of the control valves available for the use with the ultimateSAM distributor. In addition, the table provides information on the size and type of inlet-outlet connection for each valve.

Inlet-Outlet Connections

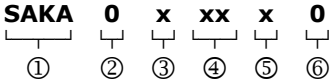
	Material, Pressure, Region Codes		
Valve Size	*****F0*0* *****H0*0*	*****00*U*	*****0H*U*
SAKV0**A*0 SAKV0**B*0	n/a	½"NPT Female	n/a
SAKV0**C*0	n/a	½"NPT Female	½"NPT Female
SAKV0**D*0 SAKV0**E*0 SAKV0**F*0	Flange DN 15	½"NPT Female	½"NPT Female
SAKV0**G*0	Flange DN 20	¾"NPT Female	¾"NPT Female
SAKV0**H*0	Flange DN 25	1"NPT Female	1"NPT Female
SAKV0**I*0	Flange DN 32	1¼"NPT Female	1¼"NPT Female
SAKV0**J*0	Flange DN 40	1½"NPT Female	1½"NPT Female
SAKV0**K*0	Flange DN 50	2"NPT Female	n/a
SAKV0**L*0	Flange DN 65	n/a	n/a

Tab. 6.c

For information about the weight, dimensions, construction materials, and rangeability of each valve, see section 9, "Specifications."

6.3 Actuators and fitting kits

After selecting a control valve that is sized for a particular humidification load, it is necessary to select an actuator. The actuator provides the means by which an analog control signal can modulate the opening and closing of the steam control valve. Table 6.d shows the system for identifying the actuator accessories.



①	ID prefix	
②	---	---
③	Type:	E = Electronic P = Pneumatic
④	Identifier:	01 Sequential # 02 ---
⑤	Region:	0 = Other U = U.S.
⑥	---	---

Tab. 6.d

Not all actuators can be used on all valves. The following selection tables should be used to select the proper electronic or pneumatic actuator for each control valve listed on Tables 6.e and 6.f.

Electronic Actuator Selection

	Material, Pressure, Region Codes			
Valve Size	*****F0*0*	*****H0*0*	*****00*U*	*****0H*U*
SAKV0**A*0 SAKV0**B*0	n/a	n/a	SAKAE001U0	n/a
SAKV0**C*0	n/a	n/a	SAKAE001U0	SAKAE002U0
SAKV0**D*0 SAKV0**E*0	SAKAE00100	SAKAE00200	SAKAE001U0	SAKAE002U0
SAKV0**F*0 SAKV0**G*0	SAKAE00100	SAKAE00200	SAKAE001U0	SAKAE002U0
SAKV0**H*0	SAKAE00100	SAKAE00200	SAKAE001U0	SAKAE002U0
SAKV0**I*0	SAKAE00100	SAKAE00200	SAKAE002U0	SAKAE002U0
SAKV0**J*0 SAKV0**K*0	SAKAE00100	SAKAE00200	SAKAE002U0	n/a
SAKV0**L*0	SAKAE00100	SAKAE00200	n/a	n/a

Tab. 6.e

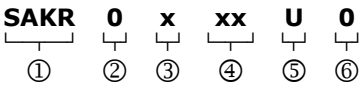
Pneumatic Actuator Selection

	Material, Pressure, Region Codes		
Valve Size	*****F0*0* *****H0*0*	*****00*U*	*****0H*U*
SAKV0**A*0 SAKV0**B*0	n/a	SAKAP001U0	n/a
SAKV0**C*0 SAKV0**D*0 SAKV0**E*0 SAKV0**F*0 SAKV0**G*0	n/a	SAKAP001U0	SAKAP002U0
SAKV0**H*0	n/a	SAKAP001U0	SAKAP003U0
SAKV0**I*0 SAKV0**J*0	n/a	SAKAP002U0	SAKAP003U0
SAKV0**K*0	n/a	SAKAP003U0	n/a
SAKV0**L*0	n/a	n/a	n/a

Tab. 6.f

For information about the weight, dimensions, supply and control parameters of each actuator, see section 9, "Specifications."

In addition to actuators, fitting kits are available to facilitate attaching threaded control valves to the ultimateSAM's threaded inlet adapters. Table 6.g shows the codes for the fitting kits. The list of fittings provided in each kit is shown in Tab.6.h.



①	ID prefix	
②	---	---
③	Material:	F = Iron S = SS
④	Size:	24= ½" Pipe 34= ¾" Pipe 44= 1" Pipe 54= 1 ¼" Pipe 64= 1 ½" Pipe 84= 2" Pipe
⑤	Region:	U = North America
⑥	---	---

Tab. 6.g

Fitting List for SAKR0***U0

Pipe Size (NPT)	Bushing F-M (size)	3"Nipple M-M (size)	Union F-F (size)
******24**	2 (½"x1")	2 (1")	1 (1")
******34**	2 (¾"x1")	2 (1")	1 (1")
******44**	n/a	2 (1")	1 (1")
******54**	2 (1¼"x2")	2 (2")	1 (2")
******64**	2 (1½"x2")	2 (2")	1 (2")
******84**	n/a	2 (2")	1 (2")

Tab. 6.h

7. SELECTION OF TRAP, STRAINER, AND SEPARATOR KITS

Traps, strainers, and drains are integral elements of any atmospheric and pressurized steam system. An inlet trap prevents condensate generated during initial start-up and normal operation from entering the ultimateSAM distributor or control valve. An inlet strainer removes pipeline debris, such as scale, rust, and other solids, which may find its way into the pipeline system. In addition, a drain must be installed on the ultimateSAM distributor to remove condensate that forms inside the system.

Figures 7.a and 7.b are examples of the basic components needed for a pressurized steam system. For serviceability and functionality, the system may require additional items not shown, such as shut-off valves and additional piping.

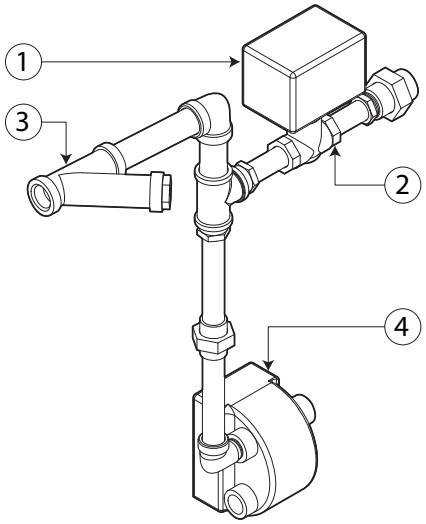


Fig. 7.a

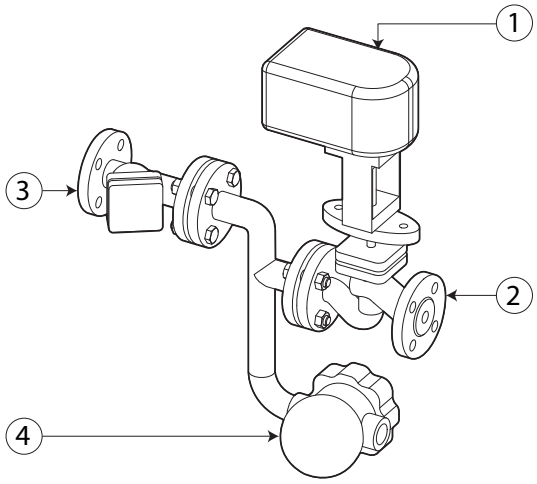


Fig. 7.b

① Actuator
② Valve
③ Y- type strainer
④ Ball float or F&T trap

When used with an atmospheric humidifier, as shown in Fig.7.c, an inlet trap is not needed on the ultimateSAM distributor. In a typical installation, the condensate in the connecting hose drains back to the humidifier. In special situations where the condensate cannot drain back to the humidifier, an inlet trap may be needed to prevent significant amounts of condensate from entering the distributor.

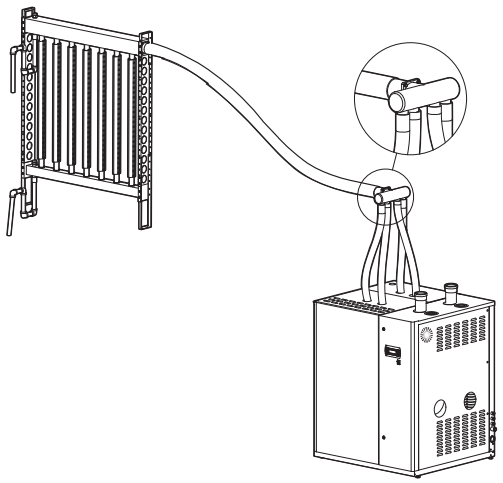


Fig. 7.c

NOTE: The adapters and steam hoses shown above are available as options. The "P" drains are not provided as part of the ultimateSAM system.
The system for identifying trap, strainer, and separator accessories is shown in Table 7.a. NOTE: Not all of the possible combinations shown on the table are available. A complete list of available kits, as well as information on other features, is provided in Section 7.1.

SAKT x x xx x 0

① ② ③ ④ ⑤ ⑥

①	ID prefix		
②	Material:	F =	Iron
		S =	SS
③	Type:	S =	Condensate separator
		T =	Trap & strainer assembly
④	Size:	15 =	DN 15 flange
		20 =	DN 20 flange
		25 =	DN 25 flange
		32 =	DN 32 flange
		40 =	DN 40 flange
		44=	1" pipe thread
		50=	DN 50 flange
		65=	DN 65 flange
		84=	2" pipe thread
⑤	Region:	U =	North America
		0 =	Other
⑥	---	---	

Tab. 7.a

7.1 Listing of available inlet trap, strainer and separator kits

Table 7.b provides a complete listing of all of the traps, strainers, and separators available for the use with the ultimateSAM distributor. In addition, the table provides information on the size and type of inlet-outlet connection for each accessory.

Inlet-Outlet Connections

	Material, Type, Region Codes		
Size	****FT**0*	****FT**U*	****ST**U*
SAKT**15*0	Flange DN 15"	n/a	n/a
SAKT**20*0	Flange DN 20	n/a	n/a
SAKT**25*0	Flange DN 25	n/a	n/a
SAKT**32*0	Flange DN 32	n/a	n/a
SAKT**40*0	Flange DN 40	n/a	n/a
SAKT**44*0	n/a	1" NPT Female	1"NPT Female
SAKT**50*0	Flange DN 50	n/a	n/a
SAKT**65*0	Flange DN 65	n/a	n/a
SAKT**84*0	n/a	2" NPT Female	2" NPT Female

Tab. 7.b

Table 7.c lists the items and quantity of threaded fittings that are included in each threaded trap and strainer kit. Flanged trap and strainer kits are fully integrated.

Item List for SAKT*T**U0

Item (NPT)	SAKT*T44*0	SAKT*T84*0
Y-type stainer	1 (1")	1 (1")
F&T trap	1 (¾")	1 (¾")
Bushing F-M (size)	1 (¾"x1")	1 (¾"x2")
Elbow F-M (size)	1 (¾")	1 (¾")
Elbow F-F (size)	1 (1")	1 (2")
Nipple M-M (size)	2 (¾"x6") 1 (1"x3") 1 (1"x6")	2 (¾"x6") 1 (2"x3") 1 (2"x6")
Tee F-F-F (size)	1 (1")	1 (2")
Union F-F (size)	1 (¾"x¾")	1 (¾"x¾")
Union F-F (size)	1 (¾"x¾")	1 (¾"x¾")

Tab. 7.c

7.2 Selecting trap and strainer kits

For flanged control systems, select a trap, strainer, or separator that has a flange size that matches the size of the selected control valve. For example, an SAKTFT1500 trap and strainer kit or an SAKSFT1500 separator is the best choice for an SAKV0F0D00 control valve.

For threaded control systems, select a trap and strainer kit based on the flow coefficient (Cv) of the control valve. For valves having a Cv less than or equal to 10, a 1" steam trap and strainer kit should be used. For systems using valves having with flow coefficients greater than 10, a 2" steam trap and strainer is recommended. For some applications, regulations may require the use of traps and strainers having all stainless steel construction.

7.3 Drain traps for distributor headers

A threaded connection (¾" male NPT for North American markets and ¾" male Gas for other markets) is provided for the condensate drains on the headers. If P-traps are used on the drains, as shown in Fig.7.c, the seal height should be sufficient such that the water column creates a pressure at least 500 Pa (50 mm or 2" H2O) greater than the static pressure in the header (PS).

NOTE: A minimum seal height of 150 mm (6") is recommended for most installations where the condensate trap drains into a sump inside the duct.

NOTE: Check local requirements regarding the minimum recommended seal height and drop height for the installation.

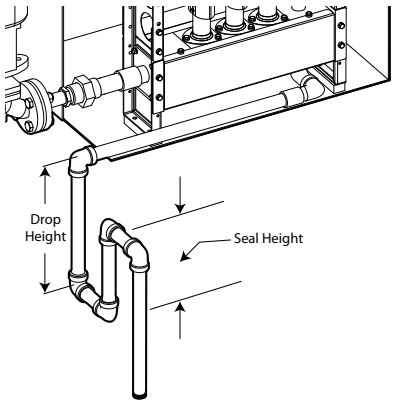


Fig. 7.d

Note: the fittings and pipe for the condensate drain shown in Fig.7.c are not included with the ultimateSAM distributor.

The static pressure within the inlet header (PS) depends on three factors:

- Height of uprights (that is, the number of nozzles)
- Number of uprights (N)
- Humidification load (H)

To calculate the static pressure within the inlet header, use the equation,

$$P_S = D\left(\frac{H}{100 * N}\right)^2$$

P_s: static pressure in kPa (in H2O)
D : constant in kPa (in H2O)
H : humidification load in kg/hr (lb/hr)
N: number of uprights

Table 7.d gives the value of the constant "D" for each height code. The calculated value may vary ±10% or ±0.1 kPa (½ in H2O), whichever is greater.

Constant "D" kPa (in H_2O)"

Height Code		
	A	45.48 (38)
	B	20.64 (17)
	C	11.97 (9.9)
	D	7.99 (6.6)
	E	5.84 (4.8)
	F	4.56 (3.8)
	G	3.75 (3.1)
	H	3.20 (2.7)
	I	2.82 (2.3)
	J	2.55 (2.1)
	K	2.35 (2.0)
	L	2.21 (1.8)
	M	2.09 (1.7)
	N	2.01 (1.7)
	O	1.95 (1.6)
	P	1.90 (1.6)
	Q	1.86 (1.5)

Tab. 7.d

If the P-trap empties outside the duct or AHU, the seal height and drop height must allow for the static pressure inside the duct or AHU. Check local requirements regarding the minimum recommended seal height and drop height. If the space limits the seal height for the condensate drain, a different type of trap, e.g., F&T trap could be used, or a distributor having a lower backpressure could be selected.

The bottom pedestals for the ultimateSAM distributor can be adjusted to provide up to 82mm (3¼") clearance for the P-trap when the condensate empties into a sump inside the duct or AHU. (See figure 7.d.) If the bottom pedestal cannot be raised high enough, an optional mounting stand is available to provide additional height (see section 8.1).

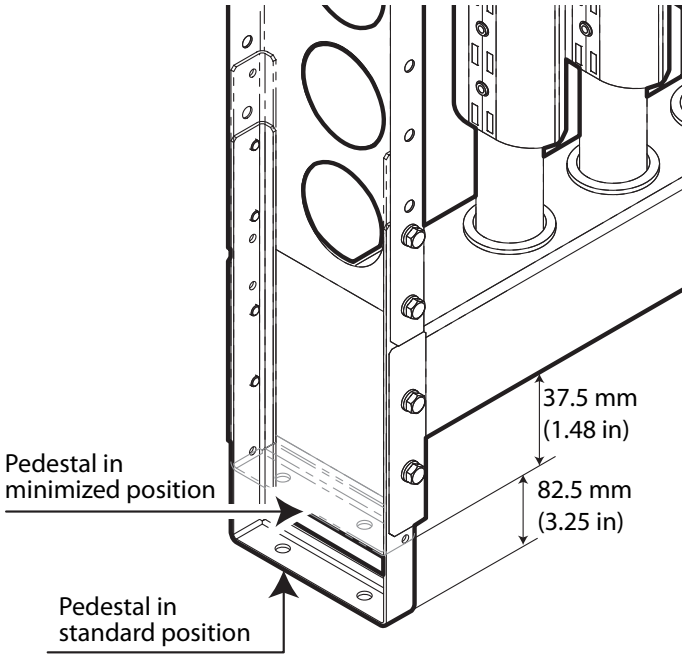


Fig. 7.e

For sites at which the condensate drains empty into a sump outside of the duct or AHU, the seal height of the P-trap must be increased by the amount of static pressure inside the duct.

8. OPTIONS

8.1 Mounting stand (SAKS010000)

The standard pedestal for the ultimateSAM Direct Steam Humidification System may not always provide sufficient clearance between the distributor and the bottom of the duct or AHU. For these situations, an optional mounting stand (SAKS010000) is available. The mounting stand can position the distributor as much as 386mm (15") above the floor. (See figure 8.a.)

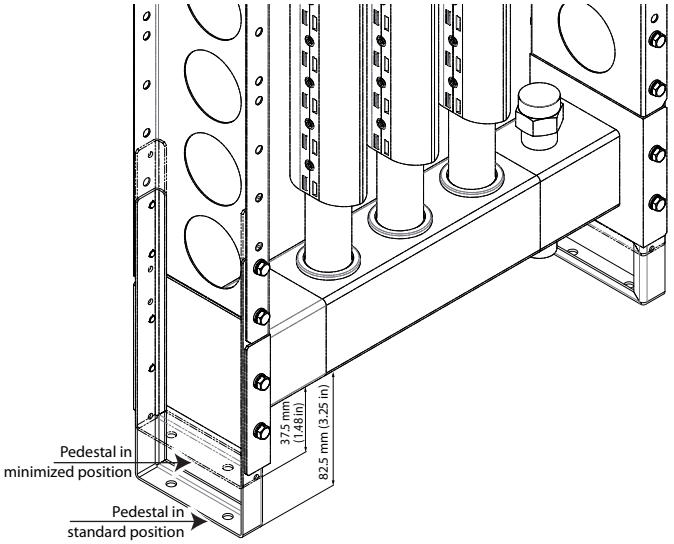


Fig. 8.a

There may be instances in which additional clearance is required above the distributor, particularly if a control valve and actuator are attached to the inlet of a top feed system and must be positioned inside the duct or AHU. In this case, the optional mounting stand can be used in place of the top mounting bracket.

8.2 Steam-to-steam heat exchanger (North American market only; SAE2S200U0)

For "clean steam" applications, an optional steam-to-steam heat exchanger (SAE2S200U0) is available in the North American market. (See figure 8.b.) This option eliminates any chance that boiler treatment chemicals might enter the ventilation system through the humidifier. The maximum capacity of the Steam Exchange option is 90 kg/hr (200 lb/hr). For additional information on this option, refer to the Steam Exchange user manual, +03U220110.

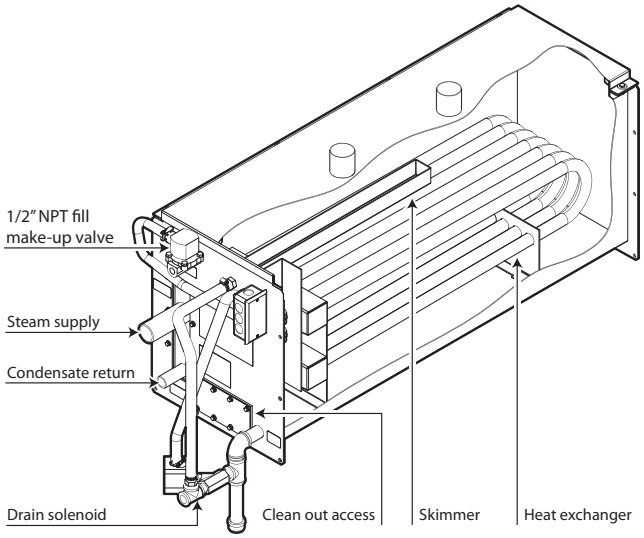


Fig. 8.b

CAREL

CAREL INDUSTRIES HeadQuarters
Via dell'Industria, 11 - 35020 Brugine - Padova (Italy)
Tel. (+39) 049.9716611 - Fax (+39) 049.9716600
e-mail: carel@carel.com - www.carel.com

Agenzia / *Agency*:

"ultimateSAM" +0300014IE - rel. 1.0 - 28.10.2010