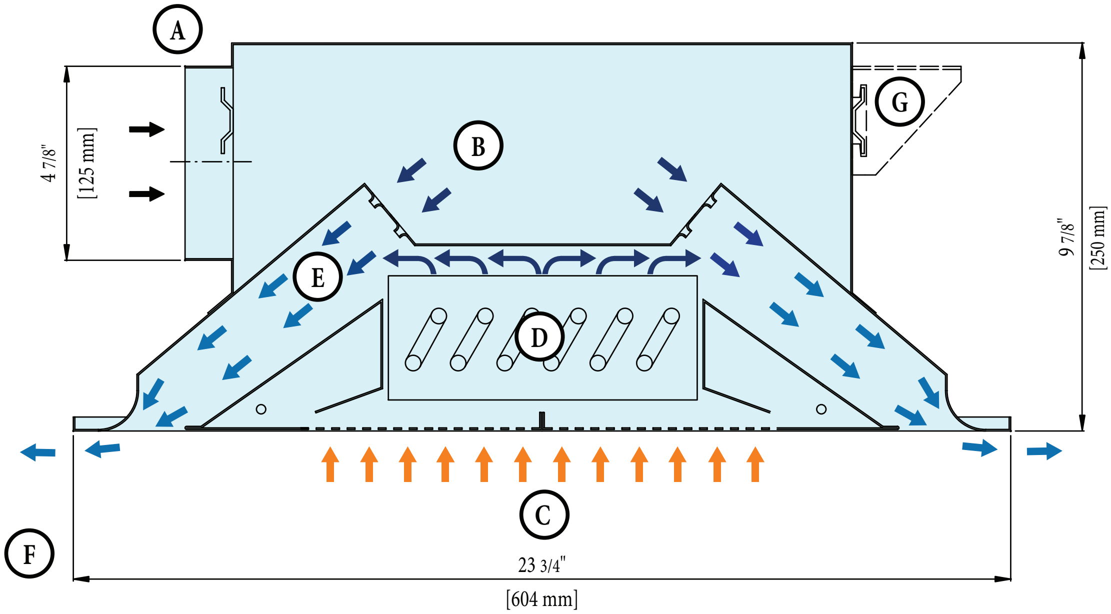
Modular Active

Chilled Beams

Twa

How Twa MAC Beams Work

Primary air (100% outside air) is dehumidified to between 50-57°F dew point and is used to: control the latent requirements of the space, provide fresh air to the occupants, and pressurize the beam plenum. The primary air then passes through an array of formed nozzles along the length of the beam. The jets of air discharging from the nozzles cause room air (secondary air) to be drawn through the unit mounted coil via induction. The coil is serviced by chilled water which is maintained at 2-8°F above the dew point of the primary air. The localized recirculation of room air provides substantial sensible cooling to the space at exceptionally low acoustic signatures (NC18-NC26). As a result of the reduction in total fan power, and higher chilled water operating temperatures, the building HVAC operating cost can be reduced by as much as 50% compared to "all-air" systems.



A) 1" (25mm) standing duct collar for primary air. Duct run-out servicing unit is sized to limit air velocity ≤ 600 fpm. Balance of system duct work sized traditionally.
B) Primary air plenum. (100% outside air)
C) Secondary air. (room air)
D) Unit mounted coil. (Two and/or four pipe available. Typical chilled water: 55-61°F, hot water: 85-115°F)
E) Mixed air. (Induction ratio range = 3:1 - 6:1 depending on nozzle selection.)
F) Discharge air (Typical Cooling: 63-66°F, Heating: 75-85°F).
G) Adjustable mounting brackets. Unit quickly attaches to building structure via aircraft cable or threaded rod.[1] (Qty: 4)

Due to the highly localized mixing within the beam, the temperature variations observed by the occupants are less than half of what would be expected with traditional air delivery systems. As a result, comfort levels are improved, and occupant complaints are minimized.

Twa MAC Beams are available in three basic sizes which are designed to fit within a standard 2' wide T-bar ceiling grid, and can also be installed within a finished drywall ceiling (2'x4', 2'x6', 2'x8'). Each module can be equipped with optional coil lengths, circuits, and induction nozzles, to suit the heating, ventilation, and air conditioning requirements of the space.

[1]Seismic locations may require additional bracing.

In a sea of available HVAC equipment options, Twa Panel Systems, Inc. with their experienced staff and agents can help guide you with your selection to one of the most efficient applied HVAC systems available today. Twa's Modular Active Chilled Beams (MAC Beams), were originally developed in Europe, and have helped to minimize building operating costs for more than a decade.

In many cases, Twa MAC Beams allow building designers to use minimal ventilation air (100% outside air) to satisfy the total cooling requirements of the space.

With Twa MAC Beams you can potentially

- Cut building operating costs by up to 50%
- Double the COP of the cooling plant
- Eliminate or reduce comfort complaints
- Minimize operating control costs
- Capture credits towards LEED certification for both Energy & Innovation

Construction Details

Twa Modular Active Chilled Beams

Comfort, Operation & Energy Savings		Installation/Controls
Twa MAC Beams use only 100% fresh outside air. Absenteeism, and lost time is reduced as a result of a more comfortable environment. Using dedicated outside air systems allow for smaller MUA footprints and provide more affordable air-side energy recovery.	Acoustic signatures of MAC Beams are barely perceptible. In the case of a unit operating at 1" w.c., all nozzle sizes will yield no more than NC26. Lower duct static pressures, yield lower sound pressure levels.	MAC Beams offer all the advantages of fan coils, yet require no: • condensate drainage • filters • electrical service • maintenance and provide comfort at up to half the operating cost.
The chilled water servicing the coil within the MAC Beam is maintained at 2-8°F above the dew point of the primary air, as a result, no condensate forms on the unit mounted coil.	Twa MAC Beams can produce one ton of refrigeration with as little as 99 cfm. This ensures that the least amount of air is processed by the HVAC system, which in turn, optimizes fan energy usage.	Buildings equipped with mixed-mode ventilation generally require dew point sensors installed on the chilled water supply lines, which help to prevent the formation of condensate on the unit mounted coil.
MAC Beams can easily provide 110 $Btuh/ft^2$ of total sensible cooling. Challenging sensible heat gains are no longer an additional fan burden. In typical HVAC applications, Twa MAC Beams require no more than 99-225 cfm/Ton of cooling.	Higher chilled water temperatures (55-61°F), and lower hot water temperatures (85-115°F) dramatically improve equipment efficiencies and potentially double the COP of the chiller plant compared to conventional operating temperatures.[2]	Chilled and hot water "RESET" allow the building automation system to optimize the comfort and energy costs of HVAC systems equipped with Twa MAC Beams.
A high induction ratio within the beam provides excellent room air mixing. Room air temperature variations are reduced, ventilation effectiveness is increased, and a comfortable air movement within the space is enjoyed by the occupants.	The low overall requirement for system air fan horsepower allows for low velocity downstream ducting. As a result, frictional duct losses can be made negligible by "slightly" over-sizing only the duct work servicing the beams. (≤600 fpm for beam run-outs.)	The approach between room and chilled water temperatures dictate the Beam's ability to absorb heat. The cooler the room, the less heat can be absorbed by the coil, and vice-versa. As such the Beam's capacity is self-regulating. The effect is linear.
Mixing of primary and secondary air within the beams, produce warmer discharge air temperatures allowing flexible beam placement. High induction ratios of 3:1-6:1 ensure the least amount of ventilation air is used to cool/heat the occupied space; minimizing operating costs.	Water-side economization is maintained with closed circuit fluid coolers, dry coolers or cooling towers. Where appropriate, mixed-mode ventilation also adds the possibility of additional energy savings. Geothermal and water-to-water heat pumps allow for the efficient management of heating/cooling loads within the building envelope.	Two-position control valves can be used to manage the MAC Beam's capacity. Approximately 65-75% of the cooling effect is provided by the chilled water coil. The primary air continues to provide ventilation with no water flow to the coil, and the dehumidification effect remains. Two-position control valves are the most common and least costly control technique.
		By using Variable Air Volume (VAV) to reduce primary air to the beam, proportional capacity control, and additional fan savings are achieved.

[2]Assuming the chiller plant has been decoupled from the MUA ventilation load.

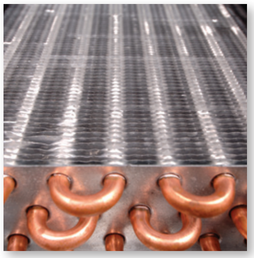
INCREDIBLE AIR SIDE EFFICIENCY

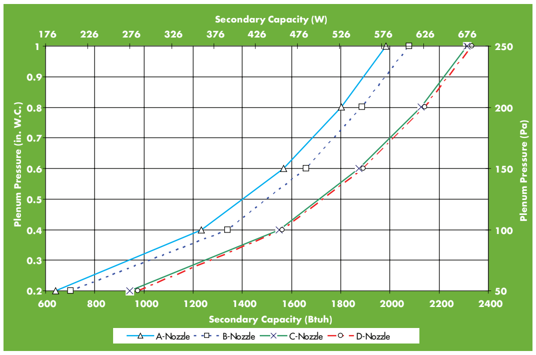
Twa MAC Beams generally require only:
99-225 CFM/Ton of cooling.[3]

Duct Static Working Pressures

As a result of efficient nozzle design, Twa MAC Beams optimize air turnover within the space, and require less primary air. Also known as "induction diffusers", Twa MAC Beams can create a higher induction effect and consequently a greater total capacity with duct static pressures in the range of (0.5"- 1"w.c.); without generating excessive noise (NC18 - NC26). Some manufacturers prefer lower operating static pressures, because their nozzle design requires too much primary air and their beams generate too much noise to justify their use at higher pressures.

Twa MAC Beams can operate with as little as 0.3" w.c. and can yield up to a 6:1 induction ratio. This allows the ventilation system to provide the least amount of outside air processing for the highest secondary cooling/heating capacity. Although fan energy is increased slightly, the increase in beam capacity generally offsets the effect.





Secondary Cooling Capacity of a 2'x4' Twa MAC Beam at 18°F approach.

[3]In typical office HVAC applications, including building envelope humidity control.

Twa MAC Beam Quick Select (Cooling Only)

Beam Coil Length	Air ΔP (APD) " w.c.	Nozzle Type **cfm** / Total Capacity (**Q_T**) = Btuh			
		A	B	C	D
2'	0.3	5.8 / 548	6.6 / 521	10.6 / 771	14.4 / 831
	0.4	6.8 / 680	7.7 / 663	12.3 / 922	16.6 / 991
	0.5	7.5/ 785	8.6 / 771	13.7 / 1034	18.5 / 1119
	0.6	8.3 / 863	9.4 / 855	15.0 / 1128	20.3 / 1221
	0.7	8.9 / 936	10.1 / 928	16.2 / 1214	21.9 / 1315
	0.8	9.5 / 997	10.8 / 988	17.3 / 1293	23.4 / 1401
	0.9	10.1 / 1054	11.5 / 1045	18.4 / 1367	24.9 / 1482
	1.0	10.7 / 1107	12.1 / 1098	19.4 / 1426	26.2 / 1548
4'	0.3	14.2 / 1354	16.6 / 1358	25.6 / 1850	36.2 / 2099
	0.4	16.4 / 1653	19.1 / 1664	29.6 / 2152	41.8 / 2440
	0.5	18.3 / 1866	21.4 / 1902	33.0 / 2406	46.7 / 2727
	0.6	20.1 / 2047	23.4 / 2087	36.2 / 2617	51.2 / 2969
	0.7	21.7 / 2199	25.3 / 2242	39.1 / 2811	55.3 / 3190
	0.8	23.2 / 2338	27.0 / 2385	41.8 / 2989	59.1 / 3394
	0.9	24.6 / 2467	28.7 / 2517	44.3 / 3132	62.7 / 3561
	1.0	25.9 / 2588	30.2 / 2642	46.7 / 3286	66.1 / 3738
5'	0.3	18.4 / 1728	21.1 / 1676	32.5 / 2289	46.8 / 2678
	0.4	21.1 / 2103	24.3 / 2085	37.5 / 2686	54.1 / 3105
	0.5	23.7 / 2368	27.2 / 2359	41.9 / 2998	60.4 / 3464
	0.6	26.0 / 2593	29.8 / 2585	45.9 / 3256	66.2 / 3766
	0.7	28.1 / 2781	32.2 / 2795	49.6 / 3493	71.5 / 4042
	0.8	30.0 / 2953	34.4 / 2969	53.0 / 3709	76.4 / 4295
	0.9	31.8 / 3112	36.5 / 3131	56.2 / 3884	81.1 / 4504
	1.0	33.5 / 3261	38.4 / 3283	59.3 / 4071	85.5 / 4723
6'	0.3	22.5 / 2092	25.8 / 2031	40.0 / 2777	58.0 / 3274
	0.4	26.0 / 2537	29.8 / 2518	46.2 / 3250	67.0 / 3788
	0.5	29.1 / 2851	33.3 / 2843	51.6 / 3619	74.9 / 4219
	0.6	31.9 / 3116	36.5 / 3109	56.5 / 3926	82.1 / 4580
	0.7	34.4 / 3337	39.4 / 3357	61.0 / 4205	88.7 / 4910
	0.8	36.8 / 3539	42.1 / 3562	65.2 / 4460	94.8 / 5211
	0.9	39.0 / 3726	44.7 / 3752	69.2 / 4667	100.5 / 5461
	1.0	41.1 / 3900	47.1 / 3930	72.9 / 4887	106.0 / 5721
7'	0.3	26.7 / 2508	30.5 / 2427	47.4 / 3369	68.0 / 3879
	0.4	30.9 / 3045	35.3 / 3013	54.8 / 3902	78.6 / 4490
	0.5	34.5 / 3424	39.4 / 3404	61.2 / 4348	87.8 / 5003
	0.6	37.8 / 3745	43.2 / 3753	67.1 / 4718	96.2 / 5434
	0.7	40.8 / 4012	46.6 / 4023	72.4 / 5055	103.9 / 5827
	0.8	43.6 / 4256	49.8 / 4271	77.5 / 5364	111.1 / 6187
	0.9	46.3 / 4482	52.9 / 4500	82.2 / 5613	117.8 / 6484
	1.0	48.8 / 4693	55.7 / 4714	86.6 / 5879	124.2 / 6796
8'	0.3	30.5 / 2871	34.8 / 2776	54.9 / 3911	78.6 / 4495
	0.4	35.2 / 3488	40.2 / 3407	63.4 / 4532	90.8 / 5205
	0.5	39.3 / 3925	44.9 / 3899	70.9 / 5052	101.5 / 5802
	0.6	43.1 / 4294	49.2 / 4268	77.6 / 5483	111.2 / 6303
	0.7	46.5 / 4602	53.2 / 4612	83.9 / 5876	120.1 / 6761
	0.8	49.8 / 4883	56.8 / 4897	89.7 / 6236	128.4 / 7180
	0.9	52.8 / 5144	60.3 / 5161	95.1 / 6527	136.2 / 7526
	1.0	55.6 / 5387	63.5 / 5408	100.3 / 6837	143.6 / 7888

MACB Size	Nom. Coil Length	H_2O GPM	WPD ft. w.c.
2' x 4'	2'	0.60	2.50
	4'	1.00	1.60
2' x 6'	5'	1.00	1.90
	6'	1.00	2.20
2' x 8'	7'	1.25	4.00
	8'	1.50	6.50

Procedure:

1. Choose a working static pressure from column: **APD ΔP "w.c.**
2. Nozzles "A" and "B" provide more total cooling with less primary air (i.e. higher induction ratios). Nozzles "C" and "D" are generally used to address higher ventilation requirements.
3. Each value within a nozzle column represents a ventilation rate in cfm, followed by a total sensible cooling capacity: Q_T, in Btuh.
   Example: coil length = 4', APD = 0.6" w.c. This beam with an "A" nozzle would require 20.1 cfm, and produce a total sensible cooling capability of Q_T = 2047 Btuh.
4. Choose the quantity of coils required to satisfy the cooling and ventilation needs of the space. Coil lengths can be mixed however, each zone would share the same static pressure.
5. Shorter coils can be mounted in longer modules.
6. The latent cooling, or dehumidification capability of the beam (Q_L), can be calculated by equation 2.0, below.
7. The total sensible cooling capacity can be determined by subtracting Q_L from Q_T.
8. The equipment has been rated with water as the working fluid, at sea level altitude.
9. Typical acoustic impact = NC18 @ 0.5" w.c., NC26 @ 1" w.c.
10. Heating is also available with four-pipe MAC Beams.
11. Q_{PA} = Sensible cooling effect provided via primary air.
12. Q_S = Secondary sensible cooling effect provided via unit mounted coil.

EQ 1.0 $Q_{PA} = 1.08 * cfm * (T_{Room} - T_{PA})$
EQ 2.0 $Q_L = 0.68 * cfm * (Gr_{Beam} - Gr_{OC})$
EQ 3.0 $Q_S = Q_T - Q_{PA}$

Table Parameters:

Room design dry bulb temperature (T_{Room}) =	75°F
Room design relative humidity =	50%
Primary air temperature (T_{PA}) =	54°F
Primary air dew point (T_{PADP}) =	52°F
MAC Beam chilled water supply temp (EWT) =	58°F
Assume typical office space requires (cfm/person) =	20
Beam's coil condensate threshold, grain ratio (Gr_{BEAM}) =	72.15
MUA off-coil grain ratio (Gr_{OC}) =	57.80

For more information on how MAC Beams can help to lower your building operating costs, please contact:

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