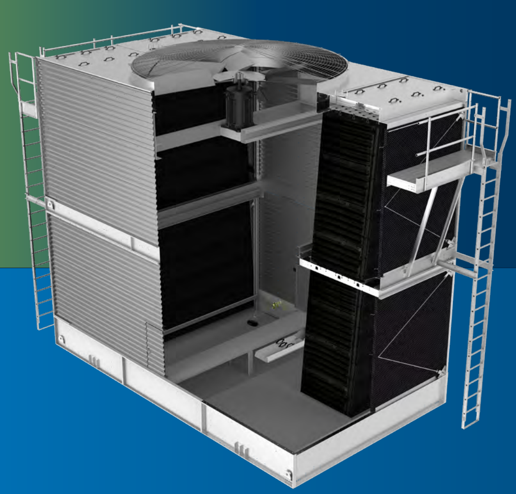
CASE STUDY

Choosing Replacement Fill

Series 3000 Cooling Tower



CASE STUDY

Choosing Cooling Tower Replacement Fill

OVERVIEW

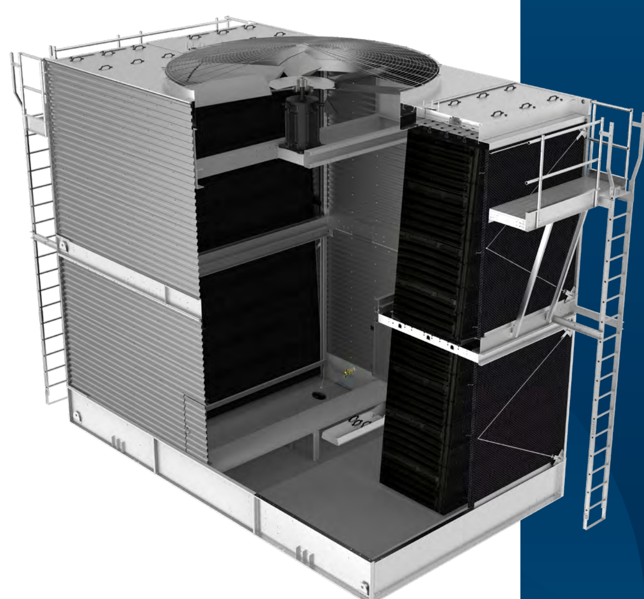
Cooling towers offer a proven and cost-effective solution for rejecting heat from condenser water and industrial processes. To maximize the operating cost savings, the fill media — the heat transfer surface that the water flows over — must be properly designed and in good condition.

The fill is the heart of the system, and the performance of the entire system depends on maximizing the surface area of evaporation, evenly distributing the water across the surfaces, and optimizing the thickness of the water film to perform efficiently.

After years of operation, the fill media can eventually degrade to the point where it must be replaced. Building owners and operators can find it difficult to evaluate the claims by various manufacturers about which type of replacement fill is the best choice.

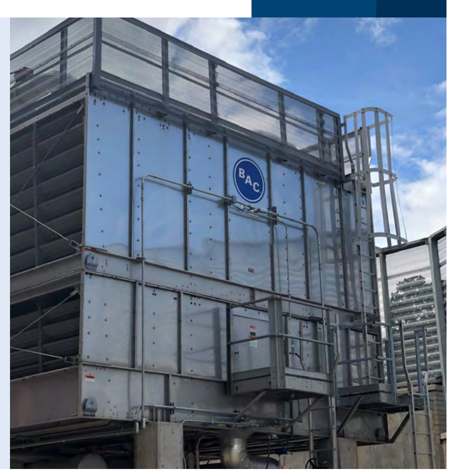
WHICH FILL IS MORE EFFICIENT?

The ideal way to understand what fill is optimal is through independent research rather than relying on manufacturers promoting their own product. The most objective evaluation would come from an unbiased side-by-side comparison, in a real-life situation. The competing products would be observed for years to determine not only how well they perform at the time of installation, but how they stand up over time.



BACKGROUND

This is exactly what happened when a large professional sports arena in southern California replaced the fill in its cooling towers. Three BAC Series 3000 cooling towers with a crossflow design had been contributing to the comfort and safety of the patrons of the 20,000-seat arena for 18 years. The cooling towers were performing adequately, but due to their age, it was decided that the fill should be replaced as part of a long-term maintenance plan.



HANGING FILL VS. BLOCK FILL

To minimize downtime, the plan was to replace the fill pack in one cooling tower per year instead of taking all three towers offline at once. In the first tower, and again in the second tower a year later, the fill was replaced with BAC's VersaCross® replacement fill, a "hanging" style fill designed to reclaim the original cooling tower performance for this Series 3000 cooling tower model. For newer Series 3000 models, BAC also offers BACross® replacement fill kits, a similar hanging fill option that ensures optimal performance. When it came time to replace the fill in the third tower, the building owner opted for a competitive "block" fill style product instead, deviating from the original hanging fill design.

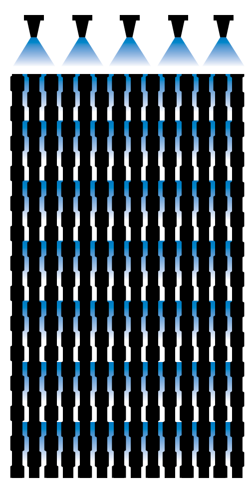
The BAC Series 3000 cooling tower has a crossflow design, meaning that the water flows vertically down the fill as air flows horizontally across it. Hot water from the system enters the cooling tower and is distributed over the fill (heat transfer surface). Air is drawn through the fill, causing a small portion of the water to evaporate. This evaporation removes heat from the remaining water, which is collected in the cold water basin and returned to the system to absorb more heat. The Series 3000 was designed to maximize thermal performance by using hanging sheet fill, and BAC VersaCross® replacement fill is the replacement OEM hanging fill for this specific cooling tower. Long continuous sheets, with patterns embossed to increase surface area, are hung to allow smooth water flow from top to bottom.

The block-style replacement fill is a fundamentally different design. The fill is in the shape of blocks comprised of corrugated layers of PVC sheets, with wavy sheets sandwiched between layers of flat sheets. The air opening is filled with these rectangular blocks.

Although block fill is faster to ship and install, it is not ideal for every cooling tower application. BAC was concerned that competitor's block style fill would not perform to the same level as BAC's VersaCross® replacement fill over time. The vertical spacing of block fill is wider than BAC's hanging fill, providing less physical surface area than hanging fill. Reduced surface area results in less evaporative cooling.

Another concern was that over time water would not flow smoothly and evenly through the block fill. Within each block, where the corrugated layers are connected to each other, water flow can be impinged.

These connections between the flat pieces and the corrugated layers and the transitions between blocks may trap solids. This can lead to scale buildup and fouling, resulting in unacceptable degradation in performance in just a few years.



Block Fill May Impede Flow Over Time

TESTING PLAN TO COMPARE PERFORMANCE

After discussion among the building ownership and the installation contractor, the parties agreed that the block fill would be installed and an independent testing company, American Air Balance Co., would be retained by the arena owner to conduct tests comparing the performance of the cell with the block fill to the performance of one of the cells with the VersaCross® fill.

The thermal testing was performed shortly after the block fill was installed. The chosen time was during a Saturday night NHL game because the arena was packed and the spectators were generating a lot of heat. All three cooling towers were running at full speed.

TEST RESULTS SHOWED CLEAR DIFFERENCE IN PERFORMANCE

When the two cooling towers were tested, Cooling Tower 1 (CT-1) with competitor block fill performed at 72% of the original fill's thermal capacity, and Cooling Tower 2 (CT-2) with the VersaCross® fill performed at 96% of the original fill's thermal capacity.

3000 Unit	CT-1	CT-2
Replacement Fill	**Block Fill**	**BAC VersaCross®**
Measured Current (Amp)	50.3	50.9
	48.7	49.5
	48.3	49.4
Average Amp	49.1	49.9
Measured Voltage (v)	435	435
Power Factor	0.95	0.95
kW	35.1	35.7 *
Motor HP	47.1	47.9 **
Entering Water Temp (F°)	82.1	82.1
Leaving Water Temp (F°)	73.0	71.0
Entering Wet Bulb Temp (F°)	59.9	61.1
Selection Program GPM	2799	1984
Ultrasonic Measured GPM	2025	1910
Unit Performance	**72%**	**96%**

* =3(1/3)*amp*voltagen*power factor/1000 ** =3kW/.746

Performance Comparison:
Block Fill vs. VersaCross®

	CT-1	CT-1	CT-1
	Block Fill	**Block Fill**	**Block Fill**
	At Installation	**Month 16**	**Month 28**
Measured Current (Amp)	50.3	47.9	42.1
	48.7	48.6	43.8
	48.3	49.8	45.6
Average Amp	49.1	48.8	43.8
Measured Voltage (v)	435	435	441
Power Factor	0.95	0.95	0.95
kW	35.1	34.9	31.8 *
Motor HP	47.1	46.8	42.6 **
Entering Water Temp (F°)	82.1	91.2	91.4
Leaving Water Temp (F°)	73.0	81.8	82.2
Entering Wet Bulb Temp (F°)	59.9	71.1	69.1
Selection Program GPM	2799	2921	3162
Ultrasonic Measured GPM	2025	2071	2048
Unit Performance	**72%**	**71%**	**65%**

* =3(1/2)*amp*voltagen*power factor/1000 ** =3kW/.746

Long Term Performance of Block Fill

SIGNIFICANT DIFFERENCE IN LONG-TERM PERFORMANCE

The cell with block fill was tested again by the independent lab 16 months after installation and again at 28 months. The results showed an additional performance drop-off during that 28-month period.

Note:
"Selection Program GPM" is a calculated prediction of how many gpm of water a Series 3000 unit with the original fill could cool with a given air inlet temperature, water inlet and outlet temperatures, and power consumption. The "Selection Program GPM" in this table above states that each of CT-1 and CT-2 with the original fill has the thermal capacity to cool 2799 gallons of water per minute from 82°F to 73°F at 60°F wet bulb while consuming 35 kW of power. Each of these same towers with the original fill can also cool 1984 gallons of water per minute from 82° to 71°F at 61°F wet bulb while consuming 36 kW of power.

CONCLUSION: FIRST COST VERSUS TOTAL COST OF OWNERSHIP

The arena's real-life experiment with side-by-side testing highlighted the impact of fill type on cooling tower performance. Originally designed for hanging fill, the cooling towers underwent a replacement with third-party block fill, which led to a 24% reduction in thermal performance at the time of installation, and even further reductions over a 28 month period.

After the testing, the arena replaced the block fill with BAC's OEM hanging fill - VersaCross® fill, which allowed the customer to reclaim nearly all of the original performance.

While the block fill had a lower first cost and saves about a day per cell on installation time and labor costs, the arena ultimately found that factors such as energy consumption, maintenance costs, and a shorter lifespan played a much more significant role in overall costs. This experience underscored the importance of selecting a fill design and quality that supports lifetime savings and maximizing cooling tower performance.

"The type of fill can make a big difference.
Design and quality are critically important."

—Steve Kline, P.E., M.B.A.
Product Applications Manager, Baltimore Aircoil Company

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