

# Johnson Controls® BlueStream™ Hybrid Cooling Systems In Power Generation Plants.



Optimizing Resource Management



# A More Resourceful Solution To Power Generation Operational Challenges

## Introducing The BlueStream™ Hybrid Cooling System



The demand for energy continues unabated, placing extreme demands on utilities and commercial industries to keep pace, requiring highly efficient power generation units.

Water-cooled systems do a great job of handling the high heat-rejection requirements of a power generation unit. Unfortunately, in many regions, continuing droughts and global warming are limiting the availability and raising the cost of makeup water used in cooling towers. Cooling tower systems also generate a large wastewater stream to mitigate the buildup of solids in the circulating condenser loop, an issue when municipalities limit allowed wastewater discharge. Permitting can be a major issue blocking new installations in water-constrained areas.

The alternative to using an air-only cooling system can be cost-prohibitive, as it requires massive units that are considered less effective than water cooled systems for heat rejection. What's more – they often require plant derates on the hottest days, when electrical demand is at its peak.



Fortunately, there's a better solution: a BlueStream hybrid cooling system that optimizes the use of two cooling

technologies in a single operating system. Used in conjunction with a traditional cooling tower, the BlueStream hybrid cooling system can reduce water consumption by up to 80%. It is highly effective across a vast range of weather conditions, as it automatically modulates to utilize the most efficient combination of water- and air-cooled systems (both individually and simultaneously) in response to changes in temperature and energy and water prices. The system's modular design is highly scalable, with the ability to add multiple units in parallel to handle the largest power plants. Key core technology within the BlueStream hybrid cooling system is the Thermosyphon cooler, a dry-heat rejection unit designed to work as a complement to your cooling tower system.

The BlueStream hybrid cooling system lets you manage both natural and financial resources with tremendous efficiency. It is equally cost-effective when building a new power plant or retrofitting a plant experiencing restricted water resource issues.

### Optimized Efficiency:

#### The BlueStream Hybrid Cooling System

At Johnson Controls, we are passionate about water conservation issues. Finding new ways to be more efficient in the use of this precious natural resource is a priority for us and the customers we serve. Our patent-pending BlueStream hybrid cooling system reduces water use by as much as 80% while maintaining peak plant output at demanding summer design conditions.

The BlueStream hybrid cooling system adds a dry cooling system to your existing wet system, then coordinates the operation of the two for optimum efficiency, utilizing wet cooling when it's hot and dry cooling when it's not. Intelligent controls allow a combination of the two to run simultaneously in all weather conditions between the two extremes.

Its modular design allows this system to be scaled up to handle the largest of facilities in the most extreme environments. The system utilizes the Thermosyphon cooler, a dry-heat rejection unit specifically designed to be used in an open cooling tower loop or as a freeze protected closed circuit cooler. Refrigerant circulates naturally through the Thermosyphon process, with no need for a pump or compressor. Freeze protection is accomplished by controlling the refrigerant flow. This system is designed for low maintenance, with an easily cleanable low pressure drop heat exchanger.

### Additional advantages include:

- Highly efficient contact with open cooling water
- Low waterside pressure drop (1-4 psi)
- A "W Coil" 12-fan design that allows minimal spacing between adjacent units, reducing plan area requirements
- Smaller installation space and lower relative cost compared with those of competitive units

Compatibility with an existing cooling water loop is easily achieved, as evaporator tube metals can be cost-effectively substituted at the design phase before manufacturing. Alternative metals include CUNI, stainless steel or titanium.

# Optimizing Resource Management

## Measuring Cost-Effectiveness: The WECER Ratio

To fully appreciate the potential operational savings of the BlueStream hybrid cooling system, you have to balance water and energy usage costs. This is expressed as the Water-to-Energy Cost Equivalence Ratio or WECER. Simply put, WECER is cost of water (\$/1,000 gallons) divided by cost of electricity (\$/kWh).

Figure 1 at right shows the annual dry bulb (in red) and wet bulb (in green) temperatures for Jacksonville, FL sorted from highest to lowest dry bulb for the 8,760 hours of a typical meteorological year. The upper sawtooth gold line represents the cooling tower makeup water requirements in gallons per net megawatt hour (MWH) produced. The yellow shaded area under that gold line is the total annual volume of water required per MWH produced.

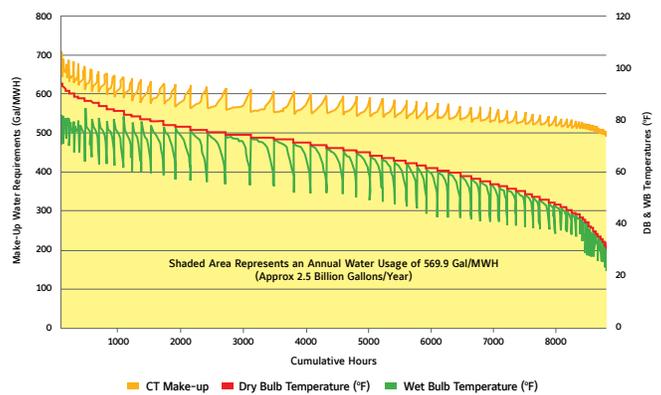
### Optimizing Your Resources

Figure 2 expands on the previous figure, and shows the impact of incorporating a TSC system upstream of the cooling tower to pre-cool the water, and thereby reduce the thermal load on the cooling tower and save water. The three shaded areas represent water savings associated with operating the TSC and cooling tower under different control strategies

The key to resource management is our BlueStream hybrid cooling system controller, which can be set for either maximum operating savings based on your WECER, or maximum water savings of up to 80% while maintaining peak output. The rust colored area represents the water that can be saved using WECER control. Additional water can be saved, as shown by the green area, if TSC fans are run at 100% fan speed. Finally, maximum water savings can be achieved controlling condenser water loop temperatures to their maximum allowable levels. This additional water savings is represented by the purple area.

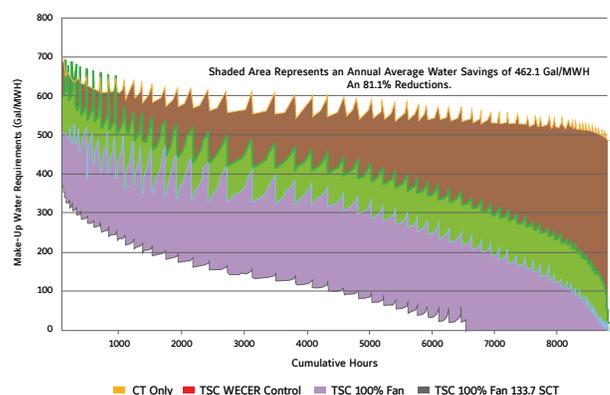
Water Usage Comparison for Jacksonville, FL  
500 MW Coal Fired Power Plant (Cooling Tower Only - Optimum SCT)

Figure 1



Water Usage Comparison for Jacksonville, FL  
500 MW Coal Fired Power Plant (32 TSC Modules - 100% Fan Speed - 133.7F SCT)

Figure 2



### Flexibility and Functionality

A BlueStream hybrid cooling system can be incorporated incrementally into an existing installation (even a nuclear power plant) without greatly modifying the existing infrastructure and with minimal disruption to plant operations.

### A Global Leader in Controls Technology

Johnson Controls provides expert assistance at every stage of your project, from overview, design and manufacturing to installation, training and maintenance support functions. Visit [www.johnsoncontrols.com/bluestream](http://www.johnsoncontrols.com/bluestream) for more information.



No need for antifreeze; freeze protection is accomplished by controlling refrigerant flow

High-efficiency premium variable-speed fans

Uses natural Thermosyphon effect to circulate the refrigerant; no intermediate pump required

Freeze-protected single-pass condenser

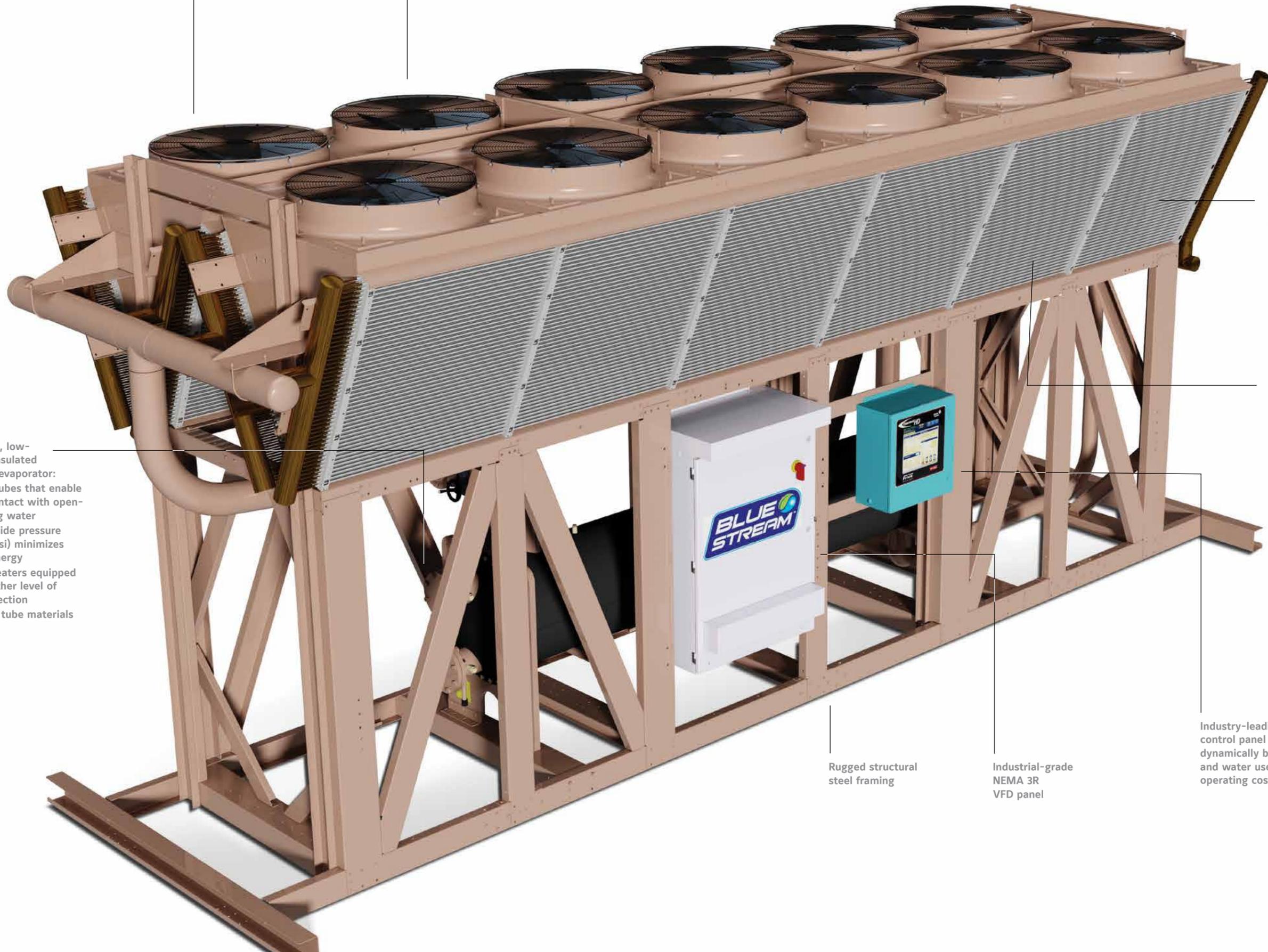
Highly efficient, low-maintenance insulated shell and tube evaporator:

- Cleanable tubes that enable efficient contact with open-loop cooling water
- Low waterside pressure drop (1-4 psi) minimizes pumping energy
- Auxiliary heaters equipped to add another level of freeze protection
- Alternative tube materials available

Rugged structural steel framing

Industrial-grade NEMA 3R VFD panel

Industry-leading Quantum™ HD control panel designed for dynamically balanced energy and water use to optimize total operating cost



# Better Resource Management Through Hybrid Technology



Our BlueStream hybrid cooling system combines air-cooled and water-cooled heat rejection systems with advanced controls, reducing water usage by up to 80% while optimizing efficient energy use. Excellent for either new or retrofit applications.



Petro/Chemical Manufacturing Plants



Central Chiller Plants



Data Centers

## Warranty and Support

Johnson Controls supports customers at thousands of worldwide locations with full parts and service capabilities to provide exceptional responsiveness.

## Contact Us for a Quote

For a quote or further information about the BlueStream hybrid cooling system, please email [BE-Bluestream@jci.com](mailto:BE-Bluestream@jci.com).

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