

INTRODUCTION

This paper attempts to contrast the design and operating limitations of cooling towers of conventional design with those of the Tower Tech Modular Cooling Tower™. Tower Tech uses innovative, patented technologies in its factory-assembled cooling towers.

There are significant differences among cooling towers, and a tower's annual operating costs can easily exceed half of the tower's initial capital cost. Accordingly, when evaluating the purchase of a cooling tower it is important to analyze the cost of energy to power the fans; water lost to evaporation, blow-down, drift, and splash-out; chemicals; maintenance; and repairs. Also, a tower's pump head and costs of installation are not insignificant. Furthermore, a tower that contains galvanized metal or treated wood will leech lead, zinc, acid copper chromate, and copper chromate arsenic into the process water, drift, splash-out and blow-down. There are also many safety concerns relating to cooling tower operation, maintenance and repairs.

With all of the problems inherent to cooling towers it is not uncommon to find that most owners and engineers believe these problems are necessary evils, that the next new tower bought or specified will be no different from the last tower bought or specified. This was true until 1991, when Tower Tech introduced the patented Modular Cooling Tower™.

EVALUATION CRITERIA

The purchase of any cooling tower requires the evaluation of at least the following factors:

- First cost
- Installation costs
- Fan energy consumption
- Pump energy consumption
- Water use
- Water treatment requirements
- Maintenance characteristics
- Worker safety
- Environmental safety
- Expected service life

Until 1991, no cooling tower builder or manufacturer offered a tower that scored well in all areas. Some had a relatively low first cost but also had a short life expectancy, were inefficient, or required much maintenance. Until that time virtually all cooling towers had similar operating costs due to design limitations and the resultant operating procedures that had become 'industry standard' over several decades. Accordingly, a cooling tower was evaluated mainly on the basis of its installed horsepower; brake horsepower; footprint; weight; and installed cost. In recent years life-cycle cost analysis has become the norm for major mechanical equipment, and yet cooling towers continue to be seen as having such similar characteristics that life-cycle costing is often ignored. As a result, the substantial costs of operating a tower are not monitored or captured. Buyers who take a little time to evaluate cooling tower life-cycle costs will gain a special appreciation for a long-life cooling tower that uses less energy and less water, fewer

chemicals, has reduced maintenance requirements, and is environmentally friendly and worker safe. (Environmental considerations and worker safety came to the fore after Legionellae bacteria were found to thrive in open-circuit cooling towers. Regulatory efforts are now made to monitor tower emissions, the health and safety of personnel engaged in the hands-on operation and maintenance of cooling towers is now deemed very important, and health care institutions have a heightened awareness of the dangers of legionella bacteria and endeavor to eradicate it in their various water systems, often starting with the design of the cooling tower loop.

FIRST COST AND TOTAL INSTALLED COST

“Quoted first cost” is only the tip of the iceberg when purchasing a cooling tower. The costs of civil construction (basin, foundation, steel, and concrete work), partial field assembly, setting the tower in place, piping, electrical, and start-up are often judged to be similar for all cooling towers. However, significant differences exist among cooling tower offerings and it is important that these differences be recognized, because most tower manufacturers’ quotes will not dwell on them for long, if at all.

In contrast, a Tower Tech Modular Cooling Tower™ is completely factory-assembled and two workers and a crane operator can install a tower module in less than an hour.

BASIN ENGINEERING AND CONSTRUCTION

Most conventional towers require civil work, structural members, and concrete columns to support the cold water basin, and the cost of

such work is seldom considered in the price quoted by the tower manufacturer.

In contrast, every Modular Cooling Tower has an integral fully enclosed high velocity Flow-Thru Basin™ which obviates the need for most, if not all, civil work. The elevated basin allows the use of horizontal split-case double suction pumps, which reduce capital outlays and reduces tower operating and maintenance costs. Furthermore, every Modular Cooling Tower arrives with its own sub-structure kit (legs) for ease of installation on steel or concrete piers.

CONTROLS AND EFFICIENCY

Manufacturers of conventional cooling towers sometimes recommend the use of two-speed fan motors or even variable-speed drives in an attempt to reduce energy consumption. This idea ignores that each fill media has an optimum L/G ratio (L = water; G = air). Ideally, the L/G ratio can be maintained in order to preserve the tower’s heat transfer efficiency, thus any reduction in airflow without a corresponding reduction in water flow will cause an imbalance, usually a gross imbalance, in the L/G ratio. While two-speed fan motors allow for limited energy savings, only a tower that keeps the L/G ratio in some semblance of balance can harvest the real energy savings to be found from controlling fans.

Only Tower Tech Modular Cooling Towers contain the patented Rotary Spray Nozzle™, water distribution system so revolutionary, that it captures all available energy savings within a cooling tower. Couple the Rotary Spray Nozzle

with the unique multiple fan configuration, coupled with a motor starter panel with optional temperature controller, allows fans to be cycled ON and OFF as required to preserve proper L/G balance, save energy, and deliver cold water of the desired temperature. One or more variable-frequency drives may be installed for even greater energy conservation and tighter operational control. Typically, the motors on a single multiple-fan tower module will all be controlled by one VFD which brings the fan speed up and down as required to maintain the desired cold water temperature set point.

OBSELETE OPERATIONAL PROCEDURES

The standard operating procedures for conventionally designed cooling towers have evolved as a direct result of the limitations inherent in their century-old design. To illustrate, where a three-cell tower is paired with three chillers, all tower cells will operate at maximum brake horsepower when the wet bulb temperature is at or above the tower's design point. But as the wet bulb temperature falls, it is common that a chiller be turned off to conserve energy. At the same time a pump and a tower cell will also be turned off, purportedly to conserve energy. (It is rare to find this perfect symmetry of chillers, pumps and towers, but the reader will understand the concept.) This SOP reduces total energy consumption by one-third. However, in the real world a pump typically feeds more than one tower cell and so the pump cannot be turned off. Instead, the valve on one tower cell may be closed while the pump continues to operate, which saves no pump energy. This SOP captures only a small fraction

of the latent energy savings. So, why was this SOP developed over the years? Because any cooling tower of conventional design has an inherent limitation: its water flow cannot be reduced below the design flow rate without seriously eroding tower efficiency (poor L/G ratio) and causing fill scaling by the frequent wetting and drying of the fill.

It is only possible to capture the latent/potential energy savings in a cooling tower if, during off-peak load or off-design conditions, one or more pumps can be shut off while all tower cells maintain a full and uniform coverage of the fill. This "full and uniform coverage" is the problem, for it cannot be achieved unless the cooling tower cell has a way of automatically detecting the lower flow rate and adjusting its nozzle orifices to compensate for the lower flow and operating pressure. A corollary SOP for cooling towers of conventional design is to reduce airflow in an attempt to conserve energy. While this approach seems sensible on its face, it actually is not efficient because it, too, causes an imbalance in the tower's L/G ratio. These SOPs, then, are the Achilles' heels of the conventionally designed cooling tower: when the conventional tower operates off-design its fill media either is flooded or starved of water. Moreover, air always preferentially migrates to the fill areas that contain the least resistance (areas with the least water), and the result is reduced tower efficiency at off-design conditions. A cooling tower "design condition" is specified for the highest or nearly the highest wet bulb temperature of the year; most of the year the tower can produce colder water because the wet bulb temperature is lower.

A cooling tower with the ability to recognize off-peak loads and off-design ambient conditions and “self-adjust” its water distribution system and air delivery system accordingly would allow for a high level of operational flexibility and efficiency. Such a tower would be able supply colder water to condensers during off-peak or off-design conditions without running additional fans.

IMPORTANT CONSIDERATIONS

(1) An electrical motor operating at full speed consumes eight (8) times the energy than it consumes when operating at half-speed. While the fan staging capability of a Tower Tech Modular Cooling Tower gives excellent control over process temperatures and reduces energy consumption, it is possible to achieve even tighter process control and greater energy savings by using a variable-frequency drive on each tower module.

(2) A cooling tower uses approximately one-fifth of the energy that a chiller would need to reject the same amount of heat. For this reason, cooling towers are considered to be an economical means of heat rejection. For every 1°F reduction in water temperature supplied to a chiller, the chiller’s energy consumption drops by 2.25%. It therefore follows that it is far preferable to put as much load on the tower and as little load on the chiller at all times.

(3) Optimum evaporative cooling efficiency is achieved when a tower’s L/G ratio is balanced.

(4) Cooling towers are designed for the hottest days of the year when the wet bulb temperature

is at the highest. However, this temperature is seen only 1% to 2.5% of the year. During the remainder of the year the tower is able to achieve colder exiting water temperatures.

IMPROVED OPERATIONAL FLEXIBILITY

It is apparent that significant energy savings could be obtained if all cooling tower cells, i.e., all the fill media’s surface area, could be efficiently wetted at all time, especially when the ambient wet bulb temperature or heat load are off-design. Such a tower, however, must have ability to operate efficiently (reduced airflow and water flow) at such times.

The Tower Tech Modular Cooling Tower stands in stark contrast to conventional towers with their fixed-flow fixed-orifice spray nozzles. Tower Tech’s patented variable-flow Rotary Spray Nozzle™ has an orifice that automatically adjusts to varying water flows from 115-350 gpm per nozzle without degrading its hydraulically uniform 6’x6’ square water distribution pattern. This revolutionary technology keeps water flows and airflows in balance as the wet bulb temperature and loads change. The result? Profound energy savings at the tower, while at the same time allowing the tower to feed colder water to chillers or other process equipment without running additional tower fans. To illustrate, consider that a Tower Tech module with 10 fans can cool 2,700 gpm of water at its design condition of 95°F HWT, 85°F CWT, and 78°F WBT. This module easily will supply the cold water needed for 900 tons of cooling (at 3 gpm per ton). So, if three 300-ton chillers and three pumps are mated, all the water can flow through the single

Tower Tech module when the heat load and wet bulb temperature are at their highest. As the heat load or wet bulb temperature drop, one chiller and one pump are turned off, and the flow through the Tower Tech module drops to 1,800 gpm. The orifice in each Rotary Spray Nozzle automatically adjusts to the lower flow while continuing to deliver the same hydraulically uniform 6' x 6' square spray pattern. (For example, the tower module will now deliver 1,800 GPM of 82.9°F water on a 78°F WBT day.) Let's continue with our illustration: If the heat load or wet bulb temperature is reduced even further, a second chiller and pump will be turned off and the water flow through the tower module will drop to 900 gpm. Once again, the orifice in each Rotary Spray Nozzle automatically adjusts to the lower flow while continuing to deliver a hydraulically uniform 6' x 6' spray pattern. (The module will now deliver 900 gpm of 80.0°F water on a 78°F WBT day.) If, however, there is no desire to have colder-than-design water, the module will deliver 900 gpm of 85°F cold water on a 78°F WBT day while just two (2) of its 10 fans are operating. Clearly, the Tower Tech design offers superior operational flexibility.

POOR WATER DISTRIBUTION YIELDS POOR TOWER PERFORMANCE

The work of a cooling tower occurs within the tower's fill media. As we have seen, a tower's highest efficiency is obtained when water is distributed uniformly and in proper proportion to the volume and speed of airflow in the fill media. The fixed-orifice nozzles common to all conventional cooling towers are a chronic problem because they are unable to adjust to

reduced water flows, or if they purport to have variable-flow capability they still are found wanting because they do not self-adjust to deliver a hydraulically uniform square spray pattern.

Fixed-orifice spray nozzles are also notorious for their tendency to become plugged by the biological debris that commonly flows through a cooling tower (scale, leaves, bird feathers, algae, etc.). A conventional cooling tower uses gravity-type or pressure-type water distribution systems with fixed-orifice nozzles. Such nozzles are designed to deliver fixed umbrella-shaped spray pattern given a fixed water volume and pressure. Even at design conditions (design load and wet bulb), this round-peg-in-a-square-hole design ensures that 22% of the fill will never see water, or if the nozzles are installed so their spray patterns overlap, the fill will see regions of alternating heavy water and light water. Moreover, if water flow through one of these conventional nozzles is reduced, the spray pattern shrinks and dry voids (air chimneys) are created throughout the fill. As we saw earlier, water in the fill creates resistance against the airflow, and air passing through the fill naturally seeks the path of least resistance — preferentially migrating to those fill areas with the least amount of water. Little, if any, effective cooling is done in these fill regions that have little water. So then, it is this most fundamental inherent limitation of conventional cooling towers that causes their manufacturers to insist that the tower always be operated at the design flow rate. Any lower flow degrades the spray pattern and results in wasted fan and pump energy, which in turn reduces tower efficiency and performance.

In contrast, the Modular Cooling Tower equipped with Rotary Spray Nozzles solves all of the water distribution problems common to conventional towers:

- (1) Variable-size orifice automatically adjusts to varying water flows from 115 gpm to 350 gpm.
- (2) Low operating pressure: 1.4 psi.
- (3) Self-adjusts to deliver a hydraulically uniform 6'x6' square spray pattern at varying flows.
- (4) Installed 2" above the fill for the lowest pump head of any nozzle system.
- (5) Rotating disc spins on a water bearing to shred & dislodge any foreign matter attempting to build up. There are no wearable parts so long nozzle life is assured.
- (6) Sprays water in medium-size droplets for improved water distribution, far less drift loss.

WASTED PUMP ENERGY

Fixed-orifice nozzles typically are installed 2' to 4' above the fill media. These so-called 'low pressure' nozzles actually operate at two, three, even four psi. As a pound of nozzle operating pressure equates to 2.3 feet of 'elevation head,' a nozzle with a design operating pressure of two pounds has an elevation head of 4.6 feet. If that nozzle must be installed two feet above the fill to deliver an acceptable spray pattern, its elevation head is 6.6 feet. It's easy to see how a poorly designed nozzle can squander energy.

In contrast, the low-profile Tower Tech Modular Cooling Tower reduces pumping costs by reducing the size and operating expense of pumps. Its patented Rotary Spray Nozzle is installed just 1" to 2" above the fill media and operates at just 1.4 psi, so total tower pumphead is reduced, usually significantly.

Furthermore, a Tower Tech module contains a fully enclosed, elevated, pre-engineered water basin that exerts positive pressure on the pumps. This feature permits the use of horizontal split-case double-suction pumps, which are more energy efficient and require less maintenance than vertical turbine pumps. Many conventional cooling towers have below-grade or grade level basins that necessitate the use of vertical turbine pumps.

Also, Tower Tech modules do not have air plenums and louvers between the basin and fill, so tower pump head is significantly lower than found in a conventional cooling tower.

Tower Tech has won the loyalty of many customers due to the operating efficiencies of the Modular Cooling Tower. *Energy User News Magazine* proclaims that a New Jersey chemical producer annually saved nearly a million kilowatts after installing a Tower Tech Modular Cooling Tower, and a study by University of Oklahoma researchers compared conventional cooling towers with Tower Tech innovative technology and lauded Tower Tech for its energy conservation achievements.

MAINTENANCE REQUIREMENTS

Economy of operation is crucial to business survival in today's competitive business climate. In the selection of a cooling tower, a buyer must evaluate the total cost of operating the tower, including maintenance costs. Nevertheless, cooling towers with poor maintenance characteristics are still widely available because some buyers do not understand the differences that exist among cooling towers.

HOW TO BUILD A HIGH MAINTENANCE COOLING TOWER

Conventionally designed cooling towers are justifiably and notoriously maintenance intensive. Cooling towers must endure the harshest operating and weather conditions, they act as air scrubbers and attract airborne dust, insects and debris. To these difficult conditions tower manufacturers add a top-mounted fan, a conventional water distribution system, an open sediment-type cold water basin, air intake louvers, stairways, handrails, doors and access hatches.

All cooling towers exhaust hot, moist air by propelling the exhaust air upward into the atmosphere. The top of a cooling tower is a hostile place in which steel, wood, rubber and other substances rot, rust, decay, and corrode. Yet, this is precisely where manufacturers of conventional towers have decided to install fans, motors, gear reducers, fan stacks, driveshafts, couplings, belts, electrical panels and other tower equipment. This harsh environment creates a vicious maintenance circle in which untimely failures of mechanical components are

commonplace. It is almost unimaginable that this (user-unfriendly) design has been the best that the cooling tower industry could come up with since the first mechanical draft towers were built early in the Twentieth Century.

Inefficient water distribution systems have plagued conventional cooling towers since the beginning. Cross-flow towers use gravity to distribute hot water through open basins located at the top of the tower, exposed to direct sunlight and open sky. The bottoms of these hot water basins have numerous small holes ('fixed-orifice' nozzles) that require frequent inspection and cleaning. Counter-flow towers use a system of low-pressure nozzles suspended by water supply pipes. These small fixed-orifice nozzles also require frequent labor intensive cleaning.

To worsen matters, the open basins of conventional cooling towers become fouled with all manner of sediment and debris, and are seedbeds for disease and pestilence. Open basins require frequent cleaning, a task no one cares to perform. Needless to say, a conventional cooling tower is not a very worker-friendly environment. The installation of mechanicals atop a cooling tower creates a host of safety problems: stairways, handrails, catwalks, access doors and panels, cranes, scaffolding, hoists and ladders are needed for routine maintenance of, or the repair of, towers with top-mounted mechanical equipment. The open fan deck area of a conventional tower is considered a free-fall safety hazard requiring the use of safety belts and harnesses. The frequent routine maintenance trips inside the tower to

clean spray nozzles and the basin normally require special protective clothing and equipment.

HOW TO BUILD A LOW MAINTENANCE COOLING TOWER

A Tower Tech Modular Cooling Tower has a forced-draft counter-flow design with very low maintenance requirements.

The Modular Cooling Tower's mechanical equipment is located beneath the tower "canopy" where it is protected from the natural elements. Its enclosed basin and Water Collection System™ obviates the need for air intake louvers and eliminates the winter operating problems faced by conventional towers.

The patented Water Collection System™ enables all direct-drive motors and fans to be installed directly beneath the tower in the cool, dry intake air stream, where they are protected from the natural elements. The Water Collection System serves as an air-water separator between the fill media and the mechanical equipment. Maintenance personnel have easy and safe access to motors and fans at grade level, where routine inspections take minutes and any required maintenance can be performed safely without climbing on top of, or inside, the tower module. In fact, you won't find any doors or access hatches on a Tower Tech Modular Cooling Tower.

Tower Tech Modular Cooling Towers are equipped with the patented Rotary Spray Nozzle. This nozzle is installed in more than 2,500 towers

worldwide and functions without any of the problems common to conventional towers. The Rotary Spray Nozzle has a spinning disc that rotates at high speed on a cushion of water. This rotating action cleans the nozzle of any biological debris attempting to build up. Scale, algae, leaves, and other biological debris attempting to build up in the Rotary Spray Nozzle are quickly shredded and dislodged. This revolutionary device all but eliminates the maintenance costs associated with conventional fixed-orifice nozzles.

A Tower Tech Modular Cooling Tower contains a Flow-Thru Basin™ that eliminates the need for air intake louvers, thus recirculating water never sees sunlight and algal growth is eliminated. Further, the constant "sweeping" action of this high flow design keeps solids in constant suspension so they can be trapped outside the tower. The Flow-Thru Basin completely eliminates the need to routinely enter and clean a cooling tower basin.

Tower Tech has forever changed the way cooling towers are maintained. The savings in maintenance costs are best illustrated by a life-cycle cost analysis.

ENVIRONMENTAL ISSUES

The environmental impact of cooling towers is coming under increasing scrutiny as public regulators endeavor to clean up our air and water resources. Conventional tower designs are fraught with environmental hazards and today receive more attention than ever from plant owners concerned with public health and liability,

OSHA and EPA regulations, employee health and safety, and corporate image. There also is increasing concern about the cost of decommissioning and disposing of a cooling tower at the end of its useful life.

DRIFT: HAZARDOUS EMISSIONS

A concern in the operation of any cooling tower is drift, the discharge of hot mist through the top of a tower. Drift is not the same as the “evaporation plume”; drift contains particulate matter of the various elements flowing through a tower, including lead and zinc if the tower is made of galvanized material; chemicals such as chlorine if the tower recirculating water is chemically treated; and copper chromate arsenic (CCA) or acid copper chloride (ACC) if the tower is made of lumber. And, of course, excessive drift wastes fresh water.

The amount of drift produced by a tower is a function of the velocity of exiting air and the entrainment and emission of fine water droplets from the nozzle spray system. Conventional fixed-orifice nozzles typically are installed two or more feet above the fill media and they emit fine water droplets caused by splashing atop the fill media. These droplets are caught in the exit airstream and are ejected from the top of the tower at 900 to 1,500 fpm. Apart from the obvious health hazards caused by drift, a tower’s airborne contaminants pollute everything they touch, promoting the rusting or decay of adjacent mechanical equipment, the paint on nearby vehicles, and adjacent buildings. Drift also causes the retardation or death of vegetation and keeps legions of window washers employed.

Recent regulatory changes at EPA and various states are taking a more stringent approach to drift emissions.

The Tower Tech variable-flow Rotary Spray Nozzle is mounted just 1” to 2” above the fill media and is designed to distribute hot water laterally in a coarse spray. This reduces drift because the water ends up in the fill media, where it belongs, and not entrained in the tower’s exit airstream. The velocity of air exiting a Modular Cooling Tower is ~ 850 fpm, which also contributes to reduced drift.

HAZARDOUS OPEN LOUVERS AND SEDIMENT BASINS

Conventional cooling towers have open louvers and open basins that allow direct sunlight and airborne contaminants to enter the tower or cold water basin. It is common for all manner of bio-growth, scaling, and other debris to accumulate in a conventional “sediment-type” cold water reservoir. This hazardous waste must be removed periodically. To prevent direct exposure to these substances, a worker must don a protective underwater dive suit and wear fresh air breathing apparatus before entering the basin to collect the waste. Where the tower can be drained first, a fresh air mask may not be necessary but a protective suit still will be needed. (Clearly, the lowest man on the totem pole is required to perform this maintenance task.)

A Tower Tech Modular Cooling Tower has no louvers and it contains a fully enclosed cold water basin. There is absolutely no opportunity

for any recirculating process water to be exposed to direct sunlight, so algal growth is eliminated and airborne debris cannot enter the enclosed basin. And, since Tower Tech's Flow-Thru Basin™ has a constant high water flow, there is no opportunity for sediment to accumulate in the basin. There should be absolutely no need to clean out the Modular Cooling Tower's Flow-Thru Basin on a periodic basis.

HAZARDOUS BLOWDOWN EMISSIONS

Most cooling tower manufacturers apply additional coatings of zinc and other materials to the galvanized tower sections in an attempt to protect against corrosion and to extend tower life. In the severe climate of a cooling tower this zinc coating and lead particles can leach into the process water, contaminating it far above levels acceptable to the EPA. This material is then discharged into the public wastewater stream in the blowdown (the routine process of eliminating unclean water from a cooling tower). Blowdown containing zinc and lead is often classified as hazardous waste. Conventional towers constructed of treated wood also present hazards to the environment. Treated wood is soaked in a solution of acid copper chloride (ACC) or copper chromate arsenic (CCA), preservative substances, which are regulated by EPA. Like zinc, these chemical preservatives are environmental hazards if they leach into a tower's process water and then enter the public wastewater stream.

A Tower Tech Modular Cooling Tower uses no galvanized metal or treated wood containing lead, zinc, CCA or ACC. (Only the vinyl coated

safety screen installed below the mechanical equipment – beneath the tower module – is made of galvanized metal.) Blowdown can be discharged into the public wastewater stream without paying 'hazardous material charges.'

PUBLIC HEALTH HAZARD

Since 1976 there have been numerous deadly outbreaks of the Legionellae bacteria, many of them traced directly to open-circuit cooling towers with sediment-type reservoirs. Most plant owners and engineers are concerned about the potential health hazards posed by Legionellae and have taken action to revamp biological treatment regimes and, in the case of most public healthcare facilities, have endeavored to eradicate Legionellae bacteria from their circulating water systems.

The Modular Cooling Tower's pre-engineered, fully enclosed, high velocity Flow-Thru Basin is never exposed to direct sunlight, thus algal growth is eliminated and it is never necessary to enter the tower structure or water basin to perform routine maintenance. Too, the self-cleaning Rotary Spray Nozzle renders it unnecessary for service personnel to enter the tower box to unplug nozzles. Also, the bottom-mounted fan design allows maintenance to be performed at grade level, without entering or climbing the tower. The only routine maintenance items include a float valve and suction screen which are easily accessed from a sump attached to the outside of the tower module.

SAFETY

Conventional towers are considered to be such safety and health hazards that, were they not ubiquitous and “grand fathered” into local building codes, they never would meet the environmental and safety regulations of our day. Conventional towers require stairways, handrails, catwalks, access doors, cranes, scaffolding, hoists, ladders and biohazard apparel for most maintenance and repairs. Their open fan decks are a falling hazard zone requiring the use of safety belts and harnesses. Over the years, many serious accidents causing injury and death have occurred during ‘routine’ cooling tower maintenance.

Moreover, the presence of lead and zinc particles, water treatment chemicals, biological contaminants, Legionella bacteria, acid copper chloride, and copper chromate arsenic make the conventional cooling tower and its surrounds a hazardous working environment.

The Tower Tech Modular Cooling Tower eliminates all these safety and environmental hazards, because its mechanical equipment is installed at grade level beneath the module. All tower components requiring periodic maintenance are at grade level or accessible with a stepladder, significantly reducing the risk of accident. Also, because there is no galvanized metal or treated wood used in the module, or any sediment-type water basins or air intake louvers, there is no need for workers to enter the tower or wear biohazard apparel or fresh air breathing apparatus while performing routine maintenance on a module.

MID-LIFE RECONSTRUCTION, FREQUENT REPAIRS

Some conventional cooling towers are purported to have a life expectancy of 20+ years, but in the real world few last that long without major reconstruction at half life or sooner. Most conventional towers are constructed of treated lumber, lightweight corrugated FRP, and galvanized metal, and over time their structures become weakened by wind load, ice loads, and operating stresses such as vibration. Their mechanical equipment is continuously exposed to the hot, moist exit airstream and the natural elements. Where a conventional tower is installed in a seaside or at low-latitudes, the effects of exposure to salt, ultraviolet light, and high winds results in rapid deterioration. Galvanized towers rarely last more than seven to 10 years in any location and rigorous duty often limits the service life of a galvanized tower to just five to seven years.

Tower Tech Modular Cooling Towers never need rebuilding because they are constructed of premium heavy-duty pultruded reinforced fiberglass (FRP). Built to withstand seismic zones 1 and 2 and 120 mph wind loads (seismic zone 4 certification is an available option), Tower Tech uses no wood in any of its towers, nor does it use galvanized metal in any wetted area of the tower. (Only the vinyl coated safety screen installed below the mechanical equipment – beneath the tower module – is made of galvanized metal.)

Tower Tech Modular Cooling Towers have FRP substructures and housings. The pultrusion

process produces continuous lengths of reinforced plastic in a consistent, rigid, machined high quality profile. In the process, fiberglass reinforcing strands (rovings) are blanketed in UV inhibiting veils, saturated in premium isophalic resin containing more UV inhibitors, then pulled through a heated steel die that gives the profile its form. The resulting pultruded shapes will not rot, and they offer more protection against corrosion than any other kind of fiberglass. Tower Tech's pultruded profiles weigh 38-54 ounces per square foot, compared with conventional FRP towers that typically use corrugated FRP weighing 8-12 ounces per square foot. While the life of FRP containing premium isophalic resin is said to be indefinite, Tower Tech recommends that 25 years be assumed when predicting service life.

SUMMARY

The Tower Tech Modular Cooling Tower is the most technologically advanced and best performing cooling tower available. With a total installed cost about the same as other fiberglass cooling towers and not significantly more than wood and galvanized towers, the Tower Tech Modular Cooling Tower delivers the highest quality and best value. The proven multiple-fan design and the patented Rotary Spray Nozzle make Tower Tech Modular Cooling Towers the most efficient way to cool water and the only tower with the ability to track the wet bulb temperature in real time for maximum tower performance. When the wet bulb temperature falls below the tower's design wet bulb, colder water is fed to the chillers to yield unmatched energy savings. Tower Tech has received

acclaim from academia and industry for its contribution to reduction of energy and freshwater consumption.

The Tower Tech Modular Cooling Tower requires less maintenance attention than other towers because its mechanical equipment is located in the cool, dry intake airstream under the canopy of the tower module, prolonging service life. When maintenance is required, it is performed easily and safely at grade level without the need for expensive cranes. Further, the Rotary Spray Nozzle eliminates the need to ever enter the tower to unplug clogged nozzles. Because there is no mechanical equipment above grade level, it is never necessary to climb or enter a Tower Tech Modular Cooling Tower to perform routine maintenance.

More aesthetically pleasing than any other cooling tower, the Tower Tech Modular Cooling Tower has a fully enclosed basin and no air louvers, so the recirculating process water never sees sunlight. These features reduce biological growth and chemical requirements while eliminating splash-out emissions. They also eliminate the noise generated by free-falling water, which contributes to half the noise produced by a conventional cooling tower. The Modular Cooling Tower even minimizes drift.

In conclusion, there is an alternative to becoming entangled in the vicious circle of buying, repairing, and replacing cooling towers. Anyone with responsibility for a high value process should investigate the Tower Tech Modular Cooling Tower with its improved operational

flexibility, longer service life, reduced energy costs, lower water and chemical requirements, improved safety, improved maintenance characteristics, and environmental friendliness. Modules are available in seven sizes and can be inter-connected to accommodate any heat load requirement to 600,000 gpm.

The Cooling Technology Institute has certified the thermal performance of Modular Cooling Towers since 1993.



To receive a customized no-obligation life-cycle cost analysis that compares any conventional cooling tower with a Tower Tech Modular Cooling Tower, contact:



P.O. Box 891810

Oklahoma City, OK 73189

EMAIL: Sales@TowerTechInc.com

TEL: (405) 290-7788

FAX: (405) 979-2159