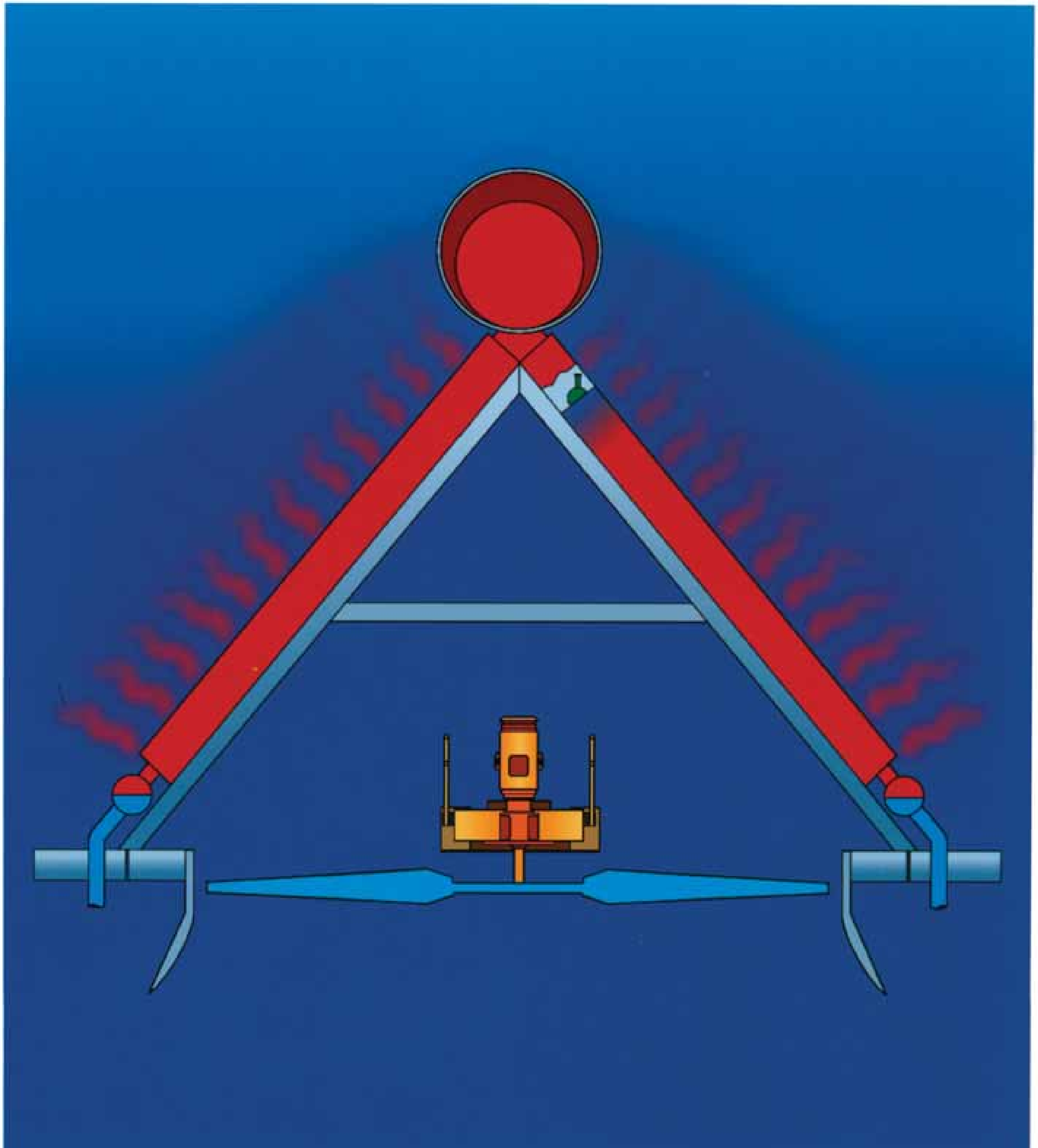
Power
Cooling
Systems

Air Cooled Condensers



Unparalleled experience in the field of dry cooling

Dry cooling is becoming more and more prevalent in the power industry as environmental regulations become increasingly restrictive and water availability becomes increasingly uncertain. GEA has unparalleled experience in the field of dry cooling, having supplied the world's first air cooled, vacuum steam condenser in 1939. Since then, GEA has captured over 90% of this market worldwide.

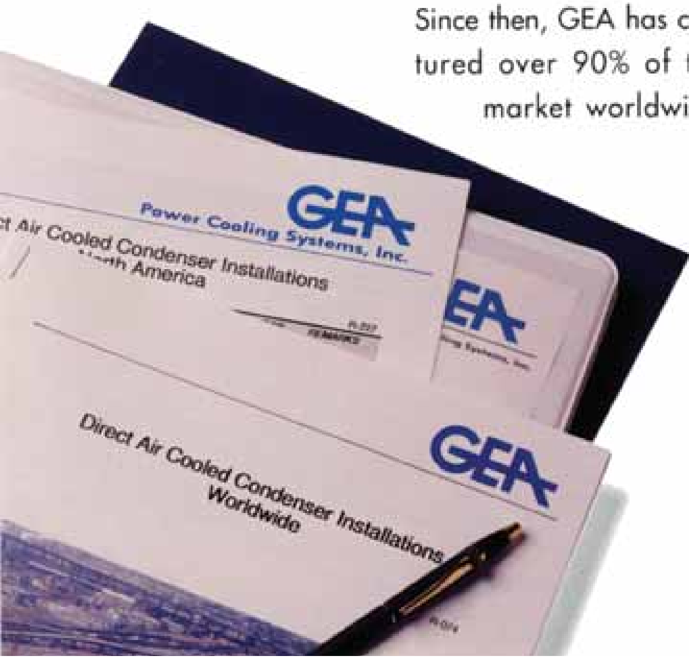
GEA's installation list contains over 400 air cooled condensers worldwide, including the world's largest at the 4,000 MW Matimba Station (right) and one of North America's largest at the 614 MW Linden Cogeneration Facility (opposite page).

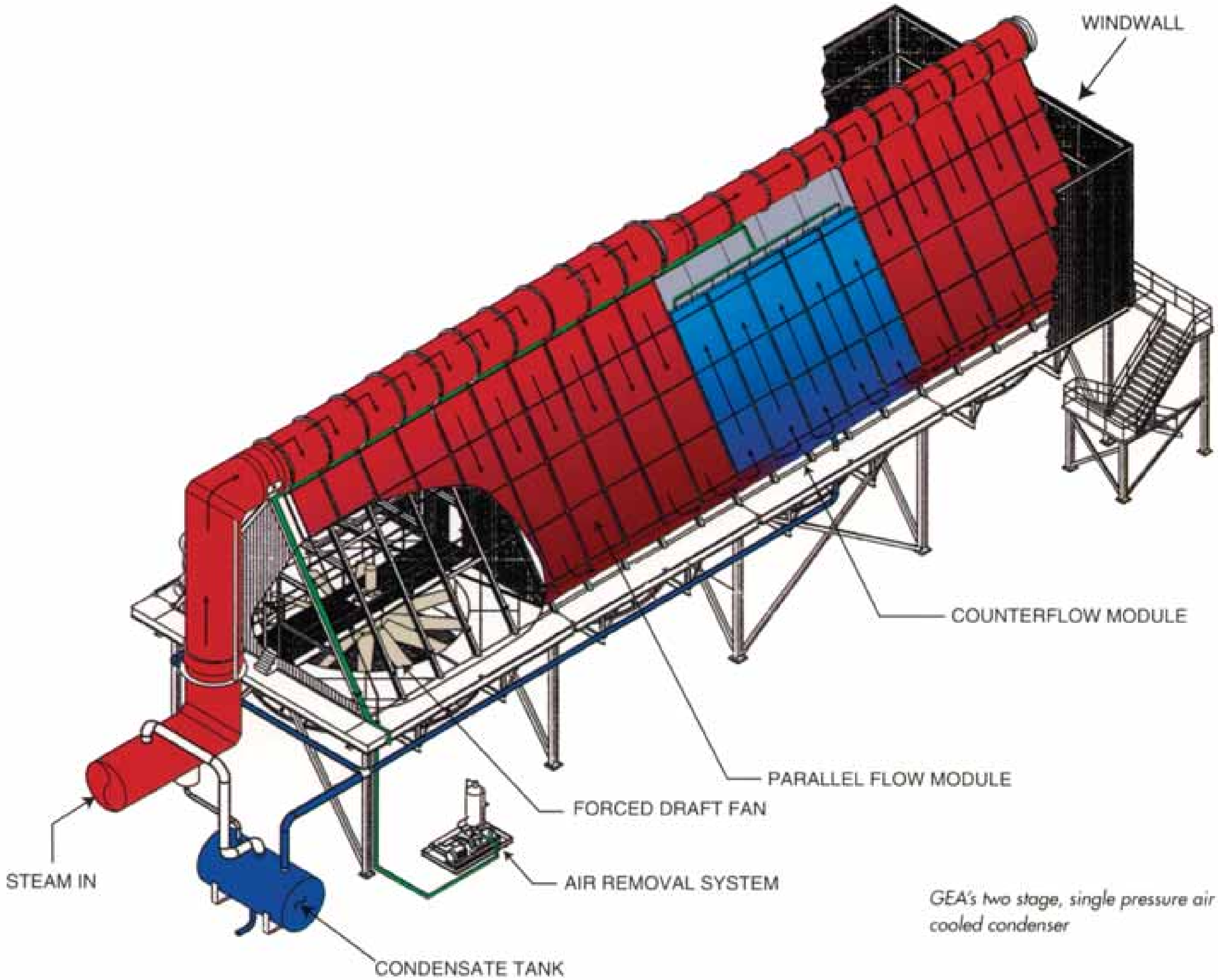
During its more than fifty years of experience, GEA has provided air cooled condensers for a wide variety of design criteria, from extremely cold to extremely hot climates, from severely space limited sites, to sites with highly restrictive noise limitations. GEA has continued to evolve the basic technology of dry cooling, striving for maximum efficiency, availability and economy of scale. GEA has, in its long history, defined the state of the art in dry cooling.

The air cooled condenser

The GEA air cooled condenser is comprised of fin tube bundles grouped together into modules and mounted in an A-frame configuration on a steel support structure, as shown at right. Vertical and horizontal configurations are also available.

GEA employs a two stage, single pressure condensing process to achieve efficient and reliable condensation. In this process, the steam is first ducted from the steam turbine to the air cooled condenser where it enters parallel flow fin tube bundles from the top. The steam is only partly condensed in the parallel flow modules and the remaining steam is ducted in a lower header to counterflow fin tube bundles. The steam enters from the bottom and rises in the fin tubes to a point where condensation is completed. Non-condensibles are drawn off above this point by ejection equipment. The condensate drains by gravity to a condensate tank and is then sent back to the feedwater system to be recycled.





GEA's two stage, single pressure air cooled condenser

Maui Electric's Maalaea Combined Cycle Plant utilizes the vertical condenser configuration. (left)

Cogen Technologies' 614MW Linden Cogeneration Facility employs an A-frame condenser. (right)

Design features that make a difference

There are two features which distinguish the GEA air cooled condenser — a highly efficient and durable fin tube and the single pressure, two stage condensing process.

The GEA fin tube — designed to last

Fin tubes comprise the heat transfer surface of an air cooled condenser, making them the most vital element of the entire condensing system. GEA recognized from the outset that available standard fin tubes were not suitable for vacuum steam condensing service and that a custom fin tube design was required. GEA found the solution in an elliptically shaped steel core tube onto which flanged rectangular steel fins incorporating integral turbulators are tightly fitted. Variable fin pitch is employed in each of multiple fin tube rows. The assembly is then hot dip galvanized. This combination of features which sets the standard in air cooled vacuum steam condensers offers the following advantages:

■ High fin efficiency
Virtually the entire fin tube is active in efficient heat transfer.

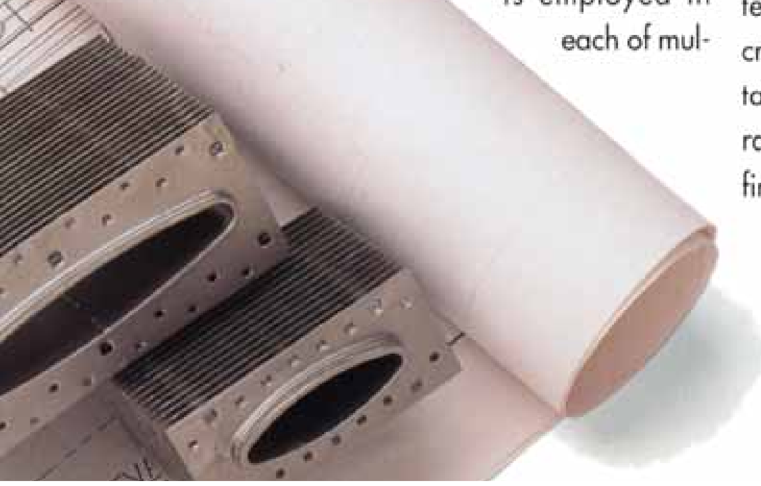
■ High heat transfer coefficient
Due to the streamlined shape of the elliptical core tube, parasitic air side pressure losses are low. Incorporating turbulators on the fins to induce air side turbulence significantly increases the overall heat transfer coefficient.

■ Uniform condensing rates
As the air traverses across multiple fin tube rows, its temperature steadily increases. In order to maintain uniform condensing rates in each tube row, the fin pitch is reduced in succeeding rows.

■ Durability
In the galvanizing process, a uniform thickness coating of zinc is applied over the entire exterior surface of the fin tube providing long term cathodic protection against corrosion. The zinc also fills the interspace between the fin flange and the core tube creating a soldered connection that is mechanically strong, as well as creating a high conductivity connection between fin and tube.

■ Efficient steam side performance
GEA's elliptically shaped core tube has a larger cross sectional area than most other fin tubes. This larger area minimizes steam side pressure losses — an important factor in achieving efficient heat transfer.

■ Cleanability
The rectangular fins are arranged into a fin tube bundle with no internal voids. This compact arrangement reduces the amount of debris allowed to lodge between the fin tubes, a problem with most conventional condensers.



GEA's second generation fin tube with its significantly larger cross sectional area provides superior performance over the smaller tube especially at low temperatures.

For maximum performance, air cooled condensers require periodic cleaning of the fin tubes with high pressure water. GEA's rugged all steel fin tubes withstand spray pressures of up to 6000 psi, in contrast to most other types of fin tubes that will deform and bend at high pressures. This ability to thoroughly clean the fin tubes allows operators of GEA air cooled condensers to maintain their equipment at full capability over the long haul.

The two row design

GEA's current fin tube is a second generation design. GEA had previously employed a smaller tube in a three row configuration. However, as the size of GEA's installations grew, the need for a larger tube became apparent. The current tube has over twice the internal cross section of the tube previously used. This larger tube is configured in a two row design which provides greater heat transfer capabilities and greater freeze protection as demonstrated in numerous low temperature applications.

Unsurpassed performance at very low temperatures

Minimizing condensate subcooling in the condensing process is a crucial requirement in order to avoid corrosion and the potential for freeze damage to the fin tubes. To satisfy this requirement, GEA developed and introduced the two stage, single pressure condensing process over 50 years ago and has used it ever since. This time proven process maintains condensate in contact with steam at all times precluding the formation of so called dead zones where only condensate and non-condensibles are present. This process ensures a virtually freeze-proof condenser.

GEA's design also incorporates other proven freeze protection features including:

- **Elliptical tube**
  Withstands multiple freeze thaw cycles.
- **Air flow control with two speed fans or VFD's**
  Permits adjustment of condenser capacity.
- **Windwall**
  Prevents winds from overpowering fans.
- **Self draining design**
  Prevents pockets of condensate from forming.

All of these features in combination add up to a condenser that will continue operating in the harshest of conditions for the life of the plant.

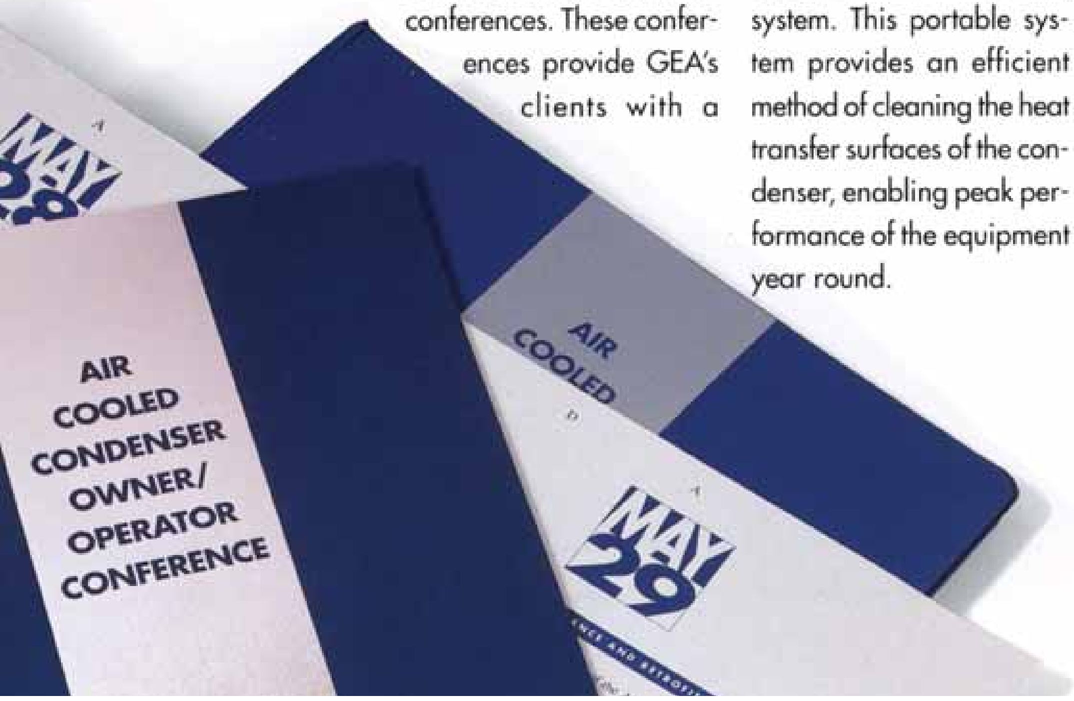
GEA air cooled condensers are virtually "freeze proof" thanks to design innovations that make this technology perfect for cold-weather projects such as the 365 MW Wyodak Power Plant in Gillette, Wyoming, where temperatures have reached −48°F.

The GEA difference is commitment

GEA's high standards of excellence extend beyond just building a better air cooled condenser. As important as its technical expertise and experience is GEA's commitment to its customers. In order to ensure that all of its customers' needs are met, GEA holds Owner/Operator conferences. These conferences provide GEA's clients with a forum for the exchange of ideas and information on operating experience. It also gives GEA the opportunity to make technical improvements that directly correspond to customers' needs. One of these improvements was the recent development of the semi-automatic fin tube cleaning system. This portable system provides an efficient method of cleaning the heat transfer surfaces of the condenser, enabling peak performance of the equipment year round.

GEA believes in lifetime customer satisfaction and stands behind every piece of equipment it supplies for the life of that equipment. This commitment to its customers is what has made GEA the world leader in heat rejection technology for the last fifty years.

A portable, semi-automatic fin tube cleaning system keeps condensers operating at peak performance levels year-round.



Background

GEA Power Cooling Systems is a member of the Germany based GEA Group, a world leader in heat rejection technology whose commitment to quality and customer satisfaction has set the industry standard for excellence. In addition to providing direct dry cooling in the form of air cooled condensers, GEA Power Cooling Systems is also able to provide cooling towers, combination systems for both plume abatement and water saving, the indirect dry Heller System and thermal upgrades.

GEA installed a water saving parallel condensing system at the Exeter Energy Resource Recovery Facility in Sterling, Connecticut.

GEA has provided numerous air cooled condensers for waste to energy facilities including this one at the Spokane Resource Recovery Facility (left) in Washington.

610 West Ash Street
17th Floor
San Diego, California 92101
Tel: (619) 232-7200
Fax: (619) 232-7177
www.geapcs.com