The Trane Difference. Efficiency.

Heat transfer is one of the most important factors in achieving heating and cooling efficiencies. Trane's proprietary coil design, Spine Fin,™ has proven to be superior to any other technology.

Extensive research and development have lead to the innovative heat transfer characteristics of radiating finned, all-aluminum Spine Fin coil heat exchangers. More than 40 years of real-world application experience have confirmed Spine Fin's long-lasting effectiveness and work-horse durability. Trane continues its tradition of excellence in heat transfer by focusing on the basics of success: always using modern and innovative technologies; only using similar metals and proven materials; and, maintaining our notably high standards in the manufacturing process.

All-Aluminum Spine Fin™ Coil

We continue to push the envelope.

Trane began full-scale production of Spine Fin coils for use in outdoor products in 1968. After years of success, Spine Fin has reached a legendary status in the industry. In fact, today it ranks as the most efficient heat exchanger currently being manufactured.

But at Trane, we're not known for resting on our laurels. Our engineers and product specialists continue to push the envelope in heat transfer technology, constantly looking for greater efficiencies and more durable processes. For example, our new woven coil technology has proven to provide ultra levels of efficiency in our high-end air conditioners and heat pumps, clearly paving the way for even greater consumer acceptance and a further reduction in the use of fossil fuels.

A typical 2-1/2 ton air conditioner or heat pump requires 30 or more brazed joint connections in the coil. A modern Trane unit of the same size requires only 10 with Spine Fin.™

Spine Fin™ coils are fabricated in continuous lengths. Because of the number of leading edges, one row has the ability to transfer the same amount of heat as three rows of plate fin.

Consumers expect efficiency from Trane.

Why is maintaining long-term efficiency important? When replacing an air conditioning or heat pump system, consumers can significantly save on their cooling bills by purchasing a more efficient system than they currently have. However, the unfortunate reality is the efficiency of their new system will decline over time, as will their savings. That's why Spine Fin's ability to retain a system's efficiency over the course of its lifetime is so significant. Not only is a Trane system efficient to operate today—but it maintains that efficiency during its years of service to the homeowner. And, that's the Spine Fin difference. Consumers have come to expect a higher standard of efficiency and durability from Trane products. Spine Fin helps us fulfill this expectation.

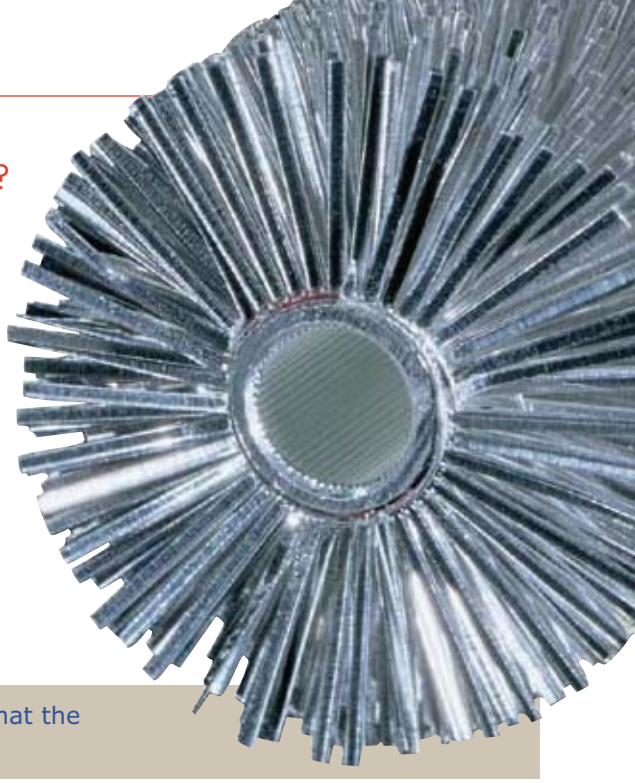
In a typical year, Trane will produce more than 55,000 miles of Spine Fin coil—that's enough Spine Fin™ to go more than twice around the world.

What causes efficiency loss?

- A leak in a coil joint.
- Loss of thermal contact between the fin and tube caused by corrosion.
- A dirty or damaged coil.
- Different manufacturing processes. For example, the use of dissimilar metals (copper and aluminum) leads to loss of thermal contact because they expand at different rates.

How does Spine Fin™ prevent efficiency Loss?

- It's designed for leak resistance.
- It's made with corrosion resistant materials and innovative construction techniques.
- It's housed in an enclosed, protective cabinet. And, it's cleanable.
- On-going research and development keep Spine Fin on the leading edge.



A reliability study by Trane's Field Operations Excellence Team showed that the field leak rate in 12 million coils was only .05% over a one-year period.

The Spine Fin™ difference: A leak resistant design.

One-third the number of brazed joints.
Spine Fin has an extremely low leak potential. Coils are more prone to leaking at joints, and Spine Fin has far fewer joints than plate fin. That's because Spine Fin tubing is manufactured in continuous lengths. Brazed connections are required only at the coil (or circuit) inlet and outlet.

Elimination of end-turns used in copper tube plate fin designs permits a dramatic reduction in brazed joints and potential leaks in this design. Of course fewer leaks increases system reliability and durability. This also means a longer compressor life, because the introduction of moisture and contaminants into the sealed system is prevented.

In contrast, plate fin coils are made by stacking flat fins on parallel tubes. Each tube pair requires an end-turn to complete the refrigerant circuit.

The rounded corners of Trane's four-sided coil design eliminates return bends and provides maximum efficiency.

A typical 2 1/2 ton air conditioner or heat pump requires 30 or more brazed joint connections. A modern Trane unit of the same size requires about 10. Plate fin coils have three times the leak potential.

Trane's unique transition joint.
Like other manufacturers, Trane uses copper tubing in piping the refrigerant circuit. What is unique is Trane's copper aluminum transition joint. This component is ultrasonically pre-tinned with a zinc rich, aluminum solder. As it is assembled into the heated aluminum tubing, it forms a solder fillet at the joint. This solder fillet is sacrificial and protects both of the base metals from corrosion.

A reliability study by Trane's Field Operations Excellence Team showed that the field leak rate in 12 million coil joints was only .05% over a one-year period.

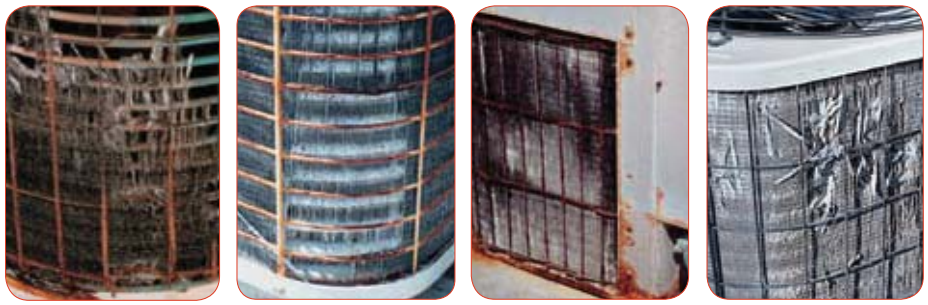
Woven coil technology is the newest generation of Spine Fin™. The woven coil design weaves a continuous roll of Spine Fin™ in a layered configuration, creating an even greater surface area. This greater surface area results in increased efficiency and a reduced cabinet size.

This patented, plated copper tube enables Trane to make a remarkably sound copper/aluminum transition joint.

The integrity of the copper to aluminum connection in the coil is legendary.

The environment outdoors is a powerful corrosive force.

The outdoor environment is harsh, with dramatic swings in temperature, precipitation, wind and humidity. Near the ocean, the air contains salt-laden moisture. In and around cities, the atmosphere contains oxides of sulfur and nitrogen, acid and alkaline dusts and gases. Most competitors' coils can't stand up to these powerful corrosive forces. However, the carefully selected aluminum alloys in Spine Fin™ provide protection from even the harshest outdoor environments.



Competitive units in Florida show the wear and tear of beachfront living.

A defense against corrosion prolongs system life while maintaining system efficiency. The positive attributes of any heat exchanger—high heat transfer efficiency, freedom from leaks, debris tolerance, and compressor protection—are meaningful only if a coil can survive the aggressive environment outdoors.

The Spine Fin™ difference: Resistance to outdoor corrosion.

A defense against galvanic corrosion.

Corrosion can prove deadly to a coil. It can cause a loss of thermal contact between the tube and fin and in turn can lead to a significant reduction in efficiency. The resistance of Spine Fin to outdoor corrosion and subsequent deterioration is a substantial benefit. Spine Fin has the lowest corrosion potential of any outdoor heat transfer technology, particularly in seacoast environments and acid rain exposure. In these kinds of damaging exposures, an air conditioning coil experiences two kinds of corrosive actions: galvanic, or two-metal, corrosion, and crevice corrosion.

Galvanic corrosion occurs when two dissimilar metals in close proximity to each other are exposed to a conducting fluid, such as salt spray, acid rain or chemically tainted rainwater. From there, the two metals act as a battery in which one metal sacrifices itself to the other. The more dissimilar the metals (for example, copper and aluminum), the greater the potential for corrosion. This is why a copper tube/aluminum plate fin coil has five times the corrosion potential of an all-aluminum coil such as Trane's.

Spine Fin is not prone to crevice corrosion.

Crevice corrosion is the second major corrosive force that can undermine the integrity of an outdoor heat exchanger. Crevice corrosion is caused when stagnant solutions are trapped in very small spaces. A few thousandths of an inch is a sufficient enough space to qualify as a crevice and is typical of the space between the tubing and fin stock of plate fin coils.

Fact: The more dissimilar the metals in a coil, the greater the potential for corrosion. Trane uses aluminum for both the fin stock and the tube in the construction of Spine Fin.™

In the construction of plate fin coils, aluminum fin sheets are stacked on parallel rows of copper tubes. The copper tubes are then mechanically expanded to make contact with the fin sheets. After a few months or years of use, a tiny gap develops between the tube and fin sheet because the two metals expand and contract at different rates. Moisture enters this tiny crevice and the coil becomes susceptible to corrosion.

Acid rain.

The corrosion resistant construction of all aluminum Spine Fin is augmented by the stabilizing characteristics of the aluminum metal itself. Industrial and urban atmospheres are corrosive environments primarily because they are ripe with sulfur gases generated by the burning of fuels. These gases mix with water vapor to form sulfurous and sulfuric acids, which form "acid rain." Aluminum is an active metal, but its behavior is stable because of the protective, tightly adherent invisible oxide film on its surface. In general, aluminum alloys have a high resistance to dilute sulfuric acid and hydrogen sulfide, which are present in outdoor environments.

At left: The patented Spine Fin™ machine wraps aluminum spined ribbon tightly onto adhesive coated tubing. At right: The colored adhesive has extruded out from under the fins, locking them together and sealing out moisture.

Corrosion resistance begins with the manufacturing process.
Trane manufactures Spine Fin on patented high-speed machines that cut, form and wrap aluminum fin stock around aluminum tubing. The tubing rises through a colored adhesive bath in the center of the machine, which coats the tube. Tension rollers wrap the ribbons tightly to the tube using the bonding adhesive. A seam of the adhesive extrudes between the fin wraps, which not only locks the fin stock on the tube, but also forms a protective barrier against moisture and contaminants, minimizing corrosion.

The Spine Fin™ difference: A protective cabinet and a cleanable design.

A protective cabinet prevents damage.
The outdoor coil in an air conditioner or heat pump can easily get damaged in a backyard environment. Lawn equipment, damaging hail, even baseballs, sticks and tree limbs can all add years of wear and tear to a heat exchanger. Trane's protective cabinet design prevents coil damage by encasing the heat exchanger in heavy gauge steel louvered panels. These panels allow air to pass through the cabinet, but seal out dangerous external elements.

Ease of cleaning a definite plus.
One of Spine Fin's strengths is that because of its design, any potential surface loading and clogging—when and if it occurs—is insignificant to its performance. First of all, its large surface area permits more airflow volume at a lower velocity. This lower velocity means that fewer solids, such as dirt, grass clippings or leaves are picked up in the airstream, which reduces the possibility of normal dirt build-up.

If dirt build-up does occur, the thousands of leading edges of Spine Fin distribute the dirt and debris throughout the depth of the coil. Airflow and heat transfer are maintained. When required, Spine Fin coils can be easily cleaned with a reverse flow of low velocity water.

The Spine Fin™ difference: Continuous research and development.

Perfecting the process.
Spine Fin is the product of extensive research—research that has been conducted over the course of 75 years, dating back to 1927, when the first compilation of the laws and data on heat transfer began. Over the years, third-party testing continues to show that all-aluminum heat exchangers are not only more thermally efficient than all-copper or copper/aluminum heat exchangers, but they're also much more resistant to corrosion.

Most recently, a study conducted at the Ray Herrick Laboratories of Purdue University in 2001, showed that a typical system's efficiency degrades twice as much with enhanced plate fin versus Spine Fin when a three- to four-year buildup of graded dust is present. Even in the event that Spine Fin is loaded with more particulate than enhanced plate fin, more system efficiency is retained with Spine Fin. This study proves the fact that surface loading and clogging are not typical to Spine Fin.

The recent development of Trane's woven coil technology takes the success of Spine Fin one step further. Its increased surface area offers an even greater prevention of dirt build-up, providing superior long-term efficiency and effectiveness against the environment outdoors.

U.S. Navy research testimony

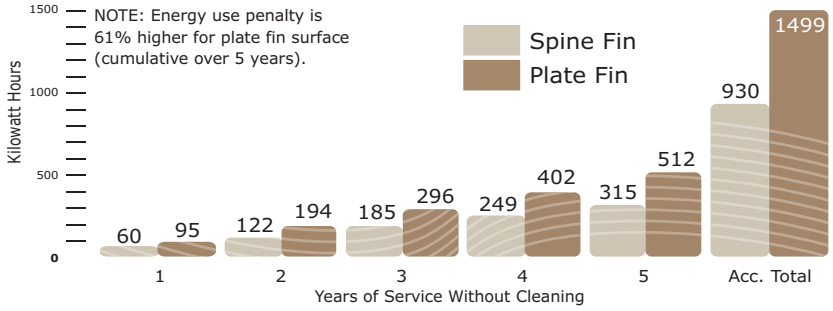
In a corrosive environment (coastal or urban), heat exchanger performance can degrade quite rapidly. According to an unbiased study performed by the United States Navy Civil Engineering Laboratory, Naval Construction Battalion Center in Port Hueneme, California, evidence of the fact, and support of all-aluminum coils in such environments is presented. Technical Report #N-1560 observes that after 24 months, aluminum tube/aluminum fin, heat exchangers are performing 32% better than copper tube/aluminum fin units.

One conclusion of this research was that "uncoated aluminum tube/aluminum fin heat exchangers are more thermally efficient than either the uncoated copper tube/aluminum fin heat exchangers after two-years of operation in a temperate marine environment."

The Purdue Study

Spine Fin™ to plate fin reformance comparison

Energy Use Penalty due to contaminated condenser surfaces in 3-ton 10 SEER systems (1500 Hrs/Yr operation)



Operating Cost Penalty for contaminated condenser surfaces in 3-ton 10 SEER systems