

*The*



*Story.*

How quality and

technology at

American Standard

are making

a difference.

*American  
Standard*  
HEATING & AIR  
CONDITIONING



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*By being the first in the industry to use a microprocessor control system, we've gained an even greater edge in reliability, serviceability, quality and performance.*

# The Inside Story.

*You've long heard us talk about the attributes of an American Standard comfort system – its energy efficiency, its durable construction, its reliable day-in-and-day out operation. But, an air conditioning and heating system is only as good as its components – and as you would expect, ours are the best in the industry. How does that affect you? Well, read on. The benefits to you and the consumer just keep getting better.*

We know what's important to you. Fewer call backs. Continuous operational efficiency for the homeowner. A flexible system with enough options to please everyone. A reputation that is enhanced, not compromised, by the product you sell. We know this – that's why we work hard to manufacture the finest, most technologically superior components available today.

Take our Duration™ compressor. Not only has it set new standards by which other compressors are measured but, it has the lowest failure rate in the industry. We know this, because when it comes to quality control few manufacturers can compete with us. Every American Standard system component is tested and retested. If it can make it through our SEET lab, it'll be able to handle just about any kind of wear and tear it might encounter in the field.

Our special brand of innovative thinking has also been applied to improving heat transfer. By developing Spine Fin and Plate Fin coils, American Standard not only found a way to maximize system efficiency, but we also advanced the entire concept of heat transfer at the same time.

We've even taken our finishing process a step further by developing a premium paint coating. Our high-gloss powder paint is superior to traditional paints, giving our units a protective

finish that will withstand the worst weather conditions for decades.

Our line of Freedom furnaces is another innovation we're particularly proud of. Built for today's efficiency-minded consumers, they're quiet and cost less to operate, and they deliver a level of comfort that's unmatched in the industry. And,

speaking of comfort and savings, American Standard's 16 SEER package units and split systems have taken the market by storm with their ability to deliver the ultimate in comfort and energy savings of up to 50 percent.

American Standard has also taken the lead in light commercial technology. With the use of a microprocessor control system we've gained an even greater edge in providing the highest quality, reliability, serviceability and performance.

Here's something else you'll find interesting. We've designed all of our products to be flexible. Our equipment has been engineered to give you options in terms of capacity, airflow, humidity control, efficiency, and noise level so you can design a system that's just right for any need. When flexibility is added to a well-tested, quality manufactured product, you can't help but have satisfied customers. Customers who know they've purchased a system they can feel comfortable with for years to come. ■





# The Heart of the System.

*With its oversized, heavy steel outer shell, its epoxy-sealed heavy duty motor, and its unique valve design, the Duration™ compressor will stand up to the harshest elements for decades — which means fewer warranty costs and more referrals for you.*

## Withstanding the stresses of time.

What's so special about the Duration compressor? Well, first of all it's designed for the extreme stress conditions of heat pump applications. A compressor used in a heat pump must be able to overcome higher operating temperatures, liquid refrigerant flooding, adverse electrical stresses, and the stress of longer operating hours. The Duration compressor's reputation was built on its ability to handle these tough conditions. Of course, these features also benefit the air conditioning application as well.

All critical system components go through three stages of testing: as a component, as the compressor, and as the final unit. For quality assurance, the Duration compressor is tested and retested in our System Extreme Environmental Test Center (SEET), which tortures it with 16 weeks of intensified wear and tear, duplicating five years of actual field stress.

In fact, compressor reliability is directly related to its ability to handle stress. Stresses encountered by hermetic compressors can be typically categorized as thermal, mechanical, electrical and chemical. Many of these

stresses are interrelated, and any of them can impact unfavorably on the life of a compressor. The Duration

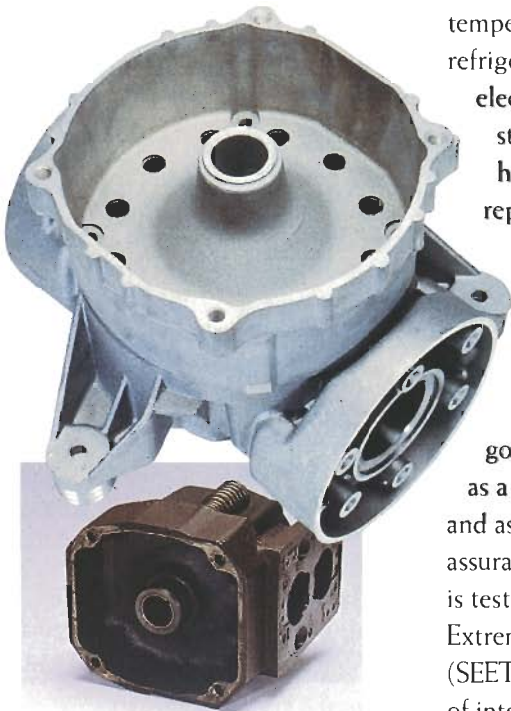
compressor is uniquely designed to withstand these stresses. ■



Our lightweight piston and connecting rods allow for easier starts and higher running efficiencies. A pearlitic cast iron cylinder increases durability.

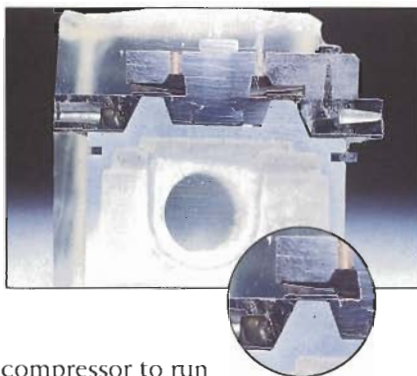


An all-aluminum frame reduces thermal stress and helps the compressor run cooler, unlike a cast iron frame (at bottom) which tends to retain heat.



## Keeping it cool: How we manage thermal stress.

The all-aluminum frame dissipates heat away from bearing surfaces. This reduces thermal stress and allows the compressor to run cooler than cast iron frame compressors which tend to retain heat, resulting in higher operating temperatures. When this occurs, motor and bearing life may be shortened and efficiency reduced.



American Standard's piston has a sculptured head that provides minimum clearance volume in the cylinder on the full upstroke of the piston. The clearance between the piston and valve assembly in the full upstroke position is just a few thousandths of an inch. This leads to high volumetric efficiency and high EER ratings.

The frame is designed with a very large intake area to minimize the dynamic pressure drop of suction gas. Suction gas flow to the valve is virtually unrestricted.

The Duration compressor uses light-weight aluminum pistons and connecting rods which means start-up will be easier and stress will be relieved on the crankshaft. For durability, a pearlitic cast iron cylinder liner is used. Since the aluminum piston and cast iron liner have different thermal coefficients of expansion, a cast iron piston ring is used to maintain sealing at high compression ratios. ■

## Managed cooling with Acousti-Cool™

With some of the highest EERs in the industry, the Duration compressor exceeds or meets other compressor efficiencies including the latest scroll compressors. The compressor has traditionally been an industry leader in efficiencies since its conception in the late 1950s. Its efficiencies originate from the Acousti-Cool process, aluminum components, unrestricted suction gas flow, and close design tolerances.

Acousti-Cool is engineered motor temperature management. Managed motor cooling allows the

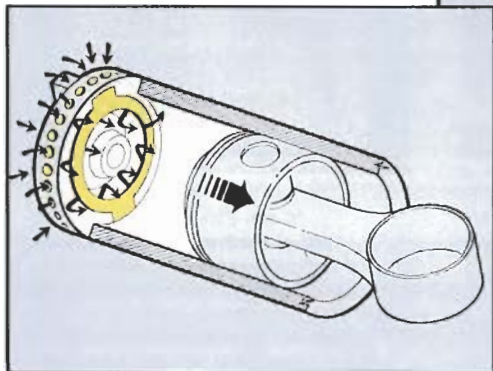
compressor to run up to 35°F cooler than other hermetic compressors. Motor cooling leads to longer motor life and lower operating costs.

During the first phase of the Acousti-Cool process, refrigerant is returned to the compressor through the high level suction inlet. As gas is drawn into the compressor, it is approximately 100°F cooler than the motor windings. This cools the top of the motor. Core motor cooling continues as the gas is routed downward through the windings and between the rotor and stator. While it's being cooled, the motor is performing the duty of a suction gas muffler. Since potential sound energy is being absorbed simultaneously with return gas motor cooling, the process is called Acousti-Cool.

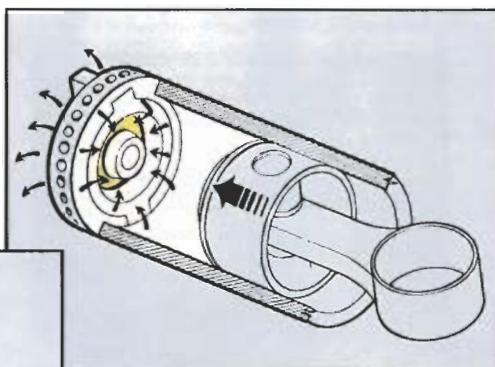
The second phase of Acousti-Cool takes place on the upstroke of the piston. The suction valve closes, holding back the incoming flow of gas until the next intake stroke. This abrupt stop creates a pressure pulse that travels backward along the inlet path at the speed of sound. The pulse of refrigerant vapor hits the bottom of the motor, muffling noise as it cools the bottom windings. ■



All return suction gas is routed over the motor. This managed motor cooling allows the Duration compressor to run 35° cooler than other hermetics leading to longer motor life and lower operating costs.



On the downstroke of the piston, when pressure in the cylinder is less than suction pressure, the suction valve is pushed off its seat allowing refrigerant into the cylinder. The gas enters efficiently in a cylindrical pattern around the circumference of the valve.



On the upstroke, the suction valve closes preventing refrigerant from leaving the cylinder. When cylinder pressure exceeds discharge pressure, the large round discharge valve lifts completely off its seat allowing gas to efficiently exit the cylinder. If there is liquid present, flow dynamics resulting from tapered surfaces and valve proximity will allow the liquid to be purged from the cylinder without damaging the valves. Besides being gas flow efficient, American Standard's valving is engineered to tolerate some liquid slugging.

## It's all in the way that we build it.

Under certain operating conditions, there will be some liquid refrigerant flooding back to the compressor.

This can lead to liquid slugging. While no reciprocating compressor is designed to pump liquid refrigerant, the Duration compressor tolerates the stresses of slugging better than other designs.



The rugged valve assembly is the most critical component of the compressor. American Standard fabricates its own valves for the Duration compressor.

The valve is undoubtedly the most critical component of the compressor. It experiences more mechanical, thermal, and pressure stress than any other component. Because of this, American Standard has always manufactured compressor valves to extremely tight design specifications.

### *A valuable valve design.*

Valves spring open and shut 57 times a second, up to 800 million times a year on heat pumps. Since Duration compressors are designed for heat pump application, a valve material that is practically indestructible is required. The discharge and suction valves are made of special Swedish-type steel which has a high carbon content and a very low content of nonmetallic inclusions such as sulfides and silicates. Because of this unique microstructure, the valve is impact and distortion resistant, as well as being resistive to metal fatigue. It is also unaffected by excessive heat.

Valve design is critical to liquid refrigerant tolerance. On mild days, liquid refrigerant can accumulate in the suction line and flood into the compressor on start-up. Therefore, the valve must be able to tolerate some slugging. American Standard's





### *The importance of shell volume.*

valve assembly allows liquid refrigerant to be expelled from the cylinder without damaging the valves.

All Duration compressors have the discharge line routed through the compressor sump. With the compressor running, the hot discharge line will vaporize liquid refrigerant in the sump separating it from the oil. In the off-cycle, crankcase heat is used on all compressors (except 10 SEER cooling

units where refrigerant quantity is small) to vaporize liquid refrigerant and maintain desired oil temperature.



In addition to vaporizing refrigerant, American Standard's discharge line acts as a vibration damper for starting and stopping. Magnets are installed in the large sump to catch metal particulate and keep it out of the bearings.

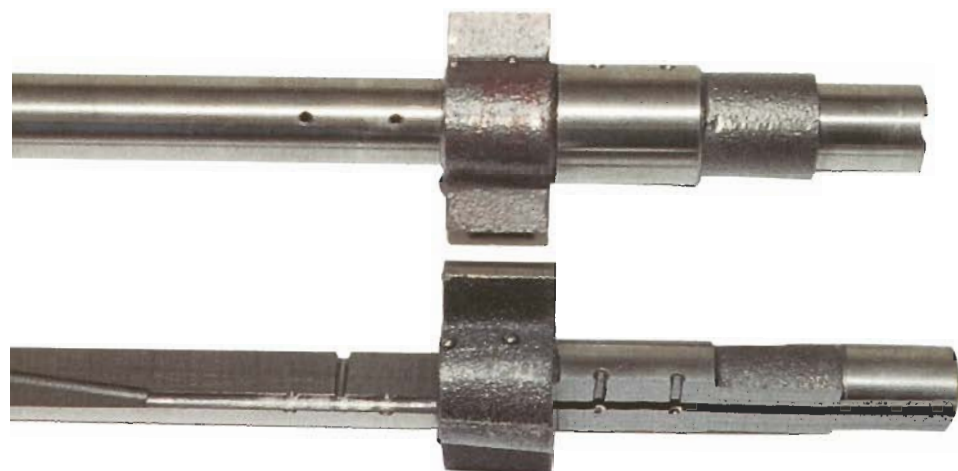
The Duration compressor has an average of 25 percent more volume inside its shell than other compressors. This gives it an additional safety margin against slugging which can be caused by overcharging or by low indoor airflow. With its large shell design, the Duration compressor eliminates the need for suction line accumulators on residential systems.

There are some distinct advantages to having a large shell design. First of all, poor oil return often associated with accumulators is eliminated. Also, performance losses due to pressure drops virtually cease to occur. Thirdly, an accumulator is an additional place for a system to leak. And last of all, the Duration compressor has features designed to vaporize liquid refrigerant. With an accumulator, there are no such provisions.

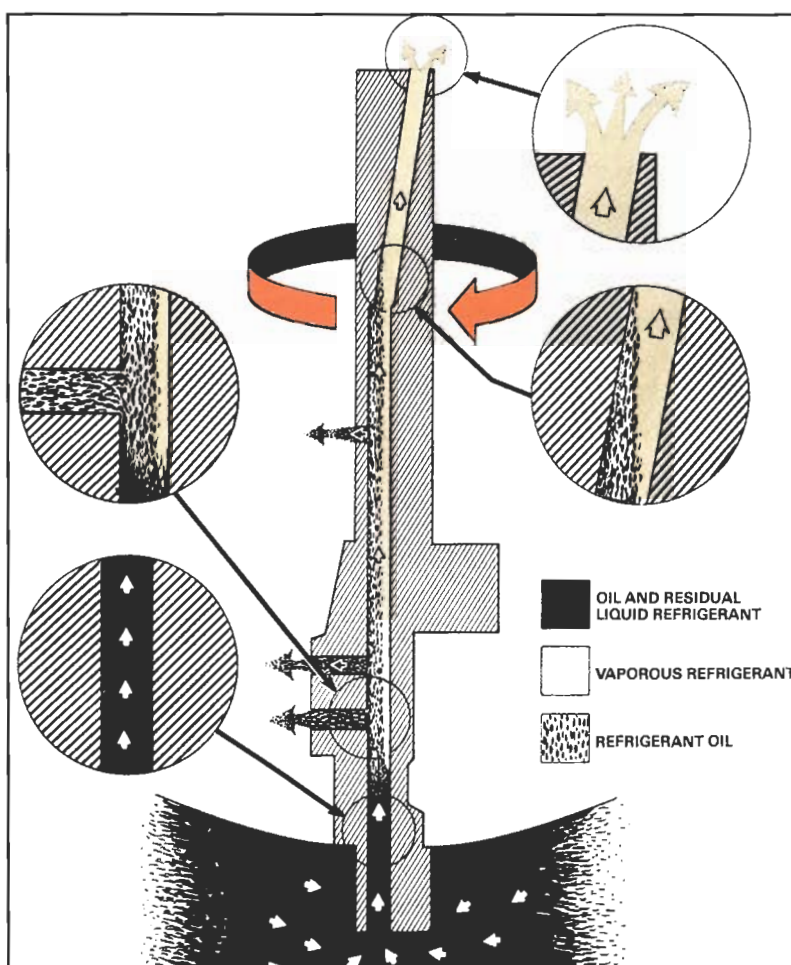


The Duration compressor's valves are made of Swedish steel to handle extreme heat and stress.

A three ton American Standard Duration compressor compared to another three ton compressor shows American Standard's larger shell volume.



A cut-apart crankshaft shows the offset and angled oil passage. The crankshaft has 15 critical dimensions and is machined and hand-polished to bearing tolerances as close as .0001 inches. This is roughly 1/30th the thickness of human hair.



American Standard's compressor doubles as a positive, non-directional, centrifugal oil pump.

### *A dual purpose crankshaft.*

Good lubrication is essential to long compressor life and is one of the keys to its reliability. The Duration compressor's crankshaft doubles as a positive, non-directional, centrifugal oil pump. It provides a constant oil supply to the bearing surfaces when the pump is running. In addition, it helps vaporize liquid refrigerant and cools the motor bearings.



## A chemical stress reliever: American Standard's special white oil.

Duration compressors use a highly refined white refrigerant oil with special additives for temperature and pressure stability. The oil has superior lubricity over a wide range of temperatures. The solubility of refrigerant in this white oil blend is less than with pale oils used by other manufacturers. Lower solubility minimizes violent oil foaming on start-up. This also reduces oil loss and provides rapid establishment of oil flow to the bearings.

Other pale refrigerant oils used in the industry tend to coke (carbonize) on the valves at high temperatures. This coking action leads to loss of efficiency and capacity that will translate into climbing utility bills for the owner. Coking can eventually lead to compressor failure as the valve cannot seat properly with the carbon build-up. American Standard's high temperature oil additive helps prevent coking. ■



American Standard's patented dual spring mounting system absorbs starting and stopping energy, reducing stress on external connections.

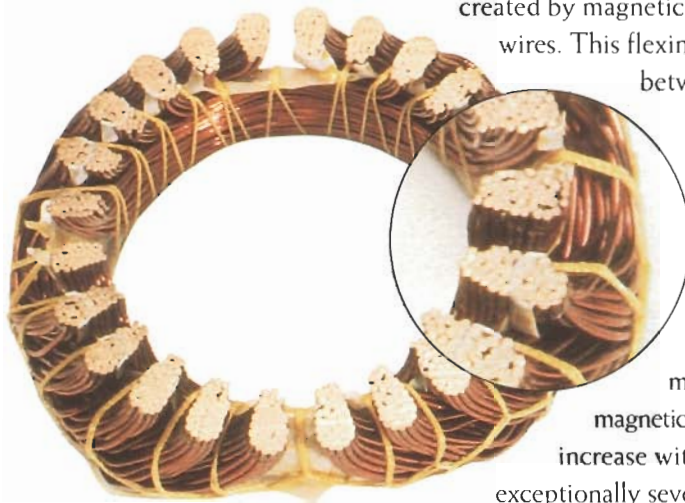
*Energy absorption leads to longer system life.*

Another mechanical stress that must be dealt with is the absorption of inertia energy during starting and stopping. The Duration compressor utilizes a patented dual spring mounting system to absorb this energy.

Heavy snubber springs absorb the starting and stopping torque stress, and a set of extra soft mounting springs quietly isolates the running compressor inside the shell. Stress is reduced on external connections because of minimized shell vibration. The result is longer system life. ■

## Motor works — controlling electrical stress.

When the compressor is operating, there is motion of the motor windings created by magnetic flux between the wires. This flexing causes rubbing between adjacent wires, wearing away the insulation. The bare wires create turn-to-turn shorts that lead to motor failure. The magnetic forces and flexing increase with current and are exceptionally severe during start-up.



American Standard's motor windings are protected by an epoxy varnish bonding system.

To prevent motor windings from flexing and wearing away their insulation, American Standard uses a super strong epoxy varnish bonding system that is virtually as strong as the wire itself. It resists flexing and has outstanding electrical insulation properties. In addition, the insulation provides a protection shield against refrigerant which is a very strong solvent.

Other manufacturers recognized these benefits and now use a winding bonding system; however, American Standard uses the Selectreat™ process that deposits considerably more epoxy within the windings. This process measures into each stator the exact, predetermined amount of bonding material required and heat cures that bonding for proper adhesion. The process places bonding material in all slots and end turns. ■



Every time a Duration compressor is returned from the field, it's cut apart and analyzed in order to identify any possible failure trends.



## The compressor protection system.

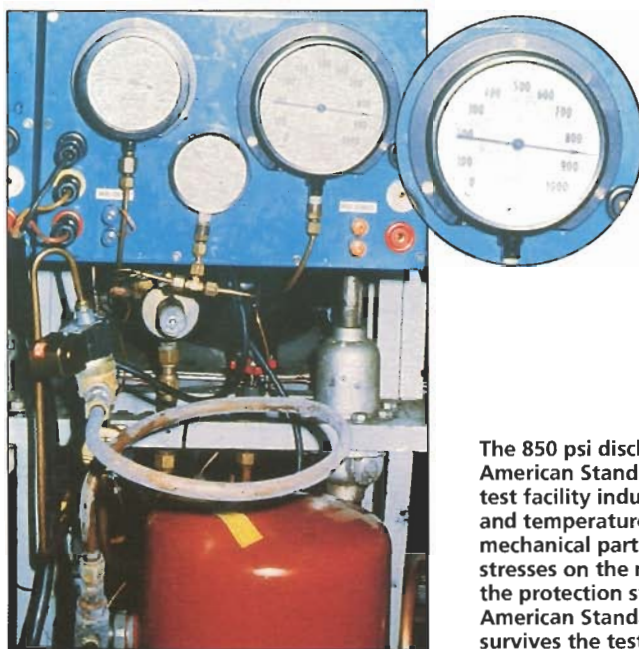
The Duration compressor has a uniquely applied protection system consisting of two integrated components: the internal overload device (IOL) and the internal pressure relief valve (IPR). Since the same compressors are used in both heat pump and cooling units, American Standard has designed the protection system for the higher temperatures and stresses of heat pump operation.

Both components are located inside the compressor shell. The IOL is mounted near the motor windings so it can sense both motor and incoming gas conditions. The IOL will trip and take the compressor off line on any combination of temperature and current that exceeds motor winding tolerances, even if neither the current nor temperature alone is sufficiently high enough itself to trip the IOL. This application gives it a high margin of reliability.



**The Duration compressor features highly reliable Rotolock fittings and safe, easy changeouts.**

The IPR valve is mounted on the discharge muffler in close proximity to the IOL. Should pressure differential between the discharge and suction sides exceed 400-500 psi, the valve will open and hot discharge gas will be drawn across the IOL. The hot gas plus the higher compressor current will cause the IOL to open, shutting down the compressor. With the IPR valve, high pressure is instantly relieved in the compressor shell where no refrigerant loss is possible. External high pressure switches used by other manufacturers can lose refrigerant to the environment. ■



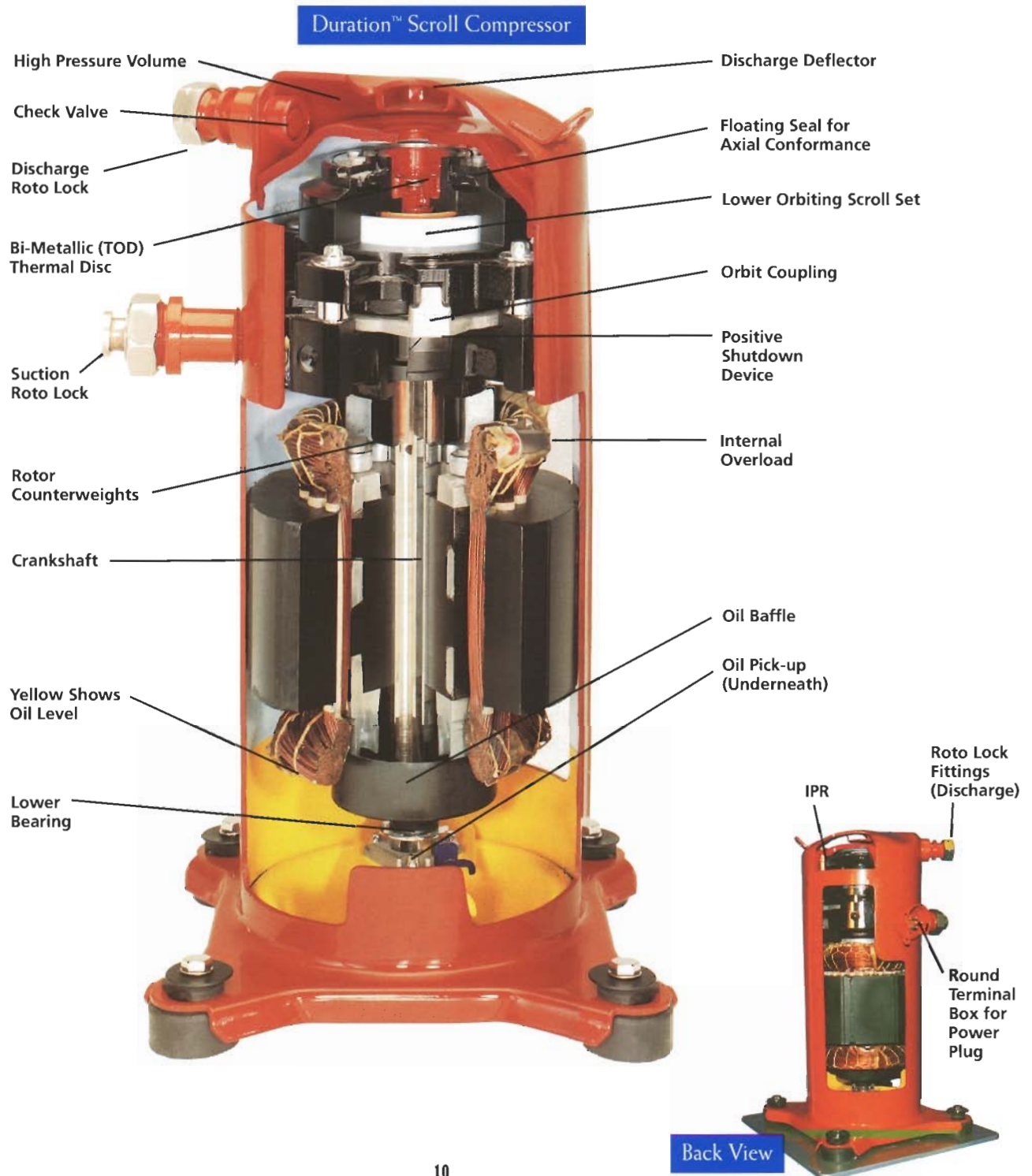
**The 850 psi discharge pressure test in American Standard's compressor life test facility induces extreme pressure and temperature stresses on all mechanical parts and high electrical stresses on the motor. Even though the protection system is bypassed, American Standard's rugged design survives the test.**

**American Standard's unique compressor protection system components eliminate the need for high and low pressure cutouts.**



# The Duration™ Compressor Technology Story Continues.

*With the introduction of the scroll compressor, American Standard unveils the latest chapter in compressor technology.*





## Scroll Gas Flow Pattern: Uncomplicated, unrestricted gas flow optimizes efficiency.



### **Cold, Low Pressure – Entering Gas.**

Compression in the scroll is created by the interaction of the orbiting spiral and a stationary spiral. Gas enters the outer opening as one of the spirals orbits.



### **Warmer, Medium Pressure – Interim Gas.**

The open passage is sealed off as gas is drawn into the spiral.



### **Hot, High Pressure – Discharge Gases.**

As the spiral continues to orbit, the gas is compressed into an increasingly smaller pocket. By the time the gas arrives at the center port, discharge pressure has been reached.



### **All Stages Working Together.**

Actually, during operation, all six gas passages are in various stages of compression at all times, resulting in nearly continuous suction and discharge.



The scroll compression volume is formed by the orbiting relationship between the two involutes. To perform properly, the involutes have to stay in contact the entire length of the involute.

## A look at how The Duration™ Scroll Compressor works.

American Standard's Duration scroll compressor represents a different approach to compression. The scroll compressor utilizes a moving pocket which is produced by the orbiting motion of the four spiral operations described at left. The compression and discharge are smooth and continuous during this 540 degrees of rotation. ■

## Innovation is a key design feature.

The Duration scroll compressor features an innovative method referred to as "conformance" for assuring a tight compression pocket. The orbiting scroll is self-adjusting. It moves radially in and out to precisely follow the involute geometry. The fixed scroll moves vertically to maintain optimum contact of the tips. This dual motion capability is the key to achieving the full benefits of the Duration scroll compressor.

The scroll's radial conformance seals in compression in much the same way as the reciprocating compressor's piston ring does in the upward stroke. An innovative bushing coupled with centrifugal force is utilized to guide the orbiting scroll involute towards the fixed scroll involute, minimizing gas leakage between the involute walls.

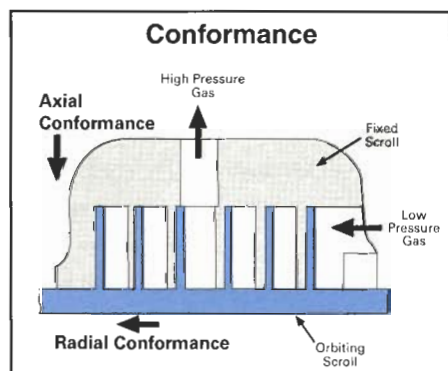
The Duration scroll's axial conformance supplements the radial conformance by sealing the tips using the controlled pressure balance forces to minimize any gaps between involute tips and the mating scroll floor. ■

## Counting the benefits of conformance.

The benefits of conformance are many, including maximized efficiency, proven durability, low voltage starts and quiet operation. Duration compressor conformance increases efficiency by continuously compressing the refrigerant gas in each rotation with minimal leakage. Very low leakage is achieved with minimal efficiency-robbing friction because of the tight manufacturing tolerance of our compressors.

Durability is improved because conformance plays a key role in the scroll's ability to handle reasonable amounts of liquid flooding and system contamination. The flanks and tips will separate if liquid refrigerant or debris is present, allowing the particulate to pass through without harm to the scroll involutes. Contaminants that are flushed through the scrolls are trapped in the system filter driers.

Scroll conformance allows the flanks and the tips to separate when the compressor cycles off and unloads the gas from its high-pressure state. This allows for easy low-voltage starts every time. Therefore, hard start kits are not required in non-equalizing systems. Quiet operation is obtained from the smooth continuous compression with little vibration due to the orbiting motion. ■



## Stress capabilities are a plus.

The Duration scroll incorporates two permanently lubricated, Teflon-impregnated bearings to insure bearing life even if sump oil is temporarily washed away from flooding, or during a long off period "dry" startup. In addition, the scroll uses a white mineral oil, similar to the Duration reciprocating compressor, for excellent lubrication and long line oil return.

A positive pressure oil sump (similar to our American Standard reciprocating compressors) is used to quickly supply oil to bearings and scroll tips to ensure long life and enhanced pressure sealing. Note oil pickup vanes in bottom of compressor crankshaft.

The Thermal Operating Disc (TOD) is a supplemental device that protects scroll tips and motor windings from high temperature/pressure damage. When discharge temperature exceeds 300° F, the TOD device flows hot gas through the bypass tube onto the IOL. The IOL safety device then cuts power to the motor avoiding damage from excessive discharge temperatures.

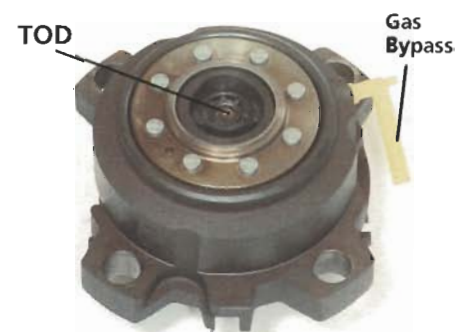
High/low pressure is separated by a minimum surface to maximize efficiency. The small high side volume of the upper cap acts as a muffler to reduce the pulsation of gas. ■



Teflon-impregnated bearings.



Positive pressure oil sump.



Upper housing with TOD and gas bypass.



High pressure area showing Muffler, IPR and Temperature Deflector Plate.



## Duration Scroll Compressor Features And Benefits

### Features

- High Pressure Volume
- Discharge Deflection
- Check Valve
- Discharge Rotolocks
- Thermal Operating Disc (TOD)
- Suction Rotolock
- Rotor Counterweights
- Crankshaft
- Oil Pickup
- Lower Bearings
- Floating Seal
- Lower Orbiting Scroll and Orbit Coupling
- Positive Shutdown Device
- Internal Overload (IOL)
- Internal Pressure Relief (IPR)
- Oil Baffle
- Round Terminal Plug

### Benefits

- The small top cap of the shell serves as the internal muffler.
- Helps reduce the shell temperature.
- Internally equalizes shell for easy start-ups.
- Allows for ease of installation and removal.
- Bypasses discharge gas (Over 300° F to trip IOL and protect motor/scrolls.)
- Allows for ease of installation and removal.
- Allows for smooth operation.
- Feeds oil centrifugally through center bore to bearings.
- Feeds sump oil through crankshaft center hole.
- Supports crankshaft and immersed in oil sump, Teflon-impregnated.
- Seals high to low pressure and allows axial conformance.
- Rotating crankshaft converts to orbiting motion of lower scroll relative to fixed upper scroll. This produces compressed gas. Designed for debris tolerance.
- Separates scrolls at shutdown to eliminate noise or reversal.
- Protects motor from overheating.
- Protects compressor from excessive pressure.
- Separates oil in sump from churning counterweights.
- Improved connections and no miss-wires.

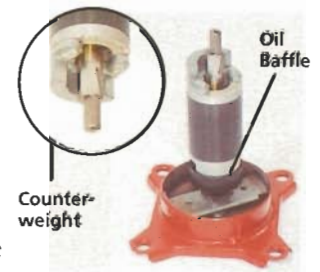
## Additional design features finish the story.

The orbit coupling connects the two orbiting scrolls and provides for smooth, quiet operation. The Duration scroll is designed to be exceptionally quiet in operation. Continuous scroll compression reduces the pulsation of gas. Balanced rotor counterweights reduce vibration, and shutdown mechanisms eliminate shutdown noise and vibration, eliminating the need for internal springs.

Rubber vibration isolators are also used to ensure no vibration is transmitted to the



system. Duration scroll crankshaft/rotor assemblies use counterweights to reduce vibrations and associated bearing loads. An oil baffle is also used to separate oil from the rotating crankshaft and rotor to reduce oil foaming for improved efficiency and lubrication.



A new method of wire connection is being used on all Duration scrolls. This "terminal plug" positively connects to the terminal header without the use of individual spade connections. This ensures correct wiring, reduces loose connections (and associated overheating), and seals the terminal box against moisture and corrosion. ■





# The SEET Lab: Only the Strong Survive.

*How tough is American Standard equipment? Tough enough to withstand 16 grueling weeks of torture that would fry the competition.*

## Enter if you dare.

Just what goes on inside the Systems Extreme Environmental Test lab? Well, picture the Sahara desert at high noon and then visualize Buffalo, New York in the middle of January. Then imagine these weather conditions occurring back-to-back, within days of each other. On top of this, throw in an aggravating series of start-ups and shut-downs. After 16 grueling weeks inside the SEET facility, it's no surprise that only the strongest systems survive.

By using high stress, accelerated conditions,

we are able to put our heat pumps through five years of wear and tear in a compressed period of time. Why do we only test heat pumps? Because if the Duration compressor can withstand SEET as a heat pump, it will easily handle any stress it may encounter as an air conditioner.

In all, the lab will put a heat pump through 2,688 hours of continuous testing, watching for any signs of weakness or unusual wear.

In addition to the Systems Extreme Environmental Test, we test other major

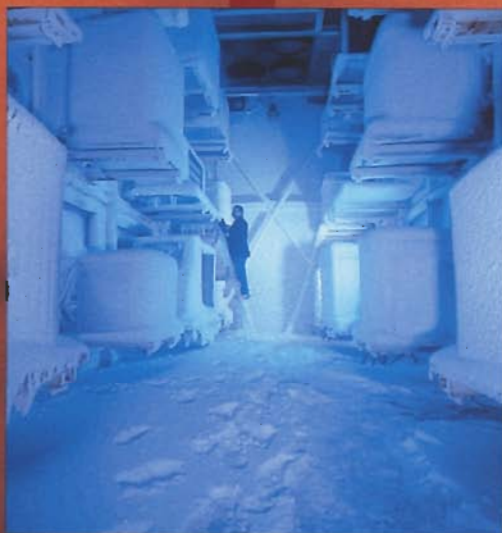


components individually. We pay particular attention to the compressor, which has earned a stellar reputation for its excellent performance.

Engineers run the compressors at twice normal operating pressures. Compressor motors are tested at five to six times the rated current and at twice normal temperatures. Each compressor is also turned on and off at cycling

rates ten times faster than normal for weeks at a time.

It's obvious we believe in the benefits of testing.



If a new product doesn't make it through the SEET lab, it won't be produced. It's as simple as that. Because

we know that subjecting a heat pump or system component to extreme conditions can only make it – and us – better. ■



## Passing the test.

Lab technicians put American Standard heat pumps through two-week cycles of torture, eight consecutive times. After the 16-week testing period, compressors are cut apart to locate failure points, allowing our engineers to devise ways to alleviate the problem and improve the failed component. And by the way, if you think these tests are excessive – you're right.

### Round 1:

*Heating defrost with snow*

Outside temp: 23° with snow

Inside temp: 105°

Objective: The heat pump's challenge is to heat and maintain an inside room at 105° while operating in sub-freezing conditions. The coil must be free of ice build-up in order to perform under these conditions. This test will require the compressor to work very hard and run almost continuously.

### Round 2:

*Cooling*

Outside temp: 100° with fan shut off

Inside temp: 75°

Objective: To cause the unit to cycle on overload by simulating outdoor fan failure. This test will also determine if the unit will restart after it cools down.

Note: When pressure builds too high, the IPR valve will open and discharge hot gases over the internal motor overload, which in turn will open and shut down the compressor. The IOL is designed to take the compressor off-line on any combination of temperature and current that exceeds motor winding tolerances.

### Round 3:

*Minimum load heating*

Outside temp: 0°

Inside temp: 90°

Objective: With minimum refrigerant flow the motor often seizes because there's not enough oil to lube the bearings to keep them from burning. The Duration™ compressor, however, has the velocity



necessary to handle this situation – it can pull oil back through the lines and into the compressor to lubricate all bearing surfaces.

#### Round 4:

*Power shut off*

Objective: After 12 hours of power outage, oil has drained or has been washed off bearing surfaces by refrigerant migration. The oil reservoir at the bottom of the sump has been floated above the oil pump opening by the heavier liquid refrigerant. On start-up, American Standard's unique bearing plating will serve as a boundary lubricant until oil flow is established. This test simulates the effects of a power outage, giving engineers the opportunity to see if the compressor can withstand starting conditions with little or no oil pressure.

#### Round 5:

*Cooling maximum load #2*

Outside temp: 135°

Inside temp: 100°

Objective: To remove excessive indoor heat, getting rid of it outdoors.

The compressor is required to stay on-line in order to pass this grueling test.

#### Round 6:

*Cooling flood*

Outside temp: 85°

Inside temp: 80° with indoor blower off

Objective: To subject the compressor to the mechanical stresses of liquid refrigerant flood back. Gross system overcharge or blocked indoor airflow could cause this condition. (These are the same conditions which created "Snowball.")

#### Round 7:

*Cooling maximum load #1*

Outside temp: 125°

Inside temp: 80°

Objective: To attempt to force the compressor to shut down under the stress of high load conditions.

#### Round 8:

*Power shut off*

Objective: To produce a start-up situation that could seize most compressors due to low oil pressure across the bearings. ■



"Snowball" has been undergoing a continuous flood back test in our compressor life test facility since 1973. The test demonstrates the reliability of the compressor under conditions like low indoor airflow or system overcharge.



# Intelligence in Action.

*One of the biggest advantages of SEET is the sophisticated technological achievements that have been developed as a result of stringent testing and evaluation. American Standard's advanced demand defrost controls are just such an achievement.*

## Demand defrost controls.

An advanced demand defrost board using complimentary metal oxide semiconductor (CMOS) components

was designed to provide the defrost application with the benefits of today's computer technology. With this control, both coil and ambient temperatures are monitored through sensors, and the information is used to initiate the defrost cycle and limit it to the shortest practical time. This procedure conserves energy while ensuring complete defrost action. The control, currently used on Heritage heat pump models as well as WCZ, WCY and DCY packaged heat pumps,

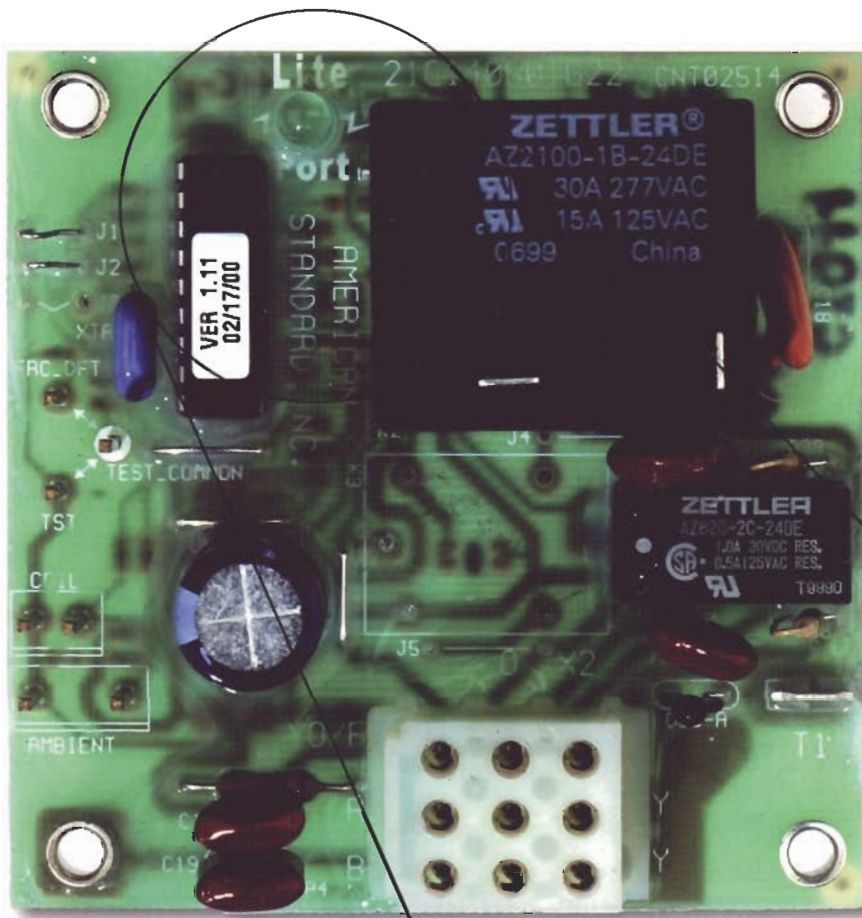
monitors current operating conditions, references the performance of previous defrost cycles, and initiates the next defrost cycle to obtain maximum efficiency.

Since the defrost cycle can create high system pressures, American Standard's demand defrost board has a soft defrost feature that allows the fan to come on fifteen-seconds early, reducing pressure before the switch-over valve returns to the heating position. This reduces switchover noise and compressor stress associated with defrost termination. In addition, the control diagnoses system faults. An indicator light on the defrost board directs the serviceman to the problem.

American Standard's demand defrost board also features test pins for easy serviceability. The pin (TST) allows the serviceman to accelerate operations by a factor of 10. A Forced Defrost pin (FRC DEF) allows the serviceman to manually initiate a defrost cycle. No special tools are required.

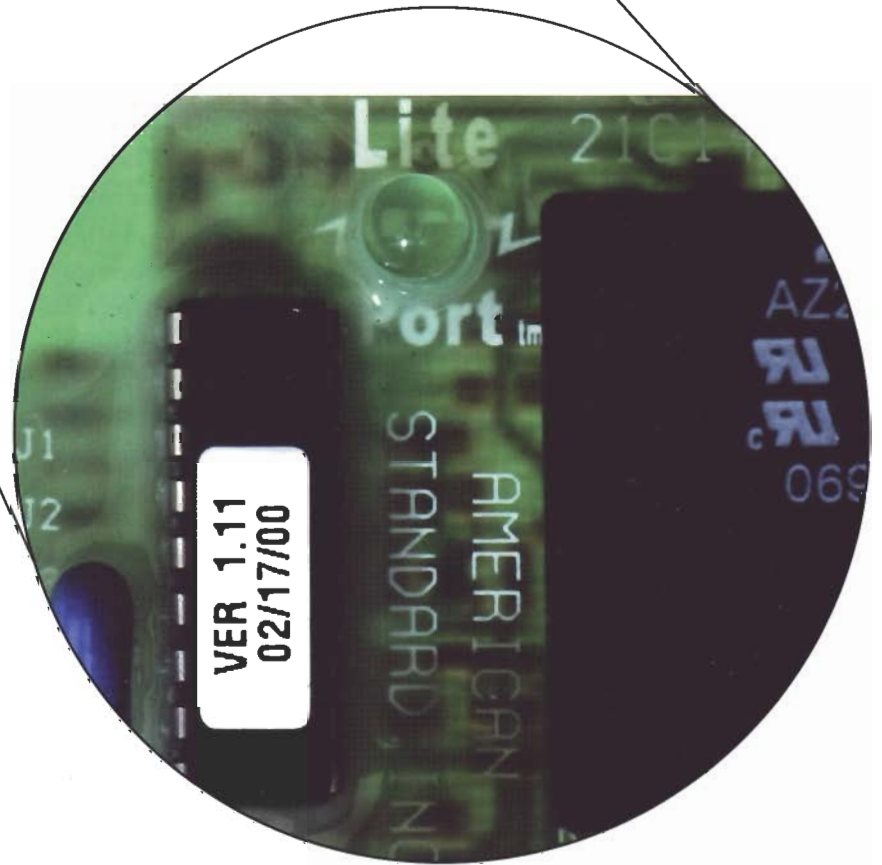


**American Standard's Heritage® heat pumps feature adaptive, self-diagnosing demand defrost control systems that were designed in response to efficiency drivers, SEET reliability parameters and the need for easier heat pump servicing.**



American Standard's CMOS defrost control diagnoses system faults. The faults will be displayed by a flashing LED on the board.

American Standard's family of defrost controls are beneficial to the dealer because problems can be quickly diagnosed which result in lower service costs. The homeowner benefits because the board eliminates unnecessary defrosts, saves money, and lengthens the life of the heat pump. ■



Intelligence  
In Action

# Making Heat Transfer History.

*At American Standard we're constantly striving to discover new and inventive ways of improving heat transfer technology. The efficiency and durability of our Spine Fin™ and Plate Fin coil configurations have placed us well ahead of the competition.*

## A reputation for innovation.

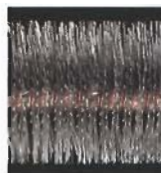
It's understood in the HVAC industry that along with the compressor, heat transfer is the most important factor in achieving heating and cooling efficiencies. And that's something that American Standard is particularly knowledgeable about. We've been leading the way in heat transfer technology since the end of the last century when we designed the earliest steam boilers and radiators for American homes as well as heat exchangers for industrial and commercial use. ■



Spine Fin's unique configuration requires no end turns. Brazed connections occur only at coil inlet and outlet, reducing potential leaks. No competitor has been able to match its reliability.



The patented Spine Fin, shown above left, machine wraps aluminum, spined ribbon tightly onto adhesive coated tubing. The red color, above right, indicates adhesive which has extruded out from under the fins, locking them together and sealing out moisture.



## Spine Fin: The design of the century.

Now we're doing it again. Since 1968 when we began full-scale production of Spine Fin coils for outdoor unitary products, Spine Fin has been unbeatable for retained efficiency and corrosion resistance. Spine Fin is the most efficient single row heat exchanger that can be built. In fact, it's so reliable and durable that it has enabled us to offer the industry's first manufacturer's 10-year warranty on outdoor heat exchangers.

The innovative design of Spine Fin puts it in a class by itself. It is engineered with internally grooved, all aluminum tubes that stir the refrigerant and enhance heat transfer. Spine Fin is carefully designed to maximize the inherent efficiency, durability and low maintenance requirement of single row, radial tube heat exchangers.

### *Manufacturing process.*

Spine Fin is manufactured on patented, high-speed machines that cut, form, and wrap aluminum ribbons around aluminum tubing. The tubing rises through a red adhesive bath in the



center of the machine. The red adhesive bath coats the tube. Tension rollers wrap the fin ribbons tightly to the tube with the bonding adhesive to assure good heat transfer. The extruded adhesive forms a barrier against capillary attraction. By sealing moisture and electrolytes out of the tube/fin space, galvanic and crevice corrosion is minimized.

American Standard selects only premium aluminum tubing, which is extruded, then sealed in a nitrogen atmosphere. The material used to manufacture the fins is selected for its unique chemistry and temper.

### *Lowest leak potential.*

Spine Fin coils are fabricated in continuous lengths. Brazed connections are required only at the coil (or circuit) inlet and outlet. This configuration eliminates end turns and permits a dramatic reduction of potential leaks. Like other manufacturers, American Standard uses copper tubing in piping the refrigerant circuit. What is unique is American Standard's copper aluminum transition joint. This component is ultrasonically pretinned 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 the base metals from corrosion.

In fact, Spine Fin is so reliable that a five-year survey by our product service department showed that the field leak rate in 2 million coils of various sizes was less than .05 percent.

### *Retains efficiency.*

Another element that adds to the efficiency of Spine Fin is the four-sided coil configuration. This unique configuration presents a large surface area to the outdoor airstream and permits more air volume to flow over the fin surface at lower velocity. Lower air velocity means reduced dirt buildup on the fin surface, delivering greater efficiency over a longer period of time.

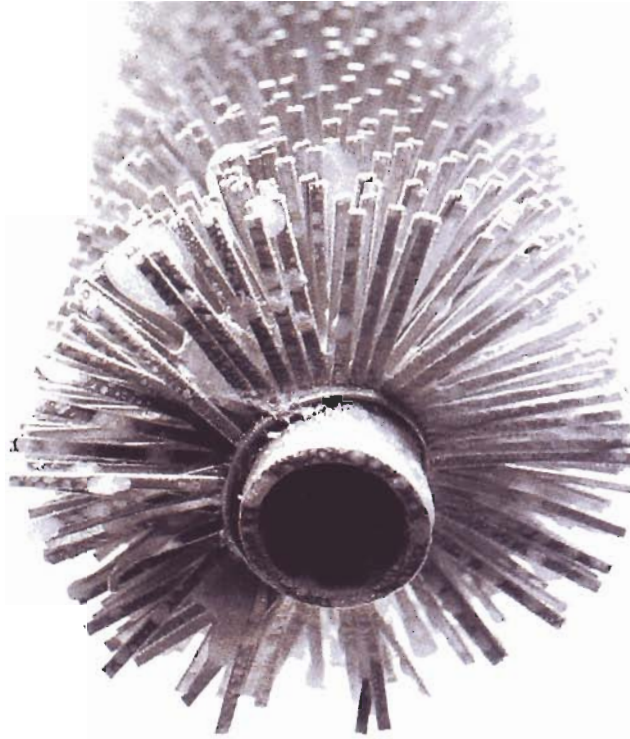
**American Standard's four-sided coil with its radius corners eliminates return bends and provides maximum efficiencies.**



**These patented transition joints are what make Spine Fin so reliable. A recent survey showed a leak rate of less than .05 percent in 2 million coils over 5 years. That is a rate of only one per 2,000 joints.**



Spine Fin readily dissipates heat to remove winter frost.



## 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/copper fin or copper tube/aluminum fin heat exchangers after two-years of operation in a temperate marine environment."

## Superior heat transfer.

Spine Fin configuration allows it to gain and dissipate heat very rapidly. In heat pump applications, the radiating fins allow the winter air to flow over each individual spine so frost build-up is slow and uniform. Spine Fin tolerates more frost while retaining efficiency and lengthens heat pump run time.

## Resists corrosion.

The outdoor environment is harsh with dramatic swings in temperature, rainfall, wind and humidity. Near the ocean, air contains salt-laden moisture. In and around cities, the atmosphere contains oxides of sulfur and nitrogen, acid and alkaline dusts and gases. Carefully selected aluminum alloys in Spine Fin provide protection from the harsh outdoor environments.

In fact, American Standard has the lowest corrosion potential of any outdoor heat transfer technology, especially in seacoast environments, galvanic conditions and acid rain environments. In such exposures, air conditioning coils are subject to two

dominant corrosive actions; galvanic (two-metal) corrosion, and crevice corrosion. For galvanic corrosion to occur, two conditions must be fulfilled:

1. There must be two (or more) dissimilar metals in proximity.
2. A conducting electrolyte, like salt spray or chemically tainted rainwater (acid rain), must be present to bridge the metals.

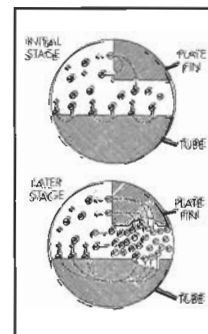
Simply stated, in galvanic corrosion the two metals act as a battery or cell. The voltage of the battery is a function of the metals which make up the electrodes. The current flow (corrosion rate) through the battery is a function of the chemistry of solution.

The second major corrosive force against which an outdoor coil must have a defense is crevice corrosion. Crevice corrosion is caused by stagnant solutions trapped in very small spaces. The site must be wide enough for a liquid to enter by capillary attraction, yet narrow enough to maintain stagnant conditions.

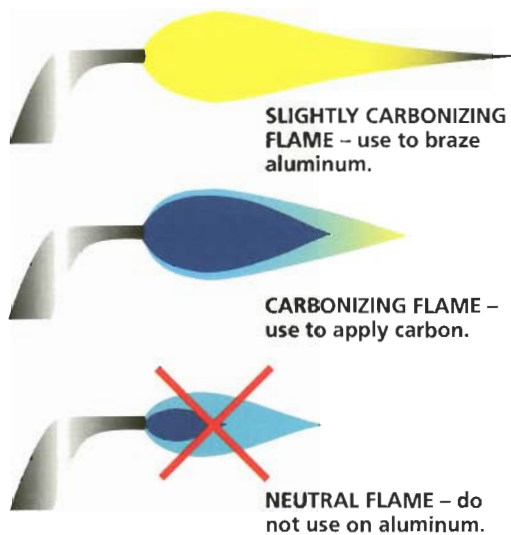
A few thousandths of an inch is sufficient to qualify as a crevice and is typical of the space between the tubing and finstock of outdoor heat exchangers. The mechanism of this

corrosion is shown in the drawing.

The resistance of Spine Fin to crevice corrosion is integral to the construction of American Standard's unique outdoor coil. ■



Enlarged view of microscopic crevice corrosion between plate fin and tube.



## Tips on brazing aluminum tubing.

American Standard Spine Fin coil is a highly reliable component which seldom requires repairs. However, because of the many questions contractors who are new to American Standard's equipment have regarding aluminum repair, we thought it would be beneficial to talk about aluminum brazing. The technique is simple.

The key elements in successful brazing are removing the layer of aluminum oxide from the tubing with a blitz or emery cloth and utilizing Allstate Welding's Aluminum Brazaloy #31 and its flux. Make a paste with the flux and clean water and apply it to the area needing repair.

The aluminum tubing used in Spine Fin coils has a melting temperature of about 150° above the flow point of the brazing alloy. The temperature of the tubing must be gauged while working on it. Turn the oxygen down (assuming an oxy-acetylene torch is being used) almost until "blackbirds" are formed. Put a light layer of carbon from this flame onto the tubing.

Readjust the torch to a slightly carbonizing flame (see illustration) and begin to heat the tube. When the carbon turns clear, the temperature is about 1000°. That's 50° away from the flow point of the alloy.

If a turbo torch is used, the temperature can be gauged by the color of the flux. When the flux paste turns clear, the temperature is almost hot enough for the alloy to flow. Remember, aluminum does have a relatively low melting point. Keep the flame moving. When the alloy seems to flatten and spread, remove the heat. The repair has been made. In addition to soldering repair, aluminum tubing can be reconnected with coupling kits. ■

## Coil cleaning made easy.

An additional advantage of Spine Fin is the negligible rate of fouling of the heat exchanger face by dirt accumulation. There are two reasons: First, the thousands of radiating fins present a large open surface area to the unfiltered outdoor airstream. The large surface area permits more air volume at lower velocity. And a lower velocity means that fewer solids (dirt, grass clippings, leaves, etc.) are picked up in the outdoor airstream reducing normal dirt build-up.





A depth-loading Spine Fin coil has many spines still transferring heat above the accumulated dirt layer.

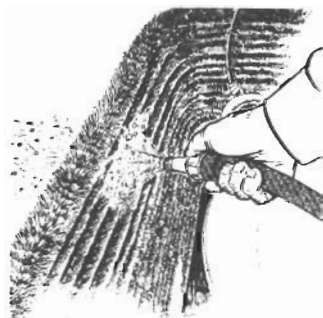
Secondly, Spine Fin has thousands of leading edges (high edge ratio). The discontinuity of these fins on the coil surface distributes dirt throughout the coil depth. This action has been termed "depth loading." Because of this phenomenon, many fins intersect the airstream above the normal dirt accumulation. Heat transfer ability is maintained. Nevertheless, a cleaner outdoor coil is always a better performer. ■

### *Treat with a cleaning solution.*

The unit may be located near a source of grease or oil causing dirt to "pack" onto the coil. Water pressure alone may not do the job. In these cases a non-acid foaming coil cleaner is recommended. ■

## Coil cleaning methods.

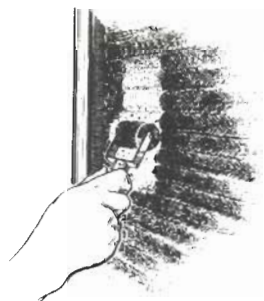
### *Use gentle water pressure.*



When required, Spine Fin coils can be cleaned with a reverse flow of low pressure water.

When the coil is contaminated with dirt or other small particles, the first step is to turn off the power to the outdoor unit. Then disconnect the fan motor power leads and remove the top cover assembly. Now direct a gentle stream of water at the Spine Fin from the inside to force the dirt outward from the fins.

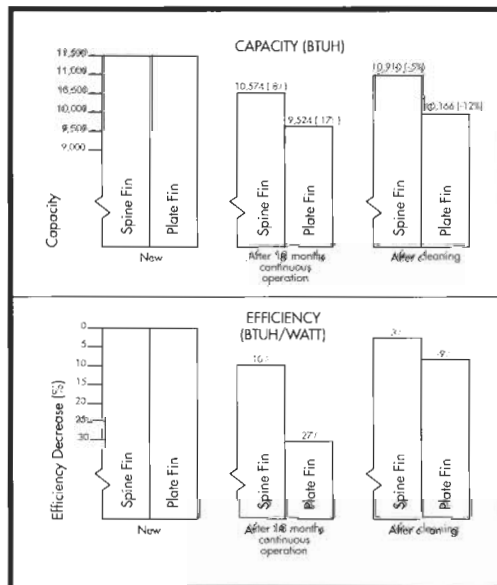
### *Singe with a flame or utilize a brush.*



Even the worst offender, cottonwood, can be easily removed by using the Spine Fin brush.

You can singe cottonwood, the worst offender, with a flame. Or you can use a brush specifically designed to remove lint, hair, cottonwood or grass clippings. The brush is made like a paint roller with bristles on the roller. Rolling the brush along the coil pulls off the material clinging to the fins. This also loosens any dirt which gathers around the tube.

A test to determine the effects of dirt build-up and coil cleaning on the two coil types was performed in 1971 and 1972 by General Electric Company in industrial environments in Louisville, Kentucky. The results indicate that the Spine Fin configuration is more tolerant of deep dirt build-up and responds well to cleaning.



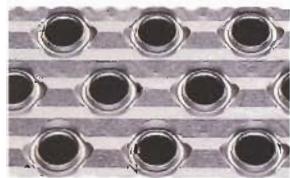
## The Plate Fin solution.

In some products, Spine Fin doesn't fit the application. American Standard engineers, utilizing many years of proven technology in thermodynamics and heat transfer characteristics, developed the Plate Fin coil design to complement Spine Fin for these products.

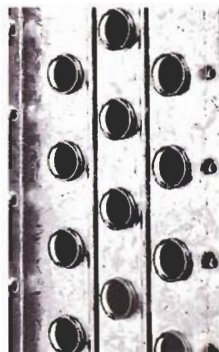
The same level of quality that goes into our Spine Fin coil has been designed into the Plate Fin coil. From materials to testing, American Standard's commitment to manufacturing excellence is unwavering.

Plate Fin takes advantage of advanced waffled fin characteristics, coupled with an internally enhanced copper tube.

Quality inspections include two separate electromagnetic field tests, which check the copper tubing for spot and straight line inclusions as well as other defects in the tubing wall.



The Plate Fin coil uses an advanced waffled fin design to maximize heat transfer.



The unique "burr free" tube sheet eliminates abrasions from vibration which minimizes the possibility of refrigerant leaks.

### *Environmentally-friendly.*

Our "burr free" tube sheet uses a drawn collar which prevents a rough edge from directly contacting the tube surface.

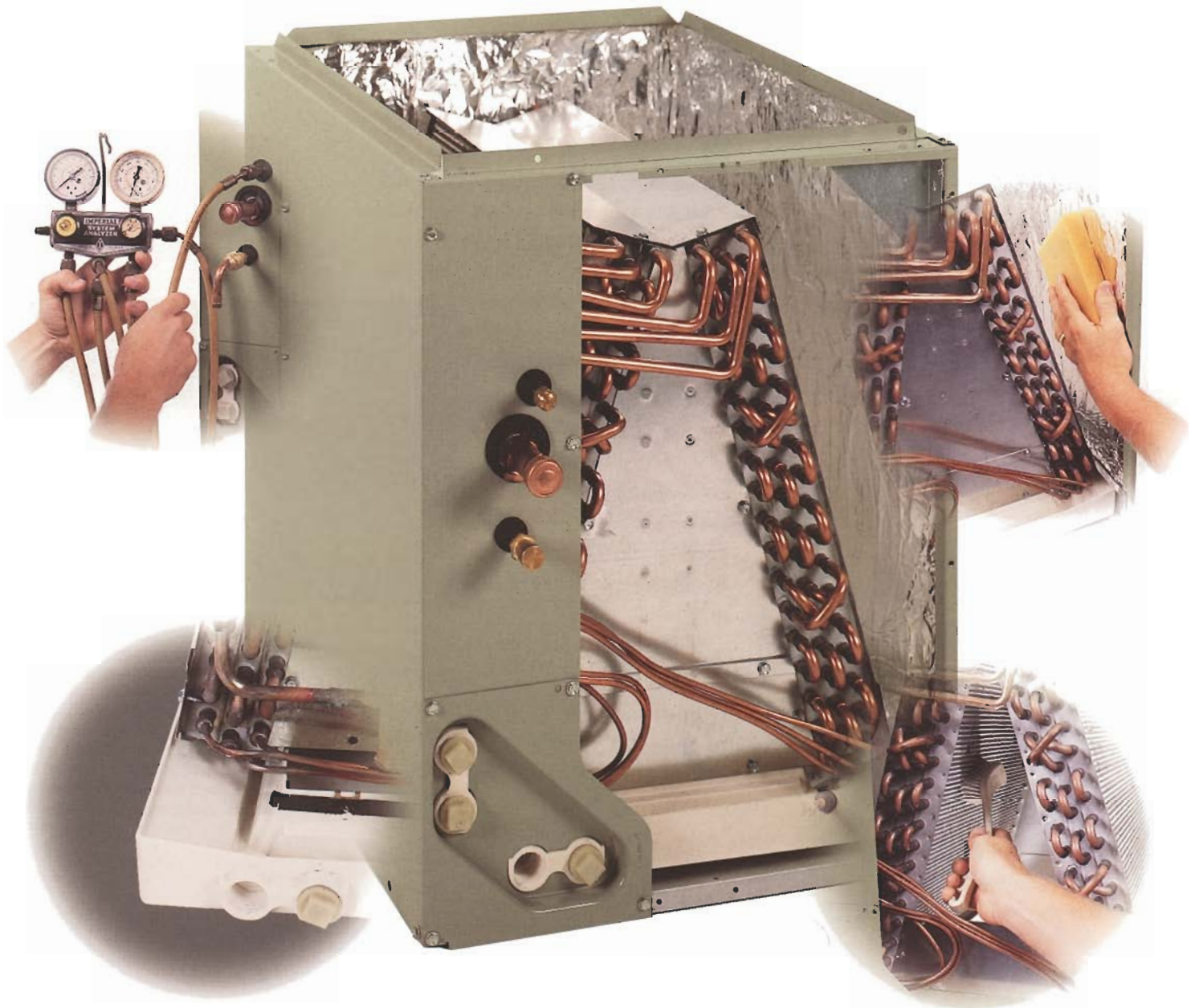
This unique design minimizes the risk of abrasions caused by vibration, inherent in all air conditioning systems. By reducing the possibility of penetrations, environmental concerns of releasing refrigerant into the atmosphere are minimized.

### *A commitment to quality.*

Another important commitment to quality is our attention to process control in order to maintain uniformity in fin collar configuration. By utilizing strict controls on aluminum fin stock through attention to detail in fin manufacturing processes, uniformity of highly efficient heat transfer is assured. ■



# The Comfort™ Coil Technology Story.



THE INDUSTRY'S BEST ACCESS.

# Comfort™ Coils Features and Benefits

## Features

New Split Front Panels  
& Removable Inner Panel

External Service Port

New Liquid Line Design

Painted Finish

Two-Way Sloped Drain Pan

New Attachment Method

Split Inner Coil Panels

Matched System

## Benefits

Provide easy removal and coil access. Makes cleaning and servicing easier which in turn leads to higher efficiency and longer life.

Quicker, easier serviceability.

Allows use of second backup wrench when tightening to prevent twisting.

Provides increased protection from rust and corrosion. Matches furnace in color, easier to sell a complete system.

Prevents standing water which improves indoor air quality. Non-corrosive material prevents rust.

Easier installation.

Makes cleaning easier.

Allows dealer to determine capacities and performance at other than ARI rated conditions.



## Clean makes a difference!

Mold, mildew and dirt result in poor performance and indoor air quality. Seasonal cleaning can reduce this problem. An American Standard Comfort™ Coil can provide easier access for cleaning and routine maintenance.



# A Look At Why American Standard Coils Are The Best In The Industry.



## New rotating coil washer.

Our coils are cleaned in a new rotating coil washer that rotates and spins the coil through the cleaning tank to remove manufacturing process oils. Afterwards, they are "heat-dried." The cleaner the coil means the better the brazed joints which means FEWER LEAKS. ■



## New liquid line design.

Allows use of second backup wrench when tightening to prevent twisting. ■

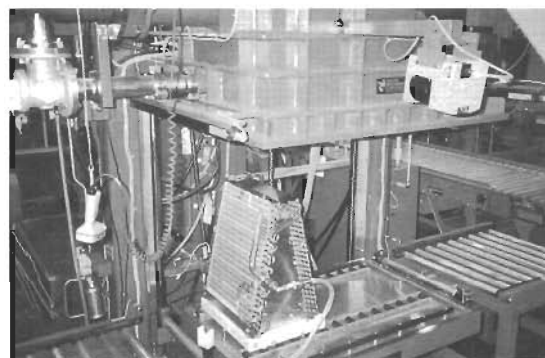
## External service port.

For quicker, easier serviceability. ■



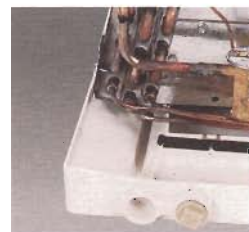
## New mass spec leak check.

Each coil is tested with pressurized helium to 325psi. High capacity 8" vacuum lines detect leaks as small as 0.10 oz./year. ■



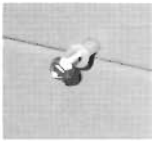
## New two-way sloped non-corrosive drip pan.

Prevents water from standing which prevents the growth of mold, mildew and bacteria. UL rated to 400°F. ■





## New attachment method.



Makes it easy to secure coil to furnace. Insert 4 stand-offs and use self-drilling screws to firmly attach. ■

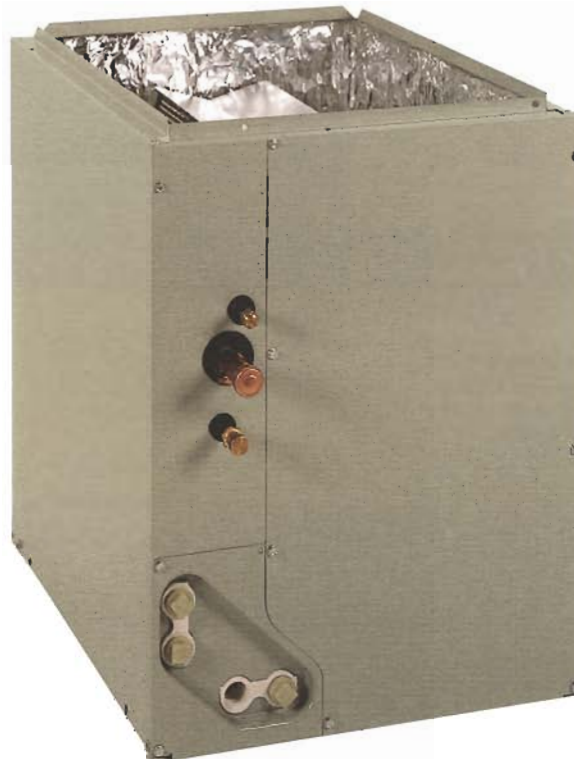
## Split inner coil panels.

Make coil cleaning a snap! Clean coils are more efficient, increase system life and improve indoor air quality. ■



## 100% foil insulation.

Easy to wipe off and contributes to quiet operation. ■



## External coil connection improvements.

### Suction Pressure Port

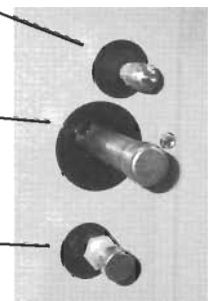
Used to insert 10 – 15 psi holding charge and for field service. ■

### Braze Cap

Soft soldered for easy removal. Also eliminates rubber plug leaks. ■

### New Brass Cap

Seals off liquid fitting and provides quick access to FCCV. ■





Without coil protection, the coil surface can become severely damaged over time. Damaged coils lead to elevated head pressure, higher operating costs and possible compressor failure due to oil carbonization.

Louvered panels help protect the coil from inclement weather. The cabinet is also designed with smooth surfaces and rounded corners providing an element of safety.



## Coil protection — the American Standard way.

American Standard's 18 gauge galvanized steel louvered panels also serve to keep the coil clean, and at the same time protect the coil surface from damaging elements like the weather or even rambunctious neighborhood kids. A damaged coil can lead to a much lower operating efficiency which is why we do everything we can to provide the proper protection.

In addition, all of our outdoor units feature baked-on powder paint, a virtually indestructible finish that is both corrosion resistant and chalk resistant.

Besides the obvious protective qualities of louvered panels and powder paint, these elements are also the most attractive methods of shielding the coil from daily wear and tear. In a recent consumer survey conducted by an independent market research firm, consumers overwhelmingly preferred louvered panels over other types of coil protection. ■



Each American Standard unit is given a complete run test at the end of the line. Air conditioners are given 32 checks; heat pumps, 64.



American Standard's dip tank is the first of eight leak tests to which coils are subjected.

## Technology that passes the test.

As with all American Standard products, each step of the manufacturing process is closely monitored. Spine Fin coils are subjected to as many as eight tests before they're shipped to our customers.

Spine Fin coils start their testing at the dip tank, where they are submerged in water and filled with 375 psi of dry air pressure. Approved coils then are assembled with a Duration compressor. The next procedure is the pressure bell, where the coil and a compressor are placed under a high-pressure bell and again injected with dry air up to 350 psi. This procedure insures that there are no loose connections that could fail once the unit leaves the factory.

After the outdoor unit passes the second leak test, a vacuum is pulled on the sealed system. While being attached to vacuum pumps, the units

are then covered and helium gas is introduced into the umbrella. A mass spectrometer is connected to the refrigerant circuit. This sensitive instrument is used to detect traces of this inert gas, which would represent a leak. Sensitive electronic leak detection tests are performed after the computer-assisted refrigerant charge is added. Then a random equipment audit is conducted at the end of the assembly area. Another random test is conducted by American Standard quality control personnel as an additional means of monitoring system validity.

And finally, as the unit is moved to the loading dock, a probe is inserted in a small hole at the bottom of each carton. If any trace of refrigerant is detected, the unit is returned to the assembly area. ■



Each unit gets its last leak test in the warehouse where the operator inserts a leak detector in a small hole in the unit carton. If a leak is found, the unit is sent back to be reworked.



Each brazed joint is carefully checked multiple times during the manufacturing process.

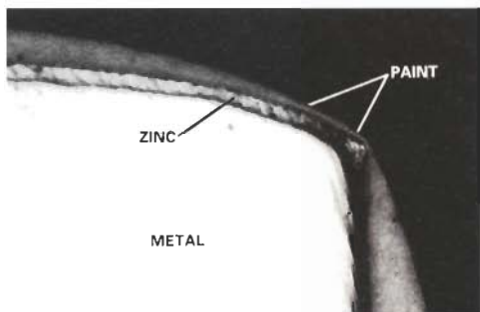


# The Really Big Finish.

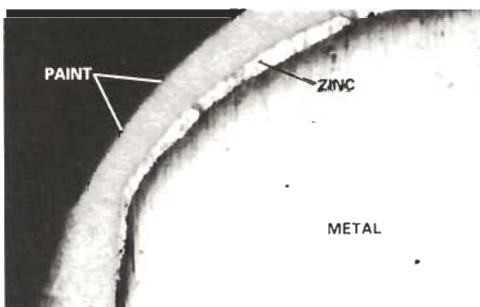
*When it comes to building in durability and reliability, American Standard pays attention to every detail, right down to the finish. Our high-gloss powder paint protects our products for years while giving them an appearance consumers love.*

## The premium paint coating in the industry.

One of American Standard's most recognizable features is high gloss



A louvered panel has been painted with liquid paint, cut in half, and magnified to show paint coverage. Because of surface tension, liquid paint recedes from the sheared edge.



With our powder paint process, an electrostatic charge builds at the edges of the metal drawing the powder to the sheared edge.

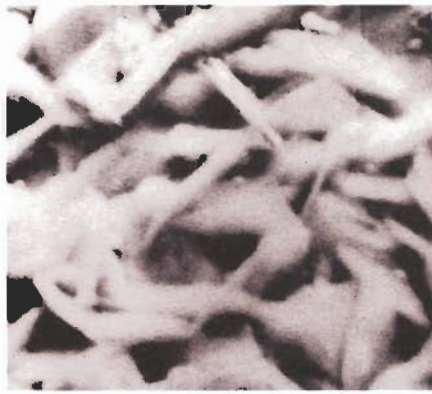
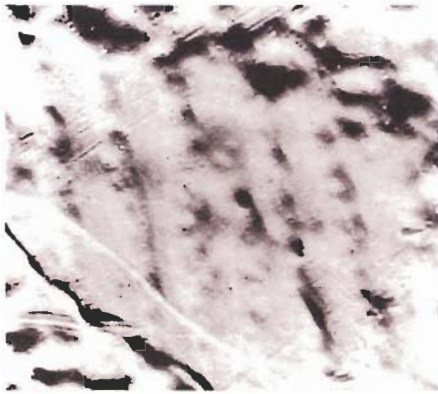
powder paint, the premium paint coating available in the industry today. It's particularly beneficial because ultraviolet light from the sun breaks the chemical bonds in most paints and results in chalking and fading. Powder paint resists the effects of ultraviolet light. The customer

who buys an American Standard unit today will have a unit that looks good ten years from now.

The electrostatic application of powder paint also gives excellent coating to sharp metal edges. Unlike liquid paint processes where the paint recedes from the edges, powder paint builds at the edges and forms a protective film to guard against corrosion. ■

## Winning the corrosion battle.

The powder paint story is really an anti-corrosion story. The quality begins with the metal itself. Untreated (non-stabilized) galvanized steel is used so it will accept American Standard's optimum paint pretreatment. Pre-treated steel can lose its zinc phosphate coating during forming and handling. By using untreated steel, we can apply the corrosion fighting zinc phosphate ourselves, ensuring that the entire part is coated after it is formed and handled. Incoming steel is subjected to galvanized stabilization tests to make sure it meets American Standard's quality standards. If the metal fails the test, it is sent back to the mill. ■



Far left: Under magnification, galvanized steel before pretreatment.  
At left: After pretreatment, the jagged edges of the zinc phosphate are very pronounced. This rough surface provides for good adhesion and thorough coating by the paint.

## How we pretreat.

An excellent paint is only as good as the pretreatment. All sheet metal to be painted goes through a six-stage pretreatment process which cleans and etches the steel, applies a zinc phosphate layer, and then seals the surface.

The zinc phosphate is present as microscopic crystals that completely cover the steel. This provides additional corrosion resistance and a jagged surface for better paint adhesion. ■

## Why powder paint?

When American Standard decided to stop using liquid paint for environmental and corrosion reasons, we began extensive testing of various paints and processes in side-by-side comparisons. Thermosetting powder was the clear winner. The combination of corrosion resistance, chalking resistance, appearance, and mechanical properties was superior to all other paint tests.

Paint must be able to cover sheet metal edges because breaks in the sacrificial zinc coating exist at these areas. Poor edge coverage is an invitation for corrosion and rust. Surface tension draws liquid paint away from sheared edges, punched holes, etc.

An electrostatic charge used during American Standard's powder paint application actually causes a build-up at those areas. This makes American Standard's powder paint more corrosion resistant than liquid paint used by the majority of other air conditioning manufacturers. ■



The Really Big Finish



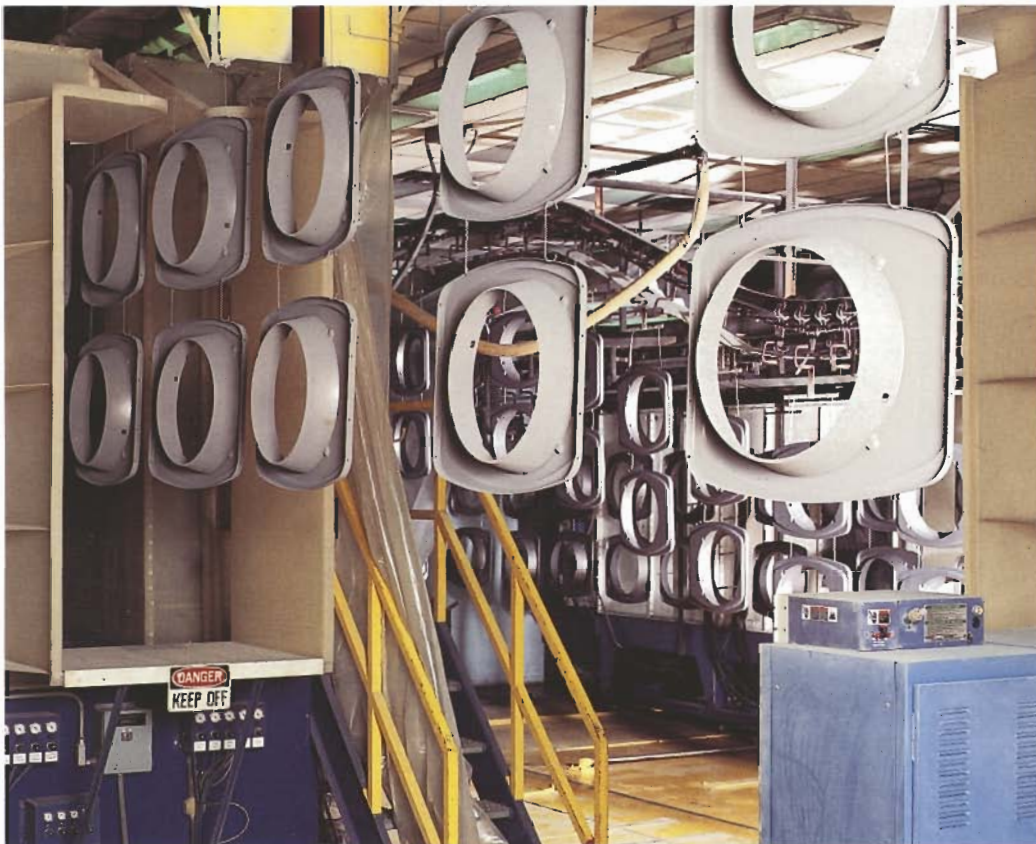
## A superior process.

After the powder is applied, the metal part is baked in a series of ovens where the heat produces superior chemical bonds in the paint. To ensure uniform quality, American Standard pays close attention to baking times and temperatures. After cooling, the result is the smooth, glass-like finish that consumers rated so highly in their list of expectations.

Most air conditioning manufacturers do not use full louvered panels to protect the coil. Wire mesh-type guards are normally used which do not offer the same level of protection as louvered steel panels.

Heavy gauge galvanized steel louvered panels are painted and used on all four sides of the unit to protect the coil against hail, lawn and gardening

equipment and children. American Standard doesn't just paint the top cover and basepan of the unit like many manufacturers. ■



In American Standard's powder paint facility, 90,000 volts are applied to the paint as it exits the gun. The paint gives up its electrons to the grounded metal resulting in a smooth finish.



Convertible package units and commercial condensers and air handlers now feature powder paint.

## The testing continues.

At American Standard we don't rest on our laurels. We have standards to maintain. That's why we continue to evaluate our powder paint process.



American Standard engineers test powder paint for impact resistance so the paint will stay intact even if the metal gets dented.

A two-pound sample of production powder is completely evaluated in the Materials and Processes Lab before

the powder can be released for production. Color is certified with each shipment. The powder is then applied to phosphated panels, baked, and evaluated for film thickness, hardness, adhesion, film flexibility and impact resistance.

Accelerated testing is performed in laboratory salt spray cabinets and in a weathering tester that simulates the damaging effects of ultraviolet light. Additional testing is conducted at severe environmental locations such as the Kure Beach National Test Site in North Carolina. ■



The Really  
Big Finish

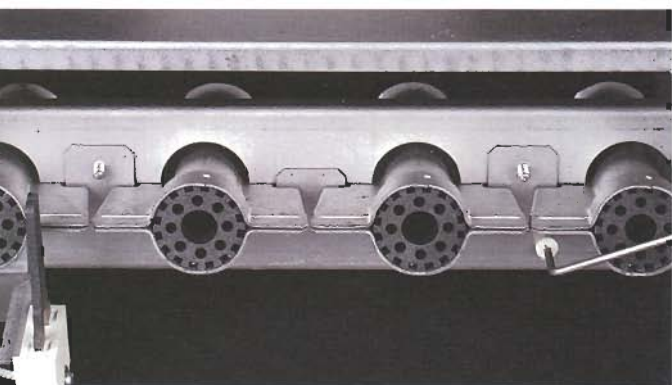


# Comfort by Design.

*American Standard furnaces and air handlers are intelligently designed to deliver maximum comfort with fuel-efficiency in mind. That's something all your customers can relate to.*

## The Freedom family.

The quality perception of American Standard's family of Freedom furnaces is quietly equaling its renowned outdoor products. With nearly 80 models introduced since 1992, the Freedom line of furnaces covers all markets with single and two-stage models, variable speed and direct vent options, convertible design and an easy-to-install size – all are designed in four industry standard cabinet widths and are only 40" tall.



American Standard's unique multi-port burner design is featured in all the Freedom furnaces. The design has been very popular with dealers as no air adjustment is required. At a fire rate of 20 MBTUH per burner versus 25 MBTUH for many other furnace designs, the burner design provides very quiet operation.

Freedom furnaces are perfect examples of well-balanced design. Every component is interrelated, every piece balanced to support the other. The overall design provides an integration of technology that puts this generation of furnaces in a whole new class.

American Standard furnaces were built for today's efficiency-minded consumers. They are quiet and cost less to operate. And, their temperature control is precise, delivering a higher level of comfort. ■

## Points of distinction.

The American Standard Freedom furnaces were designed with innovative technological touches throughout. Let's first take a look at the multi-port in-shot burners. A small, stingy orifice spreads the gas like a shower head mixing it with air for combustion by a unique hot surface ignitor. A second orifice with eight ports, arranged in a circle, shapes and directs the flame into the heat exchanger. A key design element is the heat exchanger with its serpentine-shaped channel.

An induction vent fan quietly pulls hot gases through the channel, as air flows over the heat exchanger. Because the heat exchanger is thinner, it offers less air resistance and lower pressure drops for system design.

That means less work for the blower motor, making it more efficient and reliable, and homeowners more comfortable. ■



American Standard's aluminized steel heat exchanger design was extensively field tested and had to pass a 10,000 cycle durability test before being used in Freedom furnaces.

## Precise control.

American Standard technology integrates key furnace control functions into one microelectronic system on all Freedom furnaces. The integrated furnace controller is an automatic ignition system which uses a microprocessor to continually monitor, analyze and regulate the proper operation of the gas burner, induced draft motor, and the indoor fan motor.

Continuous surveillance of the thermostat and the flame sensing element initiates the automatic ignition of the burner during normal operation.

The system's built-in microcomputer and on-board relays control the induced draft motor in the heating mode and indoor blower ON/OFF operation in the heating and cooling modes. This eliminates the need for an externally mounted induced draft motor relay, thermal fan switch, and indoor fan motor relay.

The safety fan/limit switch has been replaced with a thermal safety limit switch mounted between the heat exchanger cells. The fan relay and the induced draft motor relay are built into the controller.

A fixed, 45-second time delay controls the indoor blower motor operation in the heating cycle. When the controller senses the presence of the flame, the indoor blower ON time delay begins. Blower off timing is adjustable to 60, 100, 140 or 180 seconds by

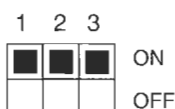
pre-setting the dip switches mounted on the control. This allows the dealer to customize the comfort level in the home or office.

The integrated furnace controls the built-in fan relay which in turn regulates the continuous fan and cooling fan speed operation. When continuous fan operation is selected at the thermostat, the system will activate low heating fan speed on two-stage models.

Cooling fan speed is activated by a call for cooling from the

thermostat. The controller has an optional cooling fan off delay of 80 seconds. This would be used to increase cooling system efficiency. (See dip switch setting illustration.) ■

### Dip Switch Settings



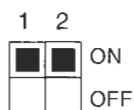
#### COOLING FAN OFF DELAY (SECONDS)

SWITCH 1 ON 0 - FACTORY SETTING  
(SWITCH 1 MUST BE ON. SEE MOTOR CONTROL BOARD FOR COOLING OFF DELAY SETTING.)

#### HEATING FAN OFF DELAY (SECONDS)

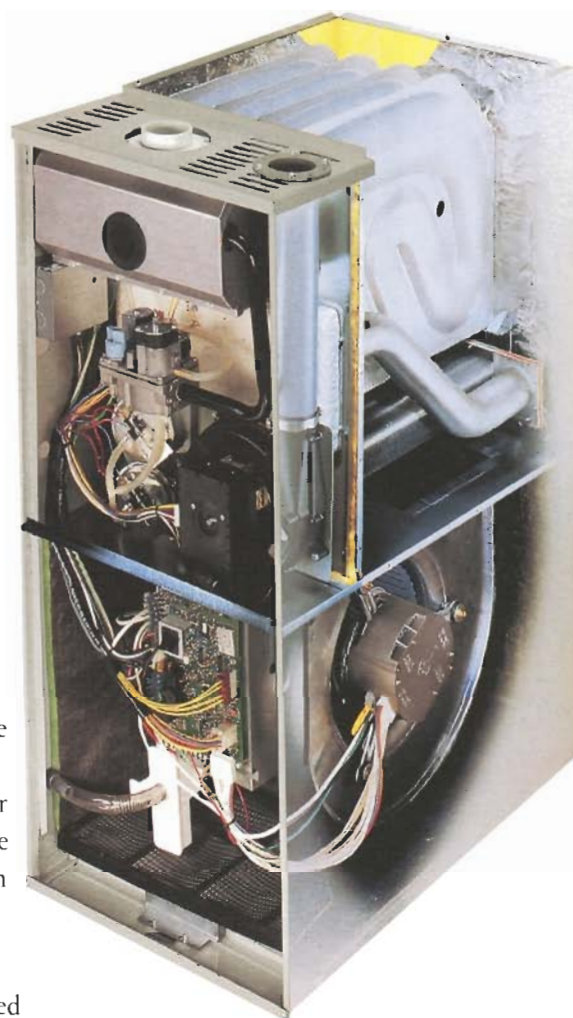
SWITCH 2	SWITCH 3	TIME
ON	OFF	60
ON	ON	100 - FACTORY SETTING
OFF	ON	140
OFF	OFF	180

### Freedom 90 VS Dip Switch Settings



#### HEATING FAN OFF DELAY (SECONDS)

SWITCH 1	SWITCH 2	TIME
ON	OFF	60
ON	ON	100 - FACTORY SETTING
OFF	ON	140
OFF	OFF	180



The two-stage, direct or non-direct vent variable speed Freedom 90 gas furnace offers the ultimate in reliability and durability with its variable speed draft inducer and silicon nitride igniter. It also offers the highest efficiency in our furnace family with AFUE's of 92% - 93%. The draft inducer also provides flexible application - with up to 200 feet of vent lengths in most variable speed 90 direct vent models.

Vent Table For Variable Speed 90  
Direct Vent Models

ALTITUDE	MAXIMUM TOTAL EQUIVALENT LENGTH (Feet)		
0 - 7,000 ft	2 inch	2.5 inch	3 inch
A*Y060	200	200	200
A*Y080	50	120	200
A*Y100	Not Allowed	60	200
A*Y120	Not Allowed	Not Allowed	200

\* Applicable to AUJ or ADY models

Comfort  
by Design





American Standard uses integral furnace controllers on all Freedom furnace models. The board pictured here is on the Variable Speed Freedom 80.

## Self-diagnostic and safety features.

In addition to providing comfort customization, the furnace controller provides complete diagnostics for easy servicing. The integrated furnace control also includes a system fault analysis for quick gas flow shutoff, coupled with an automatic ignition

retry after sensing a fault correction.

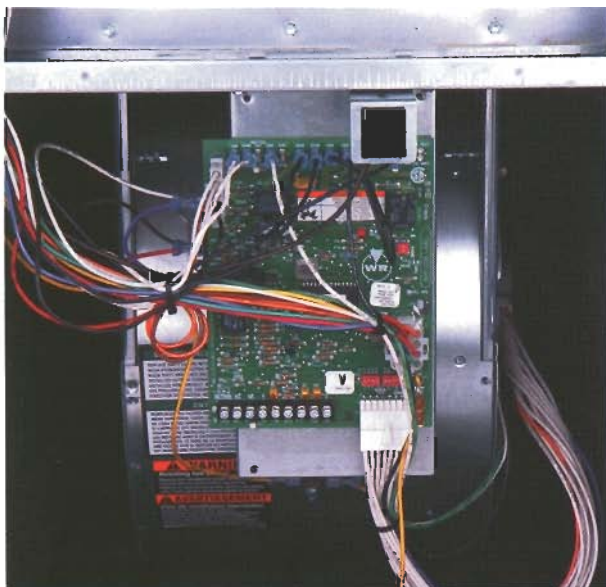
The controller, mounted in the blower section, may be viewed through a sight glass in the blower door panel to prevent resetting the control and loss of diagnostics. The controller tests for internal and external faults before allowing a heating sequence to begin.

The external check includes all safety devices and pressure switches, making certain that they are in their normally open or normally closed position. If a fault is detected by the control, it will immediately enter into a fault mode and flash the LED light according to the fault detected. The controller will remain in the fault mode until the problem is corrected. Once the fault is cleared, it will start the heating sequence as long as the call for heat still exists.

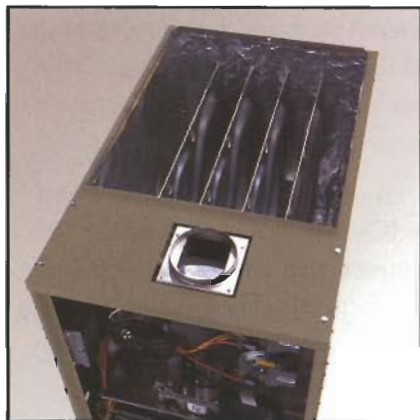
The controller has an expanded diagnostic feature on two stage models that monitors system performance. If a fault is detected during operation, the controller will de-energize the gas valve and flash the diagnostic LED according to the fault detected just like single-stage models. Then it will automatically reset a lock-out due to loss of flame every hour. This gives peace-of-mind to homeowners who may be away from their house for an extended time.

If at any time the high temperature limit (and/or aux. limit) or flame roll out switch(es) open, the gas valve will be de-energized and the indoor blower heat speed and induced draft motor will be energized. (Low heat fan and inducer on two-stage models.)

The board pictured here is on the Variable Speed Freedom 80.



Because American Standard's patented heat exchanger is thinner, it provides less pressure drop for the blower system. Less pressure drop allows American Standard to deliver airflow at higher static pressures.



If at any time a flame is sensed while the gas valve is de-energized, the indoor blower heat speed and induced draft motor will be energized in conjunction with the lockout. (Low heat fan and inducer on two-stage models.)

If during the start-up of a normal heating cycle, the safety pressure switch is closed prior to energizing the induced draft motor, the controller will wait for the pressure switch to open before starting the induced draft motor. If the wait exceeds five seconds, the controller will flash the LED three times until the switch opens. Once the switch opens, the LED will stop flashing and the induced draft motor will energize, continuing a normal cycle.

When system lockout occurs, the gas valve will be de-energized. The induced draft motor and indoor blower motor will be energized along with the diagnostic LED. The LED will flash two times with a two second pause continuously. ■

## Silicon Nitride Ignitor

All American Standard furnaces (except AUC/ADC models) feature a Silicon Nitride Ignitor for the ultimate in reliability.

Comprised of a rugged tungsten heater element sandwiched between silicon nitride ceramic insulators, the ignitor delivers dependable performance. Its ingenious design features an ignitor voltage rating lower than the line voltage to the furnace and a built-in learning process which reduces cycling.

When a call for heat is received, the control regulates the voltage supplied to the ignitor based on the line voltage it is reading. If the line voltage is high, power to the ignitor is reduced. During this learning process if the burners fail to ignite, a retry is initiated and the power to the ignitor is increased until the burners light. The result is a highly reliable ignition system and the longest possible service life.

## Ignition Control Flash Codes

FLASH RATE	AUY/ADY-R-V	AUC / ADC	AUD / ADD AUD / ADD-R AUD / ADD-R-V AUX / ADX
Slow Flash	Normal	Normal	Normal
Fast Flash	Normal/Call For Heat	Normal/Call For Heat	Normal/Call For Heat
2	Recycle/Retry Lockout	Recycle/Retry Lockout	Recycle/Retry Lockout
3	Inducer Error	Pressure Switch Error	Inducer Error
4	Open High Limit	Open High Limit	Open High Limit
5	Flame Sensed When No Flame Should Be Present	Flame Sensed When No Flame Should Be Present	Flame Sensed When No Flame Should Be Present
6	115 AC Power Reversed Or Improper Ground	115 AC Power Reversed Or Improper Ground	115 AC Power Reversed
7	Gas Valve Circuit Error	Gas Valve Circuit Error	Gas Valve Circuit Error
8		Low Flame Sense Signal	Low Flame Sense Signal
9			Check Ignitor Or Improper Ground Or Low Voltage





American Standard's two-stage Freedom 80 furnace. Access to the filter is shown below.



American Standard's variable speed products feature a controller that allows the installer to program in the right CFM by setting dip switches.



## Two-stage heating for ultimate comfort.

American Standard features two-stage heating options in both the Freedom 80 and 90 families. The two-stage Freedom models virtually eliminate short cycling and temperature swings associated with oversized single-stage models. Two-stage models typically run on first stage (65 percent of full capacity) over 95 percent of the time. This feature also helps eliminate heat stratification by gently moving warm air throughout the house. The furnace runs longer but ultimately uses less energy and operates quieter on first-stage operation.

Either single-stage or two-stage thermostats can be used. On single-stage thermostats, the furnace will automatically go to second stage (full capacity) after 10 minutes of operation if the thermostat is still calling for heat. ■

## Leading the way with variable speed technology.

American Standard offers the next generation of motor technology in the Freedom 80 and 90 two-stage variable speed furnaces. These variable speed products run quieter, make consumer's homes more comfortable and achieve energy savings like no other system. Compared to standard motors, the energy usage with an ICM (Integrally Controlled Motor) variable speed motor is like the difference between turning on one light and turning on 10 lights.

What's so different about an ICM motor? Well, standard motors

only have "off" and "on" speeds. When it's on, a standard motor will run at full capacity while using the maximum amount of energy. The ICM motor can automatically vary its speed between zero and maximum. It starts very quietly and slowly ramps up to the speed the installer has selected, using very little energy in the process.

And here's something else about the ICM motor – it's built to last. Its electronic controls are designed and manufactured to the strictest standards and its controllers are double epoxy sealed for added reliability.

American Standard uses the variable speed ICM motor in many other products as well, such as the TWE-E convertible air handlers, dual circuit air handlers, and the indoor blower motor on the five-ton "Y" and all "Z" package units. ■

## Easy installation. Strong performance. Quiet operation.

American Standard variable speed products automatically and continuously deliver the correct airflow during heating or cooling. All the installer has to do is set the proper switches on the motor controller. Static capabilities of up to 1.00 w.g. at nominal CFM are quite possible with these products. That back bedroom that can never get enough air; the kitchen that is always too hot; the living room that faces west; that noisy hallway installation – these comfort problems can be solved with American Standard's variable speed products. ■

## Comfort-R™ from A to Z with American Standard's variable speed products.

A standard system doesn't come on or turn off until the temperature has gone far past the thermostat setting. The result is the uncomfortable temperature and humidity swings that homeowners are familiar with. With American Standard's variable speed products, the Comfort-R mode of operation virtually eliminates this problem.

The Comfort-R program, selected by the installer, is set by turning on switches 5 and 6 on the motor controller. It takes the homeowner into an entirely new comfort zone – one that's so precise, it's imperceptible.

The Comfort-R process can be difficult to comprehend, much less to explain. A quick description: For cooling purposes, the ICM motor ramps up slowly, moving air slowly across the coil and giving the coil a chance to cool. The motor then ramps up to 80 percent, where it stays for 7.5 minutes. That way, it not only meets the comfort demands of the thermostat, but it also provides even greater humidity control – up to 24 gallons a day versus six gallons for a standard system. After satisfying the thermostat, the system slows down to 50 percent, where it operates for three additional minutes squeezing out every BTU.

With a heat pump in the heating mode, Comfort-R operates in much the same manner, producing a warmer air start-up.

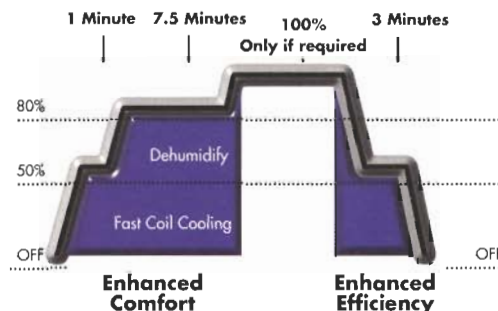
Now this might be confusing to the customer because the Comfort-R mode requires the unit to run longer. Don't let that throw you. It's important for the homeowner to understand that by running longer at a lower speed, the system is more efficient and delivers more comfort. It also offers significant energy savings.

In essence, what you are selling is a "managed system." That means managed comfort and savings for the homeowner. ■

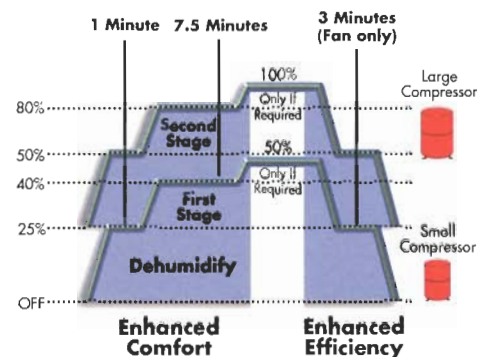
## The ultimate Comfort-R, two-stage compressor operation.

In addition to the high efficiencies and quiet sound levels delivered by the dual compressor Allegiance 16, Heritage 16, YCZ, and WCZ products, they provide unparalleled humidity control with their two-stage cooling operation and the Comfort-R enhanced mode. The two-stage cooling operation means that most of the time the unit will operate in low speed giving you increased energy savings and the benefits of greater humidity removal with longer runtimes and the Comfort-R mode of operation. During the hottest periods of the day, the unit switches to second stage operation providing maximum cooling, while still getting the benefits of Comfort-R. The same benefits apply to the Heritage 16 and the WCZ in heating operation. ■

### Comfort-R With Single Compressor/ American Standard System



### Comfort-R With Dual Compressor/ American Standard System (7A6, 6H6, YCZ, WCZ)



American Standard's unique Comfort-R feature provides improved dehumidification in cooling start-up and warmer air start-up in heating. This is accomplished by running the fan at a slower speed during start-up. A simple change to the blower control setting provides the enhanced comfort.

Comfort  
by Design



## Electronic air cleaner is a perfect fit.

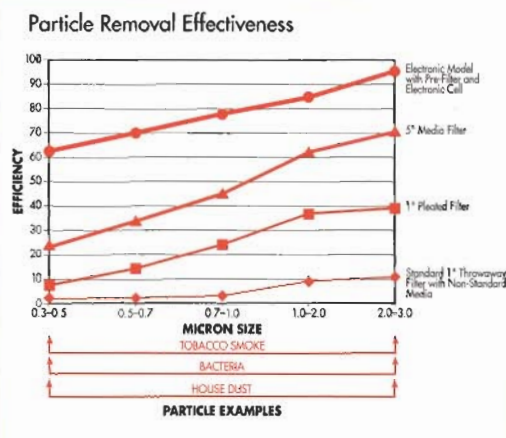
The perfect fit air cleaner is an American Standard exclusive. It fits American Standard furnaces and air handlers perfectly and is easy to install, saving the homeowner on installation costs.

Its Air-Tite™ construction provides lower operating costs and lessens the door whistling sound which is common to a lot of air cleaner installations.

The positive latch system and door handles make it easy to access the filters for cleaning or replacements.

Perfect fit air cleaners come in three different efficiency models:

1. **Good:** 1" pleated filter
  - Up to six times more effective than a standard throwaway filter.
2. **Better:** 5" media filter
  - Up to 15 times more effective than a standard throwaway filter.
- 3\* **Best:** Electronic model with pre-filter and electronic cell
  - Up to 40 times more effective than a standard throwaway filter.

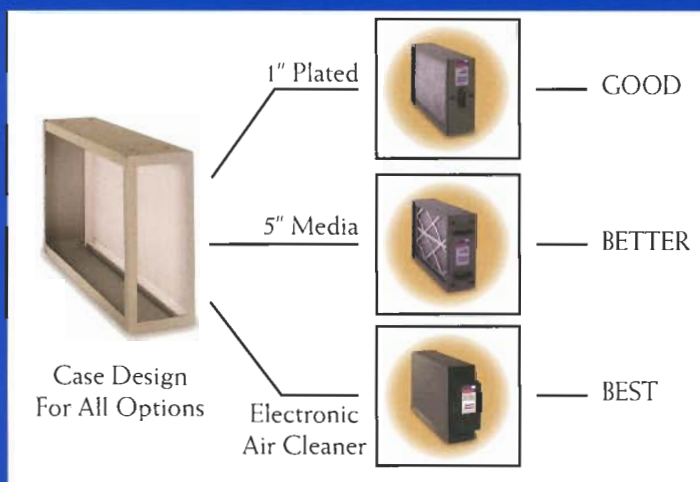


## Improved indoor air quality.

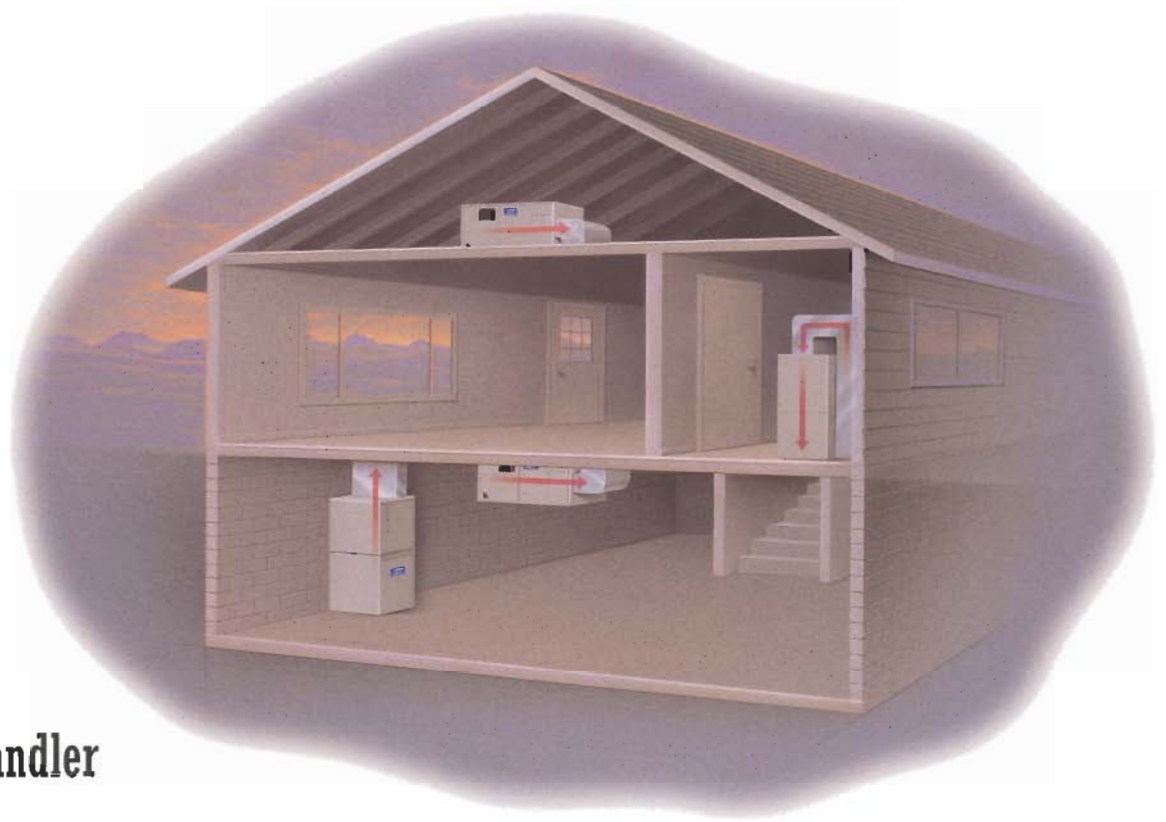
With continuous fan operation, two-stage variable speed Freedom furnaces and TWE-E air handlers offer additional benefits. For instance, with air cleaner operation, the fan should be operated continuously to take full advantage of its benefits. Consumers have failed to do this in the past because of the high utility costs associated with constant fan operation.

However, with the energy-saving variable speed motor on Freedom 80 or 90 variable speed models, continuous fan operation is a very economical proposition. In Chicago, for instance, a Freedom 80 variable speed furnace costs \$54.20 to circulate air in the winter versus \$411.30 for a traditional single-stage furnace.\* This makes electronic air cleaner operation very economical. Most homeowners who have installed variable speed American Standard products have noticed far less dust in the air and on their furniture because of the improved efficiency of their filter or air cleaner with continuous fan operation. ■

\*AUD080R9V3 vs. AUD080C936; 6732 run hours; 10¢ KWH



\*Dual filtration is the most effective filtering system for the ultimate in indoor air quality. The 1" filter captures large visible particles such as dust and lint. The electronic cells catch the non-visible particles that irritate the lung and discolor furniture. Together they offer the best in indoor air quality, especially when matched to a variable speed indoor product.



## One American Standard air handler for every job.

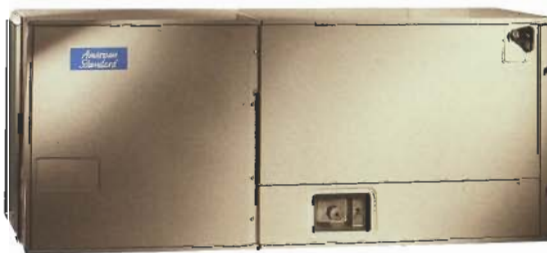
American Standard's TWE convertible air handler is designed to meet a variety of installation requirements. The unit's compact cabinet will fit in small places and it installs easily in a closet or crawl space. In fact, most models will slide right through a typical pull-down staircase.

Other features include recessed screws so they don't snag walls or door facings. And, an insulated cabinet that reduces heating and cooling losses and cabinet sweating, as well as reducing blower noise. In addition, all access panels are fully gasketed for increased efficiency and quieter operation on our "Air-Tite™" models. Plus, with an easily cleanable coil, it can stay clean over time, greatly improving indoor air quality. And, its Lexan "no leak" drain pan is not only rust resistant and cleanable, but is fully sloped to eliminate dirty standing water, another component in assuring a home's clean air.

The list of features continues with standard size filters for easy replacement, a galvanized steel cabinet for corrosion resistance, a multi-speed blower, which delivers more air with less noise, and an extra-large coil surface that provides higher efficiency and more heating and cooling capacity.

American Standard's TWE convertible air handlers deliver superior air flow, low sound levels, high performance and are built to last. ■

**Whether you need an upflow, downflow, vertical or horizontal installation, the TWE convertible air handler fits any need.**



American Standard also uses the variable speed motor in its TWE-E air handler, providing the ultimate in comfort and up to 17.35 SEER when matched with a Heritage 16 heat pump.



# Packaged Profits.

*Created from the same building blocks that have made American Standard's 10 SEER and 12 SEER convertible package units so popular, the 14 SEER and 16 SEER products have taken the market by storm with their ability to deliver the ultimate in comfort and energy savings of up to 65 percent. These products feature common cabinetry for the ultimate in product familiarization, installation and application flexibility, and inventory management of parts and accessories.*

## Big news in a single package.

With American Standard's full line of 10, 12, 14 and 16 SEER products, one-and-a-half through five ton, convertible package units, there's something for everyone – including cooling, gas electric, heat pump or dual fuel units. The YCY-G package gas/electric unit for instance, is the perfect solution in applications where indoor space is limited. Because cooling and air-handling functions are self-contained in a single compact package, the YCY-G is easy to install and service. You can flush mount it beside a home at ground level, or place it on the roof for horizontal or downflow installation by removing just two screws.

Then of course there's the WCZ single-package heat pump with self-contained heating, cooling and air-handling

functions. The WCZ features up to 15.6 SEER and HSPFs of up to 8.10, which is more than two-and-a-half times greater than electric heat (up to 3.4 COP). Its Demand Defrost System (see Intelligence in Action section) delivers defrost capabilities only when needed. It also features constant outdoor versus coil temperature monitoring and a crankcase heater for oil warming protection.

With the DCY dual fuel a homeowner gets the best of both worlds. The DCY offers all the advantages of a heat pump in its first stage of heating, then delivers AFUEs of 80+% in the second stage with gas heating – and it uses natural gas or propane. American Standard's dual fuel heating safety protection ensures that the unit will continue producing heat even if one source fails. The DCY is an excellent replacement product in L.P. markets as well as markets with utility drivers. ■



The YCY-G heat pump.



The DCY dual fuel heat pump and gas furnace.



The YCZ gas-electric.

## The leader of the pack.

American Standard's YCZ single-package gas heating and electric cooling unit and the WCZ single package heat pump unit have set an industry standard that competitors just can't match. Why are the YCZ and WCZ so far ahead of the pack? Just take a look at these attributes:



- Two-stage cooling for improved humidity control, added comfort and lower operating costs.
- Two-stage heating for added comfort and lower operating costs.
- Variable speed fan motor, saving energy and making it a quiet unit.
- Direct spark ignition that increases efficiency and enhances safety by eliminating the pilot.
- Two-stage variable speed blower that runs about 80 percent of the time at low speed for lower electricity costs and super quiet operation.
- Internally foil-faced insulated cabinet to reduce cooling losses and provide quieter operation.
- Duration compressor for years of reliable comfort backed by a 10-year limited warranty.
- 10-year limited warranty on the outdoor coil that's the best in the business.
- 20-year limited warranty on the YCZ heat exchanger.
- Comfort-R™ enhanced mode on the 14 and 16 SEER units provide unmatched indoor comfort.
- Coil protection the American Standard way... LEXAN COIL GUARDS.
- Sloped drain pan prevents water from standing which prevents the growth of mold, mildew and bacteria.

The YCZ also has the highest efficiency rating of any package unit in the industry with a SEER up to 16.05, followed by the WCZ with a SEER of up to 15.60. ■



## Winning the technology race in the small package market.

American Standard's Coil Sav'R™ Lexan coil guards not only look good, but protect the unit from hail, baseballs and lawn equipment.



It's important to note that American Standard has secured its place in the industry as a technology leader. You need only review the numerous

trademarked features to understand the innovative nature of American Standard's package products.

Among the exclusive features are the Coil Sav'R™ coil guard and protective fan grille with trim-ring, which not only look good, but also add extra protection from backyard hazards like lawn mowers, weed whackers and bats and balls. The exclusive Water-Shed™ no leak, one-piece basepan which provides unmatched water integrity. The Comfort-R™ enhanced comfort setting which provides faster coil cooling for improved humidity control as well as warmer air start up in heating. And the newest feature, the Acousti-Curb™ roof mounting curb which reduces sound in light commercial applications by up to seven times. ■

## A quiet new breakthrough.

American Standard's newest development in curb design significantly reduces the noise level of roof mounted single package units in much the same way that car manufacturers have dealt with eliminating road and engine noise in luxury cars. The Acousti-Curb roof mounting curb consists of two layers of sheet metal sandwiching a layer of polymer that acts as a sound-deadening material. These insulated deck pans are easy to install and yield amazing results. ■



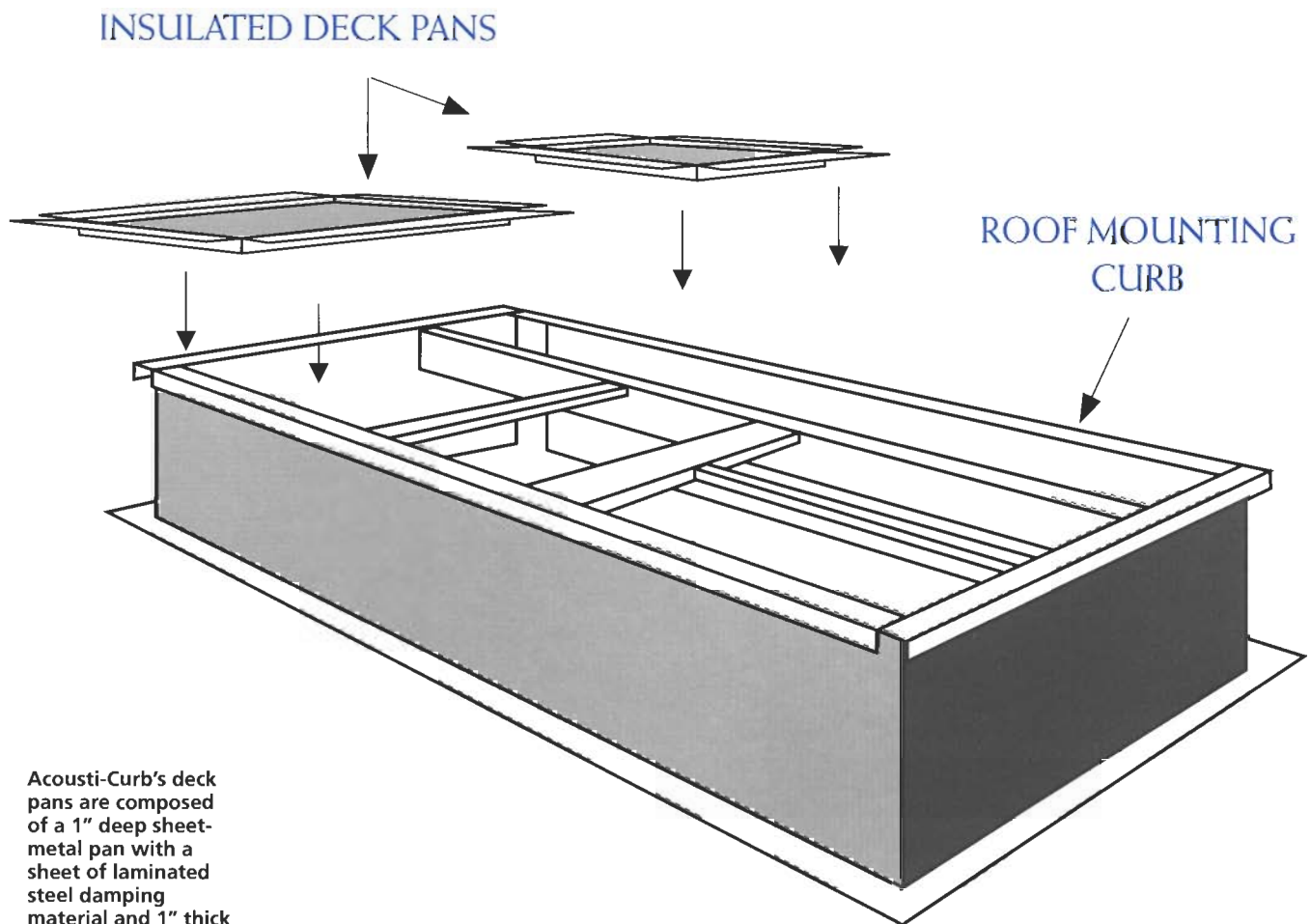
Most package units have temperature swings of 3 to 5 degrees before turning off. With 14 and 16 SEER units from American Standard, those days are long gone. The Comfort-R enhanced mode keeps the temperature closer to the homeowner's comfort zone.

# American Standard Acousti-Curb™

BAYCURB033A – FULL PERIMETER

BAYCURB034A – FULL PERIMETER

BAYCURB038A – UNIVERSAL



Acousti-Curb's deck pans are composed of a 1" deep sheet-metal pan with a sheet of laminated steel damping material and 1" thick fiberglass insulation glued on top of the laminated steel.

Acousti-Curbs have reduced sound levels by up to 7 times on actual applications.



# The Light Commercial Line-Up.

*American Standard has the most complete line of package units in the industry. The right size, the right features for every Light Commercial application.*

## Designed and built to meet your needs.

It's true. American Standard does offer the finest line-up of package units on the market today. We accomplished this by listening – to contractors who wanted a product that would save them money and help them win more jobs, and to engineers, who wanted a unit that would meet their criteria in design, quality, reliability, performance and special applications. We listened – and delivered.

We also deliver in the area of technology. American Standard was the first in the industry to use a microprocessor control system in its light commercial products. This technology gives us an even greater edge in providing the highest quality, reliability, comfort, service ease, and performance in our package units. ■



From top to bottom:  
YCD180 Gas/Electric;  
TCD090 Cooling;  
WCH090 Heat Pump.

## Building in quality and reliability.

Building a better quality, more reliable package unit means knowing what to put in – and what to leave out. So when we designed our line of light commercial products we left in the tried and true components. And we left out the parts that tend to cause failures and require service.

All in all, American Standard package units have as many as 42 percent fewer parts. Fewer screws, brackets and moving parts that can directly affect reliability and make maintenance and service both complicated and costly.

For the installing contractor, these improvements help reduce warranty callbacks. The contractor also saves money because he has fewer returns to the jobsite for service.

Here are a few of the features that give our products their reputation for quality and reliability:

### 1. *Dual compressors.*

The dual compressors in the 7 1/2-ton to 25-ton units are outstanding for humidity control, light load cooling conditions and system back-up applications.

## 2. *The microcontrol system.*

American Standard has been working with microprocessor controls for years. This experience is an integral part of the technology that is applied to all of our light commercial units.

The microprocessor prevents the unit from short cycling, considerably improving compressor life.

It also ensures that the compressor will run for a specific amount of time which allows oil to return for better lubrication, enhancing the reliability of the compressor.

And, a microcontrol system reduces the number of components required to operate the unit, thereby reducing possibilities for component failure.

## 3. *The drum and tube heat exchanger on gas/electric models.*

The drum and tube heat exchanger is designed for increased efficiency and reliability. The heat exchanger is manufactured using aluminized steel with stainless steel components for maximum durability. The requirement for cycle testing of heat exchangers is 10,000 cycles by ANSI Z21.47. American Standard requires this design to be tested to 2 1/2 times the current American National Standard Institute standard ANSI Z21.47. This standard is required by both UL and AGA for cycle test requirements. The drum and tube design has passed over 150,000 cycles which is more than 15 times the current ANSI cycling requirement.

A closer look at the heat exchanger shows that the negative pressure gas valve will not allow gas flow unless the combustion blower is operating.

Other attributes include the forced combustion blower which supplies pre-mixed fuel through a single stainless steel burner screen sending it into a sealed drum where ignition takes place. It is more reliable to operate and maintain than a multiple burner system.

The hot surface igniter is a gas ignition device which doubles as a safety device using a continuous test to prove the flame. The design is cycle tested at the factory for quality and reliability.

All American Standard package gas/electric units exceed all California seasonal efficiency requirements. They also perform better than required to meet California emission requirements.



**American Standard features scroll compressors on all 8 1/2 to 25-ton package units.**



**American Standard's drum and tube heat exchanger is used on YCD/YCH 3-25 ton gas/electrics.**



## Strict standards in testing.

### 4. *Weather-tight top and cabinet.*

American Standard 3 to 7 1/2-ton units have one single, continuous metal top for outstanding water integrity.



Quick-access panels (shown removed here) are designed to provide a water and air-tight seal.

And, all American Standard 8 1/2 to 25-ton units are outfitted with a tight top. Every part of the top overlaps in such a way that water cannot leak into the unit. These overlapped edges are gasketed and sealed to ensure advanced water integrity. Quick-access (3 to 7 1/2 tons) and Quick-access (8 1/2 to 25 tons) panels reduce the number of water entry points.

As added security, American Standard downflow units have a raised 1 1/8 inch lip around the supply and return in order to prevent water blowing into the ductwork in the event that water gets inside the unit. ■

American Standard tests its light commercial designs at the factory, not on its customers. All models are subjected to rigorous testing to make sure they measure up to the standards our customers have come to expect from us.

For example, the fan and new idler arm assembly designs have been tested to over 300,000 cycles each. American Standard's combined cycle testing is now over 7,000,000 cycles.

We also perform a 100 percent coil leak test at the factory. Both the evaporator coil and condenser coil are leak tested to 200 psig and pressure tested to 450 psig.

As a standard procedure, all parts are inspected at the point of final assembly. Substandard parts are identified immediately.

It's also imperative that each unit receive a 100 percent unit run test before leaving the production line to make sure it lives up to our rigorous standards.

Packaging is just as important to American Standard as manufacturing. We test ship our units around the country to determine the best packaging. Factory shake and drop tests are used as part of the package design process.

Rigging tests include lifting a unit into the air and letting it drop one foot to show how the lifting lugs and rails hold up under stress. ■

## Installation made easy.

Having a unit that's easy to install is an important benefit for contractors. It means less time on the job and, therefore, lower installation costs. American Standard's conversionless units provide many time and money-saving features to meet these requirements.

### 1. No job site conversion.

The dedicated design units are either downflow or horizontal and do not require panel removal or alteration time to convert in the field – a major cost savings during installation. Horizontal units come complete with duct flanges so the contractor does not have to field fabricate them. These factory installed duct flanges save time and money at the jobsite.

### 2. Microcontrol system.

The function of the micro-control system replaces the need for field installed anti-short cycle timers and time delay relays. The microprocessor ensures that these controls are integral to the unit. The contractor no longer has to purchase these controls as options and pay to install them.

### 3. Improved airflow.

U-shaped airflow allows for improved static capabilities. The need for high static motor conversion is almost non-existent, so time isn't spent changing to larger motors and pulleys.

### 4. Single-side access.

Nothing is easier to get into than an American Standard package unit. Access to all components is done through easy access panels. Just remove three screws or less on any service panel and you're inside the unit.

### 5. Easy access low voltage terminal board.

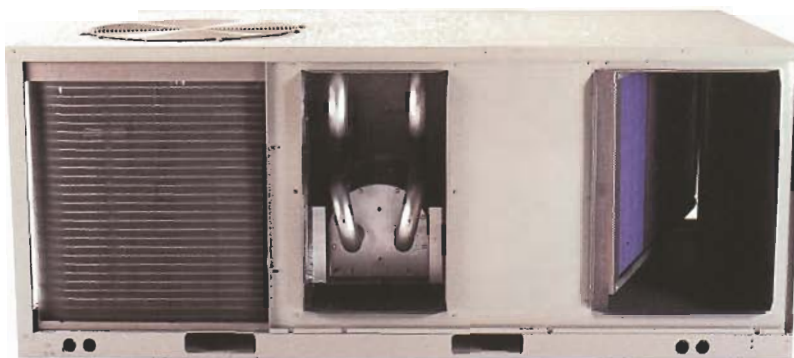
American Standard's low voltage terminal board is external to the electrical control cabinet. It's very easy to locate and attach the thermostat wires. This feature also saves time and money during installation.

### 6. The quick-adjust idler arm assembly.

American Standard's 8 1/2 to 20-ton models feature an idler pulley that provides quick adjustment for belt or motor sheaves. The contractor no longer has to adjust the motor to tighten the belt or change the motor sheave setting.

### 7. Single point power.

A single electrical connection powers all package units, 3 to 25 tons. ■



The dedicated design of American Standard commercial package units provides excellent airflow and easy installation by eliminating job-site conversions.



The quick-adjust idler arm saves both time and money by allowing the belt and sheaves to be adjusted without moving the mounted fan motor.



## The serviceability factor.

Today, owners are more conscious of the cost of service and maintenance than ever before. At American Standard we understand that, which is why we designed our package units with input from service contractors. Their information helped us produce a unit that would get the service person off the job quicker which, of course, saves the owner money. Here's how:

### 1. A simple design.

American Standard package units use up to 42 percent fewer parts than previous units. Fewer parts means a more reliable unit – and one that's easier to diagnose and service.



It doesn't get much easier than this. With single-side access, simply remove three screws or less and you're in the unit.

### 2. The microcontrol system.

A microcontrol system doesn't require any special tools to run a unit through its paces. Simply place a jumper between Test 1 and Test 2 on the low voltage terminal board and the unit will walk through its operational steps automatically.

The unit will automatically return control to the zone sensor after stepping through the test mode a single time, even if the jumper is left on the unit.

As long as the unit has power and the LED is lit, the micro-control system is operational. The light indicates that it is functioning properly.

### 3. Standardized components.

We've made certain that components are placed in the same location on all units. In other words, if you familiarize yourself with one then you're familiar with all 3 to 25 ton models.

For instance, one single microprocessor can fit all 3 to 25 ton package gas/electric cooling with electric heat, and heat pump models.



The microprocessor, clearly visible in the left hand side of the control box, is easily accessed through quick access service panels on all commercial package units.

This unit control module provides standardization of parts for the contractors.

And standardized parts allow contractors to stock fewer parts. And that means fewer dollars are tied up in inventory.

#### 4. *Single-side service.*

Single-side service is standard on all 3 to 25 ton units.

#### 5. *Quick-access panels (3 to 7 1/2 tons).*

Remove just one screw for access to the internal components – filters, wiring, motors and compressors.

#### 6. *Quick-access panels (8 1/2 to 25 tons).*

Remove just three screws or less for internal access.

#### 7. *Colored and numbered wiring.*

This feature provides an enormous savings in time and money spent tracing wires and diagnosing the unit.

#### 8. *The quick-adjust idler arm.*

On all 8 1/2 to 25 ton units, the belt and sheaves can be quickly adjusted without moving the mounted fan motor. This is done with the idler arm pulley. Quick-adjust is a major savings in time and money. ■



The blower compartment is also very accessible through the quick access panel on this YCH090.

Easy service access was a key driver for the design of American Standard commercial package units. For example, on all 8 1/2 to 25 ton units, the belt and sheaves can be quickly adjusted without moving the mounted fan motor.



## High performance and application flexibility.

American Standard light commercial units are built to meet the toughest job standards. Designed using input from consulting engineers, our products retain credibility in the field. Engineers want a unit that performs under the most rigorous conditions. And they want a unit that lives up to their customers' expectations after they give it their stamp of approval. Our package units easily accomplish this. Take a look:

### 1. *Capacity modulation.*

American Standard's gas/electric heating capabilities feature low, medium and high heat models. The 6 1/4 and 7 1/2 ton high heat models have two-stage gas heating. All 8 1/2 to 25 ton high and low heat gas/electrics have two-stage gas heating.

In cooling, the 3 to 6 1/4 ton units have a single compressor. The 7 1/2 ton units can be either single or dual compressor. The 8 1/2 to 25 ton units have dual compressors. Gas/electric and cooling with electric heat units feature scroll compressors.

The dual compressor models are outstanding for humidity control, light load cooling conditions and system back-up applications.

### 2. *Flexible applications.*

By having only five curbs, the actual tonnage required for the job can often be determined after the curb has been set.

And here's something else – airflow is outstanding. The u-shaped airflow provides high static capability and lower energy consumption. A new American Standard unit can replace an older unit with older ductwork and, in many cases, improve the level of comfort because of better air distribution.

### 3. *Microcontrol system.*

The microcontrol system has a built-in anti-short-cycle timer, a time delay relay and minimum ON time controls. These controls are functions of the microprocessor and are factory tested to assure proper operation.

One of the benefits of the micro-control system is that it softens electrical spikes by staging on fans, compressors and heaters.

Another is the intelligent fallback or adaptive control. If a component goes astray, the unit will continue to operate at a predetermined temperature set point. (See UPC Default Chart on page 58.)

In fact, intelligent anticipation is a standard feature of the microcontrol system. It functions constantly as the system and zone sensor work together in harmony to provide tighter comfort control than conventional electromechanical thermostats.

#### *4. Low ambient cooling evaporator defrost control function.*

The evaporator defrost control function provides standard low ambient cooling down to 0°F. At this temperature equipment is capable of providing approximately 60 percent of the mechanical cooling capacity. During low ambient operation, compressor run time is counted and accumulated by the unitary control processor. Low ambient operation is defined as 55°F for single condenser fan units (3 - 10 ton) and 40°F for dual condenser fan units (12 1/2 ton to 25 ton).

When the accumulated compressor run time reaches approximately 10 minutes, an evaporator defrost cycle is initiated. An evaporator defrost cycle lasts approximately three minutes which matches the compressor three minute minimum OFF time.

When an evaporator defrost cycle occurs the compressors are turned off

and the indoor fan motor continues to run. After completing an evaporator defrost cycle the unit returns to normal operation and the compressor run time counter is reset to zero. Economizer operation is not affected by an evaporator defrost cycle.

#### *5. Power exhaust option.*

This option is available on the 6 1/4 to 25 ton downflow units. It provides up to 75 percent exhaust of return air when using a downflow economizer.

#### *6. Downflow and horizontal economizer controls.*

The economizers come with three options for controls – dry bulb, reference enthalpy and comparative enthalpy.

*(Continued on page 56)*





American Standard's commercial package units have economizer accessories that can be applied in either (1) dry bulb mode (2) reference enthalpy mode (3) comparative enthalpy mode. Pictured is a TCH090 with economizer in place and quick-access panels removed.

### *7. Dry bulb economizer cooling operation.*

The standard economizer dry bulb change over temperature is field selectable to outdoor temperatures of 55, 60 and 65 degrees F.

The economizer option allows cooling with outdoor air when its temperature is below 60° ( $\pm 2^\circ$ ) F (factory setting). This air is drawn into the unit through modulating dampers. The unitary control processor signals the economizer actuator to open/close the damper(s) from minimum position to full open, cooling the space to 1.5°F below the cooling set-point. If the supply air sensor senses that the supply air is too cold, the dampers modulate closed until the supply air temperature rises, or until dampers close to their minimum position.

The economizer allows fully integrated cooling operation. In extreme cooling requirement periods, the compressor(s) can operate in conjunction with the economizer if needed to satisfy cooling setpoint. The three minute delay evaluates if the temperature is dropping faster than acceptable and will energize the compressor as needed to maintain adequate zone control.

If a power exhaust accessory is present, the power exhaust fan motor is energized whenever the economizer damper is at a position greater than 25 percent of the actuator stroke.

During simultaneous economizing and mechanical compressor cooling, the UCP continues to modulate the economizer actuator to keep the supply air temperature in the 45 - 55°F range.

### *8. Reference enthalpy economizer cooling operation.*

Reference enthalpy is accomplished by using the outdoor humidity sensor along with the economizer option. The reference enthalpy is field selectable to one of four standard enthalpies.

Reference enthalpy is similar to single enthalpy control. If the outdoor air enthalpy is greater than the selected reference enthalpy, the economizer will not operate and the damper will not open past the minimum position setting.

If the outdoor air enthalpy is less than the reference enthalpy, the dampers will modulate to maintain a 45° to 55°F supply air temperature, cooling the space to 1.5°F below the zone temperature set point.

With reference enthalpy control, no economizer operation is allowed if the outdoor air temperature is above 75°F.

If the outdoor humidity sensor or the unitary economizer module's input for this sensor were to fail, the economizer will operate using dry bulb economizer cooling operation.

#### *9. Comparative enthalpy economizer cooling operation.*

Comparative enthalpy is accomplished by using a kit containing the outdoor humidity sensor, the return air humidity sensor and the return air sensor along with the economizer option.

Comparative enthalpy is similar to differential enthalpy which is used in electromechanical units. If the outdoor air enthalpy is greater than the return air enthalpy, the economizer will not operate and the damper will not open past the minimum position setting. The economizer will not operate at outdoor air temperatures above 75°F.

If the outdoor air enthalpy is less than the return air enthalpy, the dampers will modulate to maintain a 45° to 55°F supply air temperature,

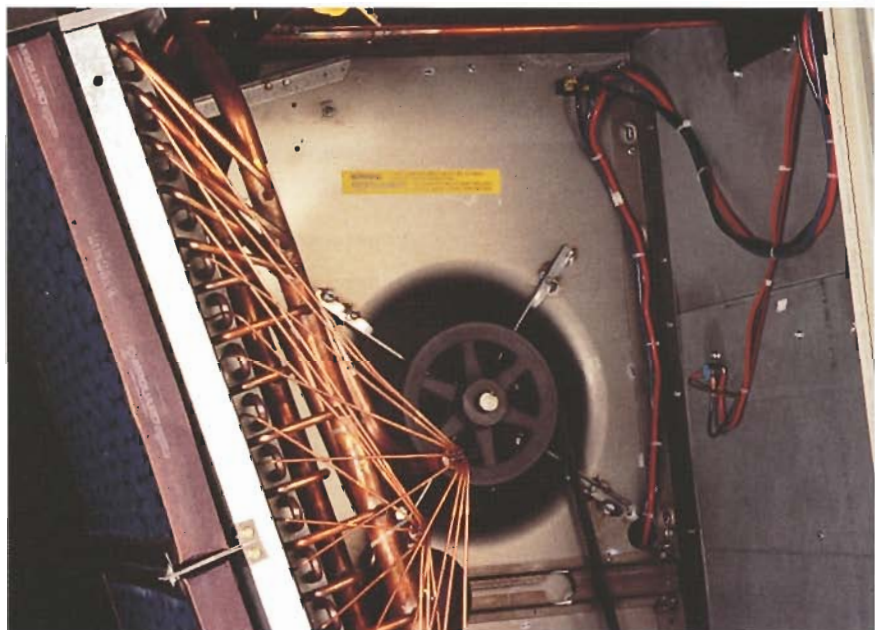
cooling the space to 1.5°F below the zone temperature set point.

If the return humidity sensor or the return air sensor, or both fails, the economizer will use reference enthalpy.

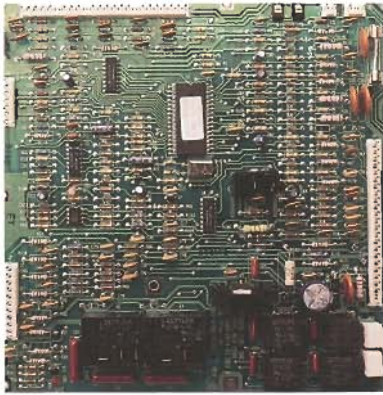
#### *10. Roof Curbs.*

Available for downflow units. ■

American Standard's commercial package units feature molex plugs for easy economizer installation. The unitary economizer module allows communication to be established once the polarized plastic plug on the economizer wiring harness is attached to the receptacle plug in the unit.







American Standard's use of microprocessor controls in the commercial equipment market is revolutionary. The application of this technology greatly reduces the number of components needed to operate a specific unit, reducing the possibilities of component failure.

## The benefits of microelectronics.

American Standard light commercial products were the first in the industry to use a microprocessor control system. This innovative technology increases product reliability and ease of service through the use of electronics. Microelectronics are particularly beneficial because they allow a manufacturer to build more functions and features into any given product.

They also provide superior space temperature control. Proportional/integral control provides the best possible comfort

level by watching and logging into the microprocessor the temperature of rooms over time.

Microcontrols also eliminate the need for additional accessories. Several time delay and equipment protection functions have been incorporated into the logic of the microcontrols, ultimately optimizing system operation.

Since equipment protection and time delays are integral functions in the microcontrol system, there are fewer components to fail and fewer to replace.

The microcontrol system also includes a built in test mode and on board diagnostics to aid in trouble-shooting. No special service tools are required.

### *Unitary Control Processor Default Chart*

Component or Function	Default Operation
Cooling Setpoint (CSP)	74°
Heating Setpoint (HSP)	71°
Economizer	Normal Operation
Economizer Minimum Position	Normal Operation
Mode	Normal operation, or auto if ZSM mode switch has failed
Fan	Normal operation, or continuous if fan mode switch on ZSM has failed
Night Setback Mode	Disabled

Note: This equipment can operate without a zone sensor mode on a temporary basis. Economizer, condenser fan cycling, and evaporator defrost functions are disabled. Evaporator will freeze during low ambient cooling.

If the unitary control processor (UCP) loses input from the zone sensor module's heating and cooling setpoint (slide potentiometers), the UCP will control in the default mode instantaneously. The temperature sensing thermistor in the zone sensor module is the **ONLY** component required for the default mode to operate.

### *A feature-rich microcontrol system.*

1. Low ambient start time function. Bypasses low pressure controls (20 and 25 ton units only) for three minutes when a compressor starts.

2. Anti-short cycle timer function. Compressor operation is programmed for three minutes of minimum ON time, and three minutes of minimum OFF time. This feature enhances compressor reliability and ensures proper oil return.

3. Delay between stages timer function. When combined with a standard zone sensor module, the unitary control processor provides a 90 second minimum ON delay for compressor staging.

4. Built in fan delay relay function. When the fan mode switch on the zone sensor module is set in the auto position, the unitary control processor provides individual supply fan timing sequences for each system in heating and cooling. The unitary control processor provides different timing sequences for heat pumps, gas electrics, and cooling only units. All three systems use the same unitary control processor.

5. Low ambient cooling to 0° F, with built in evaporator defrost control function. Utilizes time and temperature instead of temperature alone.

6. Built in electric heat staging. This feature provides a 90 second ON delay between resistance heat stages.

7. Compressor cycle rate minimization. Minimizes damaging compressor in rush current and guards against short cycling which ultimately extends compressor life expectancy.

8. The built in heat pump "smart recovery" feature. If the heat produced by the compressor(s) is making a recovery toward set point at a rate of at least 6°F per hour, the electric heat is not turned on. A nine minute stage-up delay allows time for recovery to begin.

9. Built in "soft start" feature. When a heat pump defrost cycle is terminating, the outdoor motors are turned on for five seconds before de-energizing the switchover valves. Soft start provides a smooth transition back to mechanical heating operation, minimizes noise associated with switchover valve operation, and greatly reduces stress on compressors associated with high pressure differential during defrost.

*(Microcontrol system features  
continued on page 60)*

## Microelectronic component definitions.

### *Unitary Control Processor (UCP).*

The computer and program reside in this component, which is the heart of the system. The typical, basic stand alone system will include the unitary control processor and a zone sensor module.

### *Zone Sensor Module (ZSM).*

An accessory component which replaces a thermostat. It provides operator interface and the zone temperature sensor for the UCP. A complete line of ZSMs are available with various combinations of features. Each system requires a ZSM unless a CTI is used.

### *Unitary Economizer Module (UEM).*

A standard component on the economizer accessory. This module provides the hardware necessary to connect the economizer accessory to the UCP.

### *Defrost Module (DFM).*

A standard component on 10 - 20 ton heat pump models which provides the temperature input to the UCP for the time and temperature defrost function. The DFM plugs into the UEM when an economizer is present.

### *Conventional Thermostat Interface (CTI).*

A field installed accessory component. This module can be used in special applications that require the installation of select electromechanical thermostats to interface with the UCP instead of using a ZSM. When generic building automation systems are used, then the CTI is required to allow the micro to communicate with the automation system.

10. Demand defrost (3 - 7 1/2 ton only). This measures heat pump outdoor ambient temperature with an outdoor air sensor located near the outdoor coil. A second sensor located on the outdoor coil is used to measure the coil temperature. The difference between the ambient and the colder coil temperature is the delta-T measurement. This measurement is representative of the operating state and relative capacity of the heat pump system. By measuring the change in delta-T, the need for defrost can be determined. The coil temperature sensor also serves to sense outdoor coil temperature for termination of the defrost cycle.

11. Economizer preferred cooling. Under extreme low ambient cooling conditions, the compressor(s) can operate in conjunction with the economizer if actually needed. A three minute delay evaluates and verifies that the zone temperature is dropping faster than acceptable. If so, the compressor will be able to hold the zone temperature.

12. Free night setback. A feature that allows the unit to enter an unoccupied mode by simply shorting across terminals 11 and 12 on the low voltage terminal board. The short can

be achieved by a set of dry contacts or a time clock. Once this short has been made the unit will shut off the economizer, go from continuous fan to auto fan operation, and set the temperature in the space back or up by a minimum of 7°F. For example, if you had your cooling set point at 74°F, then in the unoccupied mode the unit will be cooling to a minimum of 81°F.

13. Low pressure cutouts. This feature has been added to all compressors to insure compressor reliability in a low refrigerant situation. The compressor will lockout after four consecutive low pressure control trips. The lockout will have to be manually reset. ■



# A Look Back.

Now that you've experienced American Standard technology from the inside out we thought you'd like to know a little bit more about where we came from, and how the company became known for the kind of innovative thinking you've seen on the previous pages.

The fact is, most people already know our name. Whether it's through heating and cooling systems or bathroom faucets, American Standard is a familiar name in nearly every home or office in the country. And it's been that way for 115 years.

We've been finding better ways to do things since the 1880s when we first developed steam boilers and cast iron radiators. If it hadn't been for American Standard, folks might still be getting hot water from one spigot and cold water from another.

We've grown quite a bit over the years, and today American Standard is a global company with four major business groups. You've just read about our heating and air conditioning products and you're probably already intimately acquainted with our bathroom fixtures. Transportation is the third area. We don't make airplanes or automobiles, but the brakes manufactured by our WABCO division can stop a speeding 18 wheeler on a dime. Our medical systems group is working on dialysis technology for the 21st century. Pretty impressive, huh? But then what would you expect from a company that pioneered both atomic energy and the low-flush toilet? ■



## AMERICAN STANDARD A LONG, PROUD HERITAGE

AMERICAN RADIATOR COMPANY  
(Late 1800's)



AMERICAN RADIATOR & Standard  
CORPORATION  
NEW YORK PITTSBURGH

(1929 - 1949)



AMERICAN-Standard  
PLUMBING AND HEATING DIVISION  
AMERICAN RADIATOR & STANDARD SANITARY CORPORATION

(1950 - 1968)

AMERICAN  
STANDARD

(1969 - 1979)

*American  
Standard*

(Plumbing Products 1979 - )

AMERICAN  
STANDARD

(Air Conditioning Products  
1988 - 1997)

*American  
Standard* *American  
Standard*

(Heating & Air  
Conditioning)

(Plumbing  
Products)

(1998 - The Brand For  
The American Home)



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Standard*

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CONDITIONING

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Troup Highway  
Tyler, Texas 75711-9010  
<http://www.amstd-comfort.com>

Pub. No. 14-4011-03