Quality, Reliability and Safety

Carrier®

Turn to the Experts.℠

Standards and Testing Ensure Reliable Performance

THE CRAFTSMANSHIP OF HEATING AND COOLING

At Carrier, we work hard to provide you with the most reliable and efficient indoor comfort equipment possible to make your life easier. From our engineers and technicians to our hard working manufacturing personnel, we work together so that your customers can enjoy comfort from the most worry-free equipment on the market.

From the first phases of development to the finished product, Carrier's extensive testing guarantees that each product meets our strict requirements for quality. Our assembly line testing includes the most rigid testing in the industry. We set our standards high because we understand that homeowners everywhere depend on you to keep their families comfortable.

With more than 105,000 square feet of engineering and reliability testing facilities, 135 engineers and technicians in Indianapolis, Carrier is serious about product development and testing. In addition, Carrier's in-house reliability testing facilities occupy more than 12,000 square feet. Finally, outside testing and field testing take place year-round in various locations across the country. This effort helps make Carrier products the most reliable in the industry.

STANDARDS AND TESTING FOR SPLIT SYSTEMS

A LOT GOES INTO A CARRIER UNIT BEFORE IT EVER ROLLS OUT

Today, a new Carrier split system design will undergo more than 60 tests and verification procedures before it goes into full production. During production, 34 additional tests and checks are performed, with more than 20 of these being performed on every single unit, not just on random samples.

ISO REGISTRATION

Carrier's Collierville, Tennessee factory for split systems and the engineering facility in Indianapolis, Indiana are ISO 9001 registered. This means that Carrier meets or exceeds the requirements of ISO 9001 in the design, development, production, installation and servicing of all its split system products.

In-house reliability testing for *residential products occupies more than 12,000 square feet.*

COMPONENT TESTING

More important than its impact on Carrier's reputation, every unit that is installed has a bearing on your reputation as a dealer. If indoor comfort equipment fails or performs improperly, homeowners don't want to hear that it's because a part built by an outside supplier is inferior. Ultimately, every part in that unit reflects on you. Outside component suppliers are required to test their own products in accordance with strict Carrier requirements before they are ever approved for use in a Carrier unit. Though these tests are not required by regulatory agencies, they enable Carrier to discover and prevent potential reliability problems caused by faulty components before the end product ever makes it into the field.

In addition to these component qualifications, the final products are put through abusive tests in the Carrier laboratory. Testing is designed to subject these units to more extreme conditions than those they will ever face in actual operation.

CORROSION TESTING

Carrier spends significant time qualifying its materials for corrosion resistance. It doesn't really matter how good the internal components perform if the cabinet cannot withstand the environmental elements. Because the American Society for Testing and Materials (ASTM) is accepted world wide, Carrier uses their test methods of continuous salt fog and prohesion testing. These two accelerated test methods are extremely brutal on the unit. These tests have been instrumental in developing units specifically designed for harsh coastal conditions.

COMPRESSOR TESTING

Since the compressor is the single most important component in any air conditioning or heat pump system, it undergoes the most thorough testing. Before a compressor is approved for use in a Carrier unit, it undergoes a variety of rigorous qualification tests, in addition to those normally required by certification agencies, such as ARI, UL, and ETL. Some of these tests include the following:

Residential engineering test labs at Indianapolis occupy 105,000 *square feet and employ 135 engineers and technicians.*

***Carrier units undergo** some of the worst abuse during shipping. That is why units are tested on the shake and impact table, individual units are tested to make sure vibrations do not loosen or damage parts.*

Extreme High Ambient Test - This test is performed at 125° F outdoor temperatures, under conditions of maximum indoor air delivery and reduced voltage. This goes beyond the industry standard which is the ARI maximum load test
of 115° F.

Continuous Floodback Test - This test simulates floodback conditions that can result from overcharging and/or dirty filters in field installations. Compressors are subjected to continuous floodback under extreme conditions to ensure that acceptable discharge and sump temperatures are maintained.

Oil Pumpout / Return Test - This test is run to ensure that compressor oil levels do not drop below acceptable minimums, especially during flooded start conditions. This ensures that all moving parts within the compressor are properly lubricated for long life.

Defrost System Test - Carrier's snow/ ice/ freezing rain rooms permit defrost systems to be qualified under conditions as severe as any that will ever be experienced in actual service.

Carrier also submits system application test data to compressor suppliers for certification. This ensures that compressor performance characteristics are appropriate for Carrier's intended design and application. This action goes beyond any approvals routinely required by the independent compressor manufacturers.

ADDITIONAL COMPONENT TESTING

Other components are also subjected to retesting before use in Carrier products. For example, fan blades are tested for balance, shape, stress endurance, corrosion resistance and elimination of damaging natural operating frequencies. Contactors are also tested for 200,000 cycles, which roughly equates to 20 years of trouble-free operation.

SYSTEM DEVELOPMENT AND TESTING STAGES

Of course, testing individual components is not enough. Designing a new unit requires all the parts and materials that comprise the unit to operate as a system to achieve reliability and performance goals. At Carrier, the design of a new unit involves five stages:

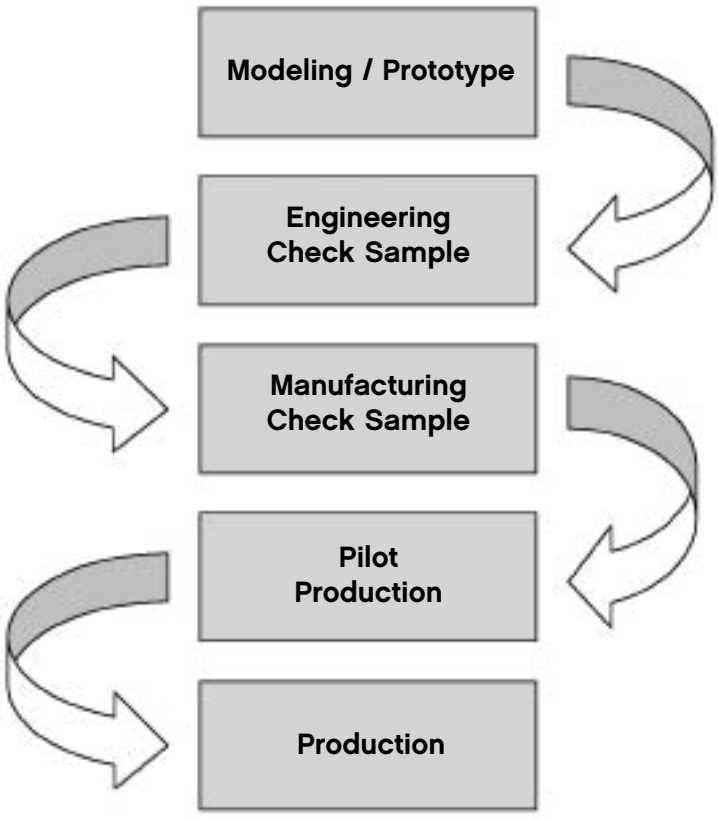
Modeling / Prototype - A computer model is generated using the latest test data to determine system capacity and efficiency performance and design. A unit is then built in the model shop. The prototype is subjected to a series of tests to determine whether or not its performance meets anticipated objectives. Often, this prototype will be refined and retested until the engineers are satisfied with its performance.

Engineering Check Sample - Next, another unit is built based on the engineer's specifications. The purpose is to make sure that the plans work: that holes in joining parts line up, that parts fit together in "real life" the way they do on paper.

Manufacturing Check Sample - At this stage, a sample quantity of the units are built at the factory for the purpose of checking the tooling and processes needed to manufacture the product. This is to ensure that all of the necessary equipment produces parts to the engineering specifications and that unit assembly and testing conforms to all requirements. Any adjustments to equipment or processes are made prior to production.

Pilot Production - This is the first build of the product on the actual assembly line. This small production run is a final check of the facilities' readiness to produce the products before they are considered production ready. All of manufacturing's fabrication, assembly, quality and testing procedures are closely monitored during the pilot run. The results are presented to a review board for approval before products are given the green light to proceed to full production.

Production - As units are assembled and roll off the line, they are subjected to systematic checks and testing. Extensive tests are performed on two or three random samples per hour, while many other performance tests are performed on each and every unit.



BUILDING IN AND MAINTAINING QUALITY

During the first four stages of new product development, testing procedures are used to develop a high-quality, reliable product. The tests run during the last stage ensure that quality is consistently maintained. Some of these tests are standard among

all split system manufacturers; they are mandatory for DOE, ARI and UL certification. However, others are self-imposed by Carrier, and are the result of years of expert field experiences. Following is a brief description of the standard tests and those additional tests voluntarily run by Carrier prior to full production.

MANDATORY ENGINEERING AND DESIGN TESTS

Department of Energy (DOE) Cooling Series - These tests measure capacity and efficiency in various load conditions. These tests must be repeated on at least two units to establish statistical reliability. Carrier typically runs the tests on at least three units to verify performance. The tested unit information is statistically averaged to ensure each unit meets the performance design.

Underwriters' Laboratories (UL) Temperature and Pressure Test - Each unit is run-tested for a minimum of 1-1/2 hours at 104° F outdoor temperature, 80° F indoor temperature at 47% relative humidity, 208 and 240 volts, at the rated airflow.

Carrier units are sound tested in accordance with ARI Standard 270.

Fan Blade Test - In addition to the component retesting, fan blades undergo further testing once they are assembled into the test unit. During a 20 million-cycle test, the fan blade frequencies are monitored to ensure vibration-free operation. Sound levels and rivet stress levels are measured as well. After the test, the blades are also physically examined for cracks or other damage.

***New split-system units are tested for proper defrost during simulated** ice conditions. Ice cold water is sprayed onto the coil to form a 1/4"-1/2" layer of ice. To pass the test, the coil must be cleared and terminate defrost by temperature.*

Carrier units are sound tested in accordance with ARI Standard 270.

Safe Transit Tests - Before a split system is ever exposed to harsh climate conditions, it goes through the cruel treatment of shipping. Carrier units and their packaging are tested to withstand the worst abuse. First, an individual unit is vibrated at four different peak movement conditions. Then boxed units are stacked on a "shake" table that simulates railroad freight car movement. They are shake tested, rotated 180° and shake tested again. These stacked boxes are then subjected to random vibrations that simulate over-the-road truck shipping. Finally, boxed test units are slammed into a wall to simulate rough handling. After each test, the units are examined both internally and externally for damage. The units must look new with no indication of product damage in order to pass this test.

Vibration Testing - All unit designs are tested with a variable frequency generator. This process identifies any naturally occurring resonances that may cause damaging tube vibrations during shipping or noisy operation once installed and running.

ADDITIONAL MANDATORY TESTS FOR HEAT PUMPS ONLY

Department of Energy Heating Series - Additional performance tests are run to determine the performance of the system in the heating mode at various load conditions.

UL Abnormal Tests - Tests are performed with a restricted inlet, a blocked outlet and an indoor fan failure.

ARI Maximum Operating Conditions - This test verifies system performance for one hour under high outdoor temperatures, high indoor temperature heat requirements, and 450 CFM/ton airflow conditions.

VOLUNTARY AND EXCLUSIVE CARRIER ENGINEERING AND DESIGN TESTING

Low Voltage Start Test - Carrier units are tested in outdoor and indoor conditions at voltages lower than standard test minimums. This test simulates unit start-up after a prolonged off-time in extremely high ambients, coupled with a "brown out" condition.

Desert Test - Past experience has shown that the 115° F outdoor temperature required by ARI's maximum load test is not always sufficient to guarantee performance in desert areas, where daytime temperatures do rise above this. In lieu of the ARI test, Carrier performs its own test, operating at a more extreme 125° F outdoor temperature, and for twice as long.

Minimum Outdoor Operation Temperature Test - When hot daytime temperatures drop off to chilly nighttime temperatures, an air conditioner left running can be subjected to minimum operating temperatures below those required in the ARI Low Temperature Operation Test. Carrier tests units at a much lower outdoor temperature than required.

Floodback Test - To test compressor reliability during floodback conditions in which a blocked or dirty filter is present, the unit is operated at 230 volts and half the normal airflow. If the compressor oil temperature is too low, the unit is redesigned.

VOLUNTARY AND EXCLUSIVE CARRIER ENGINEERING AND DESIGN TESTING FOR HEAT PUMPS ONLY

Multiple Unit Defrost Test - This series of tests is performed to qualify any new heat pumps, refrigerants, or defrost schemes. Units must pass a mandatory testing cycle under various load conditions. The heavy frost conditions are used to verify the long term defrost cycle reliability.

Heavy Frost Test - To prevent "racing stripe" residual frost due to weak or dead circuits, Carrier tests for proper defrosting. Under heavy frost conditions, units are operated through multiple defrost cycles. At the end of each defrost cycle, the coil must be free of all frost or ice.

Floodback / Accumulator Oil Hole Sizing Test - Accumulator oil return hole sizing is important to both defrost time and compressor reliability. Compressor oil temperature in Carrier heat pumps is monitored to ensure proper oil return rate and temperature.

Defrost Test During Simulated Ice Conditions - During the defrost cycle, ice cold water is sprayed onto the coil to form a layer of ice 1/4" to 1/2" thick. To pass this cruel test, the coil must be cleared and terminate defrost by temperature, while maintaining acceptable compressor pressures and temperatures.

Every unit is checked for coil leaks. *Most manufacturers allow up to .25 once of leakage per year - or one ounce every four years. Carrier's stringent standards allow only one ounce of leakage in 10 years. Specially designed service valves ensure against leaks.*

CARRIER ENGINEERING AND DESIGN TESTING FOR FAN COILS AND EVAPORATOR COILS

Cabinet Sweating - The units are tested in extremely humid conditions. The cabinet cannot show any exterior condensate that runs or drips from the product. In addition to external inspections, the units must pass internal sweating requirements. The blower housing, wiring, insulation, and underside of the condensate pan must all be free from condensate.

Condensate Disposal - The units are started with a dry trap to ensure that condensate will properly fill the trap during operation. Once primary condensate removal has been verified, this drain is plugged and the system is run until the secondary drain is verified. Finally, a double failure test is performed with both primary and secondary drains being plugged. In order to pass this test, the condensate overflow cannot jeopardize ductwork, cabinet insulation or electrical components (in fan coils).

Coil Wetability - The entire system is brought into a steady state of operation. The coil must properly control the condensate and the pan must catch all condensation formed internally on the coil and tubing. These tests are run in both normal and extreme conditions. In addition, units must perform equally as well under multiple installation positions, and with multiple direction of airflow.

Airflow Performance - This test helps to optimize the overall performance of the fan coil system. This test optimized the performance of the blower motor and the blower design to provide the most airflow with the minimum power consumption to help improve the overall system efficiency.

Safe Transit Tests - The transit tests performed by Carrier make sure that the product arrives to the consumer's home in the same condition as when it rolled off the assembly line. These tests include a vibration test to simulate over the road shipment and impact and drop testing to simulate handling abuse.

ADDITIONAL ENGINEERING AND DESIGN TESTING FOR FAN COILS ONLY

Electric Heat Testing - Multiple UL tests are performed on both the controls and heating elements. Normal and abnormal testing includes severe component failure situations to ensure that the unit will remain safe even in the midst of a failure. The tests include situations like a blower motor failure, blocked inlet airflow, blocked outlet airflow, overvoltage to 253 line volts, under voltage to 187 line volts. The elements are also tested in an overvoltage with no airflow situation. This simulates an accelerated life test under the worst possible conditions.

Sound and Vibration - Although the industry does not require any testing in this area, Carrier believes that quiet operation is critical to consumer comfort. All the product cabinets are fully insulated to aid in quiet sound levels and to provide an effective vapor barrier. Sound testing also takes careful inspection of balanced blower wheels, quiet airflow through the unit, and components (like relays) that perform quietly for the life of the product. Vibration testing ensures quiet operation without internal noisy vibration.

Quality control on the *production line is the key to quality and reliability in the field. Rigorous testing and check procedures monitor virtually every component and evaluate materials, operation, performance and appearance.*

PRODUCTION LINE TESTING

A well-designed unit is only as good as the quality control on the actual production line. After all, what you're selling and what the customer is buying comes from the plant and not from the test labs. Carrier's rigorous production line testing and check procedures monitor virtually every component and evaluate materials, operation, performance and appearance.

Production Line Test and Audits

EVERY UNIT	AUDIT BASIS
Coil Assembly	
Coil dehydration Coil leaks	Internal cleanliness External cleanliness Coil burst strength Performance Coil handling and storage
Operational Checks	
Unit pressure-proof check Contactor screws Evacuation check Refrigerant run test charge Resistance check UL dielectric voltage withstand test Low voltage start test Run test Unit vibration Final charge Final leak check	Compressor bolts Fan motor mounting screws Fan blade set screw Service valve mounting screws Service valve mounting torque
Unit Appearance	**Unit Performance**
Coil fin damage Coil alignment Inlet grille Tubing Sheet metal Paint Wiring Labels Sound shields Overall assembly	Fan motor performance

GAS FURNACE QUALITY

DELIVERING WORRY-FREE COMFORT

The testing performed during the development of a new Carrier furnace can be broken down into two categories:

- Standard requirements for gas-fired central furnaces
- Carrier specified tests

ANSI refers to the American National Standards Institute which defines the minimum requirements necessary to help ensure safety. The ANSI test requirements must be met by all furnace manufacturers. In the development of a Carrier furnace, the ANSI test requirements account for only 60% of the complete test program. Carrier's self-imposed testing requirements are designed to help ensure:

- Comfort
- Safety
- Proper system integration
- Long-term durability

ISO REGISTRATION

Carrier's gas furnace factory and engineering facility in Indianapolis, Indiana is ISO 9001 registered. This means that Carrier meets or exceeds the requirements of ISO 9001 in the design, development and production, of all Carrier manufactured gas furnace products.

On the following page is a summary of what Carrier does, above and beyond the industry standards, to differentiate our furnaces from the competition.

COMFORT

The first thing on most consumers' minds when purchasing a new heating and cooling system is the comfort that the system will provide.

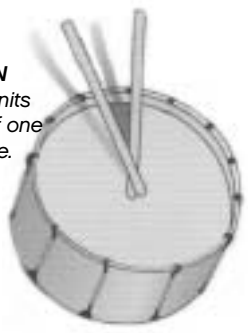
AIR DISTRIBUTION

ANSI testing standards require just one duct connected to the furnace air outlet. Many manufacturers normally test to this standard. Carrier tests with more than one branch duct connected to the furnace plenum because that's how most real applications work. As a result, all Carrier furnaces are designed to minimize the difference in air temperature entering multiple branch ducts. Without this design standard, it would be possible to have a 30° F temperature difference between the air in a duct leaving from the front of a furnace and the air in a duct leaving from the rear. Large temperature differentials lead to significant comfort complaints because the air coming from some registers is warmer than others.

SOUND

All new Carrier furnace designs are tested for sound levels in the same facility that is used to test and rate air conditioner sound levels. Since no industry sound standard exists for furnaces, Carrier continually compares the sound level of its furnaces to other manufacturers. This ongoing effort to minimize sound has prompted Carrier to develop a line of two-stage variable speed condensing furnaces, which our testing shows are the quietest in the industry at our level of low fire. This same testing showed that most furnaces have a significant noise spike during main burner ignition due to a rapid rush of gas to the cold burners. As a result, all Carrier furnaces are outfitted with slow opening gas valves to provide quieter burner ignition.

SOUND COMPARISON
It takes 24 Infinity™ units to match the noise of one standard 80% furnace.



	Development	MCS Manufacturing Check Sample	Pilot
MANDATORY TESTS **All Furnaces**			
Combustion	✓	✓	
Corrosion Test	✓		
Burner Operating Characteristics	✓	✓	
Pilot Operating Characteristics	✓	✓	
Allowable Heat Exchanger Temperatures	✓		
"Wall, Floor, and Ceiling Temperatures"	✓		
Category III & IV Wind Test	✓		
Allowable Air Temperatures	✓	✓	
Direct Vent Furnace Air Leakage	✓		
Blocked Vent Shut-Off System	✓	✓	
Manufacturing Line and Audit Tests	✓	✓	✓
DOE AFUE - Efficiency	✓	✓	
Air Delivery	✓		
Nox (Ca. Only)	✓	✓	
Flame Rollout	✓	✓	
CARRIER SELF-IMPOSED TESTS **All Furnaces**			
Igniter Application	✓		
Heat Exchanger Life Test	✓		
Air Temperature Distribution	✓		
Condensate Drainage	✓		
Flame Sensor Application	✓		
Motor Application	✓		
Corrosion Test (2x Mandatory standard)	✓		
Low Ambient Start	✓		
High Altitude Performance	✓		
Pressure Switch Application	✓	✓	
Control Life Test	✓		
Radio Frequency Interference	✓		
Sulphur Corrosion Test	✓		

VIBRATION

All Carrier furnaces have an exclusive soft-mount draft inducer motor mounting system. This soft-mount minimizes the transmission of vibration from the draft inducer motor to the furnace cabinet, ductwork and venting system. In addition, the soft-mount guards against the negative effects of dust, dirt and debris build-up on the blower wheel. Assemblies used by others have a rigid mount that runs with little vibration when new. However, after a few years of operation, dirt and debris can accumulate inside the draft inducer and create an imbalance. This can cause an annoying vibration noise that will be transmitted throughout the house via the sheet metal ductwork. The Carrier soft-mount costs a little bit more to produce, but will reduce vibration noise even in the presence of dust and debris. It maintains its effectiveness year after year. The blower motor is also soft mounted.

Inducer Motor

CONSTANT TEMPERATURE

Carrier offers the broadest line of two-stage heating equipment in the industry. Carrier two-stage furnaces operate at about two-thirds of full input for over 90% of the heating season. Even with a standard thermostat, the system will produce a more uniform temperature in the living space than typically experienced with a fixed capacity furnace. The reduced temperature swing results in improved comfort.

Through years of testing and real world experience, Carrier has found the right combination of heating capacity, airflow and duct temperatures to provide superior comfort at the lowest possible sound levels. Carrier's furnaces provide the right amount of heat all season long to ensure your comfort in your real life home.

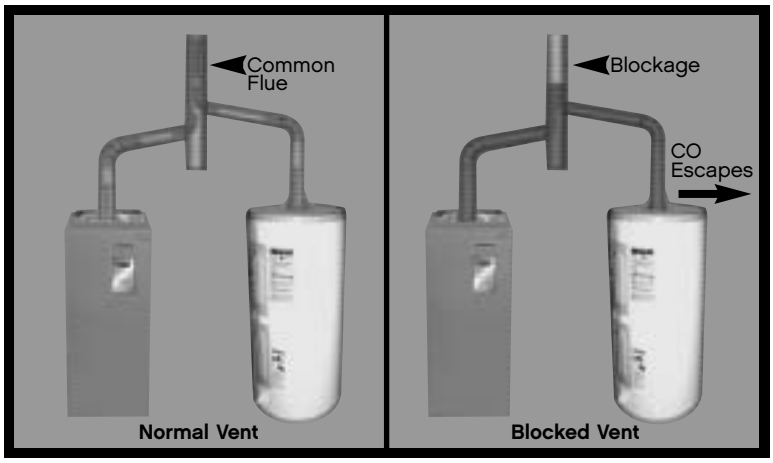
SAFETY

The safety of the heating and cooling system is the most important thing to the people at Carrier, as well as to the consumer.

In addition to the tests prescribed by the ANSI safety standard, Carrier performs tests and analysis to ensure safe operation over the life of the product. There's an old adage that states, "It's not if it fails, but when it fails." Anything can fail if left in service indefinitely. So, a critical design requirement at Carrier is to make sure a product fails safe under any single failure mode. For example, all of our furnaces are induced draft so the flue gas in the heat exchanger is always under a negative pressure. That negative pressure keeps combustion gases where they belong, inside the heat exchanger. In the event a heat exchanger fails, flue gas will not leak into your home, only air will leak into the heat exchanger, creating a safe condition.

We also perform a miswire analysis by hand on every new furnace design. This is to prevent inadvertent safety problems resulting from installation or service. Even though the industry standard requires a furnace miswiring analysis, most are performed by engineers, in their offices, on paper. Sometimes even the most careful people can miss something. It takes more time to actually miswire the furnace, but we have learned that a paper analysis may hide "sneak" circuits that can exist when an actual miswire takes place.

Other examples of where Carrier goes the extra mile for safety are...



BLOCKED COMMON VENT TEST

ANSI requires all furnace manufacturers to perform a blocked vent test. This test is to ensure the furnace shuts down before excessive levels of carbon monoxide are produced. However, many non-condensing furnaces are connected into the same vent system as the water heater. In this case, the blocked vent test required by ANSI would not shut down the furnace if the vent blockage occurred beyond the connection to the water heater vent. The result would be a continuous spillage of combustion gases from the furnace vent through the water heater draft hood.

Carrier non-condensing furnaces contain a patented system called the Blocked Vent Safeguard System. This is a thermally activated switch that detects a completely blocked common vent and shuts the furnace down. Carrier is the only furnace manufacturer to offer this type of safety protection.

FLAME ROLLOUT AND BLOWER SHUTOFF

Does Carrier add safety features that aren't really necessary?

We feel the answer is no.

Here's an example: Today, the ANSI safety standard requires flame rollout protection and a blower compartment interlock switch. A flame rollout exists whenever a malfunction causes the main burner flames to burn outside the heat exchangers. The blower door interlock switch ensures that main burners are not lit when the blower compartment is open. This prevents a negative pressure by the blower from pulling combustion products from the burners into the indoor air stream. Carrier was the pioneer in introducing both of these safety features in the late 1970's...over a decade before they became a requirement for the entire industry.

SAFETY CONTROL ALGORITHMS

Every Carrier furnace contains a number of safety control algorithms that go beyond the industry standards. That's one of the benefits of designing and producing our own electronic controls. The following is a summary of the patented algorithms and the benefits they provide:

- **Patent 5,372,120: Failed Blower Motor** - This algorithm allows the furnace control to shut down the furnace if the blower motor has failed. This prevents indefinite cycling of the main burners and minimizes long term damage to the furnace when cycling without a functioning blower motor.

- **Patent 4,850,852: Gas Valve Relay Failure** - This algorithm allows the furnace control to sense a failure of the relay that actuates the gas valve. If a stuck gas valve relay is sensed, the control shuts off power to the gas valve and prevents the spillage of raw gas.
- **Patent 4,789,330: Stuck Gas Valve** - This algorithm helps the furnace control determine whether the gas valve is stuck open due to physical debris. If a stuck open gas valve is sensed, the control keeps the draft inducer on at the end of a heating cycle so flames cannot rollout of the furnace heat exchanger. Otherwise, a fire could occur within the furnace cabinet with no means to prevent it from spreading.
- **Patent 4,401,425: Blocked Vent Safeguard** - This describes the Blocked Vent Safeguard System mentioned earlier.
- **Patent 4,891,004: Electrical Surge Reduction** - This describes a means by which the furnace control de-energizes the circulating air blower whenever the main burner igniter is energized. This minimizes spikes of electrical current to help prevent overloading of the circuit breaker.

SYSTEM INTEGRATION

The furnace, air conditioner or heat pump are the beginning of a reliable comfort system. Just as important to comfort is the way that all of the system components work together.

Carrier designs and manufactures the components that are needed for a complete residential heating, cooling and indoor air quality system. The engineers that design these components work next to the furnace engineers. As a result, each of the system components are designed to operate in concert with the furnace.

AIR CONDITIONERS

All Carrier furnaces contain easy-to-wire terminals to connect a split system air conditioner. Carrier furnaces operate the blower at high speed for proper cooling airflow and efficiency. Most Carrier furnaces also contain an efficiency-enhancing blower delay on cooling that operates the blower for 90 seconds at the end of a cooling cycle. This allows the blower to transfer the residual cooling in the cooling coil to the house.

Carrier even goes farther than most manufacturers to help keep your lights from flickering. Typically, when the compressor in an air conditioner starts, the electrical voltage to the house will sag. This voltage sag sometimes causes the lights in a house to flicker. Most Carrier furnaces contain a one-second delay that allows the electrical voltage to recover before the cooling blower is turned on. This prevents the blower from further aggravating the voltage sag (and flickering lights), while allowing the blower to start quickly at full voltage.

HEAT PUMPS

All Carrier furnaces can also be installed with a heat pump to create a Hybrid Heat™ system. A Hybrid Heat system provides the customer ultimate flexibility in reducing energy costs while maximizing comfort and reliability. In most cases one can simply use Carrier's Hybrid Heat thermostat to integrate a furnace and heat pump without the need for an accessory kit.

EVAPORATOR COILS

Carrier furnaces are tested for proper airflow, heat exchanger durability and safety limit performance with Carrier evaporator coils. Not all coils are created equally, so you run the risk of creating durability and efficiency problems when using off-brand coils. Carrier coil and furnace design changes are coordinated to make the two work together properly. For example, a coil could make a main safety limit nuisance trip, or a coil drain pan could get too hot. All of these potential problems are addressed before new models are produced. With a Carrier coil, you get peace of mind knowing the coil and furnace are designed to maintain performance, efficiency and durability.

CONTROLS

All Carrier controls are designed and tested to ensure trouble-free operation when connected to a Carrier furnace and trouble-free operation when installed with a Carrier furnace.

Carrier offers three tiers of control solutions. These include a complete range of programmable and non-programmable thermostats for the cost driven new construction market or the feature driven retrofit market. However, Carrier's best control offering is the Infinity™ System. It surpasses the industry in dealer and consumer benefits.

Infinity™ Control

The Infinity™ Control provides a homeowner with six controls in one. A single, easy-to-use, user interface that controls temperature, humidity, dehumidify, airflow, ventilation and IAQ. Easy four wire installation and automatic system start up makes dealer installation servicing convenient. Carrier patented "True Sense Dirty Filter Detection" and automatic pop-up messages reminding the homeowner about routine equipment maintenance, provides peace of mind for the homeowner and ensures that the Infinity™ System is operating in peak condition. It also has the largest backlit temperature display in the industry. Infinity™ System allows you to access the system from anywhere via the telephone or internet. The dealer and homeowner can get maintenance or urgent alert notifications via e-mail, telephone or pager.

Plus, furnace operations and reliability are improved when used with Carrier control products like the Infinity™ Control. Carrier's variable speed furnaces pull more moisture out of the air when matched with this exclusive product.

All Carrier thermostats are designed and tested to ensure trouble-free operation when connected to a Carrier furnace. There are many bargain basement thermostats on the market which have cut corners for the sake of low price. The result is they can cause problems when connected to many brands of furnaces. With a Carrier thermostat, you can be assured of trouble-free operation when installed with a Carrier furnace.

Plus, furnace operations are improved when used with Carrier thermostat products like the Thermidistat™ Control. Carrier's variable speed furnaces pull more moisture out of the air when matched with this exclusive product.

ELECTRONIC AIR CLEANERS

Airflow switches in air cleaners don't always work, especially on today's two-speed and variable speed furnaces. Direct wiring assures that this is never a problem. That's why all Carrier furnaces are equipped with electrical connections for an electronic air cleaner. That makes it easy for the field technician to properly install the air cleaner.

Carrier also makes sure that the air cleaner gives a homeowner maximum benefit. For example: Another manufacturer's modulating gas furnace actually

shuts off the air cleaner when the furnace is operating at its lower capacities. Unfortunately, this manufacturer claims that their furnace operates most of the time at these lower capacities. All that time, the electronic air cleaner that is supposed to be cleaning the air is letting airborne particles pass right through. Carrier allows the air cleaner to clean whenever the blower is running.

To improve the effectiveness of air cleaning, Carrier provides a high-efficiency variable speed motor in its Infinity™ 80 and Infinity™ 96 furnaces. This motor is so efficient that a homeowner can continuously clean the air in their home for under $40 in electric charges per year. That's hundreds of dollars less than a standard furnace!

Electronic Air Cleaner

But, not all air cleaners and filters are created equally. One of the most common comfort and durability problems that exists today is the installation of aftermarket air filters (electrostatic and media), which have a high air pressure drop. In the case of so-called high-efficiency media filters, the pressure drop can be ten times higher than the filter provided with the furnace! This increased pressure drop reduces airflow through the furnace, resulting in reduced furnace performance, efficiency and durability. The pressure drop also impacts comfort by reducing airflow and causing the air system to go out of balance.

Many filter manufacturers do not understand the effect of their product on furnace performance. Carrier, on the other hand, designs its air cleaners and air filters to maintain furnace efficiency and durability, and to maintain the customer's comfort.

HUMIDIFIERS AND ZONING SYSTEMS

All Carrier humidifiers and zoning systems are designed to maximize the efficiency and durability of the Carrier furnace. In fact, the majority of Carrier furnaces are equipped with a low voltage power supply and electrical connections for easily integrating a humidifier. In addition, all zoning systems are equipped with duct temperature limit switches to make sure that the Carrier furnace operates within its design envelope. Since most zoning system manufacturers don't design furnaces, they do not understand the effect of the zoning system on furnace efficiency and durability.

Model LFP Humidifier

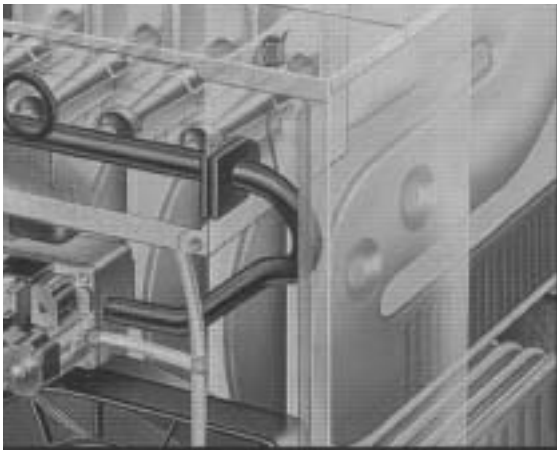
Research testing has shown that improperly designed zoning controls can cause a furnace to cycle five times as much as a normal furnace. This means that a furnace could have the equivalent of twenty years of cyclic operation in just four years. Unfortunately, if the furnace wears out under these conditions, or if there are comfort problems in the home, it's the homeowner that has to deal with the problems, not the zoning manufacturer. Carrier zoning systems contain special software algorithms that prevent rapid cycling of the furnace. Carrier zoning systems will maximize comfort and reduce long term maintenance and service costs.

Infinity™ Zone Control

DURABILITY

After hearing the comfort, performance and safety story behind a heating and cooling system, homeowners like to know that their new system will last well into the future.

A typical furnace is expected to last about 20 years with normal maintenance. Since a furnace will, on the average, cycle on and off about 10,000 cycles per year and burn gas for about 1000 hours per year, a 20-year life translates to 200,000 on/off cycles and 20,000 hours of operation. To put this into perspective, a car traveling at an average of 40 mph would have to travel 1,000,000 miles, and average 4 miles per trip in order to achieve the same expected life as a furnace and that doesn't include cooling operation!



Primary S-Shaped Heat Exchanger

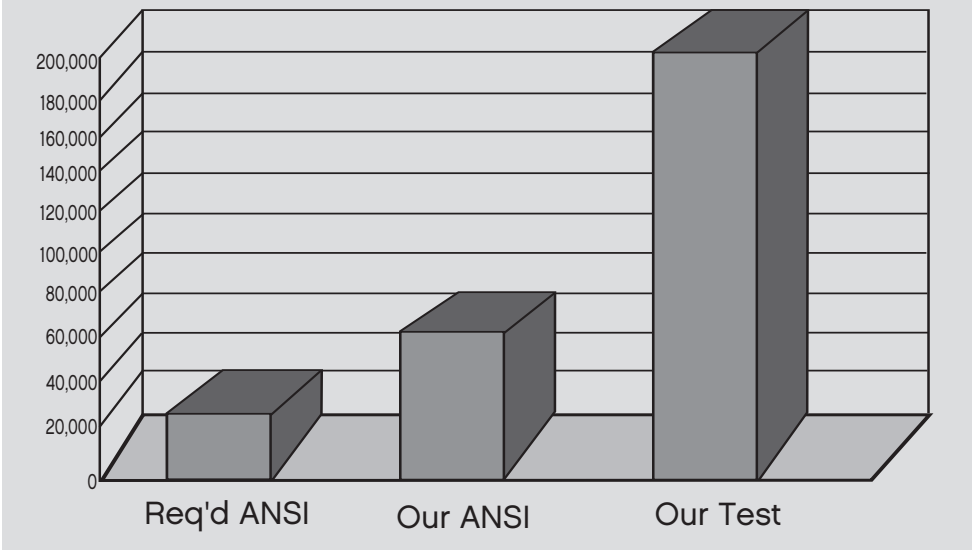
HEAT EXCHANGERS

The heart of a furnace is its heat exchanger. Since heat exchangers are typically warranted for 20 years or more, great care must be taken to assure long-term durability. All heat exchangers are qualified for long term durability in Carrier's Furnace Reliability Test facility. This 8000 square-foot, temperature-controlled facility was constructed in 1989 and has a capacity to cycle 64 furnaces under a variety of conditions. Each furnace is monitored by a central computer system 24-hours-a-day, seven-days-a-week.

The following describes the different tests Carrier uses to qualify the durability of a new or redesigned heat exchanger:

- **ANSI Cycle** - New or redesigned Carrier heat exchangers are subjected to over 30,000 high stress cycles on both natural and propane gases. The minimum industry requirement, as defined by the ANSI safety standard, is 10,000 cycles. The ANSI cycle is intended to rapidly promote fatigue cracking, which is caused by repetitive thermal expansion and contraction. A furnace heat exchanger actually expands like a balloon as it heats up, then shrinks while it cools down. The gap between adjacent heat exchangers will decrease by about 50% as the heat exchanger heats up to maximum operating temperature, which can be over 1000° E. Carrier does not believe that this test adequately simulates long-term operation. Therefore, we run additional tests to prove our products..

Durability Life Cycle Comparison Graph



- **Carrier Cycle** - Since the ANSI cycle is not truly representative of real-world furnace operation, Carrier adds its own long-term durability test. This test requires all new heat exchanger designs to be run through 200,000 cycles while over-fired and operating at maximum rated air temperature rise. This test is critical in that some heat exchanger designs passed the 30,000 ANSI cycles, but failed the Carrier requirement. This resulted in a design iteration and re-qualification before the product was put into production.
- **Computer Simulation** - In more recent years, Carrier's heat exchangers have been analyzed using highly sophisticated computer models to predict long-term durability even before the heat exchanger is placed on the cycle test.
- Condensing HX Material Audit Carrier's patented serpentuff condensing heat exchangers are made of a polypropylene laminated steel. To ensure long-term durability of every furnace produced, each coil of the laminated steel used in production is subjected to a two week test that simulates 20 years of high temperature acid exposure.

Of course, these tests don't mean anything unless they have been validated by actual field experience. The Carrier four pass heat exchanger and serpentuff condensing heat exchanger have been produced since 1980. To date, there are over 45 million Carrier 90% primary heat exchangers and 47 million serpentuff condensing heat exchangers in service with a proven record of durability.

IGNITERS

The Carrier Power Heat Igniter is composed of silicon nitride material and when energized, directly ignites the furnace burners. One of the most common failures on competitive model furnaces is the igniter. Carrier has produced an igniter that is physically and electrically robust. The Power Heat Igniter can operate on standard line voltage rather than having to introduce failure prone voltage regulators into the circuitry. The Power Heat Igniter has exceeded 20 years of reliability testing. As a result of the Carrier Power Heat Igniter, introduced in 2005, igniter failure was dramatically reduced by 95% as compared to the prior year!

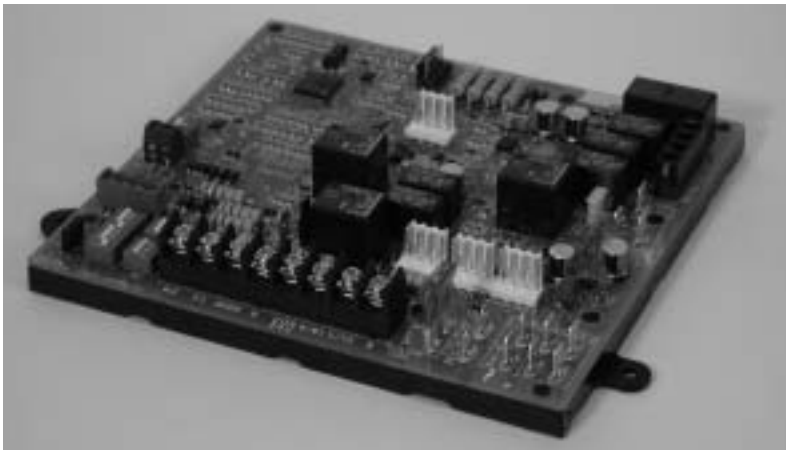
Power Heat Igniter

ELECTRONIC CONTROLS

All of Carrier's furnace controls are designed and produced by a division of Carrier. The durability of these controls is proven through a combination of high stress testing and long-term cycle testing. The vast majority of testing is performed by Carrier.

During the development phase, each control must pass an array of tests designed to simulate a wide range of application conditions:

- Electronic interference testing is used to verify that the electronic control will not affect or be affected by other electronic devices, such as a television or radio.



Furnace Control Board

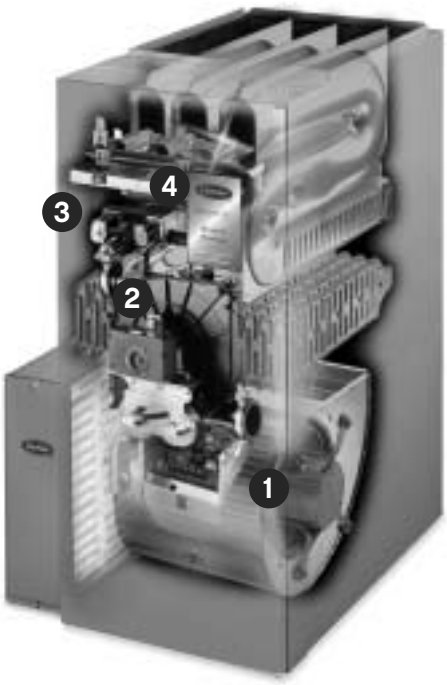
- Electric discharge (spark) testing is used to verify that the control will not be damaged by a static charge, such as the charge generated by walking on carpet.
- Temperature testing is used to verify the electronic control's operation over the range of temperatures for a given application.

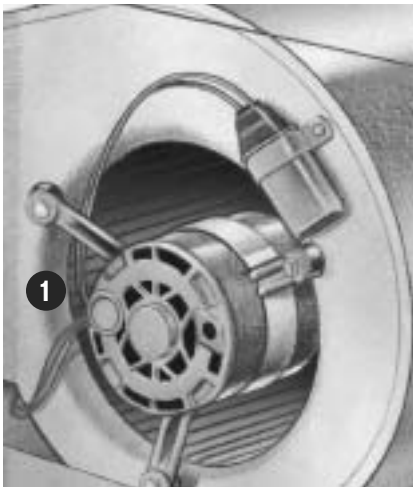
During the manufacturing process, each furnace control is operationally tested. The tests include electrical operation as well as simulated application testing.

The remaining testing takes place in the Carrier Furnace Reliability facility. Carrier uses real loads to cycle test complete furnace control systems including:

1. Blower motors
2. Inducer motors
3. Gas valves
4. Igniters

Also, new production electronic controls are audit tested over an extended period to validate operation.





Blower Motor

INDUCER AND BLOWER MOTORS

The key to motor longevity is keeping the motor and motor bearings cool. In high temperature applications, such as that of a non-condensing furnace inducer motor, ball bearings are used to ensure long life. In addition, all Carrier furnace inducer motors are equipped with stainless steel shafts. This not only allows better corrosion protection, but also makes it easier to remove the inducer wheel in the event service is needed. Stainless steel shafts do not conduct as much heat from hot flue gases, and they help minimize motor bearing temperatures.

Carrier also provides a patented (patent # 5,275,530) rubber shaft seal on all condensing furnace inducer motors. This is a floating seal that prevents flue gas condensate from entering the inducer motor bearing (a common inducer failure mode), while maintaining the flexibility of its soft-mount system.

The Carrier Reliability test facility has the capacity to test both condensing and non-condensing draft inducer assemblies under simulated field conditions. In addition, motors are tested on actual furnaces in the furnace facility as part of the furnace system cycle testing.

All new inducer motor applications must undergo a cold ambient start test. This test involves placing the furnace in a 500 cubic-foot environmental test chamber and starting the furnace in a 0° F (-18° C) degree ambient. Cold start performance is especially critical when a homeowner uses night setback on cold days.

FLAME SENSORS

Once the main burners are ignited, a flame signal is sent to the main furnace control by way of a high alloy stainless steel rod. One potential failure mode of this seemingly simple device is the buildup of an oxide layer that insulates the rod from the flame, causing the furnace to shut down. Carrier has developed an in-house test that accelerates oxide buildup. Every new flame sensor application since 1991 meets this oxidation resistance test which has greatly reduced oxidation-related nuisance operational shutdowns.

CORROSION

Current ANSI standards require all furnace manufacturers to pass a corrosion test, where the natural gas is spiked with chlorine and fluorine-laden refrigerant. Carrier believes that the minimum industry standard will not ensure acceptable long-term durability. So, all Carrier furnaces have been certified to TWICE the industry standard. In addition, tests have been run at TEN TIMES the industry standard in order to assess corrosion failure modes. In this ten times test, Carrier's patented Polypropylene Laminated Steel Condensing Heat Exchanger (patent #'s 4,848,314 and 5,439,050) withstood the effects of the highly acidic flue gas condensate. In a comparative test, the most commonly used stainless steel alloy used in competitive condensing furnaces was found perforated.

Carrier also does not use galvanized or painted sheet metal for parts that are in contact with non-condensing flue gases. Instead, all non-condensing flue gas surfaces, including draft inducer housings and wheels, are made of high grade aluminized steel. Some competitors use less expensive galvanized or painted steel for their non-condensing inducer wheel or housing. It has been our experience that these materials are inferior to aluminized steel when in contact with flue gas, and will fail prematurely in some environments.

ELECTRICAL COMPONENTS

Other electrical components, such as gas valves and pressure switches, are tested in Carrier's Furnace Reliability test facility before being released for production. Each of the electrical components must withstand at least 200,000 on/off cycles. In addition, the component must stay within performance specifications for the duration of the test. In the case of components that must operate during the heating and cooling seasons, such as a blower relay, the component must last for more than 300,000 on/off cycles.

SYSTEM CYCLE TESTING

Cycle testing of all the major electrical components is typically performed on dedicated test fixtures. This is a standard practice used by all of Carrier's component suppliers, and most likely by many furnace manufacturers. Fixture testing of discrete components, however, does not address the interaction of the components in a furnace with each other. In order to identify these interactions, Carrier performs complete system cycle tests. This involves cycle testing complete prototype furnaces, with all the new or redesigned electrical components. As a result of this testing, we have made significant improvements to our products that would otherwise have gone unnoticed. Currently, we have a number of furnaces with over 25,000 hours of operation (or over 1,000,000 miles!) and over 300,000 on/off cycles. Even when a furnace completes its targeted number of cycles or hours, we keep it running until it finally fails. Understanding how it fails is key to designing more robust products for the future.

FIELD TESTING

Field trials test the real world conditions that cannot be fully duplicated in a laboratory. The products are installed by real dealers in real applications without help from the factory. Factory personnel are present to learn what aspects of the installation and operation need to be improved or simplified. Information is systematically gathered from these test sights to continually monitor and evaluate the system performance in relation to the design criteria.

MANUFACTURING QUALITY

Carrier quality doesn't stop in engineering. The first step in ensuring manufacturing quality is to ensure the quality of the components that make up the product. If a supplier expects to have a long relationship with Carrier, they must meet strict standards of component quality and process quality. Carrier's supplier certification process is recognized as one of the leading supplier management programs in the country.

Every Furnace is 100% Tested

No Carrier gas furnace can leave the factory without passing a full production run test. Every furnace is tested for correct operation and visually inspected for assembly and appearance before packaging. The function of every component of every furnace is tested and must pass before it receives the approval and release of our quality control department. Computerized run test stations log all information by model and serial number and automatically flag any suspect units. Without proper testing results, the unit is put aside for further inspection, rework and re-testing. It will not be released to ship.

PRODUCTION AUDITS

Continuous process audits are performed daily by line inspectors to ensure production processes are in control. Master audit testing is done, but furnaces are not pulled every day. Testing can take two to three days to complete for one unit. All casing and heat exchanger materials undergo tests to assure specifications are met. Pull tests are done on heat exchanger tog-l-loks to check for proper strength. Dimensional properties of primary and secondary heat exchanger cells are checked. Secondaries are also checked for draw depth and interior gap. Individual secondary heat exchanger cells are leak tested with water. Secondary heat exchanger assemblies are leak tested with air. Torque is checked on blower wheel set screws, motor mount bolts, inducer wheel set screws, and inducer end cap clamps.

MASTER AUDIT

Testing doesn't stop with production tests. To ensure that every Carrier gas furnace performs as well today as it did last week, last month, or last year, many of the engineering development tests are repeated on randomly chosen production units. The AGA (American Gas Association) Function Test is done to ensure safe function of the unit. An efficiency test confirms performance within Carrier specifications and DOE (Department of Energy) regulations. Combustion must be clean and within specifications. Temperature rise is checked for the proper comfortable range. Limit switch performance is checked for safe operation. Flue temperature is checked and must be within specification limits. Proper pressure switch operation is verified to ensure safe operation. Nuisance limit trip test ensures unit will reach proper temperature rise without tripping the limit switch.

ISO Registration

ISO is the International Organization for Standardization. "ISO" is not an acronym, but a name, derived from the Greek word isos, meaning equal. ISO is a non governmental organization. It is made up of national standards institutes or organizations, on a one member organization per country basis. Although ISO standards are voluntary, the fact that they are developed in response to market demand, and are based on consensus among interested parties, ensures widespread use of the standards.

The ISO 9000 series of International Standards for quality management and quality assurance has been adopted in more than 90 countries and is being implemented by thousands of manufacturers and service organizations. Its primary aim is to give organizations guidelines on what constitutes an effective quality management system, which in turn can serve as a framework for continuous improvement.

The ISO 9000 family includes two quality assurance models - ISO 9001 and ISO 9002 against which the quality system can be audited to see that it complies with ISO 9000 requirements. ISO 9001 is a model for quality assurance in design, development, production, installation and servicing. ISO 9002 is a model for quality assurance in production, installation and servicing.

THE END OF THE PRODUCTION LINE ISN'T THE END OF THE LINE FOR QUALITY

In addition to the engineers and technicians who develop and test Carrier products, there are others in the field who stand behind Carrier's equipment. Carrier's Customer Assurance Team consists of field representatives who work with distributors and dealers alike, listening to needs for new products or product enhancements, assisting with complex installations, solving service problems, and developing stronger, more positive consumer relations.

SOME THINGS NEVER CHANGE...

Since 1902, Carrier has been developing and producing indoor comfort products to meet the needs of homeowners nationwide. Our team of engineers, technicians, and manufacturing personnel will continue to work together in order to provide our dealers with the most reliable heating and cooling products on the market. It's part of our commitment to provide homeowners with expert comfort.

Carrier®

Turn to the Experts.℠

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