gForce Ultra CRAC Equipment: Using the Latest Variable Capacity Technology to Lower Energy Usage & Increase Reliability

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Cooling data centers and other mission-critical environments is an ever-changing challenge. Doing so in an energy-efficient manner is an even bigger challenge. Today the CRAC (Computer Room Air Conditioning) units in use at most facilities rely on mechanically-modulating fixed speed or fixed capacity components. Although these units provide adequate climate control, they do so at a cost. Because the compressor, fans and other vital parts are either fully on or fully off, air cooling units based on this old technology must constantly cycle through the on/off mode in order to reach the desired end result. This consumes a lot of energy, and creates a great deal of wear and tear on the parts themselves.

To understand the inherent problem with mechanically-modulating compressors and other components, imagine if vehicles operated this way. What if in order to maintain speed you had to keep your foot on the gas, run your car engine flat out, but keep switching gears between neutral and drive? Not only would this waste a lot of fuel, it would also be extremely hard on the car.

LUCKILY THERE'S A BETTER WAY

The good news is, precision air cooling equipment that utilizes the latest variable capacity technology is now available, and it overcomes these problems.

In designing gForce Ultra, the latest extension of the popular line of floor-mounted CRAC equipment, Data Aire created a variable capacity unit in every sense of the phrase. This unit doesn't "just" have a variable capacity compressor. Every major component – from the fans to the electronic expansion valve to the refrigerant distributor – adjusts to variable demand.

The compressors and fans vary their capacity by speeding up and slowing down. The electronic expansion valve varies its capacity as the refrigerant flow through the valve changes. Even the components that do not move or modulate were designed to handle variable loads. In fact, from beginning to end, the gForce Ultra was designed so that the equipment varies its capacity to perfectly match the changing load demands of the room.

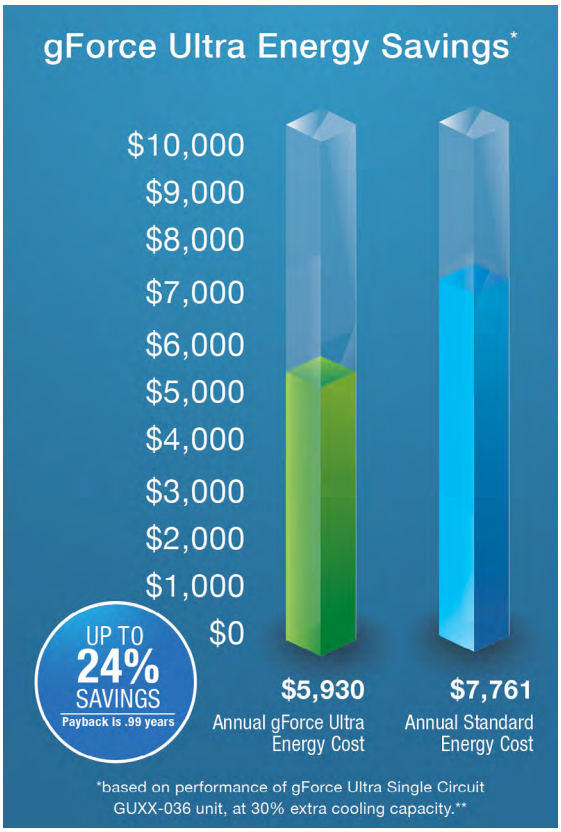
Instead of constantly cycling on and off, this unit smoothly ramps up or down to meet the demand, consuming only enough energy to meet that particular load. The end benefit of this variable capacity technology is lower energy usage and increased reliability. It's a better way to cool, and it's ushering in a new era of CRAC performance.

HOW gFORCE ULTRA LOWERS ENERGY USAGE

- **Eliminates the start/stop cycle –** Getting a mass moving and then stopping that mass from turning consumes a lot of energy. Because it truly is a variable capacity system, gForce Ultra eliminates the constant start/stop cycle offered by older technology. Instead, when there's more heat in the room the compressor simply speeds up to follow that heat load and maintain a constant temperature in the room.

When the equipment in the computer room is putting out less heat, the compressor will slow back down again.

It's much more energy efficient to drive your car on the highway with cruise control than to drive in stop-and-go traffic; having a variable capacity system that changes speed instead of cycling all the way on and off reduces energy consumption.



- **Provides high efficiency at part loads –** The reality is, most of the time you do not need your air cooling equipment to operate at full capacity. The gForce Ultra only ramps to the necessary load, using just the amount of energy needed for that demand. Instead of running at full speed, it continuously adapts to cooling demands, constantly maintaining a precise set point – often within 1 degree or less – in a very energy-efficient way, and resulting in substantial energy savings.

  Although you will not lose efficiency when the units are run at full load, the true efficiency and energy savings are seen when they're run at the exact speed necessary to meet the demand.

- **Uses highly efficient components –** The synergistic way that all of the components work together as a system makes the Ultra what it is. This includes:

  ◊ **Data Aire dap4 Controller –** Based on a predictive model of control that takes many variables into account in real time and monitoring measurements from each of the components it controls, the dap4 constantly monitors measurements from each of the components and orchestrates the system as a whole to ensure it maintains the room's temperature and humidity at the desired set point.

  For example, each unit's parameters are set to keep the compressor funtioning within a desired span within the operating range. If the controller senses that the compressor is starting to deviate from that range, it might adjust the electronic expansion valve to maintain the precisely measured load. And it will use predictive modeling to determine just how fast it needs to react to make this happen.

  ◊ **Variable Speed Compressor –** The centerpiece of the gForce Ultra's energy efficiency, the variable speed compressor turns on, stays on, and then adjusts speed based on the true load of the room. This eliminates the inrush and need to equalize all the pressure within the system that comes from repeated on/off cycles, and all of the associated electrical inefficiencies.

  It has been said that the variable speed compressor itself has the ability to be 30 percent more efficient than a standard fixed speed compressor. The variable speed compressor was designed to do more than the standard fixed

speed compressor does. In the same application that the fixed speed compressor can only run at 60 hertz, the variable speed compressor can modulate from 20 hertz to 100 hertz.

◊ **Energy Efficient Condenser Fans –** The condenser fans in the gForce Ultra are variable speed and run by electrically commutated (EC) motors, allowing them to ramp up and down, commensurate with demand. These fans feature improved reliability due to the fact that there are no belts or pulleys involved in their operation, thus eliminating the problems of slippage and dust. The wing design is extremely aerodynamic, and the blades are comprised of a light composite plastic to increase efficiency and decrease noise.

◊ **Electronic Thermal Expansion Valve –** Previous expansion valve technology operates on a mechanical platform and uses a gas-filled bulb. When it warms up, it pushes a plunger down; when it cools down, the plunger retracts to meter the refrigerant.

The gForce Ultra uses a microprocessor – in this case, the dap4 – to set the allowable temperature fluctuation. An Electronic Valve Driver (EVD) relays data back to the dap4 and when the selected set points are surpassed, the valve is continuously adjusted, in real time, to maintain the specified superheat as the load changes. The sensors are connected directly to the driver where the data is processed and the valve is controlled. This provides a level of precision that the old thermal expansion valves are not capable of, and a lower superheat than what has been recommended by other manufacturers.

◊ **Refrigerant Distributor –** The refrigerant distributor in the gForce Ultra was specially designed for use with variable refrigerant flow, and uses about a fourth the pressure drop of a standard distributor.

All of these energy-efficient features combine to provide 24% energy savings (or more) versus CRAC units that do not have this variable capacity technology. Data Aire verified this improved energy efficiency by testing the components in its Aire Lab Facility. Although energy savings will vary from case to case, the lab results showed that it will always be at least 24% and in many situations will be significantly higher.

Plus, the payback time on the additional cost of the gForce Ultra equipment is just three years or less.

WHY gFORCE ULTRA IS MORE RELIABLE & DURABLE

While this unit produces significant energy savings, many feel that the real advantage of its variable capacity technology is the increase in reliability. After all, these precision cooling units are deployed to meet the environmental requirements of mission critical equipment. Absolute reliability is paramount.

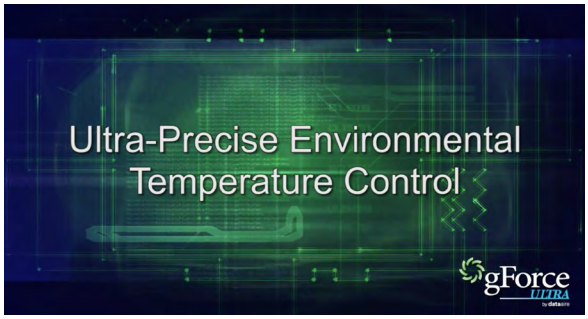
There are a number of reasons why gForce Ultra is more reliable than equipment that uses technology based on fixed capacity or mechanically-modulating components. These include:

- **Less wear and tear –** Maintaining a moderate speed in response to the true load required in the environment eliminates the repeated "start/stop" cycles and eliminates a lot of wear on the parts. It's not the continuous operation of the motor that wears it out; it's starting and stopping loads that cause problems. The variable speed compressor doesn't actually shut off and restart. Instead, it stays on and ramps up or down to whatever speed is necessary

to maintain the desired set point. In contrast, a mechanically modulating compressor is constantly engaging and disengaging scroll sets, putting high amounts of torque on them each time.

The fact that the compressor is not turning on and off also means that the repeated cycles of inrush current – and the associated need to equalize the pressure within the system – is also eliminated.

- **Built-in redundancy –** Redundancy is usually accomplished by installing extra pieces of equipment to serve the same load, so that if one must be taken out for maintenance or repair, the other can carry the load. In units with multiple fans, the Ultra offers an additional layer of redundancy. If one fails, the remaining fans will simply speed up to compensate.



- **Precise temperature control –** As explained earlier, gForce Ultra's electronic expansion valve reliably provides a level of precision in temperature control that is far beyond the capabilities of the old thermal expansion valves.

- **Superior fans –** The Ultra's backward-curved plenum fans with electronically commutated motors function without shafts, external bearings, belts or pulleys – eliminating failure points, belt slippage and dust. This makes them cleaner and more reliable than traditional fans, and results in reduced maintenance and fewer premature fan and motor failures. In addition, these fans are made of long-lasting aluminum which, unlike traditional steel blades, will never rust.

It should also be noted that Data Aire has been making CRAC units for over 50 years. The gForce Ultra precision cooling units are not just built with more reliable technology and components, they're also designed and made by a company with a solid reputation for reliability.

HOW VARIABLE SPEED COMPRESSOR TECHNOLOGY COMPARES TO OTHER COMPRESSOR OPTIONS

To further understand the advantages of the gForce Ultra's variable speed / variable capacity compressor technology, it is useful to review the other options currently available on the market.

- **Standard fixed speed compressors –** This is the basic "on/off " compressor, which does not do a good job. Due to the fact that it's either fully on or completely off, it will always overshoot or undershoot your load. Essentially modulation occurs beyond the compressor at the determination of the user.

  Every time a fixed speed compressor turns on it has to equalize the system, it's working hard just to stay on and equalize. Once it's overshot the load it will turn off, and the cycle will start again. This puts a lot of stress on the compressor as well as the other components in the system.

- **Tandem compressor installation –** Many engineers will install an array of fixed speed compressors to better meet the load. With this type of installation things are staged to divide the load between multiple units. The first compressor comes on, then the next, then the next, each having a part load responsibility.

- **Hot gas bypass installation –** With this type of installation, the hot gas from the compressor is diverted back into the evaporator coil. This essentially mixes the cold refrigerant with the hot gas in order to decrease the load. Although it is known that this is not the intended use; and it is extremely inefficient – doing a poor job modulating to the needed load – it does keep a fixed speed compressor on for a longer period of time.

- **Mechanically-modulating compressors –** This technology keeps the compressor running at a constant speed, rapidly engaging and disengaging a scroll set in order to maintain the load. Instead of overshooting levels as happens with a fixed speed system or tandem installation, levels are maintained more closely to the desired line. This is a step forward from the fixed speed compressor, but not a remarkable step forward.

  Mechanically-modulating compressors do a very good job maintaining a load. The only problem is that the motor is continually operating at high speed, which wastes energy and levies a lot of wear and tear on the parts. From the reliability standpoint, one must consider how many cycles the equipment can go through before the compressor is going to fail.

- **Variable speed compressors –** The variable speed compressor is similar to the smooth ride of the cruise control on a car. The compressor stays on, and the speed changes to meet the capacity requirements. There's no engaging and disengaging of scroll sets, which makes it an inherently more reliable and durable option. The desired load is maintained without putting undue stress on the system or using any more energy than necessary.

  In designing the gForce Ultra, Data Aire began with a variable speed compressor and built a cohesive system around it, ensuring that all of the other components are as efficient as possible, maximizing this technology.

ADDITIONAL BENEFITS OF THE gFORCE ULTRA

While lower energy usage and increased reliability are the biggest advantages of the gForce Ultra CRAC units, the technology and construction offers additional benefits as well:

- **Easily scalable –** One of the biggest challenges in designing the cooling system for a data room or data center is accurately matching the required load, knowing that the load in a data center will almost always grow over time. Designers, owners and operators need to be able to scale the cooling system so that it increases as the amount of equipment in the data center increases.

  The gForce Ultra meets this challenge by running its compressors and fans very slowly when the load is small, and increasing the speed of those components as additional equipment is added to the room. Its peak performance levels are reached at part load due to its capacity to accurately match required cooling with the demand, rather than running at full speed regardless of the demand like other units on the market.

  This unit is available in a variety of sizes, in both single and dual circuit models; and each unit has the ability to scale up or down in capacity to meet demand. Flexible capacity ranges from 2 to 35 tons (7 to 125 kW), depending on the Ultra model selected. For example, the 125 kW gForce Ultra gives you a 35 ton unit for when you eventually need it. But this unit can ramp all the way down to 6 tons while your data center is in its early stages.

- **Requires smaller back-up generator –** By reducing in-rush and start-ups, electrical surges are greatly reduced. It's like a "soft start," with no huge inrush of energy. As backup generators are sized to handle expected surges, this enables data rooms to install smaller back-up generators than what would be required for CRAC equipment that uses older technology.

- **Fully customizable –** The gForce Ultra also lives up to Data Aire's heritage of customizability. Data Aire builds custom units, and can customize this unit based on your specifications and desired configuration.

Plus, like all Data Aire products, the gForce Ultra CRAC units are very well made and available with the industry's best manufacturing lead times.

CONCLUSION

All air cooling equipment is not created equal. Data Aire is the first company to develop the new variable capacity technology and apply it to CRAC units to lower energy usage and increase reliability. With gForce Ultra, facilities get ultra-precise environmental temperature control in a system that is built so well you can walk away from it without any worries.

It's no surprise that customer feedback on the gForce Ultra has been universally positive. This is the most advanced technology on the market, and it sets a new standard for reliability, efficiency and scalability.

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