POWERHOUSE

Made in the USA

IES & SERVICES INCORPORATED

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INNOVATIVE ENERGY SOLUTIONS SERVICES, INC.

RESIDENTIAL

COMMERCIAL

INDUSTRIAL

Technical Environment Solutions
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The Power of Conservation

Innovative Energy Solutions & Services, Inc.

SAVINGS ON BILLS

As voltage is increased and stabilized, amp loads decrease reducing peak demand. Energy previously lost to ground is captured and recycled back through the system reducing energy costs.

INCREASED EQUIPMENT LIFE

Motors and components are now able to operate at optimum rpm with reduced heat and without the common voltage spikes and voltage drops.

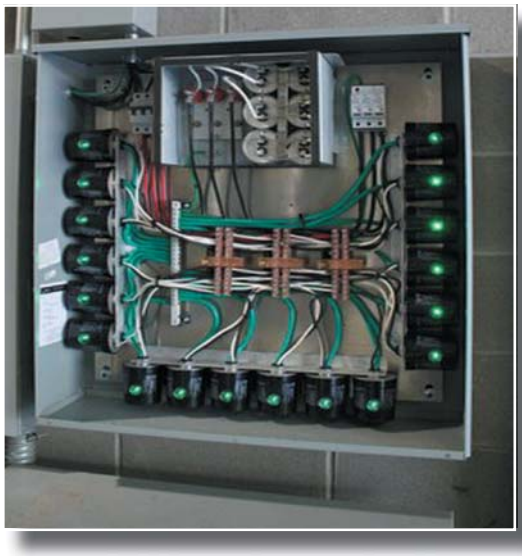
REDUCED MAINTENANCE COSTS

As a result of the more efficient conditioned power, equipment runs under less strain thus reducing heat 30% to 40%.

Costs associated with replacement of motors, compressors and ballasts are reduced as well as man hours and downtime.

THE POWERHOUSE power conditioning system by Innovative Energy Solutions, Inc. stands alone in energy conservation products.

Developed over years of research and development, *THE POWERHOUSE* has a proven track record of energy savings and increased equipment efficiency.



Power delivered to a panel by the grid is affected by external upstream influences beyond your control. These external influences result in deteriorated power quality delivered to your panel.

- c UL us approved.
- Balances voltage across all phases
- Reduces peak demand loads which results
- Reduces device vibration, noise, and heat
- Provides surge protection
- Low installation cost
- 5 year limited warranty on all parts

THE POWERHOUSE boosts, balances and stabilizes voltage across all phases.

Simultaneously, *THE POWERHOUSE* balances and reduces amp loads on the panel. Power quality is greatly improved even when demand is increased. There is no voltage drop when equipment starts up. By boosting, stabilizing and balancing power across the phases, equipment operates at peak design with decreased strain.

THE POWERHOUSE generates real bottom line savings through:

- Reduced KW consumption
- Capturing lost voltage
- Reduction of peak load charges
- Increased equipment lifespan
- Decreased maintenance costs

US PATENT NUMBER: US8971007 • US PROVISIONAL SERIAL NUMBER 61/196,036 •US REGULAR SERIAL NUMBER 12/579,030 • INTERNATIONAL PCT SERIAL PCT/US2009/060666

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Johnson

(54) **ELECTRICAL ENERGY SAVING SYSTEM**

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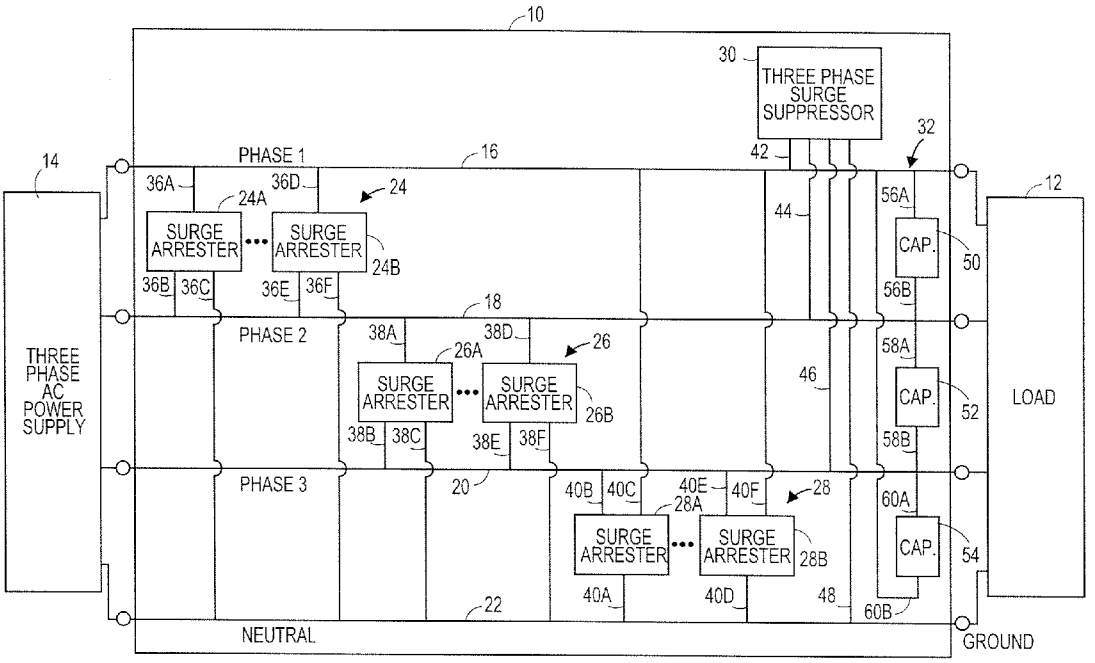
(52) **U.S. Cl.** **361/118**

(57) **ABSTRACT**

A system for conditioning the three-phase alternating current electric power, including a first phase, a second phase, a third phase, and a neutral line, supplied to a load includes a plurality of first surge arresters, a plurality of second surge arresters, a plurality of third surge arresters, a three-phase surge suppressor, and a plurality of capacitors. The surge arresters minimize the amount by which the voltage between two phases and the neutral line exceeds a rated value. The three-phase surge suppressor minimizes the amount by which the voltage between the three phases and the neutral line exceeds a rated value. The capacitors minimize the amount by which the voltage between two phases falls below a rated value.



Powerhouse Overview

When installed at a **Main Distribution Panel (MDP)**, the Powerhouse levels, boosts, and maintains voltage on all phases of a wye system that uses a neutral. Below are definitions of some terms which are utilized throughout this paper:

- **Inductive Load** - any load requiring a magnetic field to operate (motors, inductive capacitors, gaseous tube lighting ballasts, transformers, inductive furnaces, fans, relays, solenoids and chillers). Inductive loads draw a large amount of current (inrush current) when first energized, then decrease after a few cycles to a full-load running current.
- **Non-Inductive Load (Resistive Load)** - any load not containing capacitance or induction such as incandescent lighting or electrical heaters, ovens, burners and toasters. The current instantly attains its steady-state level without first rising to a higher level.
- **Reactive Power** - the power required to start and maintain a magnetic field in an inductive load. Although reactive power is necessary in operation, it does not provide real work **(kW)** and is eventually passed through the neutral line to ground. This is measured in kilovolt-amperes-reactive **(kVAr).**
- **Real Power (kW)** - the actual work an inductive and resistive load performs, as opposed to **kVAr** which does not perform actual work. Utilities bill by the **kW** and sometimes penalize on the amount of **kVAr**.
- **Apparent Power (kVA)** - measured in kilovolt-amperes, is the sum of **kW + kVAr.** It is the total power supplied to an **MDP**.
- **Power Factor** - a ratio of real power **(kW)** and apparent power **(kVA)**: **kW/kVA**. This is a measure of efficiency. The highest power factor desired is 100% or 1. A number less than 1 indicates inefficiencies within the load. A power factor of 0.80, or 80%, indicates an inefficiency of 20%. Inductive loads lead to a much lower power factor because of the non-working power needed to maintain their magnetic fields. Non-inductive or resistive loads approach 100% efficiency.

Problem: Power, as supplied by the utilities, can be fraught with issues even before the consumer is able utilize it. These can include blackouts, brownouts, line harmonics due to electromagnetic pulses (EMPs), and issues due to sudden spikes in upline or downline use. Inside the facilities, power surges, spikes and sags create undue disruption and wear on any motors, chillers, lights, and electrical devices (computers, TVs, outlets, UPS equipment, digital displays, rectifiers, relays, breakers, switches, monitors, etc). Temporary disruptions (brownouts) or more long term outages (blackouts) don't necessarily cause problems or damage when the system is down or off but most likely creates a spike as well as sags when suddenly energized or turned on. This alone is the greatest cause of equipment failure.

Low power factor creates more heat for the inductive load because more current (heat) is needed to make up for the inefficiencies of the load. Even though the damage can occur over a longer period of time, excessive heat, in the form of current, is detrimental and destructive to motors. Higher power factor will help with efficiency and increase the longevity of motors by reducing the heat (current) greatly.

Harmonics occur when voltage and current are not in phase with one another with their respective sine waves. Measured as total harmonic distortion (THD), harmonics are merely a byproduct of a nonlinear load. Examples

of nonlinear loads are battery chargers, adaptors, fluorescent lamps (because of the choke coil), LEDs, electronic ballasts, variable frequency drives (VFDs), rectifiers, uninterruptible power supply (UPS), switching mode power supplies (SMPS), photocopiers, personal computers, laser printers and fax machines. However, in a linear load, both voltage and current follow one another without distortion to their pure sine waves. Examples of linear loads are resistive heaters, incandescent lamps, and constant speed induction and synchronous motors.

Effects: The consumer ultimately pays the price in many ways:

1. Many utilities penalize commercial users who operate with low power factor (usually under 0.9) in the form of demand charges. If it is not labeled as such on a power bill, this may be disguised as a “fee”.
2. Maintenance cost of equipment can account for a company’s greatest expense. Reduction of heat (current) and higher efficiency (power factor) can reduce or significantly defer maintenance costs.
3. Most power systems can accommodate a certain level of harmonic currents but will experience problems when harmonics become a significant component of the overall load. As these higher frequency harmonic currents flow through the power system, they can cause a plethora of problems, including:

- communication errors
- overheating and damage to hardware
- overheating of electrical distribution equipment (cables, transformers, standby generators, etc.)
- high voltages and circulating currents caused by harmonic resonance
- equipment malfunctions due to excessive voltage distortion
- increased internal energy losses in connected equipment causing component failure and shortened life span
- false tripping of circuit breakers
- metering errors
- fires in wiring and distribution systems
- generator failures
- lower system power factor, resulting in penalties on monthly utility bills.

Solution: The Powerhouse addresses these issues through its use of certain components working in concert to capture and recycle reactive power (kVAr) for its reuse. Its unique wiring configuration (Patent #8971007) allows these components to redirect the kVAr to either a capacitive or distributive function as needed within a facility’s power grid. An array of 18 metal oxide varistors (MOVs), each rated at 100 kA, act as surge arresters through a series of internal diodes and resistors. The Powerhouse’s patented wiring configuration allows the MOVs to redirect the many spikes in voltage a facility experiences on a daily basis to a series of fluid-filled capacitors for eventual distribution in the case of a sag or dip in voltage, which usually occurs during sudden upsurges in power consumption within a facility. Additionally, the wiring configuration allows for the neutral to be utilized as a secondary power source and is connected inside the Powerhouse so that it can be redirected in a capacitive or distributive function. In this way, the Powerhouse treats the neutral as a “phase D” within a three phase system. It is for this reason alone that the Powerhouse can only operate within a wye and not a delta system, since the delta does not use a neutral. Also, a delta system generally has a “high leg”, making it impractical if not impossible to balance voltage between the phases. The constant and consistent “back and forth” between the MOVs and the capacitors keeps the voltage between the phases boosted, leveled and maintained at all times no matter the load -- sudden or otherwise -- within a facility’s grid. Similarly, the Powerhouse protects against spikes or surges

when the grid is suddenly energized after a power brownout or blackout. For added protection, a secondary surge protector within the Powerhouse protects the grid for up to 50,000 volts.
When the neutral is utilized within the Powerhouse, a unique effect occurs. All values for kW, kWh, kVA, Amperes and kVAr are lowered in a pronounced way. Conversely, power factor increases to typically between 0.95 and 0.99, and voltage increases and levels in all phases. These effects are confirmed by repeated on/off power logger data tests, and in various independent studies performed by General Electric, Applied Research Laboratories, the Department of Defense and the Department of Energy.
What sets the Powerhouse apart from all other manufacturers of power factor correction equipment is this meaningful drop in kW or kWh. Equipment and lighting within a facility still operate at the kW that they are rated for (as inductive and resistive loads are always going to run true to their rated kWs). The Powerhouse's ability to recycle the kVAr slows the kVA draw from the supply side (utility). This causes the appearance of a kW drop within the facility which will be reflected on the consumer's power bill. This is the "exception to the rule" when it comes to power correction equipment.
The Powerhouse also eliminates about 80% of the harmonics, which is usually the greatest concern of energy managers and electrical engineers of any facility. The increasing use of VFDs and UPSs in facilities leads to the increasing need to address problems associated with harmonics. The Powerhouse solves these issues.

Summary: In order to determine the health of a facility's power grid, power data loggers are necessary to get an overall picture of a facility's habits in power usage as well as all the values related to that use. Based upon those values, a capacitor bank is carefully calculated for the proper size to ensure adequate return of kVAr as fed to the capacitors by the neutral and MOVs. Voltage between the phases

are balanced, boosted, leveled and maintained at all times. Power factor is corrected to an ideal 95-98% and will result in the reduction in demand charges and the elimination of the associated penalties. KW is decreased enough to significantly lower power bills, since utilities generally charge by the kW or kWh. Induction loads run up to 30-40% cooler and operate more efficiently. Harmonics are mostly eliminated and will no longer pose a problem to a facility.

With over 1100 units installed and more being installed daily, the Powerhouse is proving itself in a wide variety of settings: restaurants, hotels and convention centers, mines, lumber mills, industrial processing plants, grocery stores, colleges and school systems. **The Department of Defense has completed testing of the Powerhouse and has accepted its technology for their military bases.** The Powerhouse saves KW and KWH. The Powerhouse saves money for clients. This is what differentiates the Powerhouse from other equipment.

JB3 CONSULTING
Comprehensive Energy & Financial Solutions

Independent Evaluation of Energy Savings Performance

The Powerhouse Energy Conditioning System

TESTING LOCATION: **Main Event**
9375 Dallas Parkway
Frisco, Texas 75033

PREPARED FOR: Powerhouse Distributor.

REPORT DATE: **July 1, 2016**

CERTIFIER: **John J. Burdette III**
Certified Energy Manager (CEM)
CEM Certification ID# 19189
Date of Expiration: 12/31/2018

JB3 CONSULTING
Comprehensive Energy & Financial Solutions

EXECUTIVE SUMMARY

JB3 Consulting, John J. Burdette III, a Certified Energy Manager has been retained by Wayne Jones, Manufacturer's Representative for Innovative Energy Solutions Inc., the manufacturer of the Black Hawk Powerhouse, to undertake an independent evaluation of the kWh savings arising from the installation of a Black Hawk Powerhouse Power Conditioner at the Main Event location at 9375 Dallas Parkway, Frisco, Texas, 70533. A certified Powerhouse dealer, installed the 480/100 kVAr unit in the spring of 2016.

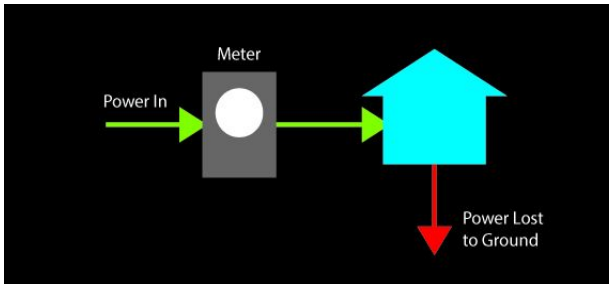
The Powerhouse Energy Conditioning System stated benefits;

1. Greatly reduces low voltage issues
2. Elevates voltage of the entire system
3. Stabilizes voltage of the complete system
4. Reduces voltage drops when demand increases.
5. Reduces tripped breakers caused by low voltage or power spikes
6. Reduces kilowatt hours (kWh) resulting in lower utility bills.

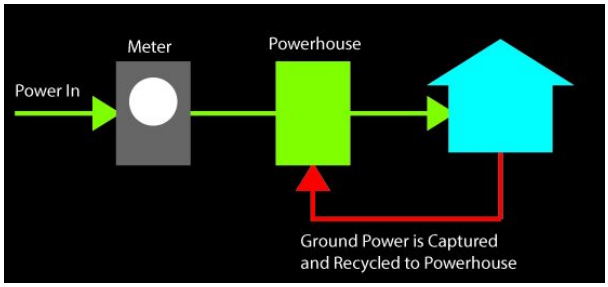
By capturing and balancing the energy, The Powerhouse ensures that equipment is running at its optimum voltages, which results in fewer mechanical problems and lower maintenance costs, thus increasing the lifespan of equipment.

How It Works

All electrical energy coming into a facility is known as Apparent Power, and the power actually used is defined as Real Power. A portion of the power entering an electrical system is lost to ground and never consumed. This is referred to as Reactive Power. The ultimate goal is to bring these two factors, Apparent Power and Real Power, closer together. The Black Hawk Powerhouse is able to accomplish this by capturing this lost energy, storing it and feeding it back into the electrical system:



Existing System



The Powerhouse

EVALUATION SITE

Dallas-based Main Event Entertainment is a 60,000 square foot facility featuring state-of-the-art bowling, multi-level laser tag, high ropes adventure courses, billiards, interactive and virtual video games, and food service. Founded in 1998, the rapidly growing subsidiary of Ardent Leisure Group (ASX: AAD) of Australia comprises 22 U.S. entertainment centers.

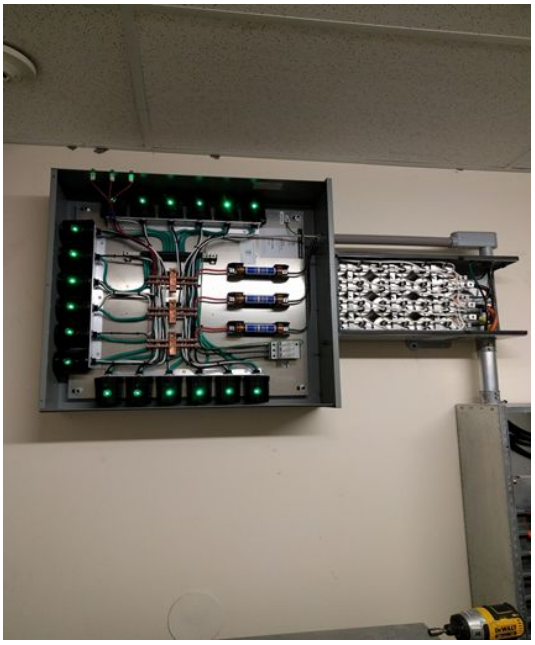
9375 Dallas Parkway, Frisco, Texas 75033
60,000 sq. ft. facility
28 bowling lanes, restaurant, huge arcade, laser tag and more

This is an excellent candidate for the Powerhouse due to the fact that there are a great deal of motors and inductive loads at this facility that will inherently lower the power factor and increase electric utility bills.

OBJECTIVE

The objective of this evaluation is to measure the differences in voltage, current, power factor and power reduction measured in kilowatts (kW) for a short duration while the device was on and conditioning the incoming power and while the device was off and not actively conditioning the incoming power.

480 Volt / 100 KVAR Powerhouse can be installed in various positions as shown above



480 Volt / 100 KVAR unit opened to expose the heart of the unit, the metal oxide Varistors shown above

Components of the Black Hawk Powerhouse:

- **Varistors**

  A Varistor is an electronic component with an electrical resistance that varies with the applied voltage. Also known as a voltage-dependent resistor (VDR), it has a nonlinear, non-ohmic current–voltage characteristic that is similar to that of a diode. In contrast to a diode however, it has the same characteristic for both directions of traversing current. At low voltage it has a high electrical resistance which decreases as the voltage is raised.

Varistors are used as control or compensation elements in circuits either to provide optimal operating conditions or to protect against excessive transient voltages. When used as protection devices, they shunt the current created by the excessive voltage away from sensitive components when triggered.

The most common type of Varistor is the Metal-Oxide Varistor (MOV). This type contains a ceramic mass of zinc oxide grains, in a matrix of other metal oxides (such as small amounts of bismuth, cobalt, manganese) sandwiched between two metal plates (the electrodes). The boundary between each grain and its neighbor forms a diode junction, which allows current to flow in only one direction. The mass of randomly oriented grains is electrically equivalent to a network of back-to-back diode pairs, each pair in parallel with many other pairs. When a small or moderate voltage is applied across the electrodes, only a tiny current flows, caused by reverse leakage through the diode junctions. When a large voltage is applied, the diode junction breaks down due to a combination of thermionic emission and electron tunneling, and a large current flows. The result of this behavior is a highly nonlinear current-voltage characteristic, in which the MOV has a high resistance at low voltages and a low resistance at high voltages.

A Varistor remains non-conductive as a shunt-mode device during normal operation when the voltage across it remains well below its "clamping voltage", thus Varistors are typically used for suppressing line voltage surges. (Sources: Wikipedia, General Electric Technical Information Series December 1972 (ref. 1))

The MOVs used in the Powerhouse, 18 in all, are manufactured by GE and are rated at 100 KA each.

- **Capacitors**

  A capacitor is a passive two-terminal electrical component that stores electric energy in an electric field. The capacitors used in the Black Hawk Powerhouse are manufactured by General Electric. They are liquid-filled (unlike the older solid-filled composition), and are projected to have a 20+ year lifespan.

- **Patented wiring configuration**

  Reference U.S. Patent #897100. The wiring configuration allows for the neutral to be utilized as a secondary power source and is connected inside the Powerhouse so that current can be redirected in a capacitive or distributive function. In this way, the Powerhouse treats the neutral as a “phase D” within a three phase system. (Source: Powerhouse White Paper)

- **A secondary surge protector**
  Protects the grid for up to 50,000 Volts

METHOD OF EVALUATION

A Dent Instruments Elite Pro XC Power Meter (ref. 2) connected with RoCoil mV Series of Flexible Current Transformers (ref. 3) to each of the three phases was installed to measure and log the following attributes of the supply power. I requested and received the most recent calibration statement from the manufacturer which indicates that the unit is in calibration and rarely if ever needs recalibration.

The meter was installed at the facility on May 20th, 2016 on a very hot day. We chose a hot day (ambient temperature 92 degrees Fahrenheit) to ensure that the air conditioners were running and the facility was occupied and loaded. Temperature inside the facility was 75 degrees Fahrenheit. Measurements were recorded with the Powerhouse *off* for one hour, and with the Powerhouse *on* for one hour. The Dent power meter collected data at one second intervals.

This meter measures each leg of voltage and provides an average measurement output in the data set collected. As a safety precaution, I also verified the averaging calculations that the unit provides. I found them to be accurate.

The meter also measures and calculates power factor and provides this output in the data set collected. As a safety precaution, I also verified the power factor calculations that the unit provides. I found them to be accurate, as well.

SUMMARY OF RESULTS

VOLTAGE

A slight improvement in Voltage was recorded on each phase.

Powerhouse On: Average Voltage = 282.78 volts

Powerhouse Off: Average Voltage = 279.93 volts

Overall Improvement: 2.85 Volts Added

CURRENT

A significant reduction in Current was recorded.

Powerhouse On: Average Current = 281.83 amps

Powerhouse Off: Average Current = 390.99 amps

Overall Improvement: 27.92%

POWER FACTOR

A significant increase in Power Factor was recorded.

Powerhouse On: Average Power Factor = 0.96

Powerhouse Off: Average Power Factor = 0.80

Overall Improvement: 16.97%

KILOWATT

A significant reduction in Peak kW was recorded.

Powerhouse On: Average kW = 230.51 kW

Powerhouse Off: Average kW = 262.89 kW

Overall Improvement: 12.3%

KVA

A significant reduction in KVA was recorded.

Powerhouse On: Average kVA = 239.08 kVA

Powerhouse Off: Average kVA = 327.99 kVA

Overall Improvement: 27.11%

CONCLUSION

In conclusion, the test data supports the stated benefits that this unit will redirect power that is typically lost and recycle it back into the electric supply system. Our findings conclude that the Powerhouse Energy Conditioning System has proved to:

1. Improve the facilities supply voltages.
2. Significantly reduce the electrical supply current.
3. Reduce the facility's peak kW (and kWh) billed by the utility resulting in lower energy costs for the facility
4. Balance voltage across all phases (legs).
5. Significantly increase the Power Factor.
6. Reduce Reactive Power losses.
7. Reduce spikes in energy demand, resulting in lower peak demand charges.

CERTIFICATION

John J. Burdette III
Certified Energy Manager (CEM)
CEM Certification ID# 19189
Date of Expiration: 12/31/2018
Certified Demand Side Manager (CDSM)
CDSM Certification ID# 19189
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Email: johnjburdette3@gmail.com