

Saif-El Principles

Saif-El is an integral system. It is equipped with a microprocessor-based controller that will monitor and respond to voltage, current and power factor in conjunction with threshold current/harmonics. The microprocessor in accordance to adjusted settings will control components through a damped circuitry to achieve the designed criteria by using electric components, *Saif-El* controller is a **real time operated system & has LCD display** for display of all power parameters (Voltage, Current, power Factor, KW, KVA, harmonics) with barchart for individual harmonic display and waveform displays. With the help of very fast reliable **heavy duty Electronic Switches**, it also gives a very fast switching of **RLC tank circuits**.

Saif-El system are equipped with a number of active and passive components such as E.Ss, resistors, capacitors, inductors / reactors, MOV's, Control & monitoring circuitry, enunciator lights and fuses etc. these components are designed and fabricated in a system with its principles of operation being based on ladder logic. **The system's design criteria are based solely on the customer's or client electrical distribution characteristics and economic consideration.**

Saif-El, an energy saving and power quality system. It saves energy by **up to 20%** with paybacks of less than two years, while filtering surges and harmonics, stabilizes voltage, and protects equipment and machinery.

OUR APPROACH

STEPS

- (A) It starts with an comprehensive electrical measurement & evaluation of your facility's distribution system using state-of-the-art power analyzer and latest software (the parameters include voltage, current, power factor, KW,KVA, Harmonics) and, finally to effectively evaluate & Address any existing inefficiencies / problems.
- (B) We actually test and measure your electrical load during the course of the plant's normal operation online without any shutdown. The measurement is done using a very fast measuring instrument and covers Min/Max values of all the 3 phase & neutral power parameters at the same time on load. From that we are able to point out the areas in your plant where energy is being wasted. These information and related electrical reading/data will be analyzed, and from which a computer generated comprehensive report will result.
- (C) Based on these measurement & past electricity bills/consumption records for the last 12 months, a load profile is made.
- (D) Finally based on these measurements & load profile we offer you with specific solutions along with the Projected Resultant parameters with savings, Project Cost, Annual Saving, R.O.I and Cost/ Payback schedule.
- (E) At the time of our presentation, we go over the entire report with you, answering any and all of your question. If you wish, your engineering staff or utility representatives may be present at all time, to help verify our claims and savings.
- (F) From this information we determine both the electrical characteristics, as well as the load behavior. After we evaluate this information, and upon the acceptance, we run the '**Link analysis**' of each branch circuit, this information determines our exact approach to address all of the problems and improvements for your plant. We then program the data in our *Saif-El* Controller, which then reacts to plant's load conditions.
- (G) If we have more than one transformer/main panel board, how many *Saif-El* systems do we need? Well, Typically one *Saif-El* is required for each transformer/ main panel board. However, exact breakdown and number of units will be determined following the **Link Analysis** to ensure *Saif-El's* performance and effectiveness.

Saif - El

“ Savings through Power quality”

With industry and government becoming more conscious about the need to deduce the consumption of electrical energy, there is a greater emphasis on energy efficiency systems.

Saif-El reduces industrial, commercial, institutional electric costs by a factor of **upto 20%** with actual payback of below two years, greatly increasing longevity of equipment and machinery, and resulting in reduced maintenance and downtime.

Many of the Energy Efficient products available to industry are based on either shutting down plant and equipment, or rescheduling the plant's production operation, so that the energy is consumed during off-peak periods. They call this Energy Management (EMS), or Building Automation System (BAS).

With *Saif-El*, we are now able to address the essential issue, which is, making more effective and efficient use of electric power without switching off any part of a plant or its electrical load.

What is *Saif – El*?

Saif –El is a renowned state of the art energy saving and power conditioning systems, with proven performance and satisfied customers. *Saif-El* is the only integrated modular system in the world specifically custom-engineered to effectively and economically optimize power quality with guaranteed electric savings of **up to 20%** (conditions apply), without any disruptions to equipment or machinery. *Saif-El* is versatile and is available in different sizes based on your facility's requirements.

Saif-El's multistage system is dual protected, with each stage independently monitored, protected, and activated, resulting in simultaneous addressing of multiple problems and functions. This eliminates the need to purchase a number of different devices to correct each anomaly.

Saif-El is a centralized power conditioning system with its control logic being fully integrated. *Saif-El* is not an energy management system, therefore it will not shut down or cycle any loads. All *Saif-El* systems are equipped with a microprocessor-based control, capable of monitoring voltages, current and power factor in conjunction with threshold current / harmonics.

Saif-El's design may incorporate a number of active and passive components such as SCR's , resistors, capacitors, inductors/reactors, MOV's controls monitoring / control circuitry, enunciator lights and fuses. These components are custom designed and fabricated to function in an integrated system with its principle of operation being based on LADDER LOGIC. Design criteria for each *Saif-El* system is solely dependent on each specific customer's electrical distribution characteristics and economic considerations. Therefore evaluation of the savings resulting from *Saif-El* should be carried out based on **Incremental Values**.

Saif - El Benefits

1. **Reduces your facility's power costs** by up to 20% through reduction of KW Demand, KVA Demand, and KWH Consumption.
2. **Protects your company investments** in plant equipment and machinery.
3. **Reduces equipment maintenance costs** and improves productivity by reducing plant downtime due to equipment failure.
4. **Balancing line voltages** cause motor to run cooler, thereby extending motor life.
5. **Makes it possible to increase** the total connected load of a circuit, without increasing size of the transformer or size of the conductors and protective equipment.
6. **Harmonics, surges and transients** are eliminated or reduced and managed properly, thereby minimizing their effects on equipment and machinery.
7. **Provides protection** for the following:-
 - a) Computers
 - b) Process/Production controls.
 - c) Electronic and related equipment.
 - d) Variable speed and automatic speed drives.
 - e) Medical equipment, Cat -Scan, MRI Unit, X-ray Equipment.
 - f) Sensitive measuring and diagnostic equipment.
 - g) Motor, pumps and compressors.
 - h) Lights and ballasts.
 - i) Transformers, switchgears, and electrical distribution.

Saif - El Features:-

1. **Voltage improvement** : improves voltage supplied to the load, thereby minimizing heat generation. This result in energy savings improved production, and increased equipment efficiency and longevity.
2. **Three Phase Balancing:** Reduces phase current and balances the load over the three phases based on X/R and Z, thereby reducing negative voltage sequences and circulating currents, resulting in reduced equipment maintenance and failure
3. **REMEMBER:** Insulation breakdown damage is permanent and cumulative.

Due to available electrical supply conditions, most motor engineers and operators have had no choice, until ***Saif-El***, but to allow motors to operate with a 2-5% voltage unbalance. However, they realize ANY voltage unbalance makes a motor run hotter, increasing the probability and degree of insulation breakdown.

That's why voltage balancing is such a high priority for the ***Saif-El*** system. ***Saif-El*** enhances and stabilizes the supply of electricity to your facility.

Saif-El will effectively filter unwanted spikes to equipment or machinery.

4. **Voltage Unbalance-** Three phase motors are even less tolerant of phase –to-phase voltage unbalance. A 5% unbalance will cause 50% temperature rise in three phase motors and is defined by the National Electric Manufacturers Association- (NEMA) as the absolute maximum unbalance under which motors should be allowed to operate for short periods of time as delineated in the NEMA specification MG1-14.34.
5. **Motor Life-**Insulation life is reduced by half for every 10 degree C temperature rise above the motor’s maximum design temperature limit A 20 degree C temperature rise means the insulation will only last 25% of its design life.
6. **Filters harmonics:** Surged and transients, thereby improving longevity of equipment and eliminating down time.
7. **Protects from Surges & Transient:** Reduces line eddy current and hysteresis losses, thereby reducing the kilowatt demand and kilowatt-hour consumption.
8. **Improves power factor** by reducing reactive and apparent power, thereby improving system efficiency, while eliminating possible related charge. This is done without any Capacitor’s deleterious side effects.
9. **Releases distribution’s wasted KVA** capacity, thereby allowing additional loads without requiring any transformers, increased switchgear size or capital expenditure.

***Saif-El* Cost Benefit**

Saif-El reduced industrial, commercial institutional electric costs by a factor of up to 20% with actual paybacks of below two years, greatly increasing longevity of equipment and machinery, and resulting in reduced maintenance and downtime.

Saif-El is the culmination of years of technological assessment and field-testing. Special computer modeling techniques were developed at university level to support the proper performance of each system.

With *Saif-El*, we are now able to address the essential issue, which is, making more effective and efficient use of electric power without switching off any part of a plant or its electrical load.

***Saif-El* Installation & Warranty**

1. Installation

Installation of the ***Saif-El*** system is simple and quick and can be carried out by your own certified electrician. Installation is the clients responsibility, however, up on the clients request licensee will proceed with the installation for which there will be an additional charge to the Project Cost (s) quoted.

2. Fail Safe

Saif-El system is guaranteed. Should the system fail for some extraneous reason, its protective devices (breaker/ disconnect and fuses, will isolate ***Saif-El*** form the load/distribution and not cause an interruption to the main electrical system.

3. Warranty

Saif Electronics Ltd. Warrants ***Saif-El*** to be free from defects in material and / or workmanship for a one-year period after original date of the shipment of the ***Saif-El*** system to the customers. This warranty does not include damage to ***Saif-El*** resulting from acts of God, Accident, Misuse, External abnormalities, Improper installation or operation, or unauthorized repair or alteration. If ***Saif-El*** should become defective within the warranty period, we will elect to repair or replace components free of charge, at our option excluding labour and fuses.

The customer's sole remedy shall be repair or replacement as expressly provided above. In no event shall Saif electronics Ltd., be liable for any incidental or consequential damages arising out of the use of ***Saif-El*** system either directly or indirectly related to the ***Saif -El*** for any purpose what so ever, other than those set forth by Saif Electronics Ltd.

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PERFORMANCE GUARANTEE (VERIFICATION OF SAVINGS)

In order to achieve a concise picture of the savings resulting from *Saif-El*, namely Peak Demand (KW) or (KVA), Energy consumption / Usage (KWh) and possible Power Factor (%). Measurement should be taken on the primary side (High Voltage) of the power transformer, with *Saif-El* one-week-off and one-week-on, or ideally one-month-off and one-month-on, the more accurate the *Saif-El's* response to the facility's load conditions and variations. Please note that our first year Annual Estimated Utility Savings, or guaranteed, is based on the data and the twelve month electric bills received at your facility.

Following base parameters must be monitored and tabulated simultaneously, for before and after *Saif-El* installation.

1. Peak Demand (KW or KVA)
2. Energy Consumption /Usage (KWh.)
3. Actual costs as reflected on the electric bills.
4. Hours of Operation.
5. Percentage of load in operation.
6. Units of production.
7. Load Factor.
8. Degree hours.

As you can clearly note, the actual savings will be affected dependent upon tolerance of all the above parameters. If within two years from the date *Saif-El* is in operation you have not realized the first year Annual Estimated Utility Savings indicated in the Savings Profile, with respected to the above parameters, SEL will make up the difference: **GUARANTEED!!**

WHAT IF LOAD CHANGES LATER?

Saif-El system is designed to address the facility's normal load at the time of measurement/design. Within these parameters the system will separate without any modifications. If the load increases beyond the design criteria, you may upgrade *Saif-El's* size to address the plant's increased load, without major capital expenditure. If you do not want to upgrade *Saif-El*, the original savings will still be available,. The only difference being that the client does not get the benefit of the *Saif-El* savings on the additional loads increase.

By adding more load, *Saif-El* will not be harmed. However the effective performance will be limited to that portion of the load that *Saif-El* was designed for. Beyond that, the extra module (s) / components need to be added to the original *Saif-El*, in order to compensate for the additional portion of the load, based on its characteristics. *Saif-El* is assembled in a modular formation so it can easily be disintegrated to smaller units to satisfy dispersion of the load.

Saif- El

A UNIQUE APPROACH TO ENERGY SAVINGS THROUGH POWER QUALITY

TECHNICAL HIGHLIGHTS

ABSTRACT

Incidents of problems and damage to customer-owned electrical equipment resulting from abnormal voltage conditions, current imbalance, surges/transients, harmonics, losses, Power Factor, power interruptions and phase loss and associated expenses, resulting in increased electric bills, excessive failure and maintenance of equipment and machinery have long been a concern to customers as well as electrical utilities.

This paper briefly quantifies the effect of all of the above undesirable conditions from an operation/maintenance and economic point of view. An alternative method to remedy such aberrances is offered through use of an integrated system called *Saif-El*, for industrial, commercial and institutional facilities.

Saif-El microprocessor based control, operating based on ladder logic principle, will insure continuous monitoring of system's reactive power/ power factor (X/R), and threshold current. An automatic system, equipped with variable high and low adjustments, whose control employs data input other than that of the system's reactive current component will perform during its corrective process in a damped or tuned RLC network response to an indicative or relative manner.

In addition, *Saif-El* can provide manually controlled specific single- harmonic tuned filters as well as multiple - harmonic tuned filters to remedy all harmonic conditions present in the industry and commerce.

Saif-El is an integrated system. *Saif-El* systems are equipped with microprocessor based control, capable of monitoring Voltage, Current and Power Factor in conjunction with threshold current /harmonics. The microprocessor, following adjusted settings, will control components through a damped circuitry to achieve the design criteria by using contactors and SCR's.

Saif-El is equipped with a number of active and passive components such as SCR's contactors, resistors, capacitors, inductors/reactors, MOV's controls, monitoring/control circuitry, enunciator lights and fuses. These components are designed and fabricated in a system, which its principle of operation is based on a Ladder Logic. Design criteria for each *Saif-El* is solely dependent on customer's electrical distribution characteristics and economic considerations.

Saif-El's Standard features address: voltage stability, three phase imbalance, surges/transients, broadband harmonics, distribution / system losses, power factor and KVA release which have been topic of this paper.

In addition, **Saif-El** offers **Optional features** that can be designed and made to address the following problems:

- A- Specific harmonics filtering-filters specific or multiple harmonics of any magnitudes;
- B- Brownout protection-maintains nominal voltage during the occurrence of temporary, momentary low line voltage;
- C- Phase synthesis- maintains continuous three phase supply on the occurrence of either a momentary loss or complete failure on one phase. This feature will allow power to be maintained until the three phase supply voltage is restored.
- D- Momentary supply failure protection-maintains continuous supply during intermittent voltage interruptions.

1. **VOLTAGE IMPROVEMENT** : Over voltage, Under voltage and voltage fluctuations are among major electrical problems, which presently exist in industry and commerce. Due to ever changing load characteristics and supply voltage requirements based on continuous variations in impedance and X/R, resulting is possible voltage instability, acceptable voltage regulation is essential. An unbalanced voltage supply to motors occurs more often than commonly known and causes numerous electrical, mechanical, and energy problems.

Voltage unbalance can be extremely detrimental to the proper operation and life of a 3- phase motor. When line voltages, supplying an induction motor are not equal in magnitude, a multitude of problems occurs. Unbalanced voltage on 3-phase motors produces large unbalanced currents, overheating of the motor, shorter insulation life, excessive losses and wasted energy. Also significantly unbalanced line currents make the problem of providing adequate overload protection more difficult.

Unbalanced voltages occur quite frequently in a 3-phase distribution system, usually as a result of the connection of a large single-phase load to two of the three phase conductors. Comparatively speaking, we have experienced that in a 3-phase system, you will normally find one phase drawing more or less than the remaining two phases. Occasionally, the voltage unbalance may be due to errors in distribution transformer tap connections, an unstable utility voltage supply, poor connections in the power supply, open delta transformer system, a problem within the motor itself, or improper functioning of capacitor banks. When line voltages applied to a 3-phase motor are not exactly the same, the unbalanced currents cause a “negative voltage sequence” to occur. The negative voltage sequence has a rotation that is opposite to that of balanced voltages.

Unbalanced voltage produces a corresponding negative sequence flux causing unbalanced currents in excess of those under balanced voltage conditions. It is important to note that excessive currents create excessive heat, which in turn shortens insulation life, insulation breakdown is permanent. In the phase with the highest current, percentage increase in temperature rise will be approximately two times the square of the percentage voltage unbalance. Thus a 3% voltage unbalance will increase temperature rise about $3 \times 3 \times 2$ or 18%. Such an unbalance could also result in electromechanical vibration, leading to bearing failure. In additions, noise and vibration will be particularly severe on high RPM motors.

Saif-El with its multiple stage Ladder Logic configuration, connected in most cases in parallel, will provide number of variable impedance stages, containing RLC networks to assist in the desired voltage stabilization with respect to each electrical distribution's Q factor.

2. **LOAD BALANCING** : In today's industry, based on production and operation requirements, there are number of equipment and machinery suppliers with products of various characteristics, functions, and requirements. Variations of the same product by different suppliers are often so unique to that product in magnitude that in most cases its characteristics from no-load to full load can not be perfectly matched by another supplier. Such uniqueness can certainly affect impedance, X/R and its effect on the facility's electrical distribution.

Most important influential factor contributing toward three-phase imbalance can be credited to single phase loads. Non linear operation schedule of single- phase load in a facility and their distribution among the three-phase system will determine degree of phase imbalance in that facility as was explained, when line voltages applied to a 3 phase motor are exactly the same, the unbalanced currents cause a 'negative voltage sequence' to occur. These negative voltage sequences have a rotation that is opposite to that of balanced negative- sequence flux causing unbalanced currents in excess of those under balanced voltage condition. It is important to note that excessive current creates excessive heat, which in turn, shortens insulation life; insulation breakdown is permanent. In the phase with the highest current, the percentage increase in temperature rise will be approximately two times the square percentage voltage unbalance. Thus a 3% voltage unbalance will increase temperature rise about $3 \times 3 \times 2$ or 18%. Such an unbalance could also result in electromechanical vibration, leading to bearing failures. In addition, noise and vibration will be particularly severe on high RPM motors.

Saif-El with its multiple stage ladder Logic configuration, connected in most cases in parallel, will provide number of variable impedance stages containing RLC network with components normally connected in a delta formation for each stage to minimize losses while the controller responds based on a the load's X/R and load factor with each stage response of not to exceed 40 seconds to assist in the desired three phase balanced load, as viewed from the primary supply side.

3. **SURGES AND TRANSIENTS** : A **Surge** is not an impulse or a spike. A surge is a transient condition where a series a peak sine-wave voltages exceed the set standard voltages for a period of time, from about one half cycle to possibly several hundred cycles. This might also be defined as from about 8 milliseconds to 2.5 seconds.

As a result common surge suppressers or surge protectors may not suppress at all. These devices are designed to suppress impulses of a high magnitude. An **impulse** is a disturbance of the voltage waveform for duration of less than roughly 1 milliseconds.

An Impulse may be additive or subtractive in nature and it may have a ringing or oscillatory characteristic. Some of the more common terminology associated with this term are **spike, notch, transient, whisker and glitch.**

In a related matter **sag** is identical to a surge except that the peak sine-wave voltage has decreased from the set standards for a period of time, rather than increasing. Some of more commonly used terminologies associated with this term are **flicker** and **dips**. A long term under voltage condition that is actually planned by the utility company, or is the result of excessive loading, is called a **brownout**. A **blackout** is a widespread loss of utility either accidental or planned.

Voltage impulse resulting from heavy loads being switched ON and OFF within the electrical distribution system such as large motors, HVAC systems, switch arcing, fuse blowing, breakers clearing and arc furnaces, to name a few of traditional culprits, are among undesirable disturbances.

A comprehensive study by **IBM** revealed the following results:-

Type of Disturbance	No. of Disturbances	Days between Disturbances.
Under voltage	1569	2.1
Over voltage	103	32.2
Outages	65	51.0
Switching Disturbances	2831	1.2
Impulses	1676	2.0
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Total	6244	0.5

If we divide the total number of disturbances by the number of monitoring days, we get an alarming average figure. We can accept 2 events of one type or another every day.

Most all circuits can withstand a high voltage for a short time. The shorter the time becomes, the higher the tolerable voltage becomes. How quickly an arrestor can eliminate a surge from a circuit depends on four factors, the magnitude of the voltage, the quantity of the charge, the speed at which the arrestor starts conducting, and the conductivity of the arrestor common arrestors, because of their inherent characteristics have some resistive load by which they perform clipping. Based on their energy ratings, in Joules, the device can easily be destroyed without any indications for possible future protection. This phenomena is among the most deceiving, costly and least understood behavior by those who use them, which are the most common cause of failure and breakdown of computers, controls and more sensitive devices.

Saif-El behavior in such applications can be designed to withstand high current, high energy with extremely fast and unlimited response surges. In addition due to *Saif-El's* damping factor, most if not all energy will be absorbed to be released based on the systems phase sequence. In case of massive magnitude of surges or transients, *Saif-El's* components are fully protected with dual element and time delay fuses with continuous diagnostic system identifying operation of each internal component.

4. **POWER FACTOR** : Power Factor is the ration of Actual Power used in a circuit to the Apparent Power delivered by a utility. Actual Power is expressed in Watts (W) or Kilowatts (KW), apparent power in volt amperes (VA) or kilo volt amperes (KVA):

$$\text{Power Factor} = \cos\Theta = \frac{\text{Actual Power (KW)}}{\text{Apparent power (KVA)}}$$

In inductive loads, such as motors and transformers, current is used to create magnetic forces which produces the required torque in motors and the transformed voltage in transformers. These magnetic forces oppose changes in current levels. In an AC system, where the supply voltage is constantly being varied due to magnetic load requirements, the current lags the voltage. The phase angle between the current and voltage is referred to as the Power factor. Ultimate system power factor is unity (% 100). The lower the power factor, from the unity, the further current will lag behind the voltage, which results for magnetic current increase. Most common and economical solution to remedy low power factor adopted by most engineers used to be static capacitors, and isolated cases some still do.

This practice, just to improve power factor, though is economical, carries potentially damaging side effects. With today's computers and electronically controlled and sensitive equipment and machinery, application of capacitor can be a **major liability**. Concerns are vastly due to cost effectiveness with respect to most electrical rate structures, but mainly from failure of equipment and machinery and plant downtime. Power Factor Correction Capacitors (PFCC) can also overheat due to harmonic distortion on line voltage in the power system. Since the impedance of the capacitor decreases as the frequency of the applied voltage increases, excessive current flow through the capacitor. Capacitors can also form a resonant circuit with inductive elements in the system, which will create a measurable increase in the voltage across the capacitor and similar loads.

Static capacitors inherent characteristics are:

- A. Over voltage
- B. Harmonics magnification, resonance and over heating.
- C. Capacitive reactance increases in the system
- D. Leading power factor under low-load or no-load.
- E. Susceptibility to surges and transients.
- F. Power Factor.

Saif-El microprocessor based control, operating based on ladder logic principles, will insure continuous monitoring of system's reactive power /power factor. An automatic system, equipped with variable high and low adjustments, whose control employs data input other than that of the system's reactive current component will perform during its corrective process in a damped response to an indicative or relative manner.

5. **HARMONICS** : Linear loads, such as purely resistive loads, carry current waveforms, which are the same shape as the applied sinusoidal voltage waveform. Nonlinear loads, such as wave-chopping DC loads, carry current waveforms which are non-sinusoidal. While traditional linear loads allow voltages and currents of the fundamental frequency (50Hz) to appear in power systems with little or no harmonic currents, nonlinear loads can introduce significant levels of harmonics into the system.

A harmonic is simple an integer multiple of the fundamental frequency. The third harmonic in a 50 Hz system is a 150 Hz current, the fifth harmonic is a 250 Hz current, and so on.

Harmonics in the power system combine with the fundamental to form distorted waveshapes. The amount of distortion is determined by the frequency and amplitude of the harmonic currents. A nonlinear load draws current in abrupt pulses rather than in a smooth sinusoidal fashion. These pulses cause harmonic currents that, in turn, result in voltage distortion and harmonics, causing even more current harmonics in various parts of the power system.

Computers are among contributors to the problem of nonlinear loads, like most other electronics office equipment, computers are equipped with a diode / capacitor-type power supply. This type of power supply draws current only at the voltage peak of the sine wave AC wave form and, as a result, generates large amounts of third harmonic currents (150hz). Other sources of harmonic currents include variable-speed motor controls, solid-state heating controls, or any other devices that do no draw current in a sinusoidal fashion.

The effects of nonlinear loads and their resultants harmonic currents can shown up in several areas of the power system, most commonly in transformers and neutral conductors, but also in motors generators, and capacitors. Ballasted light fixtures also generate harmonics. For fluorescent lighting fixtures with conventional magnetic ballasts, the third harmonic content is typically in the range of 13% to 20% of the fundamental 50Hz frequency. Electronics ballasts generate an even higher third harmonic component, as high as 80%. Overheated transformers (K factor), motors, and standby generators that are exposed to significant levels of harmonics current can suffer serious increases in operating temperature. In addition, excessive current in the neutral conductors not only over heats the conductors, possible causing the damage to insulation, but also can be reflected back into the 3-phase transformer winding as a circulating current, causing additional heat. Power Factor Correction Capacitors (PFFCC'S) can also overheat due to harmonic distortion on line voltage in the power system. Since the impedance

of the capacitor decreases as the frequency of the applied voltage increases, excessive current can flow through the capacitor.

Capacitors can also form a resonant circuit with inductive elements in the system, which will create a measurable increase in the voltage across the capacitor. Lighting Ballast capacitor are also susceptible to heat caused by high-frequency currents; frequent failures of this type are indicative of the presence of harmonics in the system.

Harmonics can be cause of inefficient distribution of power, Power Line Carrier (PLC), e.g., clocks and Energy Management Systems (EMS). Finally, harmonics can cause utility meters, KW demand and KWH consumption, to register false readings.

Harmonics are by-product of nonlinear loads, such as computers variable Speed Drives VSD, electronics ballasts, and other such nonlinear loads, which are present in most installations. Harmonics are multiple integers of the line frequency, the third harmonic multiplies the line frequency by 3, and the fifth by 5, and the seventh by 7. It is understood that third, fifth, seventh, eleventh, and thirteenth harmonics pose a real problem in industry. They can dramatically distort the voltage waveform supplied to motors, lighting, computers, and equipment generally within the installation. It can also increase KW Demand and KWH meter registrations, usually by a few percentage points. In a nutshell, harmonics can contribute to an increase in KW Demand and KWH, while distorting the voltage waveform can cause failure of equipment and machinery.

The standard *Saif-El* can filter broadband harmonics, if it is designed to do so: in addition to specific or multiple harmonics of different magnitudes.

CONCLUSION

Saif-El's comprehensive approach of individually designing and tailoring each system to enhance and improve the client's electrical system to achieve cost savings, and power quality benefits, **is unique in the world.**

COMPARISON BETWEEN OTHER SYSTEMS

1) PF IMPROVEMENT SYSTEM

The *Saif-El* System is not simply a power factor correction system. The *Saif-El* carries out a number of functions, such as reduce KW demand and KW H consumption, eliminates harmonics, stabilizes voltage, balances the three phase system, adds life to your machinery and equipment, reduces both line transmission and distribution center losses, and results in a more efficient use of power usage as well as operating cost reductions.

Moreover, Power Factor Correction Capacitors Potentially pose number of side of side effects that can harm and disrupt operation of equipment and machinery in a facility particularly where there are computers, Variable Speed Drivers (VSD), electronic ballasts, and other nonlinear loads. If a customer is not charged severely for low power factor or power factor penalty by the utility company, then it would be impossible to economically justify, purchase of the capacitors for that facility.

2) Saif-El & UPS

UPS system are connected in series and are load bound unlike *Saif-El* system which are connected in parallel and grow as the plant grows. Moreover, UPS systems waste energy rather than save it and many generate harmonics, and can be extremely sensitive to surges and transients. Installations of *Saif-El* in conjunction with UPS will enhance the system operation while it saves energy.

3) Saif-El & SURGE SUPPRESSER DEVICES

The standard surge suppresser that is available in the market is usually designed for high magnitude surges or surges that are above normal voltage sine waves, their resistance decreases as the voltage increases. Depending on magnitude of the surge, it can destroy these devices because of excess magnitude over rating and massive heat is generated for each clamping. It is also very difficult to detect component failure within these devices.

4) Saif-El & POWER CONDITIONERS

Power conditioners are normally designed for single phase application, while *Saif-El* is designed for three phases and can improve and stabilize the voltage as well as balancing the three phases based on X/R, reduces losses, increases power factor, filters surges, transients and harmonics, while freeing up KVA capacity.

However, *Saif-El* can recognize smaller surges, transients and sags and treat them without generating massive heat, with ergonomically accessible monitoring and self –diagnostic feature to detect components failures.