Transient Voltage Surge Suppressor (TVSS)

Transient Voltage Surge Suppressor (TVSS) technologies (also known as a surge protection devices, or SPD) are connected to a building wiring system and used to clamp, divert, or absorb most of the transient energy associated with spikes or surges in voltage, whether from a lightning strike or other source. The primary function of a surge-protective device is to protect sensitive load equipment against the damaging effects of a voltage surge.

Transient overvoltages can cause breakdown of insulation, resulting in either a temporary disturbance of device operation or instantaneous failure. The insulating level in the former case will be weakened leading to premature failure. The severity of the breakdown varies with the type of insulation- air, liquid, or solid. The first two tend to be self-healing, while breakdown of solid insulation (generally organic materials) is a permanent condition. Therefore, a significant potential benefit of using TVSS technology is that the lifetime of protected devices may be extended, since insulation breakdown and subsequent device failure can be avoided.

In typical AC-powered equipment, the sensitive components are powered line-to-neutral in single-phase 120-V systems, or line-to-line in three-phase systems, and that is where the TVSS is installed. There is usually no need for any protection from line to ground. The line-to-ground withstand capability of equipment is only an insulation concern, typically addressed by equipment standards and requiring levels much higher than the levels of concern in line-to- neutral surge events affecting electronic components or clearances of circuit traces.

Typical components inside the TVSS may include metal oxide varistors (MOVs), gas tubes (spark gap), and avalanche diodes (see Figure 5-1). The TVSS is an excellent device to aid in the protection of equipment from high voltage, short duration transients lasting less than one millisecond. These products typically do not provide any other power conditioning actions such as sag or swell protection or harmonics mitigation.

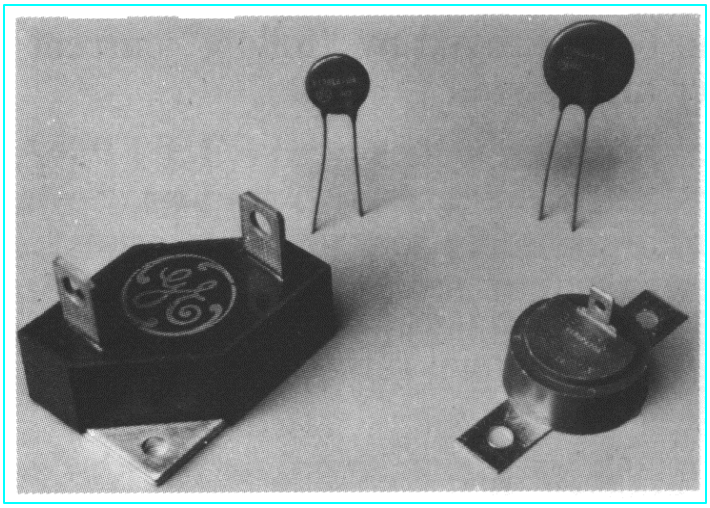

Figure 5-1. Metal Oxide Varistors (MOV) handle most transients occurring inside a facility.

In the low-voltage (end-user) environment, surge-protection schemes act by diverting impinging surges by offering a low-impedance path to return the surge current to its source, or by restricting the propagation of surges between their point of origin and the equipment to be protected. This function can be accomplished in one or several stages, depending on the system configuration and the degree of freedom available to the users for connecting protective devices at different points of their systems.

In its simplest form, the diversion can be obtained by a device connected across the line, hence the generic description "shunt-type SPD". In a more complex form, surge protection is obtained in several stages by combining diversion and restriction, such as that shown in Figure 5-2. This approach, which utilizes restriction combined with diversion places great emphasis on a restriction performed by an inductor connected in series with the line, hence the generic designation of "series-type SPD".

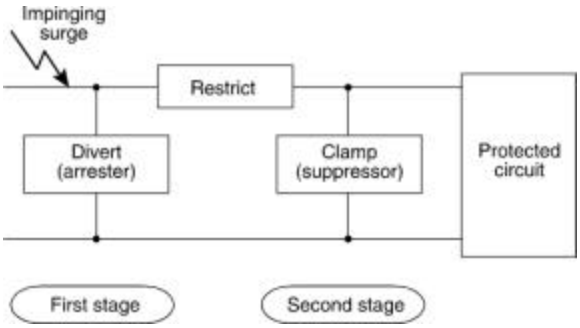

Figure 5-2
Basic Approach to Multi-Stage Surge Protection

As shown in Figure 5-2, the first stage provides diversion of impinging high-energy surges through a high-energy handling device, sometimes called "arrester," which is typically installed at the service entrance, or by a device permanently connected at the service panel. Some restriction to the propagation of surge currents in branch circuits is inherently provided by the inductance of the premises wiring, or by insertion of a discrete inductor. The second stage of voltage limiting is provided by an SPD of lesser surge-handling capability, often called "surge suppressor" or "surge protector," which is typically located close to the equipment in need of protection as an add-on, plug-in device or incorporated within the equipment by the manufacturer. This second stage completes the scheme for surges of external origin as well as for surges originating within the building.

Understanding TVSS

Important parameters for the selection and operation of TVSS devices include.

Let-Through Voltage (LTV)

The LTV specification (sometimes referred to as the clamping voltage) refers to the lightning and surge-suppression capability of the power protection device. The two issues of interest are first, did the protection device survive the transient, and secondly, what percentage of the voltage transient was "let through" to the load? Most plug in and panel mount TVSS manufacturers will claim ability to survive and attenuate a "6 kV Category A or B transient" as described in ANSI/IEEE C62.41. The remaining peak voltage (after attenuation) from the 6kV shot is referred to as the LTV and will typically be specified for all applicable conductor combinations (L-L, L-N, L-G and N-G as applicable). The manufacturer may also have a UL1449 listing and the LTV for each conductor combination will be given.

Maximum Surge Current

This "one-time one-shot" specification is important to the user because it describes the ability of the surge protective device to shunt transient surge current and the corresponding one-half cycle short-circuit current of the power system without opening up or catastrophically failing. The one shot rating for maximum surge current varies substantially from manufacturer to manufacturer but is generally derived from the specification sheet for the protection device (either the MOV, the gas tube, the avalanche diode or other suppression device used).

Confusion on this specification is caused because manufacturers may have six or more individual suppression devices inside of their product and may (or may not) add up the one shot values for all of the devices to derive their maximum surge current specification. *It is prudent for the specifier to request a more detailed breakdown from the manufacturer on how the maximum surge current rating was derived.*

MOV (Metal-Oxide-Varistor)

This device is made of sintered metal oxides, primarily zinc oxide with suitable additives. When subjected to high voltage transients the varistor impedance changes from a near open circuit to a near short circuit. Potentially destructive energy of a voltage transient is clamped and the surge current diverted or "shunted" away from the protected equipment by a varistor. Once the event is over, the MOV goes back to its normal open circuit high impedance mode of operation.

MCOV rating

Maximum continuous operating voltage MCOV is the maximum steady-state sinusoidal rms voltage that may be applied to a varistor without reducing varistor life expectancy. The higher the MCOV rating of the MOV the higher the clamping voltage. Note that while lower clamping levels imply better load protection, the closer the MCOV comes to the actual applied voltage, the shorter the life expectancy of the TVSS product. A good rule of thumb is to look for an MCOV at least ten percent higher than the expected rms voltage of the circuit because variances occur in the actual utilization voltage supplied on any given utility distribution system.

Thermal Fuse

A thermal fuse is a reliable thermal cutoff designed to protect from fire. Operation of the fuse opens an electrical circuit when the temperature of the fuse increases to an abnormal level. A typical fuse contains a sliding contact, springs and a thermal pellet inside a metal case. At normal temperature, current flows through the fuse. When the temperature near the fuse rises to unsafe levels, heat is transferred through the metal case of the fuse and melts the thermal pellet. The melted thermal pellet allows the springs to expand, which moves the contacts apart breaking the electrical circuit.

A thermal fuse protects against a surge suppressor catching fire due to a failed MOV. MOVs may fail due to old age, excessive transient exposure, or if the rated RMS voltage is exceeded for an extended period of time. A failed MOV may, under certain conditions, heat up if the upstream fuse does not open. A thermal fuse, by detecting the increase in temperature, breaks the electrical circuit, preventing the buildup of heat in the failed MOV.

The purchaser of TVSS equipment should insist that the equipment have a thermal fuse. Position of the thermal fuse with respect to ALL MOVs is critical. Every MOV connected to a hot conductor should be protected by placing a thermal fuse within a few millimeters of the MOV shell. The second edition UL 1449-1996 mandates and tests various MOV failure modes. When purchasing TVSS equipment, ensure it meets UL 1449 second edition.

Energy-handling (Joule) Rating

Joule ratings for TVSS devices have become a game of specmanship in the industry and it is highly advisable to avoid using the joule rating to attempt comparison of products or to try to determine the quality of protection.

Energy Savings Potential of TVSS

In recent years, a handful of TVSS products have been marketed not only as protection from lightning strikes and other over-voltage events, but also as energy savings tools, and claiming rapid economic payback of investment. The assumptions behind such claims is usually as follows:

1. Over-voltage events are common and occur often in most facilities
2. These over-voltage events cause end-user equipment to run hotter than normal
3. Equipment operating at higher temperatures is less energy efficient than the same equipment operating at lower temperatures
4. Installation of the manufacturer's TVSS technology isolates equipment from these over-voltages, thereby preventing heat build-up, thereby improving energy efficiency.

5. The manufacturer's TVSS technology is cost effective when compared to alternative approaches, either for over-voltage protection or for enabling cooler equipment operation.

To justify the purchase of TVSS technology for the purposes of energy efficiency improvements at a particular facility, each and every one of the above assumptions must be substantiated for that facility—a very difficult task.

There has been considerable and ongoing public debate within the electric power and power quality industry over the energy savings capability of TVSS for energy savings devices. This debate has been driven by a general lack of evidence in technical literature to substantiate the assumptions listed above.

Some recent research has found evidence that energy consumption of electrical devices is not appreciably increased by the presence of transient voltages. As an example, consider a 120 V single-phase line with a 20 Ù load and a 50 Ù source impedance. A lightning transient of 6 kV peak, 5 ìs duration will deliver about 0.4 Joules to the load. A switching transient of 6 kV peak, 8X20 ìs waveshape will deliver about 2 Joules to the same load. Based on survey data, extreme exposure to high voltage transients may be around 80 events per year. At that rate, the lightning transients would deliver about 32 Joules or 0.009 Wh to the 20 Ù load in a year. So the total energy in these transients is extremely small. In fact, the average energy even in severe transients is so small that it will neither produce discernible heating in load equipment, nor appear on a watthour meter.

Energy-Saving Technology Evaluation Check-List

When evaluating technologies that make energy savings claims, prospective buyers should use a rigorous series of questions to ascertain the credibility of the technology, its claims, and those who market it. In all cases, it is incumbent upon the marketers of energy savings technologies not only answer the questions that follow, but to *prove*—with a preponderance of clear and convincing evidence—that their technology and company are credible and worthy of consideration.

1. What is the Mechanism for Saving Energy?

Every electrical system has inefficiencies, whether manifest in the form of less-than-perfect energy conversion, or in losses due to noise, vibration, or heat. Regardless, no technology can save more energy than is being wasted. Therefore, the first step in evaluating an energy-saving technology is to require specific documentation that 1) energy is, in fact, being wasted, and 2) that this energy can be saved if the proper technique is implemented.

For a number of technologies, answering this question is readily accomplished. For example, an induction motor-driven fan system operating at full speed, but with output throttled by inlet vanes offers a clear mechanism for energy savings: reduce the motor's speed, match the output of the fan to the needs of the process, and remove the inlet vanes.

In the case of power factor correcting capacitors, it can be readily demonstrated that electrical current moving through wires causes I^2R losses and, by reducing the amplitude of the current, that these losses can also be reduced.

For energy savings from TVSS, however, the energy savings mechanism is much less clear. To satisfy this question, a seller of TVSS purporting to save energy should be required to convincingly *document* that 1) many voltage spikes occur, 2) these overheat end-use devices, and 3) how much excess energy these overheated devices use. Without providing this level of documentation, it is extremely difficult to make an informed purchase decision.

It is, unfortunately, not uncommon for marketers of technologies that purport to save energy to present a smorgasbord of energy saving mechanisms, often including such sundry and diverse mechanisms as reduced reactive current, reduced harmonic current, improved voltage regulation, improved voltage unbalance, and ill-defined claims of "system balancing" and "matching output to the needs of the load." It is the sole responsibility of the technology marketer to prove that each and every one of these claims is not only valid, but of sufficient magnitude to be worthwhile.

2. How does the Technology Implement the Energy-saving Mechanism?

Proving that a opportunity exists to save energy is a crucial first step, but it's just the start. Next in the line of inquiry is to substantiate that the energy saving technology actually does something effective in reducing the losses. Or, put another way, does the technology actually *implement* the mechanism substantiated in Question 1 above?

When evaluating adjustable-speed drive (ASD) technology, for example, it can be readily demonstrated that the technology is capable of reducing the rotational speed of an induction motor and its load. Therefore, the savings mechanism of reduced speed is capably implemented by the technology.

For reducing losses in facility wiring, power factor correction capacitors are also well known as effective tools in reducing reactive current in systems that have poor power factor.

For claims that TVSS can save energy, however, answering this question is a bit more difficult. Not only is it necessary to show that the particular surge suppression technologies are effective in reducing voltage spikes, it much be shown that the TVSS technologies suppress voltage transients *sufficiently* to prevent excess heating in load devices.

3. Is the Value of Any Energy Saved Sufficient to Economically Justify a Purchase?

Once the prospective purchaser has seen the technology vendor substantiate that there's energy to be saved, and that the suggested technology actual goes about saving it, then it's time to turn to economics. While this is familiar terrain for any technology purchaser, it is important to evaluate the economic impact of energy-saving technologies based on cost savings that are particular to each end-use facility, and not vendor literature.

Although ASD technology is capable of saving 50% or more of energy use in some installations, the actual load factor of the particular installation should be used.

Although some 1-2% of facility energy use *can* be attributed to losses in intra-facility wiring, levels of 0.5-1% are more common and available for savings by power factor correction capacitors.

Some marketers of power factor correction capacitors claim energy cost savings of as high as 10-25%—levels that are extremely difficult to substantiate. Some marketers of TVSS as an energy-saving technology promote claims of 20% savings on energy usage—levels that are also extremely difficult to substantiate.

4. How does the Technology Compare with Competing and Alternative Technologies and Techniques?

If the energy-saving technology has passed muster thus far, it then faces the most difficult hurdle of all: is it the most cost effective method to achieve the desired results? Unfortunately, this question is consistently overlooked by technologies evaluators. What every purchaser of a technology really wants is to reduce energy costs at the lowest price, not to be the proud owner of any particular company's widget. However, the effort spent in doing due-diligence on one particular technology can blind evaluators to less costly, but equally effective alternatives.

For example, although the benefits many be attractive for addition speed control (via an ASD) to a motor-driven fan installation, for some installations a two-speed motor may be more cost effective and provide the same benefits.

For power factor correction, there are many different manufacturers and packaging schemes for these systems, with a factor of 10 spread in their pricing. Does a facility need small, expensively-packaged capacitors sprinkled throughout, or will one inexpensive capacitor bank at the service entrance provide the same benefits? If I^2R losses are high in a facility, are the wires properly sized?

If a vendor of TVSS technology has satisfied demands for documentation of the energy-savings benefits of surge protection, then why not use the least expensive TVSS technology available? Alternatively, if the excess energy use is manifested by overheated equipment, perhaps the best approach is to improve the cooling of end use equipment, which may also be achievable at lower cost.

Understanding the Shortcomings of Some of the Common Techniques for Marketing Energy-Saving Devices

Marketers of energy-saving devices often turn to a handful of techniques that, on the surface, appear to present a compelling case for purchase. However, a number of these techniques have serious shortcomings. Being aware of these shortcomings can empower the careful evaluator and enable an informed and, one hopes, profitable final decision on which technologies to pursue, and which to leave by the wayside.

The Dangers of ``Before and After'' Energy Use Comparisons

It is quite common for marketers of energy saving technology to present data showing a facility's monthly energy bills before and after the installation of an energy-saving technology. Unfortunately, the two most common questions that purchasers of new technologies seek to answer—does the technology in question save energy? and, if so, how much?—are seldom answered by such a crude metric as the difference between before-and-after utility bills. Energy use at a facility is affected by too many variables, and utility bills provide too few data points, to allow for a valid before-and-after comparison.

The basic technique employed by marketers when using the before-and-after energy use technique is as follows: if a facility's energy use for a particular month was, say, 200,000 kWh, and a year later the energy use has dropped to, say, 180,000 kWh, the market would almost certainly claim that this entire 10 percent decline is attributable to a particular energy-saving technology installed during the intervening twelve months. To accept this claim as credible, however, one must accept the following difficult assumptions:

- **No Other Changes to the Facility's Behavior**: The central assumption in virtually all before-and-after energy use comparisons is that the addition of the energy-saving technology is the only variable of consequence. In fact, an untold number of variables regularly influence the amount of energy that a particular facility may use, including changes in occupant or business activities; changes in the many types of equipment installed such as motors, lighting, and computers; changes in the behavior or use of these many types of equipment (such as how long ventilation systems, lights, or chillers are operated, or how efficiently air

compressors or pumping systems function), changes in output due to the economic climate, etc.

- **The Energy-Saving Technology is the Dominant Contributor to Changes in Energy Use**: Even without major changes to the way a facility operates, other cyclical factors can influence how a facility uses energy, including outdoor temperature, humidity, and other weather; normal business cycles (number of weekends in a month, for example), normal seasonal variations (holidays, etc.), and normal operation (and mis-operation) of end-use equipment. In some cases, even the number of days in a billing cycle can vary depending on when meter-reading days fall. All of these factors can give the appearance of profound changes in energy use even if they're aren't any.

Given the clear weaknesses of before-and-after bill comparisons, it is interesting to note how may marketers still cling to them as their main support for energy-savings claims. If stronger data existed, such as detailed audits by reputable third parties, rigorous laboratory testing, etc., it would seem that those results would be featured and, thereby, sway more customers.

The Folly of Averages

It is too common a practice, when trying to assess the effectiveness of a new technology or technique, to make a handful of measurements before the installation, and some after, and then to compare the averages of the before-and-after measurements to see if there is any change. This approach is attractive to many technology marketers, as well as end users, because it requires comparison of only two numbers—the before-and-after averages—and allows easy computation of the percent change. The dangers in this practice lie in three areas:

- **Loss of important information**. A significant amount of information is lost when multiple data points are boiled down to a single average number, such as how much variation existed within the original set of data points, or if the data was uniformly distributed, or clustered in some way. For example, comparing the average error in two lots of machined metal parts may show an improved average error in the second lot, but conceal that there are more rejected parts (parts that fail to meet minimum standards) in the second lot than in the first.

- **The average may not be a meaningful number**. Just because an average can be calculated does not mean it is a useful metric for evaluating performance. For example, some investor may find it interesting to compare the average rise or fall of the Dow Jones Industrial Average during odd versus even calendar years. These two averages can be easily calculated and even compared, but it is unlikely that they will provide any meaningful insight into how stocks will perform in the coming year.

- **An average is only as good as its original data**. One of the more common mistakes in comparing averages is that they are calculated from too few data points, or from data points that have been somehow ``filtered'' so that they are not a true random sample. In general, the more variability seen in the data, the more data points need to be gathered. While fewer data points may serve in some

situations, a sample of 25 to 30 data points is generally considered adequate for most analyses.

"File Cabinet" Testing

A common and seemingly irresistible technique for product marketing is to present to prospective buyers only those case histories that are most flattering to the technologies capabilities. This technique, known as "file cabinet" testing because all of the bad cases are left back in the office safely ensconced in the file cabinet, is disingenuous for a handful of reasons:

- **The spectrum of potential outcomes is skewed**: Selecting only the most attractive case studies for publication gives a false impression of certitude for excellent product performance. In reality, the performance of many energy-saving products ranges widely depending on the vagaries of each particular application.
- **Positive results could be nothing more than random chance**: One reason why good market researchers always insist on a random sample of a target population is to avoid the problem of specially selecting a sample, and having that special selection yield up a false conclusion about the nature of the population as a whole. For example, if one were to survey 100 companies about their energy use this year vs. last, some number (say, 1/3) would report higher energy use, another portion (say, another 1/3) could report lower energy costs, and the remainder might report little or no difference. To ignore those that report higher or same energy use, and credit a particular technology with the "successes" of the lower energy use clients would be a classic example of "file cabinet" testing.
- **Extraordinary results are presented as "the norm:"** Excluding less flattering results from information passed to prospective buyers creates greatly facilitates the tendency to have excellent, but unlikely results gradually take on the appearance of being the normal outcome or average result. An excellent example can be found in energy savings from power factor correction. Saving more that 1% of total facility energy through power factor correction is a very good and uncommon outcome. However, marketing literature for such devices commonly report examples where savings have been in this range or even higher, creating the impression that higher level savings are available to all purchasers of the technology. In reality, most users will achieve less than 0.5% energy savings from power factor correction.

Item One

WARNING OF MISLEADING CLAIMS CONCERNING SURGE PROTECTIVE "ENERGY SAVING" DEVICES

by the
Surge Protective Devices Committee of
the Power Engineering Society of
the Institute of Electrical and Electronics Engineers

The combination of energy conservation and the development of effective surge suppressors has set the stage for unscrupulous operators to become active and take advantage of the willingness of the uninformed public to invest hard-earned dollars in futile attempts to decrease their power bills.

The claims made by these operators, camouflaged by pseudo-technical terms, centers on the surge suppression properties of their devices (generally a true claim) that allegedly can eliminate power losses in the circuits and appliances used by the homeowner. Energy savings of 10, 20, 30% or more are claimed. Typically, each device contains a packaged suppressor worth at most a few dollars, but they are being sold for about $150.00. Such energy savings claims are somewhat difficult to refute in layman's language. Simple knowledgeable logic, however, points out the errors in their claims. For instance, if we consider the case of the "lossy" contactor cited by some of the sales literature: contact degradation due to transient-induced sparking decreases the efficiency of the motor and wastes power. Now if we have a 20% loss on a 2 HP motor circuit, that means 300 watts of power dissipation at the contacts: clearly they would burn up in a hurry if the claim of wasted power were true.

Others have attempted to check these claims by tests. For example, a permanent injunction was issued by the Commonwealth of Virginia against one such operator. The injunction cites a test report from the Virginia Polytechnic Institute and State University: refrigerators were run with and without the "energy saving" device...no difference was found. Dr. E. R. Chenette of the Electrical Engineering Department of the University of Florida subjected this device to tests and found the claim completely unsubstantiated. In February 1976, TV station WPLG of Miami, Fla. conducted a series of programs exposing the questionable sales practices of these operators. These promoters use other deceptive tactics. In their sales literature, they include, for instance, an IEEE paper (reprinted with or without permission) describing the occurrence of surges. They also submit test reports by independent laboratories attesting that the devices conform to specification... but the particular energy-saving feature was not included in the specifications submitted for verification.

Therefore, the Surge Protective Devices Committee of the Power Engineering Society urges IEEE to take a strong stand on this issue, warning the public on the fallacy of these claims and fraudulent practices. This should also be taken up with the Federal Trade Commission, at the request of IEEE, instead of issuing injunctions on a state-by-state and operator-by-operator basis.

Prepared by: F. D. Martzloff, Member

Approved by: W. R. Ossman, Chairman
IEEE Surge Protective Devices Committee

Item Two

TRANSIENT VOLTAGE SUPPRESSION

Fifth Edition

GENERAL ELECTRIC

Breakdown of solid insulation generally results in local carbonization of an organic material. Inorganic insulation materials are generally mechanically and permanently damaged. When no power-follow current takes place, the system can recover and continue operating. However, the degraded insulating characteristic of the material leads to breakdown at progressively lower levels until a mild overvoltage, even within ac line overvoltage tolerances, brings about the ultimate permanent short circuit. Since the final failure can occur when no transients are present, the real cause of the problem may be concealed.

Breakdown along surfaces of insulation is the concern of "creepage" specifications. The working group of IEC cited above is also generating recommendations on creepage distances. The behavior of the system where creepage is concerned is less predictable than is breakdown of insulation in the bulk because the environment (dust, humidity) will determine the withstand capability of the creepage surface.

When considering the withstand capabilities of any insulation system, two fundamental facts must be remembered. The first is that breakdown of insulation is not instantaneous but is governed by the statistics of avalanche ionization. Hence there is a "volt-time" characteristic, which challenges the designer to coordinate protection systems as a function of the impinging waveshape. The second is that the distribution of voltage across insulation is rarely linear. For example, a steep wave front produces a piling up of voltage in the first few turns of a motor winding, often with reflections inside the winding. Also, the breakdown in the gap between the electrodes, initiating at the surface, is considerably dependent upon the overall field geometry, as well as on macroscopic surface conditions.

1.6.4 Effects on Power Consumption

As a result of the increasing emphasis on energy conservation, a number of transient voltage suppression devices have been offered for sale as energy savers. The premise seems to be that transient overvoltages would cause degradation of electrical equipment leading to increased losses and thus to a waste of energy. No convincing proof has been offered to support this claim, and injunctions against making such claims have been obtained in several states.[15]

1.6.5 Noise Generation

With sensitive logic gates gaining popularity, noise problems are frequent, especially in environments with electromechanical devices. Noise can upset automatic manufacturing equipment, medical equipment, computers, alarms and thyristor-controlled machinery. Such disruption can cause loss of product, time, money, and even human life.

Noise enters a system either directly on wires or grounds connected to the source or through coupling to adjacent wires. Noise problems are dealt with by suppression at the source, at the receiver, or by isolation. Noise is induced when stray capacitance or mutual inductance links the susceptible system to the noise-generating system. The amplitude of the induced noise is then related to the rate-of-change of either the current or the voltage of the noise source. The low-frequency components of the induced noise (which are hardest to filter out) are a result of the amplitude of the original transient impulses.

Frequently, the source of noise is the arcing of contacts breaking current through an inductor, such as a relay coil. A low-current, high-voltage arc creates a series of brief discharges of a damped oscillatory nature, occurring at kHz to MHz frequencies with amplitudes of from 300 to several thousand volts. These pulses and their reflections from loads and line discontinuities travel along the power wires, easily inducing noise in adjacent wiring. This interference is best eliminated by preventing it at the source (the inductance) with voltage-limiting devices such as varistors.

1.6.6 Rate of Rise vs. Amplitude

Interference coupled into electronic systems, as opposed to damage, is most often associated with the rate of rise of the interfering signal rather than its peak amplitude. Consequently, low-amplitude fast-rise interference which is dealt only by the capacitance of a varistor until the clamping level is reached by the impinging interference may still be a problem with the circuit if attempts are made to suppress it with a retrofit varistor at the location of the victim. A much more effective cure would be to install the appropriate varistor near the source of the offending surge, so that the interference radiated or coupled by the surge would be confined to the immediate vicinity of the offending source.

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Item Three

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CBBB WARNS CONSUMERS, BUSINESSES ABOUT "SURGE SUPPRESSORS"

Washington, D. C., June 1, 1977 -- Such new phrases as "surge suppressors" and "energy savers" are becoming increasingly familiar to today's energy-conscious consumers. The Council has prepared the attached Report, based on professional engineering tests, which warns that "there is no merit to the claim that transient voltage and power surge suppressors will reduce electricity costs."

The exhaustive and authoritative research which resulted in the Report may deflate the hopes and beliefs of many, but it is more important to set the record straight in the atmosphere of present-day critical concerns about energy conservation.

Please feel free to use this study in whole or in part as suits your purpose.

COUNCIL OF BETTER BUSINESS BUREAUS, INC.
1150 17TH STREET, N.W., WASHINGTON, D.C. 20036

REPORT

May 1977

TRANSIENT VOLTAGE/POWER SURGE SUPPRESSORS

The information contained herein has been compiled from sources deemed to be reliable and, while not guaranteed, is believed to be factual and accurate. It is not intended to recommend or deprecate, and is furnished solely to assist you in exercising your own judgement.
THIS REPORT IS NOT TO BE USED FOR SALES OR PROMOTIONAL PURPOSES.

Introduction

With the energy crisis that has faced the nation in recent years, numerous products and devices have been marketed that promise to save energy and reduce the costs involved in energy consumption. Joining the growing list of "energy savers" are transient voltage or surge suppressors - devices for use in household and business electrical circuits that many sellers claim will save from 10% to 40% on electric bills.

According to professional electrical engineering organizations, tests by engineering schools and actions by some state attorneys general, there is no merit to the claim that transient voltage and power surge suppressors will reduce electricity costs. This report summarizes the data obtained by the Council of Better Business Bureaus on these devices.

What are they?

Typically, the device is an electrical apparatus consisting of simple electronic components - varistors, diodes and fuses - mounted in an encapsulating material (e.g. epoxy cement), and installed either at the electric service entrance (fuse or circuit breaker panel) to a home or business establishment, or on individual internal circuits.

A function of the devices, which range in price from $150 to $750, is to suppress or "clamp" transient voltage surges caused by such external and internal sources as lightning and the switching on or off of appliances, motors and other electrical equipment.

It is the transient surges, or over-voltages, of electricity which some sellers claim will be suppressed and dissipated by their devices with a resultant reduction in the use of electrical energy and a corresponding savings in electric bills.

Do they suppress surges?

The electrically significant component in the several devices tested and examined by the sources providing data to the Council of BBBs was a varistor - an electronic resistor selling for as little as 75¢ in quantity lots - that is designed to "clamp"

high voltage surges or pulses by absorbing the energy associated with them.

The presence of a varistor or functionally similar semiconductor device, according to our sources, can result in the suppression of transient voltages - but the duration of these transients is so short (generally 0.1 to 100 microseconds) and their energy content so small that the presence of transients would have no measurable effect on either appliance efficiency or energy dissipation.

Do they reduce electric bills?

Tests of various surge suppression devices by such highly regarded institutions and organizations as the Virginia Polytechnic Institute and State University (VPI), Lehigh University, University of Florida, and National Aeronautics and Space Administration (NASA) show that such devices reduce neither power consumption nor electric bills.

The Laboratory Support Services of VPI reported in a test of two devices that they "may well suppress transient voltages and may very well improve power factor, but these are not quantities measured by the residential watt-hour meter and thus could not reduce the watt-hour meter reading, which is the basis for billing by the power company."

A test by NASA's Langley Research Center of a device on circuit with a motor, fluorescent light and a fan revealed that the device "did not result in any power savings."

In tests of the ability of two models of surge suppressors to reduce energy consumption when applied to representative residential and commercial loads, a report by Dr. John G. Kassakian, consulting engineer and professor at the Massachusetts Institute of Technology, concludes for each device that "No measurable increase or decrease in energy consumption attributable to the presence or absence of the device was observed." The report concludes with a "last point worth mentioning" that "if a service entrance is equipped with a (suppression device) and a watt-hour meter capable of responding to voltage transients, any externally generated transients will have already been metered before being dissipated by the (suppression device)."

State regulatory actions

At the time of this report three state attorneys general were known by the Council of Better Business Bureaus to have obtained either permanent injunctions (Virginia, Jan. 7, 1976; New Jersey, April 1, 1977) or a temporary injunction (Texas, April 27, 1977), restraining certain marketers of surge suppressors from representing in advertising and selling that their devices would, among other things, reduce electrical energy consumption and decrease electrical costs.

A significant provision in the New Jersey injunction requires the defendant companies to disclose conspicuously in all retail contracts and distributorship agreements that "THERE IS NO SCIENTIFIC PROOF THAT THE USE OF THIS PRODUCT WILL RESULT IN APPRECIABLE REDUCTION IN ELECTRICAL ENERGY CONSUMPTION." The court permitted the companies to seek modification of the warning "upon a proper showing of scientific evidence to support such modification" after October 11, 1977.

Recommendations

The Council of Better Business Bureaus recommends that any consumers and business establishments considering the purchase of devices for electrical systems, whether or not they are represented to be capable of reducing energy consumption and electric bills, should:

1. Find out from local and state housing and building authorities if the device meets electrical code requirements.

2. Determine whether the device has been tested for hazards to life and property (e.g. electrical, shock, fire) and found safe by a competent and recognized laboratory, such as Underwriters Laboratories Inc. (UL).

3. Consult the local power company for information and advice.

4. Make sure that installation will be made only by a licensed and registered electrician or electrical contractor.

Acknowledgements

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Industry Standards Department

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