White Paper

The Case for Pure Power

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Introduction

It's a fact of life: modern electronic phone systems are smarter and faster. They're also more sensitive to certain types of failures. These failures are related to the quality of the electrical environment in which the equipment operates. We can't blame the utility company because the electrical environment has not changed. The changes have occurred in modern electronics. Breakthroughs in technology have increased the susceptibility of electronic phone equipment to disturbances that have always been a part of the electrical environment. And as sophisticated telecommunications become more and more critical to business operations, the “Case for Pure Power” becomes even more compelling.

This paper describes the technical relationship between power and telephone system reliability and then discusses the business benefits of effective power protection.

The Electrical Environment

All electrical environments are hazardous places for electronic equipment. The only issue is how hazardous. Everyone understands the need to protect from lightning, but few are aware of the “lightning storms” that are continuously created within buildings by the normal functioning of their electrical equipment.

These internally-generated disturbances are constantly present and insidious. They are most often the culprits that lower system reliability and cause soft failures such as “no dial tone,” dropped calls and intermittent errors. They also cause most of the hardware failures. Known by a series of names such as “transients,” “spikes,” or “electrical noise,” this high frequency energy is created whenever certain types of electrical equipment are in use. Photocopiers, elevators, dimmer switches, heating, ventilating and air conditioning systems are just a few of the noisy electrical loads in most buildings. They all inject harmful electrical disturbances into the power system that will ultimately reach your telecommunications equipment.

Before integrated circuits came into use, telecommunications equipment was rugged enough to withstand the detrimental effects of electrical noise. In other words, the AC Power was “pure” enough. Not so today. With changes in technology, particularly in the areas of power supply design and chip miniaturization, electrical noise tolerances are far lower. Therefore, what used to be sufficient electrical protection is no longer appropriate.

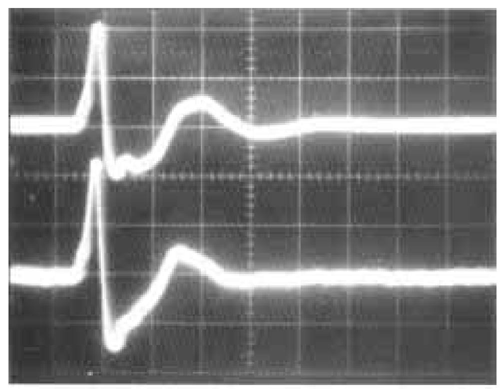

Fig 1: Actual noise measurement taken from an AC outlet next to an office photocopier in operation. The top trace shows 60 volts peak-to-peak of normal-mode noise (between hot and neutral). The lower trace shows 18 volts peak-to-peak of common-mode noise (between neutral and ground).

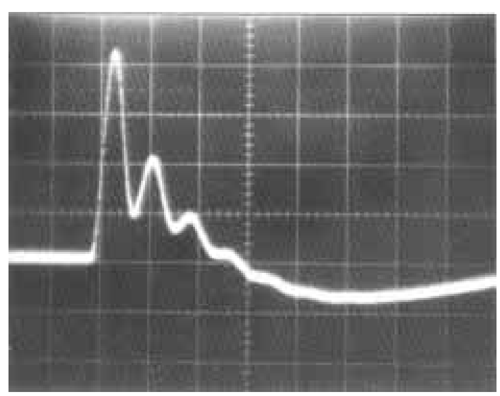

Fig 2: Noise measurement made adjacent to a lighting dimmer switch. over 200 volts peak-to-peak of normal-mode noise is present.

What’s Enough Protection?

Studies show that as much as 80% of all hardware failures in modern electronic equipment are the result of electrical noise — power that wasn't pure enough. Therefore it stands to reason that if the electricity reaching such systems didn't also have these harmful properties, than a large number of failures would be eliminated.

An easy way to visualize this is by looking at the familiar bathtub curve. Figure 3 shows the expected failure mechanism of semiconductors, from burn-in, through the infant mortality period in the field, to the point of wear-out. By controlling the electrical environment, the entire failure curve can be brought down (Figure 4). The space between the curves represents the improved reliability that is the result of effective power conditioning.

It is extremely difficult to define the operational sensitivity of components within a system. Because of this, it is almost impossible to say with assurance that anything other than the most stringent controls is enough. It stands to reason, therefore, that more protection is certainly preferable if cost-effective. Protection specifications emerged in relationship to standards developed by IEEE and ANSI with the goal of controlling the electrical environment within buildings so that the noise levels are totally safe for electronic equipment.

In these standards, electrical disturbances are described in two forms, normal-mode and common-mode. Normal-mode noise exists between line and neutral, and common-mode is noise between line or neutral and ground. Common-mode specifications must be more stringent because of the direct path the ground wire has into the system logic.

If noise levels are kept to 10 volts normal-mode and 1/2 volt common-mode, then electronic systems will have protection that is compatible with their sensitivity. This level of protection will insure that your equipment will follow the lowered failure curve defined in Figure 4 of the bathtub curve. It is this lowered failure rate that can be translated into decreased service calls, smoother operating equipment, and increased customer satisfaction.

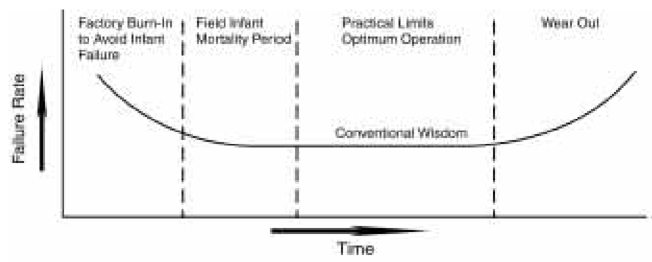

Fig 3: Conventional Wisdom

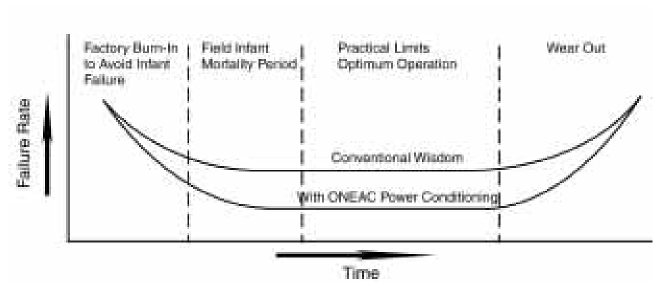

Fig 4: Conventional Wisdom with ONEAC Power Conditioning

Telecommunications System Reliability

Briefly stated, two factors are critical to enhancing the field reliability of telecommunications systems. One is correct grounding practices and the other is effective conditioning of the AC power. The two are inextricably tied together, and each enhances the other. The most important grounding principle is single-point grounding; all AC grounds must be brought back to a common point. This is done to minimize the possibility of destructive ground loops. Effective power conditioning, the other part of the equation, should meet the criteria previously defined — no more than 10 volts normal-mode and 1/2 volt common-mode noise should get through the conditioner to the protected equipment. Effective power conditioning practices incorporate both single-point grounding and maximum noise suppression.

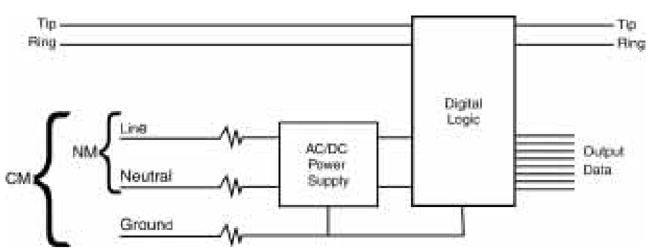

Fig 5: Telecommunications system Block Diagram

One way to prove the value of power conditioning and also quantify its effect is to conduct field trials. Over the years, ONEAC has sponsored numerous such trials in conjunction with customers. These have been conducted using a variety of PBX and key systems. All of the field trials were conducted using the same test conditions; data on failures were collected in a before and after mode, generally for six months. Where possible, failures were tracked in the following categories: No Trouble Found (NTF), Switch (SW), Station (ST) and Network or Trunk. ONEAC power conditioning can directly reduce the number of service calls in the categories of NTF and SW. It can indirectly reduce station failures. It can do nothing, however, to reduce network failures. Therefore, these improvement rates are for non-network related service calls.

Key System Trials

This graph represents the compilation of results from four separate studies on four types of key systems. Although the individual studies varied slightly, in general their results were consistent, averaging around 40%. The reduction in service calls was most pronounced in two areas — No Trouble Found and Hardware Failures.

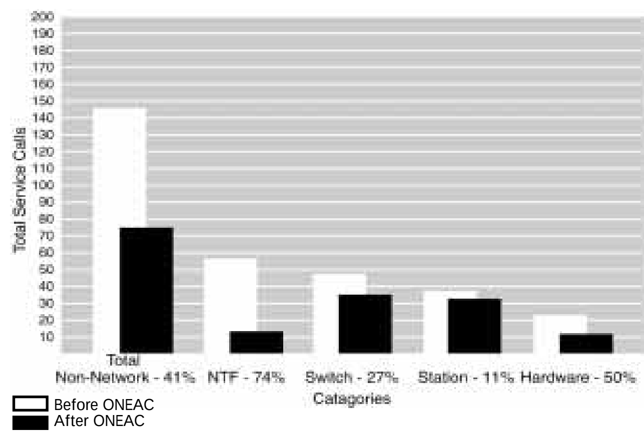

Fig 6: Key System Field Trials (49 sites)

The following field trial results, will take a broader look at the question of "How much improvement should I expect to see if I condition my telephone system?"

The graphs on the following page show the results of different types of systems, ranging from "troubled sites," those exhibiting unusually high levels of failures, to "good sites," whose trouble reports were below the average, to "random sites," sites chosen to replicate the range of systems.

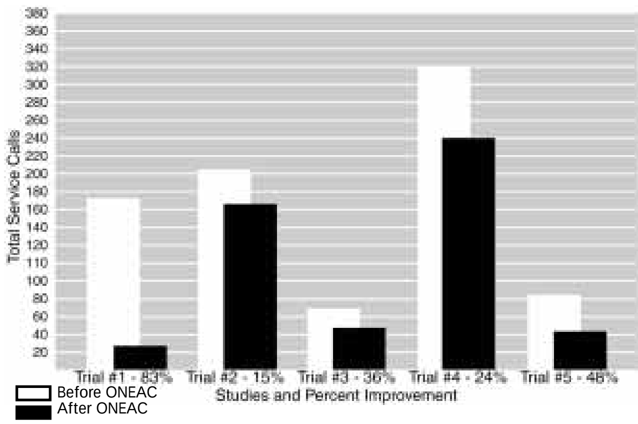

Fig 7: Field Trial Summary Results. There is a wide range of improvements — up to 83% on Trial #1 (the "troubled sites"). If all of the trials are combined, the overall reduction in service calls is 38%, almost exactly the same reduction as that found with the key system trials.

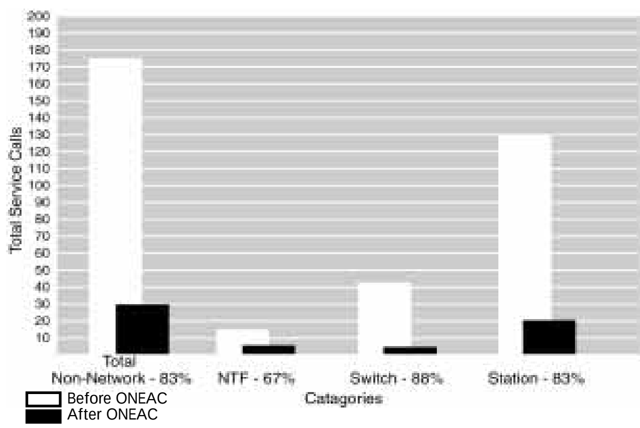

Fig 8: Trouble Sites. Trial #1 depicts 5 PBX systems that were considered trouble sites.

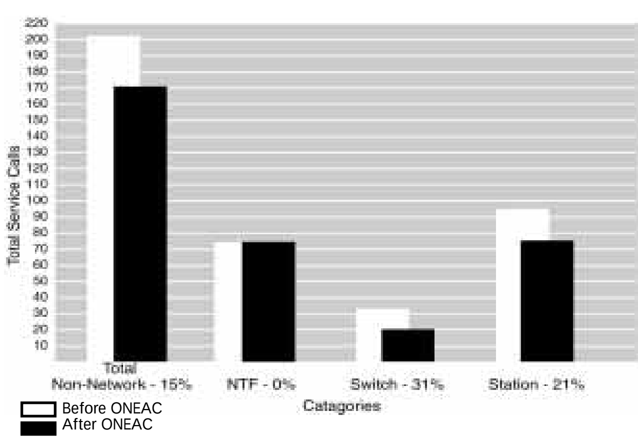

Fig 9: Good Sites. Trial #2 depicts 17 PBX systems in a territory where all "troubled" sites had been conditioned in a major retrofit program. These systems were considered "average to good." The average number of lines was 139.

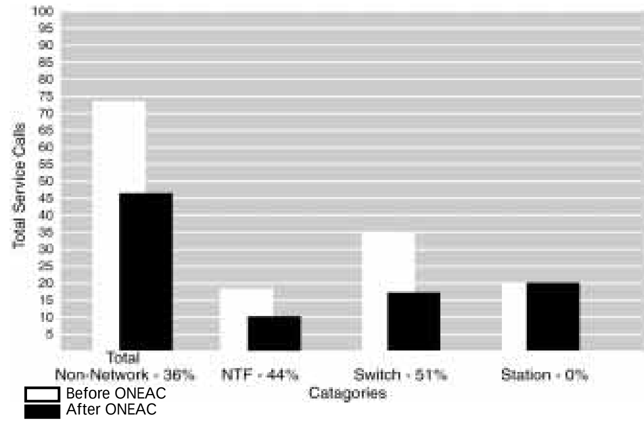

Fig 10: Random Sites. Trial #3 depicts 12 PBX systems that were part of a network. The systems had been in operation for three years with only a normal number of problems. The average number of lines was 121.

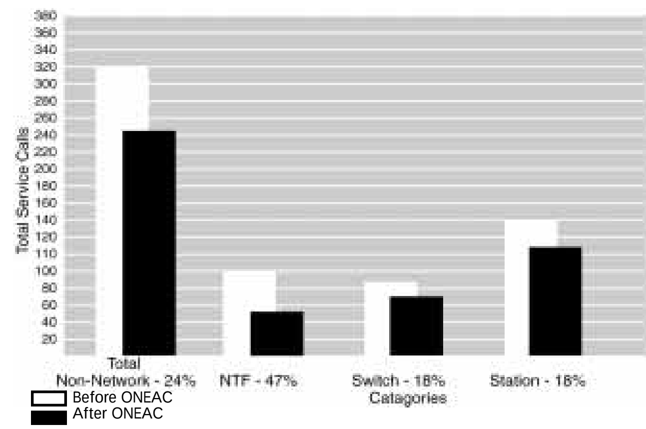

Fig 11: Random Sites. Trial #4 depicts 12 randomly selected PBX systems with an average of 225 lines per system.

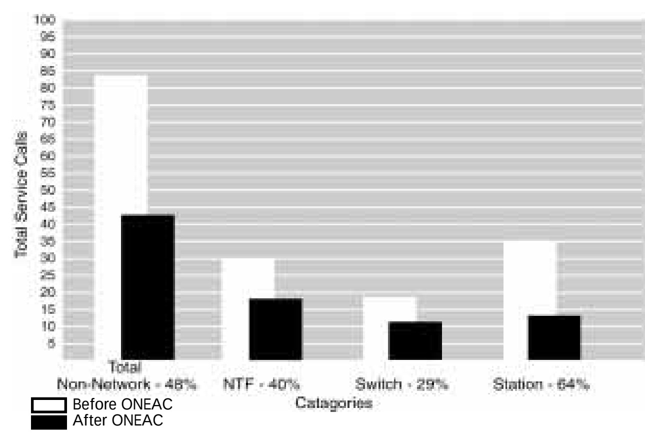

Fig 12: Random Sites. Trial #5 depicts 5 randomly selected PBX systems.

Site-by-Site Analysis

There is another way in which this data can be analyzed, and that is on a site-by-site basis in order to answer the question, "Are the improvements concentrated in just a few systems, or are the improvements consistently spread across all of the sites?"

Interestingly, the number of systems that showed no improvement was the same as those that showed a greater than 90% improvement. These results are reasonable, in that they indicate that the electrical environment in which these systems operate ranges from hospitable to hostile, and everywhere in between. The other fact that these trials allude to is that, because the electrical environment is dynamic and ever-changing, there is no guarantee that the electrical environment that currently exists at these sites will remain the same. This means that every system is likely to find itself in a harsh environment someday. Consequently, all electronic phone systems can benefit from effective power conditioning in the long run.

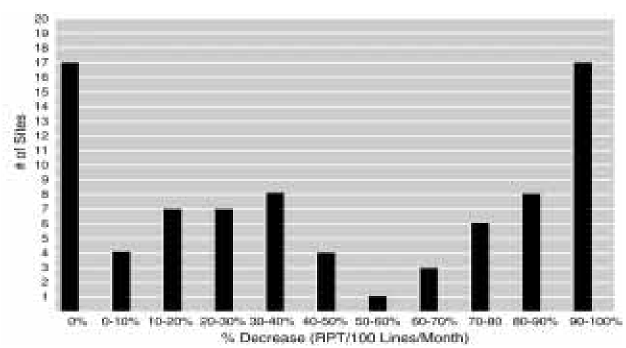

Fig 13: Site-by-Site Analysis

Business Benefits

What do all these field trials mean to the telecommunications manager? These results indicate that the vast majority of systems can experience significant improvements in reliability if the AC power is properly conditioned. To the extent that an organization depends on its telecommunications systems to effectively compete, these reliability improvements can have measurable impact. Not conditioning the power can have a negative affect — dropped calls, no transfer, unrecorded voice mail messages and other problems can mean lost business, not to mention customer frustration and irritation. Also, a decrease in service calls mean that less time will be spent tracing and solving problems. This certainly increases the productivity of both the telecommunications staff and the system users.

Conclusion

This paper illustrated the relationship between the quality of electric power and reliability of electronic power and reliability of electronic phone systems which use that power. The evidence shows that:

- Power disturbances ranging form thousands of volts all the way down to 10 volts have a significant impact on the performance and life-span of modern electronic phone systems.
- The quality of the electric power ranges widely from site to site and changes over time, usually from bad to worse.
- ONEAC power conditioning reduces service calls not only at "troubled sites" but at "good sites" as well, especially in the area of hardware failure and "no trouble found" calls. This translates into better performance and higher reliability for the whole spectrum of electronic phone system users.
- Across-the-board application of ONEAC power conditioning is easily cost-justified in terms of fewer service calls, less downtime, less lost business and less customer frustration.

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