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Managing power quality in the laboratory

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HEALTH-CARE COST control is a driving factor in the development of powerful diagnostic systems based on the latest high-performance microprocessor and semiconductor technology. These systems are susceptible to a variety of electrical power quality problems including electrical surges, spikes, noise, brownouts, and blackouts.

Equipment manufacturers and laboratory managers face an increasingly frequent problem—how to ensure the reliable function of sophisticated technology when the compatibility of the electrical environment cannot be guaranteed. Gen-Probe™ Inc. (San Diego, CA) recognized elements in an article on electrical power quality (Ver Mulm D. Poor power quality in the laboratory: a possible source of instrument operating problems. Am Clin Lab 1995; 14[5]:12–4) and contacted POWERVAR, Inc. (Lake Forest, IL), for help in designing an effective strategy for dealing with power quality disturbances.

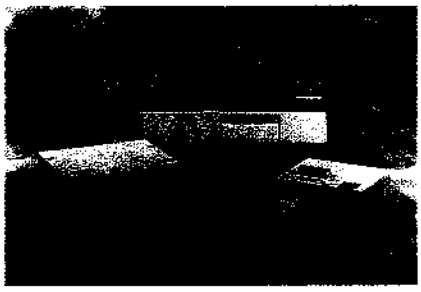

Figure 1 *Gen-Probe DNA-based diagnostic systems.*

A problem of infrastructure

Many of Gen-Probe's clients are public health departments that use its DNA-based diagnostic test systems (see *Figure 1*) for the detection of sexually transmitted diseases such as gonorrhea and chlamydia. Like many facilities (public as well as private), laboratories are located in older buildings where the electrical system may be inadequate or outdated. Funds for electrical rewiring or similar physical improvements are seldom available. As a result, these sophisticated instruments of the 1990s are often installed in a 1950s electrical environment.

Throughout the world, a proliferation of sensitive computer systems is escalating the demand for clean, reliable electrical power. At the same time, cost constraints are creating an electrical infrastructure that is woefully inadequate for reliable operation. Negative consequences result for the instrument manufacturer, health-care provider, and patient.

Manufacturer's issues

Gen-Probe instrumentation is not subject to severe power disturbances in every installation. However, when power problems do occur, unprotected systems experience costly consequences. Random system errors and printer dropouts force tests to be repeated. Before adopting a power management strategy, both Gen-Probe and its clients struggled to determine if failures were an instrument problem, an assay problem, or some other unidentified cause. Frequent problems required exchange of the

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instrument for a new one. The time and personnel involved in the return, quarantine, decontamination, recalibration, and recertification of a suspect instrument were substantial and expensive. Often, no problem existed with the returned instrument.

Health-care provider's issues

Unrelenting cost pressures force providers to find ways of reducing capital and operating costs. On the operational side, the labor component has become an important operating cost factor. Facilities depend heavily on the productivity of personnel and nothing destroys that productivity like downtime. Power quality related downtime results in repetition of tests, waste of disposables, and delay of other scheduled procedures. Operating costs increase and physicians are inconvenienced due to the delay in patient results. Incomplete tests cannot be billed to Medicaid or other public health plans for reimbursement. The result for health-care providers is much the same as for the manufacturer—dollars lost.

On the capital side, one way to decrease capital cost per exam is to spread instrument cost over more exams. Controlling power quality results in higher uptime, longer instrument life, and a larger volume of tests over the instrument's lifetime. Amortizing instrument cost over a larger test volume results in lower capital costs both per exam and per patient.

Patient's issues

Speed of delivery and quality care are important patient issues. Gen-Probe offers DNA-based detection of tuberculosis in less than 4 hr. Repeating interrupted tests requires additional time, and it may also be necessary to acquire another patient sample. There are other considerations as well. For some clinical procedures, patient appointments may need to be rescheduled or canceled. Inpatients may require longer stays, resulting in additional discomfort, inconvenience, and cost.

Real-world scenario

A LEADER™ luminometer (Gen-Probe) is used for the final stage of the test procedure. The photomultiplier tube used in the luminometer requires a clean, reliable voltage supply to ensure that the chemiluminescent event is accurately recorded. Power disturbances disrupt the test procedure, resulting in delays, sample loss, and wasted assays.

The company's experiences with power quality problems are no different from those of other instrument manufacturers. A variety of observable symptoms may occur, and power disturbances such as those illustrated in *Figure 2* are often the culprit. Electrical power does not cause problems at every installation, but the difficulty and expense of predicting where problems will occur require a proactive approach to addressing power quality issues.

Gen-Probe contacted POWERVAR with the aim of developing a strategy for dealing with client power quality problems in an effective and economical way. The foundation of this strategy is an understanding of how modern technology reacts to power disturbances. Almost all computer technology today uses nonisolated switch-mode power supplies.

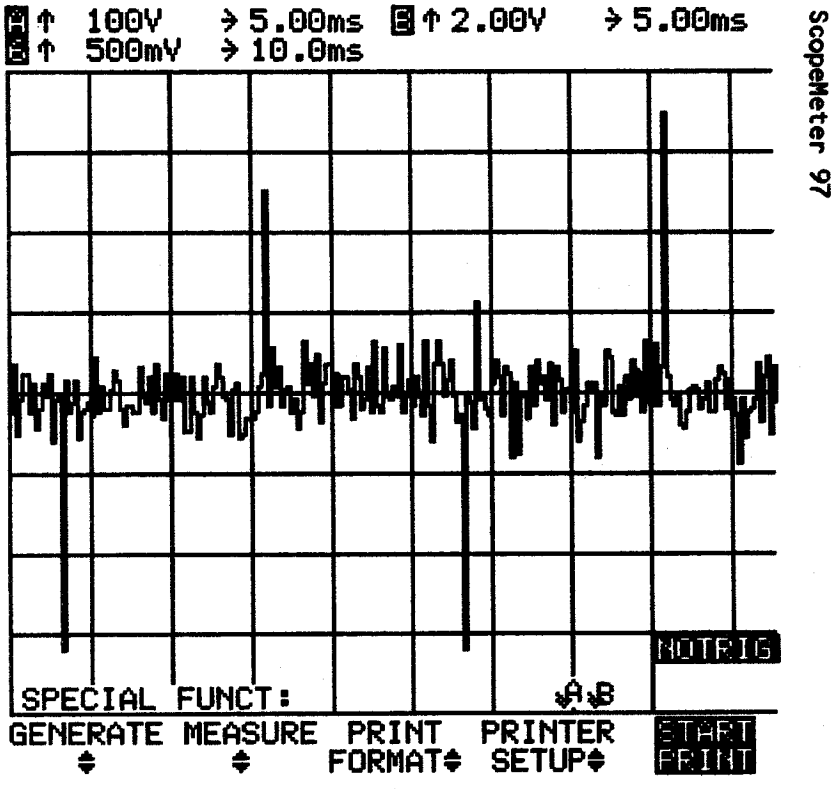

Figure 2 *Common mode noise at laboratory receptacle.*

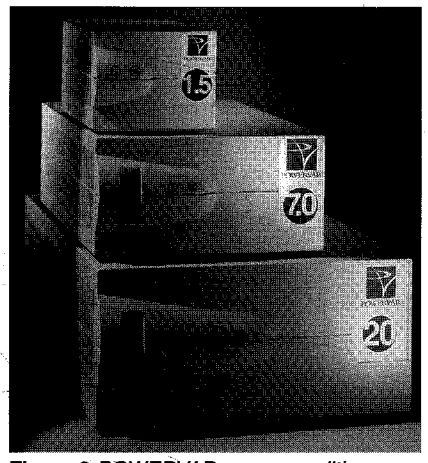

Figure 3 *POWERVAR power conditioner.*

These supplies are tolerant of brief voltage fluctuations, but require electrical power that is free of high-voltage impulses, high-frequency noise, and neutral-to-ground (common mode) voltages. In addition, some applications also require uninterruptible power.

Electrical noise and impulses are a natural by-product of the use of electric power in a facility, and all electrical devices contribute to the power quality problem. It is a paradox that the same technology that provides productivity also creates an obstacle to it. As systems become more sophisticated, they tolerate less of the power disturbances created by their electrical neighbors. Substandard wiring and grounding practices only serve to aggravate the condition. Manufacturers and laboratories are caught in a quandary: The more modern and sophisticated the instrumentation, the more susceptible it is to power problems.

The two companies developed a sound power quality strategy. First, selection of appropriate power quality solutions is critical. Like many instrument manufacturers, Gen-Probe's expertise is not electric power or power protection devices. In partnership with POWERVAR, Gen-Probe learned that, in spite of marketing literature that purports otherwise, most uninterruptible power supply (UPS) products do not contain all the elements necessary to provide instruments with complete power protection. Like most modern systems, the company requires three basic elements for a good power protection platform: a surge diverter, an isolation transformer, and a noise filter. The POWERVAR power conditioner combines these three elements in one package (see *Figure 3*).

Next, a UPS product was needed for those applications and installations in which uninterruptible power is a necessity. The UPS is used with the power conditioner to provide a complete power quality solution. Using this strategy, the incidence of system downtime has been reduced significantly. The effects of power quality problems have largely been eliminated.

The results are predictable. Power quality is no longer an unknown variable in Gen-Probe installations. Problems are reduced substantially, and the company's ability to respond to customer support issues has been enhanced. Unnecessary return of instruments is greatly reduced, as is the cost of decontamination, recalibration, and recertification. From the client's perspective, delivery of health-care services is faster and more efficient. Capital and operating costs are better controlled, and productivity is higher. For the patient, health care is more convenient and more economical.

Conclusion

Given the level of sophistication of today's microprocessor-based systems, electrical power related instrument failure is inevitable. Modern laboratories must carefully protect sensitive instrumentation from the effects of power quality problems, and instrument manufacturers must be prepared to provide appropriate advice and power quality solutions. Cost control, productivity, speed of delivery, and quality of patient care depend on it.