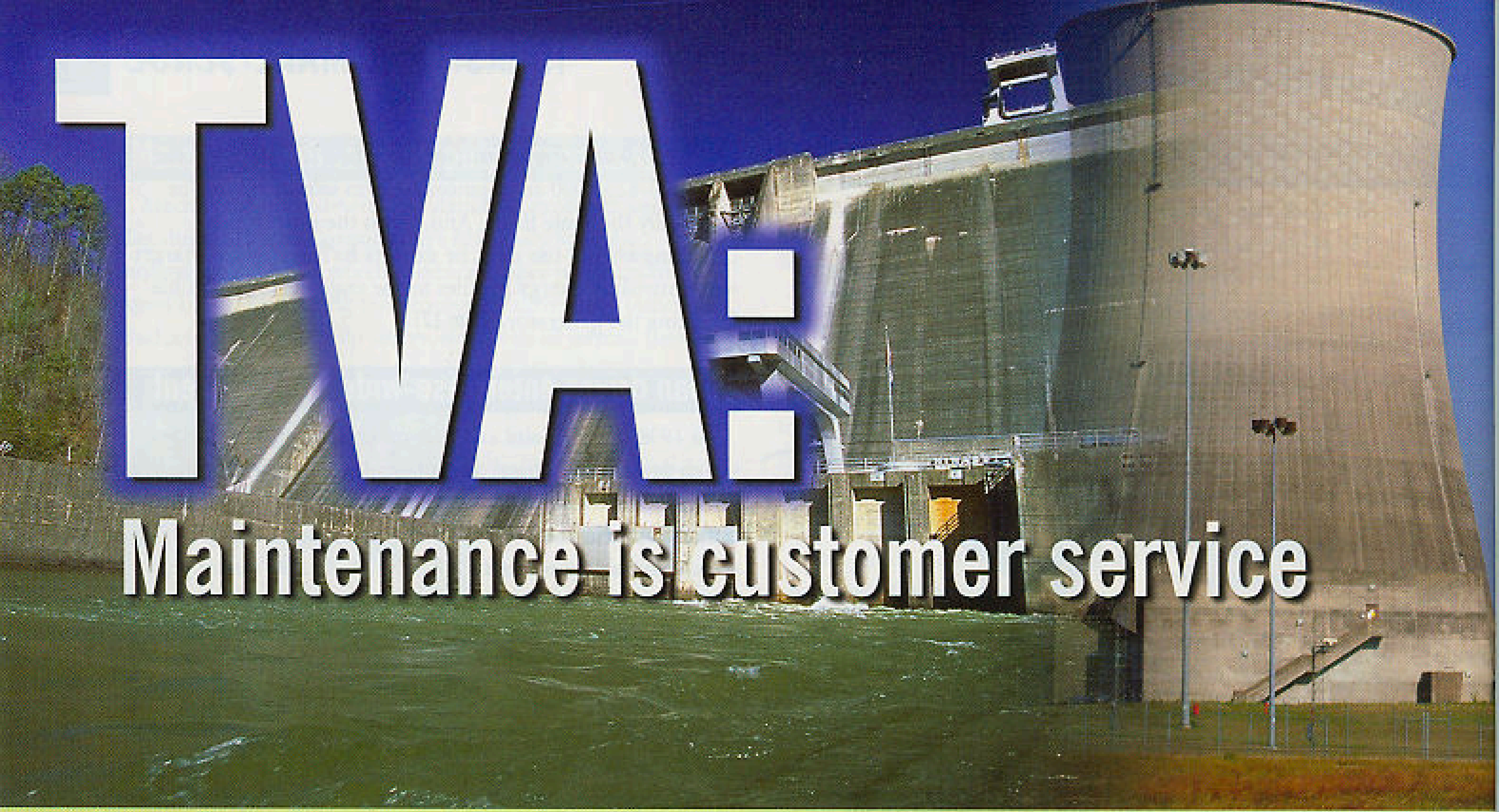


TVA: Maintenance is customer service

When workers at the Tennessee Valley Authority say they listen to their customers, they mean it in more ways than one. For almost a decade, TVA has been using state-of-the-art ultrasonic technology to conduct compressed air surveys for a variety of companies in industries from manufacturing, food and aerospace to housing, utilities, suppliers, hospitals and automotive plants.

By Kevin Whitehead

Compressed air is vital to many plants' operations. Leaks in a plant's air system are caused by normal wear and tear and as such are common in plants that have been in operation for a long time.

A "giant Christmas tree"

But leaks also can spring up in new equipment. This was the case in a brand new automotive facility. It had just been plumbed for compressed air and didn't even have operating equipment in place yet, but its maintenance workers realized they had leaks because they could hear hissing throughout the plant even without using diagnostic equipment.

They asked the TVA to come in and establish a baseline for the compressed air usage which would be such a vital part of their operation. Equipped with a handheld ultrasonic instrument, the TVA technician found so many leaks that by the time all the tags were hung, workers said the plant looked "like a giant Christmas tree."

In the end, the TVA technician tagged nearly 5,000 leaks, which were costing the company well into six figures in wasted electricity.

TVA to the rescue

The TVA has a comprehensive program that provides engineering services to commecial and industrial end-users. The TVA and participating distributors of TVA power finance the program, so there is no direct cost to the customers for these maintenance surveys.

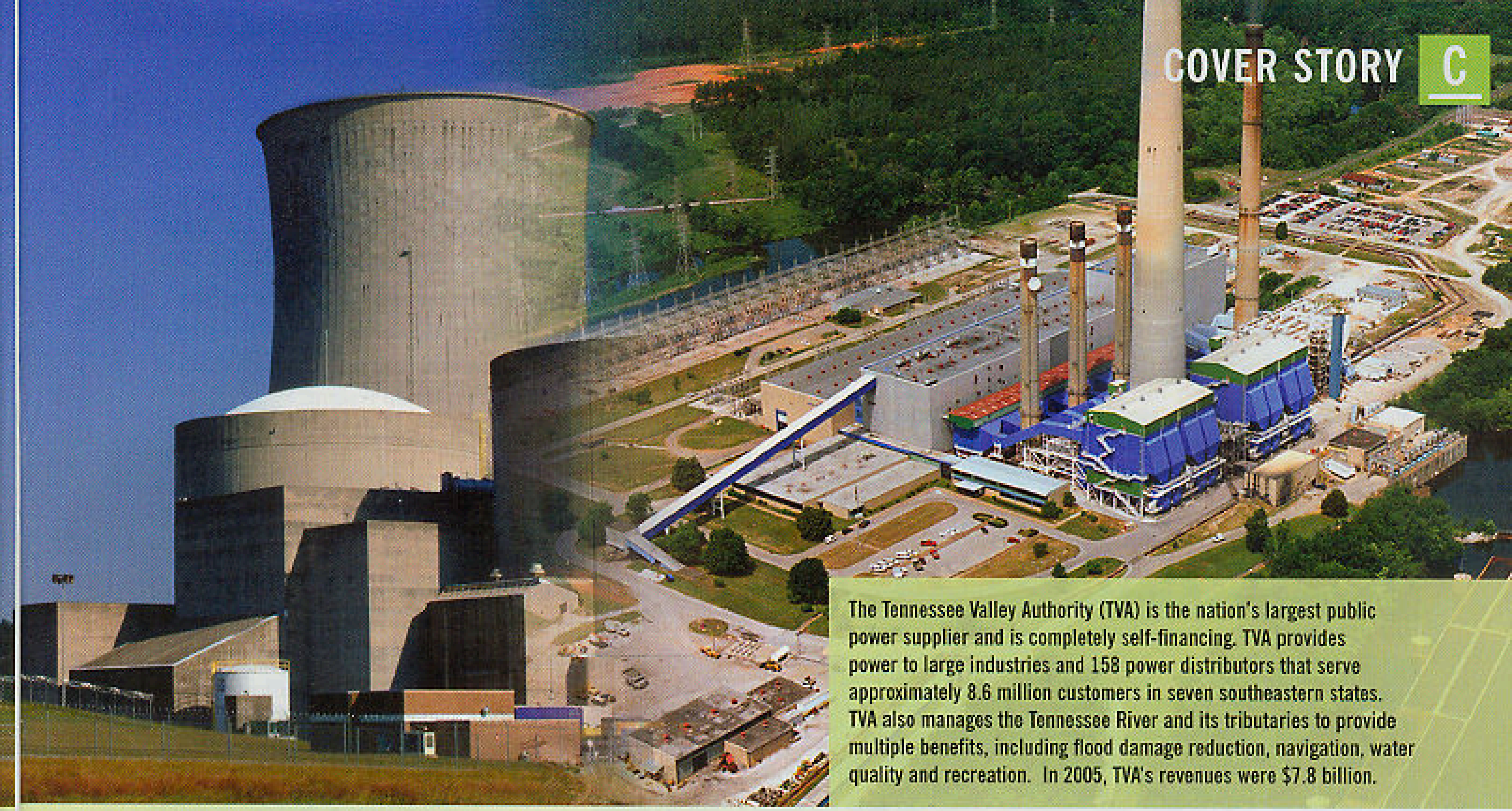
Companies contact their power distributors who, in turn, approach TVA, to do surveys for a variety of reasons. They may have a faulty piece of equipment, or are using more power than they need, or they want to find ways to conserve energy. Usually these end-use customers are willing to come to us because they perceive the TVA as an objective third party.

You might think the TVA would want customers to use as much power as possible, but what we really want them to do is use power responsibly and wisely. This helps maintain an even demand on our system and reduces the TVA's need to purchase power or construct new generating facilities.

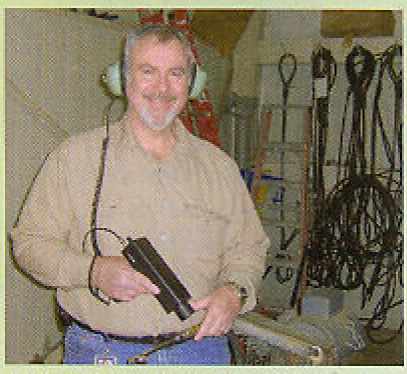
Some companies have their own maintenance staffs that can perform compressed-air surveys, but often they simply do not have the equipment or the manpower to conduct thorough surveys. The TVA has employees throughout its service area who have the expertise and the equipment to perform these studies.

"A" is for automobile

One of the most dramatic surveys completed recently was for an automotive facility (we'll call it Company A) in the southeastern United States. Located over five buildings, the



The Tennessee Valley Authority (TVA) is the nation's largest public power supplier and is completely self-financing. TVA provides power to large industries and 158 power distributors that serve approximately 8.6 million customers in seven southeastern states. TVA also manages the Tennessee River and its tributaries to provide multiple benefits, including flood damage reduction, navigation, water quality and recreation. In 2005, TVA's revenues were $7.8 billion.



Kevin Whitehead, a senior technician with the TVA's Customer Resources division, has dedicated his career to helping TVA customers save energy costs.

plant is divided into five major divisions. Partnered with a company maintenance person, it took a TVA technician several months, working five days a week, to survey the entire plant with an ultrasonic instrument.

To survey the plant, we used state-of-the-art airborne ultrasonic detection equipment with the instrument's scanning module, rubber focusing probe and long-range adapter. The survey began by inching along the compressed air system, slowly scanning back and forth, using the long-range adapter, which can pick up noises at a distance of 25 feet. Upon hearing a revealing noise, we walked toward it until within five feet of the source. Next, we attached the focusing probe to the instrument and started taking measurements.

The plant was divided into grids and then each grid was surveyed. The leaks found were then identified and tagged before moving on to the next grid. This ensured that there was no overlap or missed area.

Once a leak is located, it is tagged and recorded by noting its location, identifying it by machine, column or aisle number. This enables the maintenance staff to come back and repair it at their convenience.

Measuring money in cubic feet per minute

A dollar value is assigned to each leak by measuring it using the cfm (cubic feet per minute) system. A computer program for compressed air systems from EPRI (Electrical Power Research Institute)helps determine the cost of generating compressed air, based on charges for electricity, hours of operation and number of compressors. By gauging the rate at each leak site, we can determine how much each leak is costing the company in wasted electricity each year.

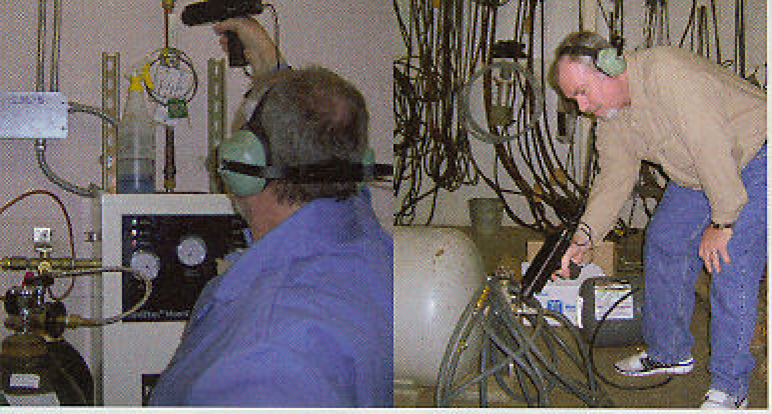
Six centrifugal air compressors totaling 13,500 horsepower generate compressed air for the entire plant. Their total output is approximately 50,000 cfm. Typically, the company uses about 27,000 cfm of air and pays, on average, about $1,000,000 a month for electricity. So, in a typical year, the company spends $1,760,000 to generate compressed air — about 15 percent of its yearly electric bill.

The old engine facility was the first section examined. This plant had a total consumption rate of approximately 11,500 cfm of air and the 615 leaks found equated to about 1,500 cfm, or 13 percent of the total. Each leak averaged a little over $210 so the calculated the cost of all of them came to be over $130,000 a year.

Next, we surveyed the body system section, which also uses about 11,500 cfm of compressed air. Using the ultrasound instrument, we discovered this section was leaking about 3,570 cfm from 1,931 leaks — about $345,000 a year!

In the vehicle systems area, which used less compressed air than the other areas, we found a large number of leaks;

continued on page 16



Money talks but it also hisses: some large ultrasonic monitoring jobs have taken TVA teams six or more weeks to complete.

713 in all. These leaks equaled 850 cfm, or about 40 percent of the total, which equated to almost $82,000 a year.

To understand why so much compressed air was being lost, we conducted a study of the area's air usage history for the previous two years. We found that the plant's compressed air demand had risen by almost 20 percent. This was puzzling because the plant had purchased no additional equipment or made any significant production changes.

Finally, we discovered that new replacement robots had come from an overseas supplier and had been installed by the manufacturer's representatives. Once they were installed and powered-up, we found that many of the robots had leaking internal connections — poor quality control by the manufacturer!

Next came the main utilities building, which houses the air compressors for the entire plant, the electrical switchyard, the natural gas head and the chilled water system. The amount of compressed air assigned to this area is 500 cfm. Here we identified a total of 45 leaks and, although the number of leaks was small, the amount of leakage was huge; each leak averaged a little more than $265, or $12,000 a year.

The last area surveyed was the new engine plant. Here we found 257 leaks that wasted approximately $28,000 a year.

A summary of the results of the compressed air leak surveyor, Company A:

Area	Total CFM	# Leaks	$ of Leaks/Yr.	CFM of Leaks	% Leakage
Old Engine Plant	11,500	615	$130,000	1,500	13%
Body Systems	11,500	1,931	$345,000	3,570	32%
Vehicle Systems	2,000	713	$82,000	850	42%
Main Utility Bldg	500	45	$12,000	130	26%
New Engine Plant	1,350	257	$28,000	290	21%
Totals	**26,850**	**3,561**	**$597,000**	**6,340**	**24%**

In terms of total costs: $597,000 (cost of 3,561 leaks) ÷ $1,760,000 (cost to generate compressed air) = 34%
$597,000 (cost of 3,561 leaks) ÷ $12,000,000 (total electric cost per year) = 5%

A summary of the results of the compressed air leak surveyor, Company B:

Area	Total CFM	# Leaks	$ of Leaks/Yr.	CFM of Leaks	% Leakage
Trim and Chassis	4,500	355	$28,750	555	12%
Paint	5,500	525	$48,100	880	16%
Body Frame	5,000	460	$42,500	775	15%
Stamping	4,650	220	$35,150	630	13%
Boiler Room	500	25	$2,500	65	13%
Totals	**20,150**	**1,585**	**$157,000**	**2,905**	**14%**

In terms of total costs: $157,000 (cost of 1,585 leaks) ÷ $1,080,000 (cost to generate compressed air) = 14%
$157,000 (cost of 1,585 leaks) ÷ $12,000,000 (total electric cost per year) = 1.3%

Another plant, another $150,000

For another automotive company (Company B), TVA first conducted a preliminary test at one location. The company was so impressed with the results that management commissioned the power distributor to have us survey the rest of their facilities. However, the company was changing its product line and adding new vehicles, so there was a delay of a few months before the survey could resume.

In the four areas of the painting facilities, 525 leaks were located, equating to 880 cfm, or a leak rate of around 16 percent, which was costing the company about $48,100 a year. Also identified were areas where the company could save additional money by improving its paint processes. For instance, there were four places where, instead of compressed air, the plant should have used an air blower, a less costly option. Our suggestions amounted to a potential savings of over 400 cfm of compressed air, or $50,500 a year in savings.

In the body frame area, measured usage was approximately 5,000 cfm of compressed air for its processes. We located and tagged 460 compressed air leaks, which represented 775 cfm (about 15 percent of body frame's total usage) at a cost of approximately $42,500 per annum.

When surveying the company's stamping area, not as many leaks in proportion to the other areas were located, but those found were generally much larger. While only 220 leaks were found, they equaled 630 cfm, almost twice the ratio of the other three areas inspected. These 220 leaks were costing the plant $35,150 a year.

The final area surveyed was the company's boiler room, which houses nine compressors for the compressed air system and is home to the company's steam boilers. The amount of compressed air assigned to the boiler room had been limited to about 500 cfm. Only 25 (mostly small) leaks were found, which equated to 65 cfm, or about 13 percent of the total of 500 cfm. These few leaks were costing the company $25,000 a year.

Both companies, "A" and "B," have large maintenance staffs and were able to repair all the leaks in a timely manner. Companies that don't have the luxury of maintenance manpower usually develop their own repair schedule. This often becomes a matter of the maintenance person going through the plant once a week with a list of leaks and repairing as many as he can in a limited amount of time.

Fortunately, some repairs can be made without shutting down operations. Because air systems are just like water plumbing, the maintenance person easily can create bypasses by isolating the leak in question and closing off some valves. Sometimes a leak can be fixed by simply tightening a loose joint or replacing a hose connection. Others can get more complicated and involve replacing a reducer or even a regulator.

Ultrasound provides additional troubleshooting benefits

In the nearly 10 years TVA has been using ultrasonic instrumentation to detect and diagnose problems in compressed air systems, a number of additional and valuable applications for this remarkable technology have been discovered.

Recently, while checking for compressed air leaks at a Nashville (Tenn.) utility, a 1,500-hp pump motor was heard making a noise like marbles rattling in a tin cup. When we brought it to the attention of the maintenance tech assisting with the audit, he asked us to do a further inspection right on the spot. Using the ultrasonic detector with its contact probe, we located some badly worn bearings on the backside of the pump.

Soon after, the maintenance team shut it down, brought in a back up, and repaired it. Within 24 hours they had the pump up and running again. If the problem had gone unnoticed and that pump had failed during operation, it would not have been a pretty sight.

We have also successfully used our ultrasonic detection equipment to inspect electrical systems. Once, while conducting a survey for a writing instrument manufacturer, we heard a sound like bacon frying in the electrical switchgear. Upon removing its cover, we found the box was full of graphite — an accident waiting to happen! We carefully replaced the cover and immediately reported the problem to the plant manager. A maintenance crew went out that

continued on page 18

afternoon, shut it down, cleaned up the graphite deposits and tightened up the loose connections that were causing the original problem.

Catching heat

Ultrasound is particularly useful when used in conjunction with infrared thermography. While infrared is designed to detect heat generated by loose connections and faulty bearings, an ultrasonic instrument is designed to pick up noises caused by worn bearings, as well as arcing, tracking and corona in electrical switchgear before they have a chance to generate much heat.

Because it can spot problems before they develop and get out of hand, the technology is invaluable in predictive and preventive maintenance.

The idiot's guide to ultrasound

Airborne ultrasound instruments generally sense sounds in the frequency range of 20 kHz to 100 Hz, well beyond the human hearing range. The high frequencies generated by air and gas leaks, worn bearings and faulty electrical equipment are electronically translated down to human hearing range by a process called heterodyning, where they are heard through headphones and viewed as intensity levels on display panels or meters.

By either touching the instrument to a test spot or pointing it at a target, one can hear the ultrasonic sounds through headphones and determine their sources. The shortwave characteristic of ultrasound provides three major advantages: the source of the ultrasonic sound is fairly directional and can be easily identified with little interference from competing sounds; the applications for ultrasound are numerous and cover most potential mechanical, electrical and leak problems; and potential failure conditions can be detected, trended and analyzed earlier than with traditional PdM technologies. It's a win, win, win situation for plant maintenance.

"Hey, we have something just like that!"

One final note. It saddens me to say this but it's true nonetheless. Every so often, when I am called in to conduct a survey, unpack my ultrasound equipment and begin using it, maintenance people will say, "Hey, we have something just like that back in the shop but we've never known what it's for."

More often than not, this is because the company's former ultrasound "expert" has moved on and his replacement was never made aware of the instrument's purpose, much less trained how to use it. However, after giving the maintenance workers a crash course on how to use it and after they see with their own eyes how much time and money ultrasonic surveys can save, they become converts for life. ◉