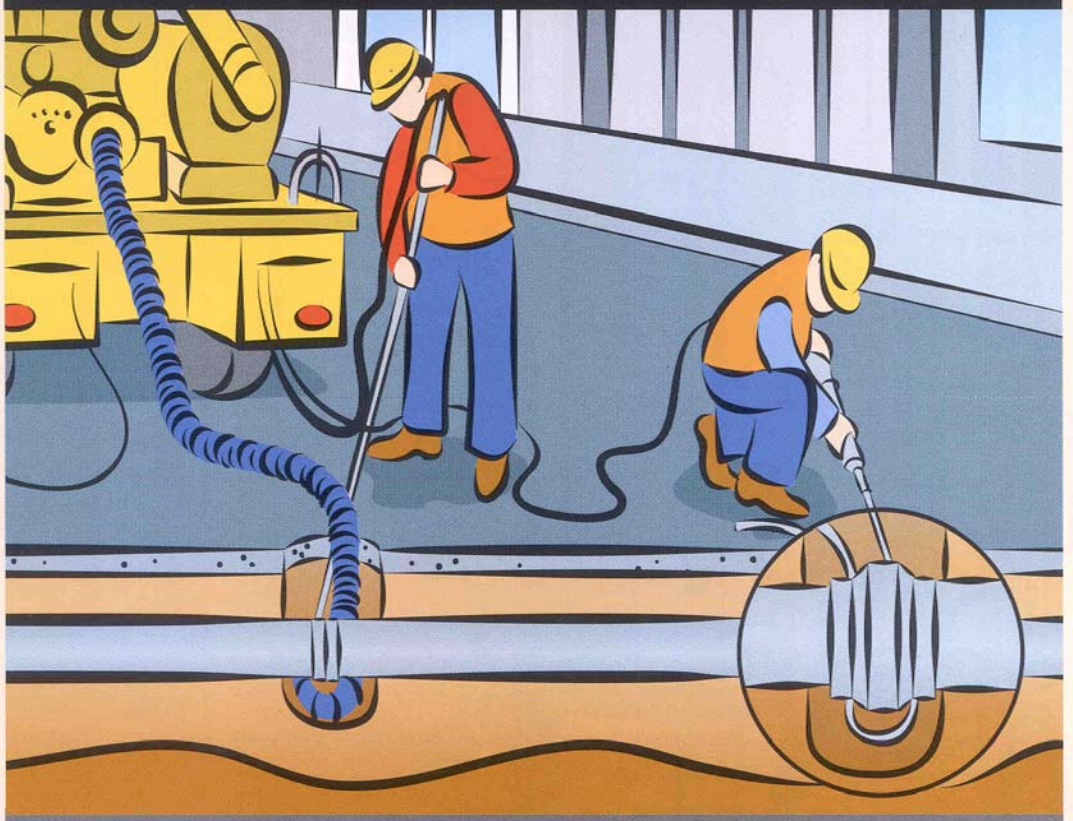
# UNLOCKING SAVINGS

## with Keyhole Technologies



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# UNLOCKING SAVINGS

## with Keyhole Technologies

"It's all about making smaller incisions, and then using specialized tools and techniques to keep the system operating at optimal efficiency," explains GTI's Dennis Jarnecke, Principal Project Manager, Transport Materials and Systems, who leads many of GTI's keyhole technology efforts. "In medicine, it is the patient who benefits. In the natural gas industry, there are multiple beneficiaries."

While gas company operations staff can realize significant savings using keyhole technologies (excavation and pavement restoration costs are typically 50 percent less), consumers and the general public also benefit through less disruption and noise, quicker repair times, fewer and shorter gas service interruptions, and reduced traffic inconveniences.

Civil engineers like to compare a natural-gas piping system to the arteries and organs that pump blood through the human body.

Both systems are vital; both can require a certain amount of maintenance; and both benefit from technologies that lessen the intrusive nature of making repairs.

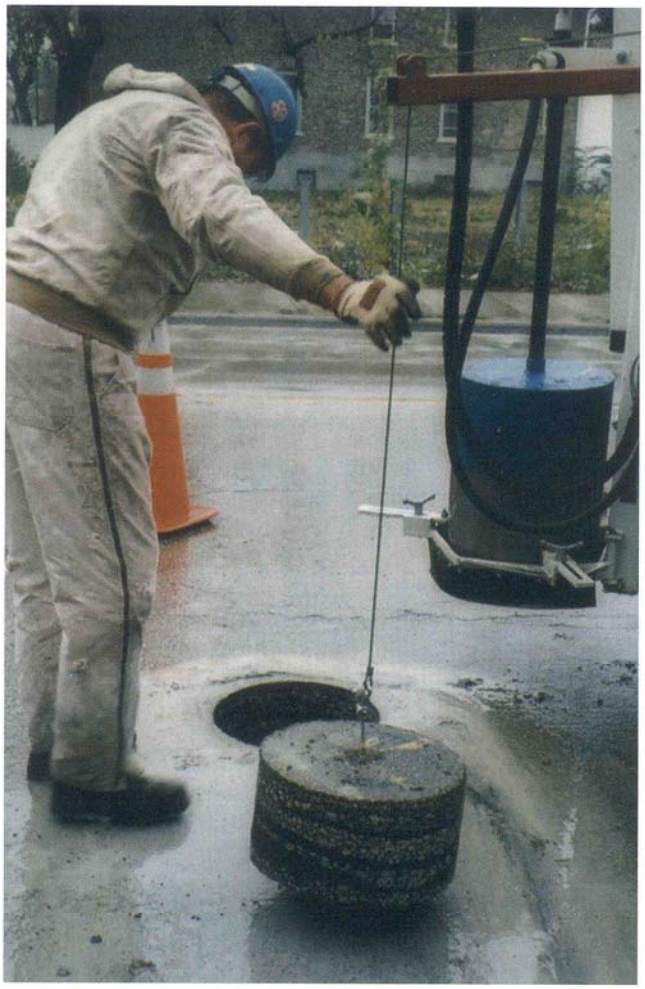
### Replacing
## CONVENTIONAL PRACTICES

Conventional repair practices often require large "open" excavations (surface cuts measuring about three feet by four feet), followed by the removal and disposal of unwanted pavements and soils. Jobs are commonly performed using several large pieces of equipment: backhoes, crew trucks, dump trucks, flat-bed trucks, pavement breakers, shoring timbers and jacks, steel plates, tamping equipment, backfill material, temporary paving materials, and barricades. Excavation and restoration activities can account for 80 percent of the total cost of a repair job. Excavation can also be the major cause of traffic congestion, and, in some areas, conventional repairs are further hampered by municipalities that limit the hours utilities can dig.

With excavation and restoration costs currently costing U.S. gas companies more than $1 billion annually, gas system operators are turning to keyhole methods as a way to reduce overall maintenance costs.

Common keyhole methods involve creating a pavement opening only 12 to 18 inches in diameter (usually created in "cookie-cutter" fashion with a coring tool), and removing soil with vacuum excavation equipment. The pavement hole is usually made with a circular-drill core-hole cutter, and the cut pavement section is permanently replaced after repairs are made.

Vacuum excavation systems alone (which have shown to provide paybacks of two years or less) can eliminate the need for several large pieces of equipment, such as a backhoe and dump truck. Researchers explain that smaller excavations equate to reduced backfill, paving, and permitting costs.



Urban utilities—with much of their vast piping networks buried under concrete and asphalt—have been driving the development of keyhole technologies through projects and partnerships with GTI. Washington Gas, Philadelphia's PECO Energy, the Southern California Gas Company, New York City's KeySpan Energy, Toronto's Enbridge Consumers Gas, and others are using new keyhole technologies in their daily operations, while working with the research community to advance the industry's ability to pinpoint problems and make repairs with even greater precision.

Currently, several construction and maintenance activities can be performed through keyholes, including: potholing/depth checks, valve box cleanouts and installations, plastic pipe squeeze offs, service cut offs, and cast-iron joint sealing. To advance the state of the art and identify needed technologies, GTI has established a collaborative research project with 17 utilities to thoroughly analyze the current status of keyhole tools and further develop keyhole processes worldwide.

"Conventional keyhole technologies are easy to apply when you know exactly where to dig," says Jarnecke. "Consequently, some of GTI's major efforts in this area are to develop technologies that can precisely locate gas leaks, corrosion, or other pipe problems."

## Locating
# THE PROBLEM

In a project—sponsored by GTI's Sustaining Membership Program (SMP) and the GTI research collaboration program on keyhole technologies—researchers are developing a digital leak detector that can locate the source of a leak to within a few inches. Conventional leak-detection products—such as combustible gas indicators—are accurate enough for a relatively large excavations (3x4-foot cuts), but not consistently accurate enough for keyhole repairs. The digital leak detector uses the sound a leak generates to pinpoint the location of the escaping gas. (Unlike the gas, the acoustic signal cannot migrate away from the leak.)

"Improving the ability to locate leaks will not only advance the use of keyhole technologies, but can help avoid unnecessary digs," Jarnecke notes. "For a utility crew that finds and repairs 10 leaks per week, reducing the number of incorrect locates by 10 percent could save $50,000 per year."

In some areas, finding the pipe itself can be a problem. Plastic piping, older systems, those in highly congested underground environments, and those with less-than-precise maps and data can present particular problems. Consequently, parallel efforts at GTI involve the investigation of capacitive tomography and ground-penetrating radar techniques to locate all kinds of buried gas piping materials. In a U.S. Department of Energy project, GTI is developing a compact and inexpensive capacitive tomography imaging sensor that takes the form of a flat plate or flexible mat that can be placed on the ground to create an image of objects embedded in the soil. A variety of technologies have been investigated and tested, including the PipeHawk® locater developed through England's EMRAD Ltd., and Radiodetection Corporation's Precision Pipe Locator®.

In 2002, PECO Energy, with the assistance of GTI, completed a year-long pilot program involving the use of GTI-supported pipe-location products and other advanced technologies to find, identify, and accurately verify the horizontal and vertical location of underground facilities. By accurately identifying underground facilities ahead of time, PECO avoided facility relocates, reduced construction downtime, and reduced the risk of third-party damages. PECO estimates that the company can save $1 million a year by improving the process for verifying utility locations.

Says PECO's Mark Andraka, Senior Engineer: "This program has not only helped our company improve how it

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>
> ▼ **Dennis Jarnecke, GTI Principal Project Manager, Transport Materials and Systems**

manages its locating activities, but also helped to enhance some of the tools that are increasingly being used throughout the world for locating subsurface facilities. Importantly, the program underscored the point that no single technology was the 'catch-all' in facility verification. Each technology had benefits and limitations. GPR, for example, proved very effective in identifying plastic pipe as small as one inch in diameter at depths of six or seven feet. However, certain areas proved difficult because of debris in the ground and age and condition of iron pipe."

PECO expects that further technology advancements will reduce the size and number of excavations necessary to attain verification. The company plans to expand its field studies to include pavement coring, smaller excavations, and innovative utility identification and examination techniques.

## MICRO-EXCAVATION

By adapting new sensors, lighting methods, and other advanced technologies, researchers are looking to develop tools to allow repairs to be conducted through openings that are microscopic in comparison to those currently used. The technique is often compared to the medical field's laparoscopic surgery.

A GTI/SMP project currently under way is focused on adapting micro-excavation to reduce of size and number of utility bell holes (an estimated 1.1 million are now made annually, at a cost of $1,000 per hole) utilities commonly use to reach areas in need of repairs.

The micro-excavation technique in this project involves drilling one or more six-inch-diameter holes in the ground until they reach the pipe. Next, tubes are inserted to create passageways for remote tools, sensors, and lighting equipment. After researchers prove the six-inch concept, work will be conducted to reduce the tube size even further, down to one inch.

"The ultimate goal," says Jarnecke, "is to develop a tool that can be inserted into the tube, sense a gas leak, direct itself to the leak, and repair it. However, significant savings can be gained just in excavation by minimizing pavement contracting costs and settlement issues."

## Keeping KEYHOLE TECHNOLOGIES Safe

As with all gas operations, safety is the top priority. Consequently, in developing keyhole technologies, GTI is conducting research to ensure that keyhole practices remain safe.

One safety concern has been with the use of vacuum excavation equipment in the presence of potentially flammable gases. There has never been a reported incident of ignition involving vacuum excavation since the technology was introduced more than 40 years ago. However, with the rapid increase in vacuum excavation operations, the industry has called for scientific investigation into vacuum system safety. Working with New Jersey's Public Service Electric and Gas Company, various vacuum excavation safety issues were addressed. While studies are ongoing, initial results show that vacuum excavation is very safe.

"So far, GTI has identified several reasons why it is difficult to create an ignition," notes PSE&G's George Ragula, Distribution Technology Manager. "However, further research will help answer other questions, such as whether static electricity can create an ignition."

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