

# Pipe Leak Repair: New and Improved

There's now a digitally assisted way to repair and prevent leaks in industrial piping systems. Recent experience at oil production facilities and nuclear power plants have proven out the method. It's faster, safer, and more effective.

An oil drilling operation in North America struggled with a nagging pipe leak problem. Sand coming up from the ground along with the crude oil was wearing away at their plant's piping system – especially where the pipes made 90-degree bends. The company had to routinely shut down the affected drilling operation to repair the pipes. It was a long, drawn-out maintenance process that could sometimes take multiple weeks to complete.

That is, when they approached the problem in the old-school way.

The traditional repair process – tearing down the damaged pipes, taking measurements manually, and designing, building, and installing custom replacement pipes – was indeed a laborious, time-consuming task. Plus, there was no slam-dunk guarantee the replacement pipes would precisely refit to the full piping system's configuration.

The oil company's field-engineering firm proposed a very different way to tackle the pipe leak problem – a method both more efficient and more effective. They contracted Dimensional Engineering, Inc., the Michigan-based provider of 3D digital data capture and analysis services, to make it happen.

First, the Dimensional Engineering team used the latest laser scanning equipment – battery-powered and non-contact – to collect pipe measurements. They measured digitally, not by hand, for higher accuracy. Shooting directly into the pipes' headers, they determined the dimensions on a number of full pipe trains – all in just a couple of hours. There was no need for scaffolding.

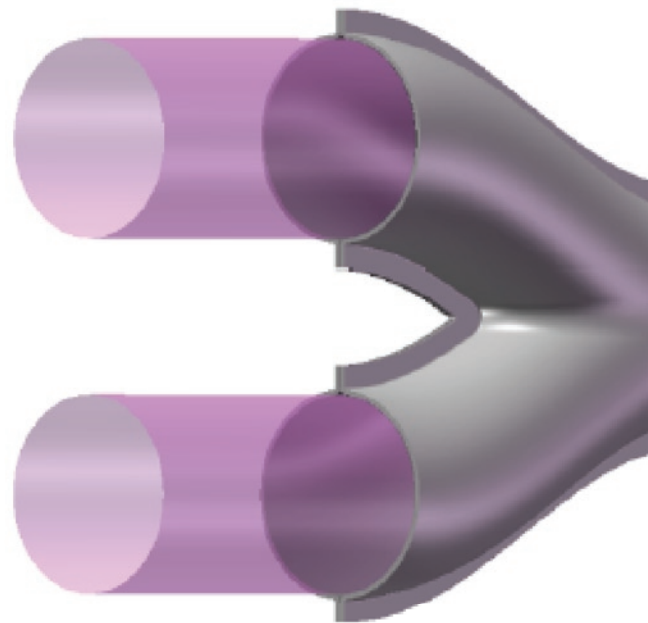
With digital measurements taken, Dimensional Engineering next turned to CAD software to design custom enclosures for the worn areas of the pipes. Newly fabricated, the enclosures were then installed to the pipes. All have worked perfectly; they fully encapsulate the pipes' sensitive areas and minimize further risk of leaks.

Bottom-line benefit: The drilling operation suffered total downtime of just hours, rather than weeks. Thanks goes to Dimensional Engineering and their innovative, new-school approach to pipe leak repair.

## Mission: Speed and Simplify

It isn't only oil producers who feel the need for improved pipe leak repair. Dimensional Engineering has also recently applied its expertise in digitally measuring piping systems and designing leak-preventing pipe enclosures at nuclear power plants. Chemical processing facilities are also now evaluating the method.

“Leak repair and prevention are challenges wherever industries rely on complex piping,” says William Bonner, managing director of Dimensional Engineering. “We hear this concern wherever pipe



A leak in a Y pipe is most likely to occur where the passages split. With a 4-foot diameter pipe, the area to be measured for the outer repair shell may extend for 8 feet or more, and may include irregular surfaces. Highly detailed 3D CAD geometry allows Dimensional Engineering to measure sections of the pipe and the shell enclosure in any direction. This helps ensure the enclosure's precise fit with a constant distance to the pipe.



leaks can reduce or even halt production in a plant.”

Per Bonner, repair teams have traditionally used ultrasound measurements to help pinpoint areas in pipes where leaks are likeliest to develop. “Take, for example, a typical Y pipe,” he says. “It may be 4 feet in diameter. Excessive wear can occur where the Y splits into two passages. It’s here that the impact from chemicals, oil, water, steam, or hydrocarbons rushing through the pipe will create pressure, turbulence, and vibration.”

As Bonner explains, pipe leak repair teams have always operated in preventative mode. Their task

creating the shell enclosure. A field engineer would straddle the pipe, or hang above it from scaffolding and a harness, and use handheld devices to measure surfaces near the point of the leak. With a Y pipe of this kind, the area to be measured might extend for 8 feet or more, and it could include irregular surfaces.

“Obtaining these measurements by hand was an arduous effort,” says Edward Hogan, Dimensional Engineering’s director of engineering. “It could be generally expected to take up to a week. Each daily hand-measuring session could last for five or six hours.”

### Risks of Error and Danger

Accuracy, according to Hogan, has been another key concern for pipe leak repair teams. He says, “The success of the repair work, then as now, has depended almost entirely on how precisely the field engineers could collect the pipe joint’s measurements.”

From the field-collected data, the repair team would traditionally create a 2D drawing for the tooling required to produce the shell enclosure. No matter how thoroughly the leak-threatened area was measured, the dimensions gathered by hand could never truly be precise enough. “The repair team would need to extrapolate at least some of their 2D drawing’s surface data,” says Hogan. “Blind spots could creep into the results.”

Not only difficult and imprecise, the process of data collection could be dangerous too. Injuries threatened when hot water or steam escaped from the pipe. Risk could be greater with pipes carrying highly toxic materials, such as phosgene, or highly flammable materials, such as hydrogen sulfide. A small spark could even cause an explosion.

And, of course, the longer the hand measurements took to collect, the longer the field engineer was exposed to the danger, and greater were the chances for accidents to occur.

The challenges didn’t necessarily end there. Once the shell enclosure was fabricated, it had to be validated to the hand-measured data collected in the field. As Hogan notes, “If design problems were then found, it was back to the drawing board for the repair team – or even back to the piping itself for more hand measurements.”

The entire process of repairing the leak in this way – from collecting the field data and producing the 2D drawing to fabricating the shell enclosure and installing it on the pipe – typically took weeks. “Clearly,” Bonner says, “a better method was needed.”

### From a Safe Distance

Enter Dimensional Engineering, with its digitally driven method for capturing the field data needed to repair pipe leaks and validate the designs of the repair shells. “Our way is not just faster and safer – the repair team also gets more accurate data,” says Bonner. “They’re much more confident in their ability to repair the leak completely.”

Dimensional Engineering is internationally recognized for applying laser scanning and tracking technology to help solve design and production engineering problems. The company’s preferred tools for these applications include the Focus 3D laser scanner from Faro Technologies, and the PolyWorks 3D metrology software from InnovMetric Software, Inc.

“The blanket term ‘reverse engineering’ is often used to describe what we do,” says Bonner. “But that provides a limited view of our technology’s capabilities.”

“Literally millions of points of data are captured. We can document, with high accuracy, the entire envelope of the most complex pipe joint configuration.”

has been to design and fabricate outer shell enclosures to shore up the weak spots they find in the pipes. The objective: to stop leaks from actually happening, so as to prevent the plant from experiencing costly shutdowns in production.

In most cases, the repair process began with collecting the dimensions needed for

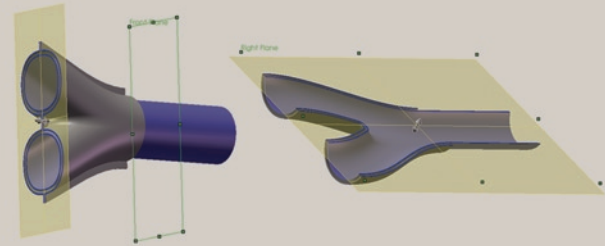
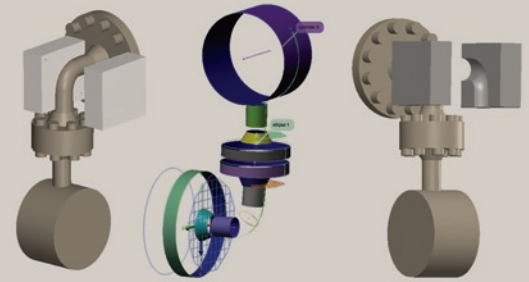


High-accuracy field machining is a Dimensional Engineering specialty. Clients also rely on the company for quality inspection, reverse engineering, beginning-to-end project traceability, root cause analysis, and design validation. Another common usage: preserving, as 3D virtual models, legacy tooling that might otherwise exist only as physical master models or 2D engineering drawings.

When repair of a leak in complex piping is the issue, Dimensional Engineering's use of laser scanning lets them capture the joint configuration's dimensions from a safe distance – on the ground, or in the case of a floating facility such as an oil rig or tanker, on the deck. Generally, scaffolding and harnesses are not required.

Per Hogan, "Literally millions of points of data are captured. We can document, with high accuracy, the entire envelope of the most complex pipe joint configuration. As a result, the repair project is completely traceable and repeatable."

What's best, says Hogan, "We can do this in just a few hours, rather than days."



"The engineering team can feel confident the shell enclosure will fit into place properly. There's much less risk of costly delays from design errors."

## Precision Is Paramount

With all necessary dimensions collected, Dimensional Engineering creates highly detailed 3D CAD geometry for the shell enclosure. The CAD software allows the team to inspect and measure sections of the pipe and the shell enclosure in any direction. This helps ensure the enclosure's precise fit with a constant distance to the pipe.

"Precision is paramount," Bonner says, "especially since the gap to be filled between the pipe and the shell enclosure will be as thin as one quarter of an inch."

When CAD data has been verified, tooling is produced, and the metal shell enclosure's halves are ground out and validated against the digital scan data collected in the field. Technicians then fit the enclosure's pieces to the pipe, bolting them at the flanges. The gap between the enclosure and the pipe is filled with a solidifying sealing agent.

Bonner uses the term "virtual build and bolt" to describe this process of certifying a critical modular component on the computer before installing it in the field. He says, "The repair team can feel confident the shell enclosure will fit into place properly, without further modifications. This can cut repair time from weeks to days. There's much less risk of costly delays from design errors."

Early application of the virtual build and bolt process – at the drilling operation in North America, along with projects at other client sites – have confirmed the efficacy of Dimensional Engineering's method. "It's faster, safer, and more effective than traditional solutions," says Bonner. "We're now working with a leading leak repair company to build our technology and expertise into their standard pipe repair process." ■

## SOLUTION AT A GLANCE

### Virtual Build and Bolt for Industrial Pipe Leak Repair

**Save time.** By replacing hand measurements with laser scanning and tracking, surface dimensions for repairing a threatened pipe leak can be safely collected in hours instead of days. Validating the designs in CAD further speeds repair.

**Cut costs.** The field engineering team can find and correct design problems before installing the repair shell. It works right the first time. This can save literally millions of dollars from build delays and interruptions in production.

**Enhance precision.** Capturing the complex joint configuration's dimensions digitally documents the entire project in a highly accurate, up-to-date, as-built 3D point cloud. The project is fully traceable and more easily repeatable.

**Improve safety.** All data is collected from a distance. There may be no need to straddle the pipe or hang from above. Since the process takes less time and limits the field engineer's exposure, there are considerably fewer chances for accidents.



## Old vs. New

### How Virtual Build and Bolt Helps Streamline the Industrial Pipe Leak Repair Process ... and Delivers Bottom-Line Advantage

Need/Task	Old Way	New Way	Benefits
<b>Data Collection</b>	<p><b>Manual:</b> Measuring by hand is a tough slog, and prone to error.</p> <p><b>Up Close and Personal:</b> The field engineer may need to straddle the pipe, or hang from scaffolding and a harness.</p>	<p><b>Digital:</b> The latest laser scanning equipment helps automate the task.</p> <p><b>From a Distance:</b> Non-contact laser scanning and tracking is the enabling technology. It makes data capture safer.</p>	<p>Measure quickly, completely, and accurately</p> <p>Reduce the risk of injury</p>
<b>Design Validation</b>	<p><b>Cross Your Fingers:</b> The repair team measures the pipe, builds and installs the enclosure ... and hopes it works properly.</p>	<p><b>Virtual Build and Bolt:</b> The repair team can fully prove out the enclosure design and validate it in CAD before installation.</p>	<p>Get it right the first time</p>
<b>Project Documentation</b>	<p><b>Binders, Loose-Leaf, and Sticky Notes:</b> Much can be lost when taking measurements and logging a repair process manually.</p>	<p><b>Start-to-Finish Traceability:</b> The entire project exists digitally in the point cloud – complete, accurate, up to date.</p>	<p>Repeat the repair, when needed, more quickly and easily</p>
<b>Process Improvement</b>	<p><b>Downtime:</b> Pipes may need to be torn down and dismantled for measurement. Repair and replacement can take multiple weeks or more.</p>	<p><b>Uptime:</b> Digital data capture – a relatively “hands-off” approach – should cause little or no disruption to normal production.</p>	<p>Minimize shut-down time and optimize production yields</p>

## Passion for Precision

Since 2005, Dimensional Engineering, Inc. has helped quality-driven engineering teams solve urgent design and production engineering problems through the application of 3D digital data capture and analysis services. The company pioneered this specialized field and continues to be recognized worldwide as its leader.

Dimensional Engineering's clients are leaders in the power and energy, process manufacturing, aerospace and aircraft, automotive, and defense industries, among others. Some include ATP Oil and Gas, Boeing, Chart Energy & Chemicals, General Dynamics, General Electric, General Motors, Hawker Beechcraft, Johnson Controls, Lockheed Martin, Maersk, Quadrant, Raytheon, Thermal Engineering International, IAC, CH2M Hill, Rolls-Royce, Triumph Group, and Webasto.



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