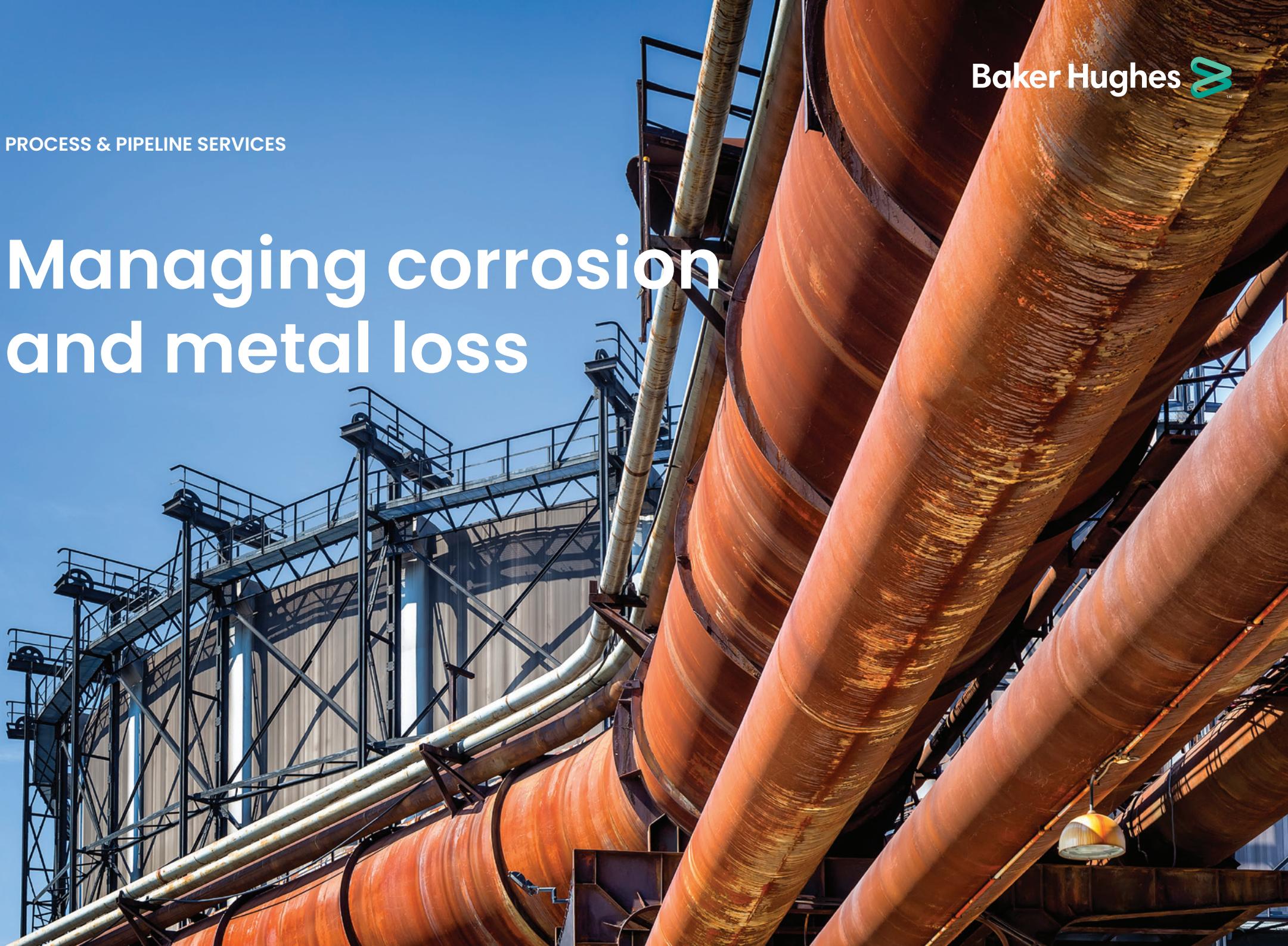


# Managing corrosion and metal loss



# Improving your asset's safety, integrity, and profitability

The safety, integrity, and operating efficiency of your assets are at the core of what we do. Our unique portfolio of services helps you confidently manage the lifecycle of your pipeline—delivering timely and stress-free startup, supporting day-to-day reliability, and enabling controlled decommissioning.

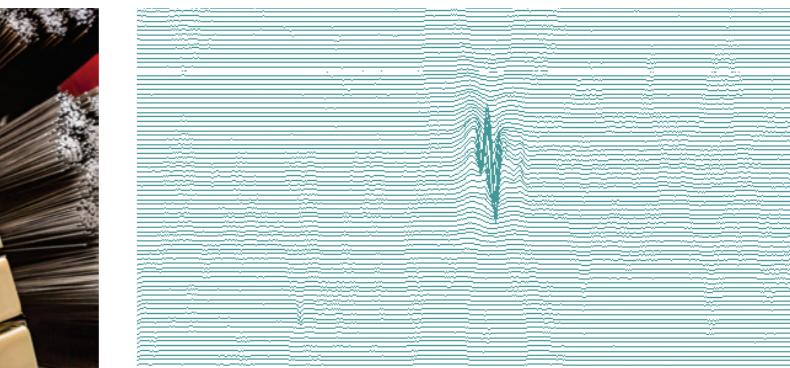
Corrosion and metal loss are the most common threats to pipeline integrity, regulatory compliance, and security of supply. Our technologies and expertise have helped pipeline operators minimize those risks—and the associated costs—for over 50 years.

By combining powerful engineering capabilities and experience with a strong service footprint, we bring peace of mind to even the most complex challenges. We'll partner with you to deliver technology, solutions, and expertise for smarter ways of working.

No matter where your pipeline may be, our goal is to help you attain safer operations, improved asset integrity, and higher profitability.



## Technology spotlight



### Heavily corroded and difficult-to-access pipelines

**VECTRA GEMINI HD, UltraScan™ WMP, and MagneScan™ SHRP** are our highest-specification in-line inspection tools. Whether caused by external microbe-induced corrosion or internal pitting, pinholes are always extremely difficult to detect. Our highest-definition tools have the capability of detecting pinhole-sized features, and seeing the most minute areas of metal loss. VECTRA HD, for example, has industry-leading sensor resolution, and yields multiple data sets in a single run—resulting in a sharper view that more accurately locates, identifies, and sizes complex anomalies such as pinholes. On top of inspection tool capabilities, we're constantly improving our algorithms and models so our analysts can more accurately quantify these difficult features. All in all, your advantages are reduced maintenance costs and less lost revenue, in exchange for increased uptime, fewer digs, and improved safety.

### Pinhole corrosion

Very small pinholes can cause major problems—leaks. Whether caused by external microbe-induced corrosion or internal pitting, pinholes are always extremely difficult to detect. Our highest-definition tools have the capability of detecting pinhole-sized features, and seeing the most minute areas of metal loss. VECTRA HD, for example, has industry-leading sensor resolution, and yields multiple data sets in a single run—resulting in a sharper view that more accurately locates, identifies, and sizes complex anomalies such as pinholes. On top of inspection tool capabilities, we're constantly improving our algorithms and models so our analysts can more accurately quantify these difficult features. All in all, your advantages are reduced maintenance costs and less lost revenue, in exchange for increased uptime, fewer digs, and improved safety.

### Pilferage and illegal tapping

When two illegal taps were discovered in a European refined-product pipeline (along with a tank holding 30,000 liters of stolen product), we quickly mobilized a MagneScan tool to assess the unknown risks. We compared the results to another MFL inspection we completed several years earlier. Within a week, we produced a highly practical Change Report that gave precise location details about new anomalies. We identified nine illegal taps along nearly 200 km of pipeline. Six months later, we ran the process again and found several new illegal taps. Not only has this helped the customer minimize its losses, but it's raised industry awareness and vigilance around this critical financial and safety issue. We now offer the Change Report with our MagneScan SHRP and Vectra Gemini HD inspection services.

# Industry-leading technologies and expertise

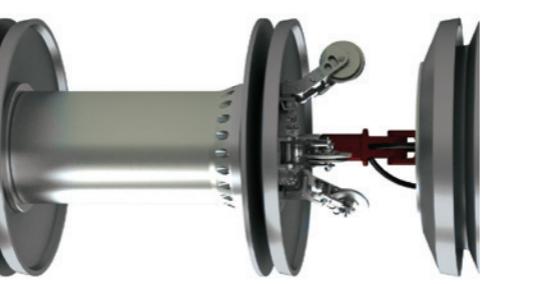
Our corrosion and metal-loss integrity solutions date back to the development of magnetic flux leakage tools in the 1960s. Now, with over 2 million km of pipeline inspected worldwide, our advanced technologies, engineering experience, and data-interpretation capabilities are all well proven in helping operators meet increasingly stringent regulatory requirements—while enhancing the safety and productivity of their assets.

From the moment a pipeline is commissioned, it begins to deteriorate. No matter which cathodic protection system or coatings are used, or what product is in the pipeline, corrosion will eventually compromise pipe wall integrity. We provide the accurate defect detection, sizing, and classification to efficiently prioritize necessary maintenance, determine growth rates, and plan future inspection. Each of our technologies offers unique advantages, so the selection decision can be closely aligned with the underlying threats and your objectives.

All our inspection services have one thing in common: they ensure that, through better accuracy performance, you save more money by repairing only what you need to repair.



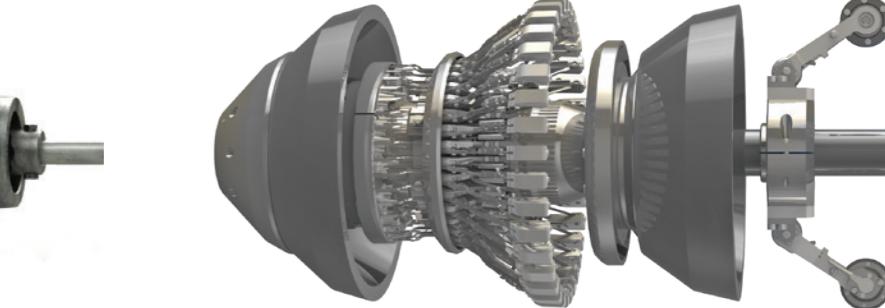
## Technology spotlight



UltraScan WMP



MagneScan HR & SHR



CPIG

### Offshore heavy-wall pipelines

Offshore pipeline inspections can be much more complicated than onshore inspections, as multiple pipes are often clustered together on the platform and subsea. Their close proximity and adjacent pipe walls can confuse some inspection tools. But that's not a problem for our MagneScan SHRP and UltraScan™ WMP technologies. For example, MagneScan identified a critical feature of around 80% wall thickness that was extremely difficult to analyze and verify because of its location at a transition between spools of different wall thicknesses, and directly behind the caisson wall. This resulted in lower than expected magnetic field levels for the known wall thickness. To be certain, we worked with the client to design highly specialized and rigorous pull-through tests to verify that the defect was indeed below the critical 85% wall thickness that would require shutdown. The tests confirmed the tool's accuracy, and the client was able to keep operating the pipeline until a replacement line was constructed with substantial cost savings.

### Baseline and routine inspection

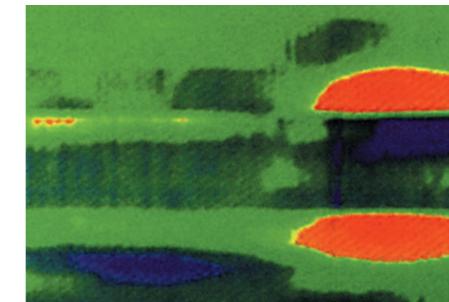
Whether an operator is looking for reliable baseline surveys or routine inspections, our MagneScan HR & SHR and CPIG fleets continue to be among the go-to solutions for most customers around the world. Both fleets provide accurate and reliable corrosion inspection, which enables the integrity management programs of most pipeline operators. Robust designs and extensive track records result in industry-leading first-run success rates; and they also have a combination of inspection options. Geometry and pipeline mapping can be added to a metal-loss inspection to simplify operations. Furthermore, the latest-generation MagneScan tools provide an additional option to increase detection and sizing specifications, which are particularly valuable for pipelines with higher incidence or complexity of corrosion.

### Difficult to inspect

CPIG is ideal for pipelines with low pressures, dual diameters, or otherwise complex geometries—running effectively in many pipelines previously considered unpiggable. Available for diameters of 4 in. to 42 in., CPIG can navigate multiple 1.5D back-to-back bends, and bore reductions up to 25%. In many cases, it eliminates the need for modifications to the pipeline, launcher, or receiver. As well as providing a high level of detection and accuracy, the tool greatly streamlines logistics and costs by combining metal-loss, caliper, and inertial data in one run. It's ideal for dual diameters across the fleet range.

HEAVILY CORRODED AND DIFFICULT-TO-ACCESS PIPELINES	PINHOLE CORROSION	PILFERAGE AND ILLEGAL TAPPING	DIFFICULT TO INSPECT	BASELINE AND ROUTINE INSPECTION	OFFSHORE HEAVY-WALL PIPELINES	GIRTH WELD CRACKING	AXIALLY ORIENTED SEAM CORROSION	HIGH FLOW RATES (UP TO 5 M/S)
CPIG For complex or unpiggable geometries	●	●	●	●	●	●	●	●
MagneScan™ HR High-resolution MFL inspection	●	●	●	●	●	●	●	●
New MagneScan™ SHR Next-generation high-resolution combination MFL	●	●	●	●	●	●	●	●
VECTRA High-accuracy MFL inspection	●	●	●	●	●	●	●	●
VECTRA HD Superior accuracy to optimize dig programs	●	●	●	●	●	●	●	●
New MagneScan™ SHR & VECTRA GEMINI High accuracy MFL inspection with caliper	●	●	●	●	●	●	●	●
New MagneScan™ SHRP & VECTRA GEMINI HD Superior accuracy to optimize dig programs	●	●	●	●	●	●	●	●
TranScan™ TFI Detect axial flaws with confidence	●	●	●	●	●	●	●	●
UltraScan™ WM High accuracy, direct wall-thickness measurement	●	●	●	●	●	●	●	●
UltraScan™ WMP Higher resolution, higher accuracy direct wall measurement	●	●	●	●	●	●	●	●

● Optimum specification   ● Good specification   ● Available   ● Consult BHGE



### Girth weld cracking

Cracks in girth and spiral welds have been causing operators concerns for a number of years; but finding a reliable inspection solution has been challenging. Advancements in our MagneScan and VECTRA technologies have led to increased confidence levels in detection and sizing of these features with MFL technology. We've gathered a large database of actual pipeline defects, alongside manufactured defects, to develop a bespoke analysis process and associated report specifically for girth and spiral welds. This is now proven to be a reliable solution for operators who know they have pipeline construction concerns, and need to better focus their integrity and maintenance budgets.



### Complete project management and execution

Our precommissioning and maintenance (P&M), and in-line inspection (ILI) teams regularly join forces to provide a single point of responsibility for complex projects. One example of a successful combined effort was for a German operator with a 22-day shutdown planned to inspect two oxygen lines. ILI in a water batch would be the easiest option, but with a high cost. We instead proposed a nitrogen batch, which was more complex—but faster and less expensive. Bringing extensive nitrogen experience to the table, we worked closely with the customer and three suppliers to manage everything from pre-engineering to ILI and N<sub>2</sub> execution, infield troubleshooting, and fast-track reporting. The team worked like a well-oiled machine, and the inspection was a huge success with high accuracy from our MagneScan SHRP tool.

### Axially oriented seam corrosion

For over 20 years, our **TranScan™** inspection fleet has been the industry go-to for detecting seam-weld defects, axial flaws, and third-party damage. TranScan's transverse field inspection (TFI) technology ensures that axial flaws (cracks and elongated metal loss) present their largest dimension to the magnetic flow, creating a strong signal from flaws that are invisible to other magnetic tools.

TranScan tools are very robust, and equally at home in gas or oil pipelines. They can inspect up to 4 m/s and have a high tolerance to dirt and wax. They have even been used to detect flaws in seam welds as narrow as 0.1 mm. TranScan has become the tool of choice among operators and regulators for the detection of hook cracks and lack-of-fusion in pre-1970 ERW gas pipe. Its sensitivity to dents, associated cracking, and metal loss also makes it ideal for the detection and classification of third-party damage.



### Corrosion management and response planning

It's industry standard to compare data from different inspections to determine corrosion growth rate, but the application of the resulting information is not well understood. By contrast, our **RunCom™** product provides a range of corrosion-growth and integrity-assessment services that support response-planning decisions. By moving away from fixed corrosion rates to instead use joint-based and cluster rates, we leverage the real power of RunCom's signal-level data analysis—this significantly increases the precision of growth-rate calculations, and improves decision-making about re-inspection intervals and repair initiatives. With excavation and repair costs typically \$100,000, RunCom's ability to avoid unnecessary digs has very clear value.



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